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# Effect of auditory feedback on lower limb weight bearing symmetry and gait parameters in patients with hemiparesis

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## Abstract

### Background and purpose

To assess the effect of auditory feedback along with the conventional methods in improving the weight bearing symmetry of lower limbs and spatial temporal gait parameters in stroke patients.

### Design

Non- randomized control trial.

### Setting

Kasturba Hospital, Manipal and S.D.M. Ayurvedic Hospital, Udyavara, Karnataka.

### Subjects

30 stroke patients (15 in experimental group and 15 in control group).

### Interventions

Conventional weight bearing exercises was given for control group while the same was supplemented with auditory feedback device called "Ped Alert" for the experimental group. Exercises were given one hour per day, five days a week for two weeks.

### Main measures

Weight bearing symmetry, spatial parameters (step and stride lengths), and temporal parameters (single and double limb support time, gait velocity, cadence, asymmetry ratio), of gait and Wisconsin Gait Scale (WGS).

### Result

Within group comparison showed significant improvement in weight bearing symmetry, unaffected single limb support duration (SLSD), cadence, asymmetry ratio and WGS for the control group and significant improvement in velocity, cadence, affected step length, unaffected step length, affected stride length, unaffected stride length, WGS and weight bearing symmetry in the experimental group.

Between groups comparison showed significant improvement in velocity (p=0.021), unaffected step length (p=0.013), unaffected stride length (p=0.048) and WGS (p=0.026).

### Conclusion

Auditory feedback training has an additional role in improving unaffected step and stride lengths and gait velocity. However it may be as effective as conventional treatment in improving other spatial and temporal parameters of gait.

### Key words

Stroke, gait, weight bearing, auditory feedback.

## Introduction

Asymmetry or uneven weight distribution in legs during standing and gait is a commonly encountered problem in patients with hemiparesis. Hemiparetic gait is characterized by slow and asymmetric steps with delayed and disrupted equilibrium reactions and reduced weight bearing of the affected limb[1]. Subjects with hemiparesis have significantly slower walking speed, stride length, and cycle duration than normal subjects[2,3]. They exhibit an asymmetrical standing posture; supporting most of their weight in the non-paretic leg[4]. Even functionally ambulant hemiparetic patients demonstrate marked limitation in capacity to shift weight. Disorders of lateral weight transfers and in particular the ability to shift weight from one foot to another predisposes patients to pain, joint damage and increased energy expenditure.

Postural disorders of hemiplegics in an antigravity position, impaired sensation, and unilateral neglect leads to decreased weight bearing on the affected side. Fear of falling further limits the functional activities of patients with hemiplegia[4]. Several researchers have found a strong correlation between various measurements of static standing and locomotor function[4]. Static standing balance is therefore, crucial for ambulatory performance[4] and, enhancing a symmetrical standing posture becomes important in rehabilitation process of people with hemiparesis[1].

Cueing is an important component of therapeutic instruction used in the rehabilitation of patients with hemiparesis[5]. The experienced therapist exercises vigilance and uses vision and touch to monitor a patient's performance throughout the session[6]. Unfortunately, close monitoring and individualized instruction is often intensive and limited to the time spent together each session[6]. Furthermore, verbal feedback is neither immediate nor continuous and correlates poorly with proprioceptive feedback[6].

The use of an external device to enhance awareness of sensory input is termed as augmented sensory feedback[5].

These devices provide constant and immediate feedback that is easily understood by patients[6]. A Cochrane review of seven randomized clinical trials indicated that feedback from a force platform resulted in improved stance symmetry after stroke but did not improve balance during active functional activities, nor did it improve overall independence[7].

Ped alert is an auditory feedback device in the form of a shoe that provides sensory information about weight bearing of lower limbs during stance and gait. It provides auditory feedback to the patients by virtue of sensor pads in its sole. These sensor pads sense the pressure by means of weight and as it reaches threshold level it gives a beep sound. In gait training, the patient wears it on the affected foot, so that whenever the patient places more than half the body weight on the affected foot, the buzzer sounds and provides information about the occurrence, duration and distribution of weight bearing.

Our study aims to find the effect of auditory feedback using Ped alert along with the conventional methods in improving the weight bearing symmetry of lower limbs and spatial temporal gait parameters in stroke patients.

## Materials and methods

Design: Non-randomized control trial.
Setting: Kasturba Hospital, Manipal University, Manipal; S.D.M. Ayurvedic Hospital, Udyavara, Karnataka.
Subjects: Thirty patients with hemiparesis were included for the study by convenience sampling. The first fifteen patients were placed in control group and the next fifteen patients were placed in experimental group according to our convenience.
Materials:
Ped Alert
Video camera (Sony ® DCR-TRV 460E) and its accessories
Adobe premiere software (version 1.5)
Ten meters walkway
Paper sheet 10 meter long
Stop watch
Ink and Inch tape

Clinical Evaluation:
Single limb support time: Is the amount of time that elapses during the period when only one extremity is on supporting surface in a gait cycle[8].
Double limb support time: Is the amount of time that a person spends with both feet on the ground during one gait cycle[8].
Stride length: Is the linear distance between two successive events that are accomplished by the *same* lower extremity during gait[7].
Step length: Is the linear distance between two successive points of contact of *opposite* extremities[5].
Cadence: Is the number of steps taken by a person in one minute[8].
Walking velocity: Is the rate of linear forward motion of the body which can be measured in meters per second[8].
Gait symmetry:[9]

$$\text{Asymmetry ratio} = \frac{\text{Single support time (unaffected)}}{\text{Single support time (affected)}}$$

Weight asymmetry (Operational definition)

$$\frac{\text{weight transmission through the affected limb}}{\text{weight transmission through the unaffected limb}}$$

Wisconsin Gait Scale (WGS): Wisconsin Gait Scale is used to evaluate the gait problems experienced by the patient with hemiplegia following stroke. This can be used to monitor the effectiveness of rehabilitation training[9]. It is a 14 item scale maximum score being 42 and minimum 13.35. The higher the score the more seriously affected gait.

## Procedure

The study protocol was reviewed and approved by the institutional research committee of Manipal College of Allied Health Sciences (MCOAHS). Prior to data collection, the purpose and procedures of the study were explained and the informed consent was obtained from the patients. Thirty patients were included in the study by convenience sampling after they met the inclusion criteria. Selected patients were divided into two groups as control and experimental based on the order of their arrival to set up. The first fifteen patients were placed in the control group and the next fifteen were placed in the experimental group.

Pretreatment assessment included weight bearing symmetry, spatial temporal parameters of gait and WGS. Weight bearing symmetry was assessed by making the patient stand with one foot each on two separate standardized weighing machines and the weight bearing load on each extremity was noted (fig.1).

Spatial and temporal parameters were analyzed by video recording of gait on a ten meter walkway along the side of the wall. A video camera was mounted on a tripod stand at 12 inches high from the ground and two meters away from the middle of walkway. The camera was adjusted in such a way that frames include up to the knee level during gait.

The video file format that was used for data recording was Windows Media Video with a frame rate of 25 per second. The patients were asked to stand at the initial point of the 10-meters walkway. Visual demonstration and verbal instructions were given to each subject before videotaping the gait in the walkway. Patients were given a practice trial in the walkway after which the recording was done. The feet were dipped into red colored dye and the subjects were asked to walk at their preferred speed and were videotaped. The footprint obtained in the walkway was used to calculate spatial parameters (fig. 2). The middle six meters was taken for the measurement of temporal and spatial parameters to avoid acceleration and deceleration effects.

**Fig. 1:**

**Fig. 2:**

The temporal parameters of gait including single limb support duration, double limb support duration, cadence, velocity and asymmetry ratio were analyzed using Adobe Premiere software (version 1.5). Patients were also scored using WGS.

After assessment, exercises were given to both the group patients. Control group patient treatment included double leg bridging and single leg bridging with the affected foot in weight bearing position, forward and lateral weight shifts in sitting position and sit to stand without upper limb support. They were also given weight shifting exercises in step and stride standing with emphasis on weight bearing to affected foot. Reaching out activities in sitting and standing, marching in place with and without hand support were also given to patients to prepare them for ambulation. The patients were given gait training during which they were instructed to walk as symmetrically as they could.

The patients in the experimental group received same treatment as that of control group accompanied along with the auditory feedback using Ped alert (fig. 3). The threshold for the Ped alert was set individually as half of the patient's body weight. The device produced a beep sound only if the patient bears the set weight on the device (which is half of his body weight), thereby it provides the patient clear idea of the desired effort needed.

Treatment was given one hour per day, five days per week for two weeks to both the groups. Following two weeks

**Table 1:** Pre and post treatment median values of temporal parameters in the conventional group (n=15).

| Temporal parameters | Pre treatment median (IQR) | Post treatment median (IQR) | P value |
|---|---|---|---|
| Affected SLSD (sec) | 0.26 (0.14) | 0.27 (0.14) | NS |
| Unaffected SLSD (sec) | 0.5 (0.13) | 0.41 (0.12) | 0.017 |
| DLSD (sec) | 0.43 (0.21) | 0.31 (0.24) | NS |
| Velocity (meters/sec) | 2.38 (1.07) | 3.22 (1.61) | NS |
| Cadence (steps/min) | 84 (11) | 90 (10) | 0.002 |
| Asymmetry ratio | 1.92 (1.41) | 1.06 (0.59) | 0.012 |

**Table 2:** Pre and post treatment median values of temporal parameters in the experimental group (n=15).

| Velocity (meters/sec) parameters | 2.38 (1.07) median (IQR) | 3.22 (1.61) median (IQR) | NS |
|---|---|---|---|
| Affected SLSD(sec) | 0.34 (0.23) | 0.48 (0.12) | NS |
| Unaffected SLSD (sec) | 0.5 (0.23) | 0.28 (0.12) | NS |
| DLSD (sec) | 0.29 (0.14) | 0.28 (0.07) | NS |
| Velocity (meters/sec) | 4.55 (1.59) | 6.21 (1.38) | 0.001 |
| Cadence (steps/min) | 100 (7.5) | 108 (11.5) | 0.002 |
| Asymmetry ratio | 1.18 (3.03) | 1 (0.62) | NS |

**Fig. 3:**

the post treatment assessment was done using the above mentioned outcome measures.

**Statistical Analysis:** Data were analyzed using SPSS statistical package (version 10.0). All comparisons were done using non parametric tests of comparisons. The significance level was kept at $p< 0.05$ was for all analyses. Wilcoxon Signed rank test was used to compare the measures within each group and Mann Whitney 'U' test was used to compare measures between the two groups.

## Results

Forty seven subjects were screened and identified as potential participants for this study. Ten patients in conventional group and seven patients in experimental group had dropped out.

## Discussion

Feedback training was intended to improve weight bearing status of the affected limb and thereby reduce the

**Table 3:** Median change scores of temporal parameters between two groups.

| Temporal parameters | Change scores conventional group | Change scores experimental group | U value | P value |
|---|---|---|---|---|
| Affected SLSD (sec) | 0.01 | 0.14 | 111.5 | NS |
| Unaffected SLSD (sec) | 0.36 | 0.23 | 80.5 | NS |
| DLSD (sec) | -0.12 | 0.01 | 93 | NS |
| Velocity (meter/sec) | 0.84 | 1.56 | 57 | 0.021 |
| Cadence (steps/min) | 6 | 8 | 100 | NS |
| Asymmetry ratio | -0.86 | -0.18 | 96 | NS |

As shown in the table 1, there was a significant change seen in unaffected side single limb duration (USD), cadence (CAD) and asymmetry ratio (AR) of the conventional group. Table 2 shows significant change in velocity and cadence in the experimental group. Table 3 shows significant difference in velocity in between group comparison.

**Table 4:** Pre and post treatment median values of spatial temporal parameters in the conventional group (n=15).

| Spatial parameters | Pre treatment median (IQR) | Post treatment median (IQR) | P value |
|---|---|---|---|
| Affected Step length (cms) | 31.3 (7.59) | 33.1 (7.6) | NS |
| Unaffected Step length (cms) | 33.16 (10.7) | 29.2 (11.5) | NS |
| Affected Stride length (cms) | 63.2 (19.15) | 62.28 (12.95) | NS |
| Unaffected stride length (cms) | 62.3 (19.8) | 63.46 (18) | NS |

**Table 5:** Pre and post treatment median values of spatial parameters in the experimental group (n=15).

| Spatial parameters | Pre treatment median (IQR) | Post treatment median (IQR) | P value |
|---|---|---|---|
| Affected Step length (cms) | 34.3 (5.43) | 40.16 (5.7) | 0.009 |
| Unaffected Step length (cms) | 39.8 (7.05) | 42.14 (6.8) | 0.001 |
| Affected Stride length (cms) | 74 (13) | 82.08 (12.4) | 0.017 |
| Unaffected Stride length (cms) | 74.16 (12.9) | 81.7 (13.35) | 0.003 |

**Table 6:** Median change scores of spatial parameters between two groups.

| Spatial parameters | Change scores conventional group | Change scores experimental group | U value | P value |
|---|---|---|---|---|
| Affected Step length (cms) | 1.8 | 5.86 | 85.5 | NS |
| Unaffected Step length (cms) | -3.96 | 2.34 | 53 | 0.013 |
| Affected Stride length (cms) | -0.92 | 8.08 | 66 | NS |
| Unaffected Stride length (cms) | 1.16 | 7.54 | 65 | 0.048 |

load on the unaffected limb. This was measured by the single limb support duration of affected and unaffected limb and the asymmetric ratio.

The results of our study indicate that single limb support duration (SLSD) had improved clinically in the experimental more than the control group. However statistical difference was not found between the two groups. The results could have been influenced by the shorter duration of treatment and the variation in the groups because of non-randomization.

The asymmetric ratio improved significantly in the control group whereas the experimental group did not show significant change. This could be explained by the variation between the two groups as the patients in the control group had lower symmetrical values which could have lead to more scope of improvement in the control group than the experimental group patients.

The double limb support duration (DLSD) reduced after treatment in both groups however the difference was not statistically significant. The reasons could be same as that for the asymmetry ratio. These results contraindicate with the earlier study which showed significant improvement in SLSD following stepping in place training. The reasons they attributed were sustained loading of lower extremity during single limb support and increased attention during stepping activity[14].

**Step and stride lengths**

The spatial parameters of gait include step length and stride length of both affected and unaffected side. The results of our study showed significant improvement of all the spatial parameters in the experimental group and between groups comparison showed significant improvement in unaffected step and stride lengths. The spatial parameters are equally important with temporal parameters that contribute to functional gait in patients with stroke. A significant positive change in any of the parameters will prove beneficial to the patient. This improvement in unaffected step and stride lengths could be attributed to the indirect effect of additional feedback training where emphasis was made on improving

**Table 9:** Median change scores of WGS and weight symmetry between two groups.

| Parameter | Change scores conventional group | Change scores experimental group | U value | P value |
|---|---|---|---|---|
| WGS | 2 | 3 | 59 | 0.026 |
| Weight symmetry | 0.25 | 0.16 | 109.5 | NS |

the symmetry of weight bearing in both the lower limb. We also extrapolate that improvement in symmetry of gait could lead to increase in spatial parameters and there by the distance walked.

**Gait velocity**

Gait velocity was the only parameter which improved significantly in the experimental group than in the conventional group. This could be attributed to the improvement in single limb stance duration of affected side and decrease of double limb stance duration during gait. The statistical significance also showed that auditory feedback has a role in improving gait velocity in patient with stroke.

This was further supported by the earlier study done by Gunes Yazuver 2006, who found significant improvement in gait velocity of stroke patients following four weeks training and attributes the effect to the improvement in single limb stance duration[11]. This is a positive outcome of the study as the velocity is the most preferred outcome for hemiparetic gait research as it is easy and reliable to measure.

**Cadence**

Cadence improved significantly in both groups statistically however between groups comparison showed statistical insignificance. This suggests that both groups were equally effective in increasing the cadence. This could also be attributed to the improvement seen in the single and double limb stance duration as well as the spatial parameters of the patients in the experimental group[12].

**Weight asymmetry**

The improvement in the weight symmetry in all the patients suggests that both conventional and auditory feedback techniques were effective in improving the lower limb weight bearing ability of patients with hemiparesis. In spite of statistical insignificance between two groups, we observed a better clinical improvement in experimental group. This could suggest that auditory feedback used in experimental group could have a better role in improving lower limb weight bearing symmetry in patients with hemiparesis. This was further supported by earlier studies which found significant change in weight symmetry in patients with balance platform and visual feedback training when compared to conventional methods.

**Wisconsin gait scale (WGS)**

The significant improvement in WGS in both groups suggests that the treatment techniques had a positive effect in improving the functional gait. The between group significance also shows that auditory feedback along with

**Table 7:** Pre and post treatment median values of WGS and weight symmetry in conventional and experimental groups.

| Parameter | Conventional group (n=15) | | | Experimental group (n=15) | | |
|---|---|---|---|---|---|---|
| | Pre treatment median (IQR) | Post treatment median (IQR) | P value | Pre treatment median (IQR) | Post treatment median (IQR) | P value |
| WGS | 22 (5) | 20 (2) | 0.001 | 20 (2) | 17 (2) | 0.002 |
| Weight symmetry | 0.51 (0.14) | 0.76 (0.23) | 0.005 | 0.64 (0.11) | 0.80 (0.11) | 0.002 |

conventional treatment could play an important role in improving functional gait.

This is in accordance with the study by Rodriquez AA in 1996 in which WGS scores significantly improved following gait training of eighteen hemiplegic subjects. Turani 2004, showed significant improvement in gait of patients using WGS and found it to be correlated to gait velocity[13]. Use of WGS is emphasized in earlier studies stating that it is useful tool to rate qualitative gait alterations of post stroke hemiplegic subjects and to assess changes overtime in rehabilitation training[13].

**Limitations of the study**

The limitations of the study were non randomization and non-stratification of the treatment groups which could have led to the variation in the base line values. These could have also led to the skewing and made the results statistically insignificant. The shorter duration and lack of follow up data could have also affected the study results. This was also supported by earlier studies which were done after a minimum period of four week duration had significant results.

## Conclusion

By our results we conclude that auditory feedback training has an additional role in improving functional gait and velocity where as it may be only as effective as conventional treatment in improving spatial temporal parameters of gait in patients with hemiparesis.

## Suggestion for future research

Future studies can be performed with randomized control trial, longer study duration and follow up.


## Acknoledgements

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# An 8 yr girl spastic diplegic presenting with oromotor spasticity in Kasturba Hospital, Manipal: A case report

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## Abstract

### Introduction

Cerebral palsy is a disorder of posture and movement that occurs secondary to damage to immature brain before, during or after birth. Pronounced secondary conditions include epilepsy, speech or communication disorders, eating problems and oromotor issues, sensory impairments, mental retardation, learning disabilities and/ or behavioural disorders.

We here present a case of spastic diplegic with oromotor spasticity and balance problems. The association of oromotor muscle spasticity and topographic classification has not been established but research quotes its occurrence with spastic tetraplegics most. Hence we found this a rare phenomenon. We would like to draw the reader's attention on physiotherapy intervention to the objective and subjective improvements in both initial complaints. Hence we emphasis the importance of adherence to a tailor made objective specific physiotherapy home programme

### Case presentation

An 8 year old girl, Asian complained of hoarseness of voice, difficulty in climbing stairs and frequent falls. She was born to a primigravida mother who under went regular antenatal instructions from obstetrician. In 8th month, diagnostic ultrasound revealed abnormal curvature of foetal spine. Natal and postnatal period was uneventful. Delayed development was reported in gross and fine motor functions and speech and language domain. Objective findings included spasticity of mastigatory muscles(Modified ashworth score 2) and PBS scores of 46/57. Moderate tightness of gastrosoleus, rectus femoris and hamstrings. After 3 months of home programme she had marked improvement in tone (ashworth score 1 +), PBS (53/57) and voice quality.

### Conclusion

1. Involvement of oromotor spasticity is an underreported entity in spastic diplegia.
2. Home programme schedule plays very important role in the management of balance, coordination and speech issues in mild spastic diplegics.

### Keywords

Spastic diplegia, oromotor spasticity, paediatric balance scale.

## Introduction

Cerebral palsy is a disorder of posture and movement that occurs secondary to damage to immature brain before, during or after birth[1]. It manifests as a multi-domain problem due to primary and secondary consequences. The important secondary conditions include seizures, epilepsy, speech or communication disorders, eating problems and oromotor issues, sensory impairments, mental retardation, learning disabilities and/ or behavioural disorders.

We here present a case of spastic diplegic with oromotor spasticity and balance problems. The association of oromotor muscle spasticity and topographic classification has not been established but research and literature quotes its occurrence with spastic tetraplegics most[2,3]. We found this an underreported phenomenon. Whether this is because of the primary brain insult or a secondary perceptual problem is difficult to comment on, but we would like to draw the reader's attention to the objective and subjective improvements in both initial complaints[4]. Hence we emphasis the importance of adherence to a tailor made objective specific physical therapy home programme.

## Case presentation

An 8 year girl, resident of Kerala presented to the pediatric unit of physiotherapy with hoarseness of voice and unclear speech since past 1 year; difficulty in climbing stairs and increased frequency of falls past 1 year.

**Prenatal history**

She was born to a primigravida mother who under went regular antenatal evaluation, received calcium and iron supplements. Mother suffered repeated urinary tract infections which were treated by antibiotics (no information on genre). She also reported of sustaining two falls during antenatal period i.e. 4th and 7th month following both she underwent obstetric evaluation and diagnostic ultrasound which showed no significant findings.In the 8th month, mother had pain in lower abdomen which was diagnosed as urinary tract infection and treated with antibiotics. This time when ultrasound was done, abnormal curvature of fetal spine was explained to mother but no active intervention offered.

Natal History: Patient was born around the expected date of delivery with immediate birth cry and 2.2 kg birth weight. She was fed within the first half an hour of life and sucked well at breast and moved all 4 limbs well.

Post Natal History: The child received complete immunization. No history of seizures/ pyrexia/abnormal posturing or kernicterus

Developmental history: Gross motor: social smile: 6 months, Head control: 9 months, Side rolling: 1 year, Sitting: 8

months, Crawling: never attained, Buttock shuffling:1 year, Standing with support: 1 and ½ year, Standing without support: 2 years, Walking with support: 2 years, Walking without support: 3 years

Fine motor skills: grasping: 1 year, Picking up objects: 3 years, Writing: 5 years, Reach out: 3 years

Language skills: vocalizations: 4 months, Babbling: 6 months, Monosyllables: 3years Phrases / sentences: 3 years

She suffered from recurrent Upper Respiratory Tract Infections resulting in chronic cough and developed change of voice which progressed to hoarseness in past 1 year. She has difficulty in swallowing liquids and prefers solid diet.

Academic performance: completed grade 2. She is slightly lagging behind when compared to her peers. She can recognize and narrate alphabets and numbers till 50 but fails to write till 100. She can speak Malayalam (Mother tongue).

**General Examination**

Patient was conscious, cooperative and playful. Cardio respiratory and anthropometric parameters were normal.

Chest: Mild kyphotic thorax with loss of lumbar lordosis and thoraco-abdominal pattern of breathing.

CNS: Well oriented with respect to time, space and person.

- **Reflexes:** All the deep tendon and superficial reflexes elicited. Exaggerated jaw and knee jerks with up going plantar reflex.
- **Cranial Nerves:** normal.
- **Sensory system:** Normal superficial, deep and cortical sensations.
- **Motor system:** Examination revealed hyper tonicity of right lower limb-hamstrings, calf, adductors and masseter and pterygoid muscles on left side Modified Ashworth's grade – 2. Muscle strength evaluation according to groups and MRC grading showed weakness of hip abductors(R3,L2), extensors (2)bilaterally; ankle dorsiflexors(R4L3) and plantar flexors(3) bilaterally and or upper(3) and lower(2) abdominal strength.

  **Balance and Coordination:** She had poor balance as expected of her age with fair dynamic balance on stable surface and unable to perform on unstable surface; limitation of single limb stance time to just 2 seconds; affected tandem walk, toe walk, heel walking, stepping on stool; Paediatric balance scale scores were 46/ 57.She also performed poorly in equilibrium and non equilibrium coordination tests.

  **Gait:** Her gait was grossly affected with reduced step length, arm swings and trunk rotations with a cautious gait with negligible toe –off phase. Romberg's sign was negative with inability to perform sharp Romberg's test. Her wee fim scores were 98/126.
- **Higher Mental functions:** She demonstrated poor praxis skills with difficulty in planning and executing complex tasks and poor involvement in bimanual activities.

Loco motor System: Full range of motion in all joints of upper limb and lower limb except for the knee and ankle. Moderate tightness on right hamstrings and rectus femoris and mild tightness of the left hamstrings and rectus femoris. Mild bilateral gastrosoleus tightness. Transitions were slow and awkward. Bilateral pes planus were noticeable.

Speech and language evaluation: Inadequate speech and language skills with reduced rate of speech was more evident .Speech was characterized by reduced vocal loudness especially during conversation. However the loudness was adequate at word level. GRBAS scale was administered. Findings indicate G=1, R=0, B=3, A=0, S=2. Maximum phonation time was reduced to 3-4 seconds and diadochokinetic rate (/puhtuhkuh/) observed to be 1-2 syllables /second. The above speech related findings attributed to poor breath support for speech. On Malayalam articulation test, no misarticulations were evident. Speech intelligibility rating revealed score of 2 (on 5 point rating scale) indicating moderate involvement. Child was able to express 6-7 word sentences with intermittent breaks in utterances. Comprehension and expression of the grammatical categories consisting of nouns, pronouns, adjectives (qualitative and quantitative), verbs, tenses, prepositions, singular / plural markers and opposites were found to be age adequate. On story telling tasks, she was able to narrate only simple stories which, highlights the language deficit.

## Impression

She was diagnosed as spastic diaplegic cerebral palsy with developmental delay and possible involvement of oromotor muscles.

**Course**

- She had 4 physical therapy sessions including assessment and home program.
- Following exercises were given to the child and parents were instructed to do it everyday.
- Coordination, strengthening, general mobility, thoracic mobility, chest expansion exercises.
- Balance training in forms of single leg standing, different types of walking viz. side walking, heel walking, toe walking etc.
- Oromotor therapy included mild massage with more emphasis on deep pressure over the mastigatory muscles.
- Postural correction.
- Speech therapy: Demonstration speech therapy was recommended. Speech therapy was aimed at improving oromotor coordination and vocal loudness. Oromotor exercise was carried out for the articulators lips, tongue, jaw and soft palate using isotonic exercises. Breath support for speech was worked out by improving MPT (Maximum phonation time) and diadochokinetic rate. Story telling tasks were also emphasized in home training.
- Patient was discharged and asked to follow up after 2 months.

**Outcome**

- On follow up complaints of voice hoarseness had reduced with marked improvement in balance with reduced frequency of falls.
- Muscle strength scores have improved in hip extensors(R3L3), abductors(3) bilateral and dorsiflexors(L4)plantarflexors(R4L5) muscles along with upper(4) abdominal strength.

- Pediatric balance scale score has increased to 53/56 with no significant changes in Wee FIM scores.
- Tone has improved (modified ashworth grade – 1 +) but the pattern remained similar.
- Speech therapy: Post therapy assessment revealed significant improvement in maximum phonation duration (5-6 seconds)and speech intelligibility (fair at conversation level). Voice assessment indicate reduced breathy component (G=1, R=0, B=2, A=0, S=1). However, no significant change observed in vocal loudness perceptually which warrants loudness training on follow up.
- Oromotor spasticity improved on subjective examination with palpation.
- The single limb stance time has improved to 16 seconds as best time in 3 attempts; balance on unstable surfaces was still affected.
- Gait has much normalized, though cautious still; the toe off phase was significantly noticeable.
- Patient was discharged again with progression of present exercises and inclusion of new activities which challenged balance like hop scotch, skipping activities etc.

## Conclusion

1. Involvement of oromotor spasticity is an underreported entity in spastic diplegia.
2. Home programme schedule plays very important role in the management of balance, coordination and speech issues in mild spastic diplegics.

Abbreviations: R-Right
L-Left

## Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

## Competing interests

The authors declare they have no competing interests.

## Authors' contributions

Neha Agarwal did the physical examination under the guidance of Mrs. Bhamini K. Rao. Neha Agarwal wrote the manuscript. The final edition was done by Mrs. Bhamini K Rao. Both authors have read and approved the final manuscript.

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# Risk factor estimation for coronary heart disease and its correlation with body composition in asymptomatic individuals

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## Introduction

Due to modernization and mechanization, cardiovascular disease (CVD) is a leading cause of morbidity and mortality[1,7]. American Heart Association states that at least 25% of coronary patients have sudden death or myocardial infarction without prior symptoms[2].

Research in the past three decades indicate that atherosclerotic process begins as early as two years of age which are influenced by genetic and modifiable risk factors to manifest as cardiovascular disease later in life. Results from Young Finn's study reaffirm the link between risk factor exposure in 12 – 18 year old adolescents and preclinical atherosclerosis in adulthood[7].

A growing body of evidence indicates that Asians are at high baseline risk for Coronary Heart Disease (CHD), as compared to American whites. However, there is limited evidence of primary prevention among Asians[1].

Therefore there is dearth of evidence regarding

- Screening young asymptomatic Indians for primary prevention.
- To find out any correlation between body composition and presence of risk factors for developing CHD in young Indians.

Thus the objectives of this study were

- To screen asymptomatic individuals between the age group of 20 – 30 years by the On-line Risk Assessment Tool (designed by Adult Treatment Panel III of National Cholesterol Education Program from data of Framingham Heart Study, 2002) for estimation of risk in developing CHD over a 10-year period.
- To correlate the risk with body composition analysis.

## Methodology

Fifty subjects were randomly selected for the study.
Study design: cross sectional study
Setting: Dept of physiotherapy, Manipal
Procedure
Fifty subjects were randomly taken for the study as per inclusion criteria and informed consent was obtained from them.

Inclusion criteria

- Asymptomatic individuals in the age group of 20-30years

Exclusion criteria

- Any individual with history of chest pain
- Congenital cardiac diseases
- Known cardiac problems

The lipid profile of all the individuals was taken after a fasting period of 12 hours. Then the Body Mass Index, Fatpercentage using hand-to-hand Bioimpedence Analyzer, Waist Hip Ratio was measured.

Risk was estimated using Risk assessment tool designed by Adult panel III from Framingham Heart Study.

Risk estimate obtained was correlated with body composition analysis.

Statistical analysis

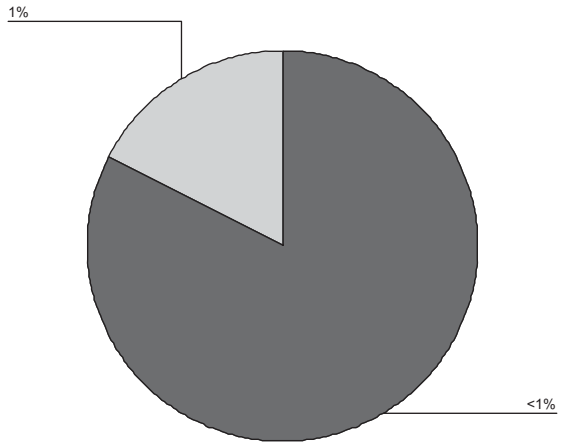
- Descriptive analysis was used for risk estimation
- Spearman's correlation coefficient was used for determining correlation between BMI, WHR and fat % with risk

## Results

**Risk and gender**

Twenty five females w
ere enrolled for the study. 88% were at <1% risk and 22% were at 1 % risk

**Fig.:** Risk for developing Coronary Heart Disease in 10-year period in females.

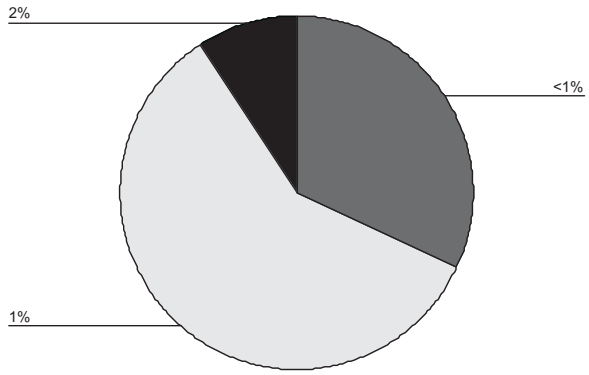



Out of the 25 males 36% were at <1% risk, were at 8% 2% risk and 56% were at a 1% risk for developing coronary heart disease in 10 years

Results were further divided into 2 groups
Group 1
Group 2
Group 1 (20 – 24years)

- 78.3 % were at <1% risk,
- 17.4% at 1%
- 4.3% were at 2 % risk

**Fig. 2:** Risk for developing coronary heart disease in 10-year period in males.




| Group | Correlation of BMI and RISK | Correlation of WHR and RISK | Correlation of FAT% and RISK |
|---|---|---|---|
| Males | 0.384 | 0.608 | 0.633 |
| Females | 0.228 | 0.384 | 0.754 |

Group 2 (25-30 years)

- 57.1% at 1 % risk
- 38.1% at <1% risk
- 4.8% at 2 % risk

**Fig.:** Risk estimate for Group 1.

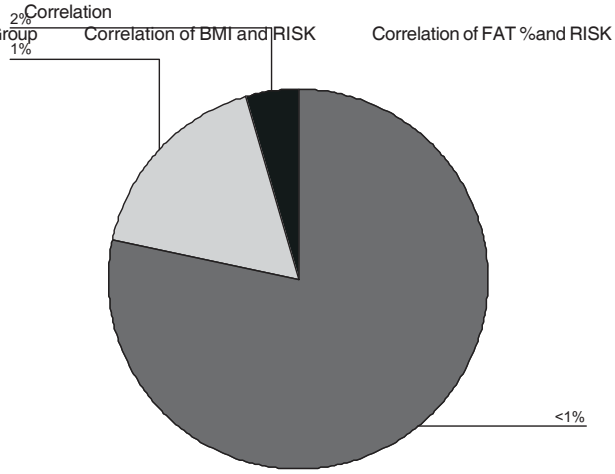
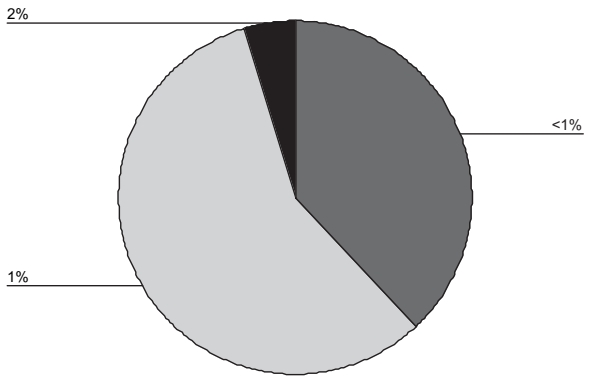



**Fig.:** Risk estimate for group 2.




Correlation

| Group | Correlation of BMI and RISK | Correlation of FAT % and RISK | Correlation of WHR and RISK |
|---|---|---|---|
| Group 1 (20 – 24 years) | 0.320 | 0.426 | 0.318 |
| Group 2 (25 – 30 years) | 0.310 | 0.416 | 0.503 |

## Discussion

According to WHO, cardiac disease accounts for the 6th major cause of mortality and morbidity in India. Data of the past three decades indicate that atherosceloritic process begin in early childhood and are influenced over the life course by genetic and potentially modifiable risk factors and environmental exposures.

In India occurrence of coronary artery disease is reported. According to American Heart Association (AHA) atleast, 25% of coronary patients have sudden death or non fatal myocardial infarction without prior symptoms. Therefore, screening asymptomatic individuals is a prime requisite in primary prevention of Coronary Heart Disease (CHD).

**Coronary Heart Disease and Gender difference**

This study evaluated 50 asymptomatic subjects (25 male and 25 female) between 20 – 30 years of age and risk for developing CHD over 10 year period.

Out of 25 females, 22% had a 1% risk for developing Coronary Heart disease in a 10 year period, 88% were at <1% risk. Out of the 25 males 36% had <1% risk, 8% were at 2% risk and 56% were at a 1% risk for developing coronary heart disease in 10 years.

This gender difference is due to the cardio protective nature of the female sex hormone, estrogen that increases the HDL values.

Secondly in Indian society smoking among females is less reported as compared to males. Out of 25 males 17 were smokers and hence were at higher risk as compared to females.

The risk obtained was correlated with Body Mass Index (BMI), Waist Hip Ratio (WHR) and fat % by bioimpedence analyzer (BIA).

Both males and females showed moderate correlation with Fat %( 0.633 and 0.754 respectively). This proves that the increased fat mass poses a risk for developing coronary heart disease. When BMI was compared with risk it showed a weak correlation in both the sexes. This finding is consistent with results of epidemiological studies that state BMI as a poor indicator of body composition as compared to fat % measured by BIA.

WHR showed a weak correlation in females (r=0.384) as compared to males (r=0.608).This can be due to the difference in pattern of body fat deposition in males and females. Females have a gynoid type of obesity whereas male have an android pattern.

The subjects were further divided into 2 groups. Group 1 that included subjects between in the age group of 20–24 and group 2 included subjects in the age group 25-30.

Coronary heart disease and age difference.

Group 1 (20 – 24years) 78.3 % were at <1% risk, 17.4% at 1% and 4.3% were at 2 % risk.

Group 2 (25-30 years) 57.1% were at 1 % risk, 38.1% were at <1% risk and 4.8% were at 2 % risk.

This difference is due to the age and heterogeneity of

the population in the groups. Group 1 had more females as compared to males when the results were divided according to age.

Both the groups showed moderate correlation of risk with fat % measured by BIA (r=0.438 and r=0.416).

WHR showed weak correlation in group 1 as compared to group 2(r=0.318 and r=.503 respectively). This difference is due to heterogeneity of the population as we have already got weak correlation of WHR in females.

## Conclusion

- Correlation of BMI and risk was low in both the groups (r=0.320 r=0.310) which is consistent with the results of epidemiological studies which state BMI as a poor indicator of body composition Asymptomatic younger age group people are at a low risk of developing Coronary heart disease.
- Fat % was found to correlate best with the risk and hence can be used as a non invasive tool for screening asymptomatic individuals.

**Clinical importance of the study**

This study found that asymptomatic younger age group people were at a low risk of developing Coronary heart disease.

Fat % was found out to correlate best with the risk and hence can be used as a non invasive tool for screening asymptomatic individuals and hence, can be used as a screening tool for primary prevention.

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# Comparative efficacy of low metal glucosamine sulphate iontophoresis in the management of lumbar spondylosis

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## Abstract

Low back pain is a major problem worldwide and the annual prevalence and incidence is on the increase. Lumbar spondylosis remains a major cause of a decrease in functional capacities of clients and because of debilitating effect associated with it there is still need to further enhance penetration of drugs through other means such as iontophoresis. Crystalline glucosamine sulphate metal salts either sodium or potassium was recently observed to have significant effect on reducing pain but there is still limited data on it.

The primary aim was to compare the relative efficacy of low metal glucosamine salt iontophoresis, glucosamine cream iontophoresis and methylsalicylate+ ointment (Neurogesic) in the management of lumbar spondylosis. This study involved 30 participants from the out patient, Physiotherapy department of O.A.U.T.H.C, Ile – Ife.

The subjects were randomly assigned into three (3) treatment groups namely the Glucosamine sulphate cream, Glucosamine sulphate with low metal and methylsalicylate group. An equivalent of 3ml of each drug was applied through iontophoresis for 15minutes three times per week for 4weeks. The data was analysed using descriptive statistic and 2-way ANOVA to compare the pain level of the three (3) groups, and paired t-test (dependent) was used to compare the Pre and Post treatment pain level at the first treatment session. The result of the study showed that Group 2 participants who had iontophoretic application of the compounded glucose salt with low potassium had greater significant reduction in the pain after 4 weeks of glucosamine Iontophoresis compared other groups. ($F=35.49$, $P<0.000$). Also, the study showed that the iontophoretic application of all the drugs had significant acute effect in reducing pain in a single session immediately after treatment.

## Introduction

Low back pain is the most common symptom of lumbar spondylosis and is a consequence of habitual wrong posture, chronic strain, weakened back muscles and stress tension fatigue syndrome[1]. It is one of the most commonly treated disorders in out-patients' Physiotherapy Clinics worldwide[2] and has been found to have a significant impact on functional ability thereby restricting occupational activities with marked socioeconomic repercussion[3].

Low back pain (LBP) is a major problem worldwide[4]. The lifetime prevalence of low back pain is estimated to 60-85%, while the annual prevalence in the general population is ranging from 15-45%[5]. The annual incidence of LBP in the general population is estimated between 10-15%[6]. Disability has been shown to correlate with performance tasks and clinically relevant improvements in pain may lead to almost unnoticeable change in disability[7].

Management of osteoarthritis aims at controlling pain, maintaining and improving the range motion and limiting functional impairment. Glucosamine is one of the drugs being canvassed to be a possible solution for arthritis. Glucosamine sulphate is a derivative of glycosaminoglycans found in articular cartilage[8]. Glucosamine is found naturally in the human body and it is also found in the exoskeleton of crabs, lobsters, and shrimps (chitin). It works in a much different way than Non-steroidal anti-inflammatory drugs (NSAIDs) because it is natural.

The evidence that glucosamine can modify the structure of joints is still early and inconclusive. Some clinical trials have shown that glucosamine may help to prevent or slow down the loss of your cartilage rather than re-grow it[9].

Deep-heating rubs applied to the skin can relieve back pain by increasing blood flow to the area. Methylsalicylate ointment is one of the topical analgesics commonly used. Most topical analgesics and anti-inflammatory drugs are applied through massage. There are still challenges on increasing permeability and deliverance across the skin. The use of iontohoresis generally in the clinical setting is becoming an alternative to oral and injection delivery system of drugs, although only a few studies have investigated its effectiveness in pain management of lumbar spondylosis[10]. Glucosamine sulphate iontophoresis is a means by which glucosamine sulphate is passed transdermally to underlying tissues through the use of an electric stimulator. It stimulates cartilages cells and synthesizes glucosaminoglycans and proteoglycans – chemicals that help to repair and rebuild worn out joints[11]. These ingredients also permit cartilage to flex and absorb physical shock while at the same time suppressing destructive chondrocytes from breaking down cartilage.

Currently, there is no cure for osteoarthritis and it is usually managed by a combination of treatment[13]. Lumbar spondylosis remains a major cause of a decrease in functional capacities of clients. It is pertinent to discover an efficient and precise solution to this ailment rather than depending on anti – inflammatory non – steroid based drugs that have been observed to have adverse side effect. The problem with such medicine is that, in the long term, they may only harm the body and reduce its immunity[14]. There are increasing numbers of clients with this condition who are inhibited from normal functioning because of pain and reduced spinal range of motion. In view of this, there needs to further explore treatment techniques.

Furthermore, it seems that most previous studies focus on degenerative changes at the peripheral joints. It appears there is dearth of adequate information on the use of topical

glucosamine sulphate in the management of lumbar spondylosis. There is the need to further enhance penetration of drugs through other means such as iontophoresis.

Recently, crystalline glucosamine sulphate metal salts (with low metal content) either sodium or potassium were recently observed to have significant effect on reducing pain but there is still limited data to ascertain this claim.

The primary aim was to compare the relative efficacy of low metal glucosamine salt iontophoresis, glucosamine cream iontophoresis and methylsalicylate ointment (Neurogesic) in the management of lumbar spondylosis. Another objectives was to determine the acute effect of glucosamine cream, glucosamine gel and methylsalicylate ointment iontophoresis.

## Materials and methodology

This study involved 30 participants from the out patient, Physiotherapy department of O.A.U.T.H.C, Ile – Ife. The participants were radiographically confirmed to have lumbar spondylosis with degenerative changes at L1-S2. Subjects excluded from the study were those with: Acute inflammation, Tumors, Pregnant women, Cardiac pacemaker and metallic implant. Also, patients with impaired sensation, cancer, peripheral vascular disease and seizure disorders were excluded from the study.

## Instrumentation

- A Numerical Pain rating scale was used to assess the level of pain.
- A Bathroom scale was used to measure the weights of the participants.
- A Stadiometer was used to measure the height of the participants.
- An Electrical Stimulator (Medi-link model 70A, serial no 99160) was used along with its electrodes to drive in the drugs into the patient's back.
- Compounded glucosamine sulphate gel (paste) containing potassium

## Preparation of Glucosamine Sulphate gel

A 300g gel containing 8% of Glucosamine sulphate with low potassium was prepared by triturating the powder of low potassium glucosamine Sulphate with 30g of methylcellulose and 7.5g of absolute ethanol was added to the powdered mixture and triturated together. Then 0.45g and 0.15g of methyl paraben and propyl paraben respectively were added. The powered mixture was made up to 300g with deionized water.

The resulting glucosamine sulphate gel was secured in an amber colored bottle with a screw cap and kept in a refrigerator ($8^0$C) for 48hrs to allow for complete hydration of the methylcellulose before use.

- A stimulation tray consisting of a) A bottle containing 70% alcohol to clean the surface to be stimulated, b) Cotton wool, a bowl of water and Bandage which served as lint used for covering the electrodes of the stimulator during Iontophoresis and a spatula to help quantify amount of gel used.
- Urah Transdermal Glucosamine Cream (glucosamine sulphate 8% w/w).
- Neurogesic greaseless ointment (Methylsalicylate 15% and menthol 5%).

## Procedure

The ages, weight, height and sex of each subject was taken and recorded. Participants were involved in this study subsequent to their informed consent. Thirty (30) participants with confirmed lumbar spondylosis referred for physiotherapy were recruited for this study. They were within the ages of 38 and 71 and there were 20 females and 10 male participants. Subjects were randomly assigned into three (3) treatment groups in order of how they arrived with ten (10) participants in each group.

Participants were positioned lying prone on a plinth. The lumbar region of all the participants was cleaned with 70% alcohol to minimize risks of burns. Glucosamine sulphate cream (an equivalent of an equivalent of 3ml) was placed on the active electrode (+ve electrode), as glucosamine being the active electrode is positively charged[15]. It was placed on the first lumbar vertebra, while the indifferent electrode (-ve electrode) was placed on the second sacral vertebra. The electrodes were placed in wet pad and were strapped round the patient using adhesive straps. The electric stimulator was switched to direct current and the intensity was gradually increased and maintained at the patient's pain threshold for 15minutes. All treatment groups received baseline treatment of soft tissue massage and back extension exercises of 10 repetitions.

The second group was subjected to treatment using iontophoretic application of an equivalent of 3ml of glucosamine salt (compounded gel) and was transdermally massaged after treatment till the whole cream disappeared. The third treatment group that was the control group received iontophoretic application also using an equivalent of 3ml of methylsalicylate. All groups received back exercises and soft tissue massage.

The above procedure was carried out for three days weekly for four weeks. A progressive assessment of the main clinical outcomes (i.e. pain) was recorded before treatment and after and at the end of each treatment day.

## Data analysis

A descriptive analysis was used to determine the mean, and standard deviation of the ages, height and weights of the subject. An inferential statistic, 2-way ANOVA was used to compare the pain level of the three (3) groups, and paired t-test (dependent) was used to compare the Pre and Post treatment pain level at the first treatment session to determine the acute effect of iontophoretic application of glucosamine cream, glucosamine salt and methylsalicylate ointment.

## Results

The mean age, weight and height of the experimental group glucosamine cream (Urah) was found to be 58.80years±11.50, 62.20kg±2.05, and 1.61m±0.046 respectively while that of the glucosamine salt (compounded gel) group was found to be 59.00yrs±6.56, 61.60kg±6.79 and 1.65m±0.037. Also in the Methylsalicylate (Neurogesic) group, the mean age, weight and height was found to be 58.60±6.0yrs, 62.00yrs±2.92 and 1.58±0.065 respectively,

**Table 1:** Physical Characteristics of subjects: Mean Age, Height and Weight.

| Variables | Groups | Mean | S.D |
|---|---|---|---|
| Age (year) | 1 | 58.80 | 11.50 |
| | 2 | 59.00 | 6.56 |
| | 3 | 58.60 | 4.67 |
| Weight (kg) | 1 | 62.20 | 2.05 |
| | 2 | 61.60 | 6.79 |
| | 3 | 62.00 | 2.92 |
| Height (m) | 1 | 1.61 | 0.046 |
| | 2 | 1.65 | 0.037 |
| | 3 | 1.58 | 0.065 |

The result of the 2-way ANOVA showed that there was significant reduction in the pain level between the groups (F=35.49, P<0.000), within the groups (F=12.59, P<0.000) and combined linearly (F=127.06, P<0.000), (Table 3). The result of the Post Hoc analysis comparing the post pain levels across the three groups i.e.( glucosamine cream, glucosamine gel and methylsalicylate ointment groups,) showed that there was significant reduction in post pain in all groups (p<0.00).

**Table 2:** Comparisons of the pain levels on vas before and immediately after the first treatment session.

| | Mean | S.D | t | p |
|---|---|---|---|---|
| Group I (glucosamine cream) | | | | |
| Initial pain level | 6.40 | 1.34 | | |
| Final pain level | 3.80 | 0.84 | 10.61 | 0.000 |
| Group II (glucosamine salt) | | | | |
| Initial pain level | 7.60 | 2.07 | | |
| Final pain level | 2.80 | 0.84 | 6.00 | 0.004 |
| Group III (methylsalicylate) | | | | |
| Initial pain level | 5.80 | 0.84 | | |
| Final pain level | 3.60 | 0.55 | 4.49 | 0.01 |

(Table 1). The result of the study showed that the 3 groups were comparable in anthropometric parameters.

The result of the study showed that for glucosamine cream group that there was reduction in the initial pain level before treatment on Visual Analogue scale of 10 (VAS) from 6.40±1.34 to 3.8±0.84 immediately after the first treatment session. Also for the glucosamine salt (compounded gel) group, there was reduction in the initial pain level on VAS from 7.60±2.07 to 2.80±0.84. There was also reduction in the initial pain level on VAS from, 5.8±0.84 to 3.6±0.55 after the fist treatment session in the Methylsalicylate group (Table 2).

The result of the paired t-test showed that immediately after the iontophoretic application of glucosamine cream (Urah), there was highly significant reduction in the pain level (P<0.000). Also there was significant reduction in pain level (P<0.004) for the glucosamine salt (compounded gel). Similarly, there was significant reduction in pain level (P<0.01) in the Methylsalicylate group.

## Discussion

Topical application of glucosamine sulphate and chondroitin sulphate may be effective in reducing pain form knee osteoarthritis[16] Iontophoresis may likely enhance the permissibility through skin. Iontophoresis is a non-invasive method of propelling high concentrations of a charged substances, normally medication or bioactive-agents, transdemally by repulsive electromotive force using a small electric charge. It works on a principle of repulsive electromotive forces, which like charges repel each other and unlike charges attract each other. It is becoming popular as an alternative to oral and injection delivery system of NSAID because it is non-invasive, non-traumatic, and painless and it is specific in delivery[10]. Iontophoresis of ionized drugs provide 20-60 folds increase in penetration over tropical application, also, use of iontophoresis as local anesthesia, and for corticosteroid therapy for non-specific

**Table 3:** Comparison of pain levels between the glucosamine cream, glucosamine salts and methylsalicylate ointment.

| | Mean | S.D | F (within) | P | F (between) | P | F (linear) | P |
|---|---|---|---|---|---|---|---|---|
| Group I | | | | | | | | |
| Initial treatment | 6.40 | 1.30 | | | | | | |
| Final treatment | 1.20 | 0.84 | | | | | | |
| Group II | | | | | | | | |
| Initial treatment | 7.60 | 2.07 | | | | | | |
| Final treatment | 0.40 | 0.00 | | | | | | |
| Group III | | | | | | | | |
| Initial treatment | 5.80 | 0.84 | | | | | | |
| Final treatment | 1.20 | 0.84 | 12.59 | 0.00 | 35.49 | 0.00 | 127.06 | 0.00 |

Group I (glucosamine cream)
Group II (glucosamine salt)
Group III (methylsalicylate)

**Table 4:** Post hoc result for post pain levels across groups.

| I (Group) | J (Group) | I-J | p-value |
|---|---|---|---|
| Initial Pre-Urah | Final Post-Urah | 5.20 | 0.00 |
| | Final Post-Neuro | 5.20 | 0.00 |
| | Final Post-Gel | 6.00 | 0.00 |
| Initial Pre-gel | Final Post-Urah | 6.40 | 0.00 |
| | Final Post-Neuro | 6.40 | 0.00 |
| | Final Post-Gel | 7.20 | 0.00 |
| Initial Pre-Neuro | Final Post-Urah | 4.60 | 0.00 |
| | Final Post-Neuro | 4.60 | 0.00 |
| | Final Post-Gel | 5.40 | 0.00 |

inflammatory lesion is documented[17]. This study was designed primarily to compare the relative efficacy of glucosamine Iontophoresis in subject with lumbar spondylosis.

The result of his study showed that there were significant reductions in the pain experienced by participants in the three (3) groups. The result of this study showed that Group 2 participants who had iontophoretic application of the compounded glucose salt with low potassium had the greater significant reduction in their pains after 2 4 weeks of glucosamine Iontophoresis compared other groups. Although, the result showed that participants in the glucosamine Cream and Neurogesic group also had significant reduction in their pains after four (4) weeks.

Recent studies on glucosamine therapy showed that glucosamine can alert chondrocyte metabolism and this is the rationale usually given for its use in osteoarthritis[18]. This study further supported the efficacy of iontophoretic application of topical mediation. Anderson et al[19] reported that dexamethasone was also facilitated through Iontophoresis and that there was drug penetration into local tissues. Similarly, panus et al[20] reported that Iontophoresis enhances nonsteroselective ketoprofen permeation into the fascia-muscle interface, with delivery to deeper tissue sites; however there was no apparent enhancement over passive application. Sorinola and Ogunfuwa[10] also reported that iontophoresis of piroxicam also cause reduction in pain level in their previous study. This study also supported that of Onigbinde et al[21] who reported that glucosamine application via iontophoresis was more effective in pain reduction in knee osteoarthritic subjects than application through transdermal message.

The results also showed that there was significant reduction in pain experienced by participants after the first treatment session in all treatment groups. This showed that iontophoretic application of methylsacliclylate (Neurogesic ointment) also have significant acute effect to relief pain.

The outcomes of this study suggested that Iontophoresis using glucosamine cream, glucosamine salt and methylsaliclylate ointment were all effective in reducing pain

in subjects with lumbar spondylosis but glucosamine salt with low potassium content appeared to be the most effective in pain reduction compared to other groups.

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# Efficacy of modified hand function activities in rehabilitation of stroke patients

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## Abstract

### Aim

The aim of the study is to find out the efficiency of modified hand function activities in stroke patients.

### Need of the study

The need of the study is to make the patient independent to the maximum with the training of task – oriented activities.

### Objectives of the study

1. To evaluate the voluntary activity by Jebsen – Taylar Hand function test.
2. To evaluate the disability of hand by motor assessment scale.

### Research hypothesis

The modified hand function activities along with conventional physiotherapy may improve the hand function in hemiplegia.

### Methodology

Subjects are randomly divided into two groups control and experimental group and written informed consent was provided before participation. Control group undergone conventional physiotherapy and instruction regarding hand functional activities. The experimental group has undergone conventional physiotherapy and hand functional activities.

### Results

Data analysis of my study is done by using SPSS software systems for windows and level of significance set at <5%. Wilcoxon rank signed test and paired t-test is used for evaluation of MAS & Jebson Hand function test. Results of my study showed statistical difference between two groups regarding motor assessment scale & Hand functions.

## Introduction

Stroke is on acute onset of neurological dysfunction due to an abnormality in cerebral circulation with resultant signs and symptoms that correspond to involvement of focal areas of the brain[15]. The cerebrovascular accident or stroke is accompanied by either ischemic or hemorrhagic cerebrovascular lesions.

Clinically a variety of deficits are possible including changes in the level of consciousness, and impairments of sensory, motor, cognitive, perceptual and language functions. And the stroke is the third leading cause of death and its management includes medical surgical and physiotherapy interventions.

An annual incidence of stroke is 0.2 to 0.25 per 1000 population. CVA is an important health problem world wide[14].

In India, annual incidence of stroke is 33 per 100,000 and mortality rate 73 per 100,000[13]. The majority of individuals who survive a stroke have minimal to moderate neurological deficits and 50% of them are expected to live more than 5 years[4]. Approximately 70% of 80% of people who sustain a stroke have upper – extremity impairment. The increasing number of persons surviving with stroke are left with impairment of hand and foot, which ultimately decreases the functional status and quality of life. Hemiplegics with hand paralysis due to cerebral vascular accidents (CVA) or other neurological impairments lost the ability to grasp objects for activities of daily life, such as eating, drinking, writing, brushing teeth, etc.,

They are unable to perform these activities independently, and it may also increase the loading to their families both economically and mentally. Following a stroke patients often undergo rehabilitation to regain the functional lost due to stroke[4].

The unique contribution of physiotherapy to the rehabilitation of individuals following stroke is the training of motor control based on a contemporary understanding of impairment and secondary adaptations, biomechanics, motor learning, exercise science and factors that influence brain reorganization after injury. Physiotherapy consists of traditional exercise programmes and neurophysiologic approaches.

Traditional exercises consist of passive range of motion exercises and active joint by joint exercises and these exercises prevent complications of immobilization and improve ADL Skills at the earliest. Neurophysiological approaches are based on neurophysiological principles of motor control and recovery and various neurophysiological approaches include proprioceptive neuromuscular technique (PNF), Bobath's neurodevelopmental approach, Brunstorm's technique and Road's approach.

It has been noted that soon after stroke the excitability of the motor cortex is decreased and cortical representations are reduced.

A series of studies of squirrel monkeys that modeled the effect of focal ischemic infarct within the hand motor area of the cortex, found that there was further loss of hand representation in the area adjacent to the lesion when monkeys had no post infarct intervention (nudo and Milliken 1996)[16].

This suggested that further tissue loss could have been due to non-use of the hand and this was confirmed by a follow-up study which showed that not only could tissue loss be prevented when the unimpaired hand was restrained and the monkeys had daily repetitive training in skilled use of the impaired hand, but there was also a net gain of approximately 10% in the total hand area adjacent to the lesion (Nudo et al. 1996).

Some of these type of the studies suggest that retention of the spared hand area and recovery of function after cortical injury might depend upon repetitive training and skilled use of the hand (Nudo and Friel 1999). The recovery of function occurring early following stroke reflects reparative processes in the peri-infarct zone adjacent to the injury.

These include the resolution of local factors such as edema, absorption of necrotic tissue debris and the opening of collateral channels for circulation to the lessoned area. It is thought that this takes place over a relatively short period, perhaps 3-4 weeks (Lee and Van Donkelaar 1995).

The major objective of physiotherapy is the optimization of motor performance in functional actions.We move our arms in order to place our hand at the appropriate place for manipulation in the working environment and totransport objects from one place to another. The muscle forces produced and the timing and sequencing of joint movements involved in a specific action are a function of the task being performed, the object, the individuals position relative to the object and the constraints of the environment.

Most important aspect in functional training is to optimize motor control by learning. Training is designed to help the patient regain the ability to harness the degress of freedom available so the limb functions as a coordinated unit in functional actions with many different goals. And skilled motor actions are characterized by patterns of segmental movement which best address the spatiotemporal demands of the action. The concept of simplification also enables the development of exercises the effects of which are likely to transfer to improved performance of a number of different tasks.And the somatosensory input is required for accurate motor control and for the acquisition of motor skills[10]. Many of the stroke patients do not regain functional use of the paretic arm.

Several randomised controlled trials have demonstrated that structured exercise programs improves functional ability in chronic stroke survivors (Dean et all 2000, Duncan et al 1998, potempa et al 1995, Teixeira – Salmela et al 1999)[5]. A pilot study by Pang MY.et al (2006) employed a community based exercise program for 19 weeks. This study shows that the community – based group upper – extremity program is feasible and is beneficial for improving upper – extremely function. A study by Hide M.Feys et al "effect of a therapeutic Intervention for the hemiplegic upper limb in acute phase after stroke (1998) shows adding a specific intervention during the acute phase after stroke improved motor recovery, which was apparent 1 year later. These results emphasize the potential beneficial effect of therapeutic interventions for the arm.

## Methodology

Subjects are randomly divided into two groups control and experimental group and written informed consent was provided before participation. Control group undergone traditional physiotherapy and instruction regarding hand functional activities. The experimental group has undergone traditional physiotherapy and hand functional activities.

**Study design:** Experimental study

**Study setup:** SVIMS Hospital

**Sample Size:** 12

**Materials:**

- Steel cans (453g)
- Glass 0.333 lits
- Zip Lock bag 170 mm x 200 mm
- Carom board coins (1-1/4 inch)
- 3 x 5 inches cards
- Cylinder ½ inch x 4 inch
- Glass marbles same size 10 in number
- Stop watch

**Inclusion criteria:** Had a single stroke

- Post stroke duration more than 3weeks.
- Dominant side affected patients
- Age : 25 – 69 years
- Sex : Male & Female.

**Exclusive criteria**

- Had other neurological conditions in addition to stroke
- Recurrent stroke
- Non dominant side affected patients
- Any other orthopedic problems

**Procedure**

- Both experimental and control groups participated in physiotherapy treatment one hour a day six days / week for 4 weeks.
- The experimental group treatment focused on modified hand function activities and conventional physiotherapy.
- Modified hand functions activities are listed below:
  - (i) Turning over 3 x 5 inch cards
  - (ii) Picking up small glass marbles and placing them in a container
  - (iii) Stacking checkers
  - (iv) Moving empty large can
  - (v) Moving weighted large can
  - (vi) Lifting Glass of water
  - (vii) Opening & Fastening Zip
  - (viii) Grasp Contact (Cylinder)
  - (ix) Conventionalphysiotherapy

Frequency and duration of modified hand function exercises are 10 repetitions / day,6 sessions / week,Total 4 weeks.

Control group treatment focused on conventional physiotherapy and instructions regarding hand function activities.

## Outcome measures

1) **Motor assessment scale (MAS):** was developed by carr and shepherd to measure impairments and disability on a six – point ordinal scale.
   - It includes eight items of motor function, including movement transitions (supine to sidelying, supine to sit, sit to stand), balanced sitting, walking, upper arm function, hand movements and advanced hand function.
   - In these study we consider outcome measure only upper arm function and hand movements, because we evaluate only hand functional activities only.

**Jebsen Test of Hand Function**

- Upper extremity function was evaluated with the Jebsen Test of Hand Function.
- Jebsen is a standardized assessment of the time it takes to perform hand activities.
- Six of the 7 JTHFT subtests were included in this study turning over cards, picking up small objects and placing them in a container, stacking checkers, eating (stimulated), moving empty large can and moving weighted large cans.
- Patients were instructed to perform the tasks and record the total time take for each activity and sum of the total time is recorded.
- Some of the patients were unable to perform the writing tasks due to dominant hemisphere stroke, we excluded this particular subtest from the study.

## Data analysis

Mean Value of Motor Assessment Scale and Jebsen Taylor Hand Function Test Pre and Posttherapy.

**Control Group**

| Outcome measures | Pretherapy | Posttherapy | P-Value |
|---|---|---|---|
| Mean | Mean | | |
| Motor assessment scale | 1 | 1.8 | 0.045 |
| Jebsen Test of Hand Function | 35 | 22.6 | 0.04 |

**Experimental Group**

| Outcome measures | Pretherapy | Posttherapy | P-Value |
|---|---|---|---|
| | Mean | Mean | |
| Motor assessment scale | 1 | 3 | 0.03 |
| Jebsen Test of Hand Function | 37.2 | 9.6 | 0.006 |

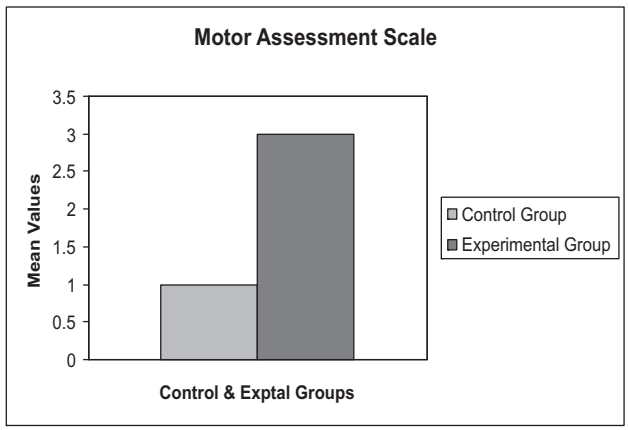
Data analysis of my study is done by using SPSS software systems for windows and level of significance set at <5%. Wilcoxon rank signed test and paired t-test is used for evoluation of MAS & Jebson Hand function test.

**Fig.1:** Materials used in the experiment.

## Results

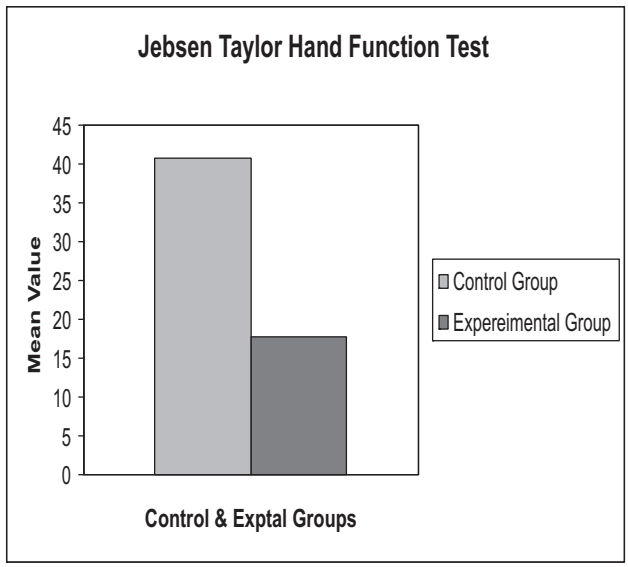
Results of my study showed statistical difference between two groups regarding motor assessment scale & Hand functions.

**Mean Values of Motor Assessment Scale of Control and Experimental Groups**




The above bar diagrams showed there is a statistically significant difference between two groups & it shows decreased hand impairment in the experimental group. (Mean ± SD: 3±1.58; P<0.03).

**Mean Values of Hand function activities of control and experimental Groups**




The above graph shows that there is statistically significant improvement in voluntary activity of experimental group. (Mean ± SD: 9.6±3.78; P<0.006)

## Discussion

The findings from a number of longitudinal studies show that, irrespective of the type and the amount of therapy, logistic pattern of recovery after stroke is determined by certain unknown underlying biological processes.The observed improvements especially in the first weeks of post stroke, most likely to reflect the restitution of non infareted of diaschisis and recovery of neurotransmission in spared tissue near and remote from the infarct.

Luria suggest that an essential condition of reorganisation is that a particular activity practiced be necessary and he states that the greater the need, the more

automatically and easily will reorganisation be carried out.And the early practice of relevant motor tasks takes advantage of the brain's plasticity, so it is also possible that lack of relevant practice can allow secondary neuronal atrophy to occur or inappropriate neuronal synapses to be made. Carr and Shepherd suggests that patients on his specific programme of motor learning, which should commence within the first few days following stroke, make a more impressive recovery of function with less reflex hyperactivity than patients receiving more traditional physiotherapy.

In this study, the subjects from experimental group made functional recovery during the intervention period. This may be due to the emphasis of very early task – oriented training.The effects of the intervention were measured using Jebsen Taylor hand function test and Motor assessment scale, which showed significant improvements in the hand function.

Some of the previous studies support that adding a specific intervention during the phase after stroke improved motor recovery (Hidden M.et al 1998). Blennerhassett J and Dite (W) (2004 / on his study concluded that additional task – related circuit training improves the upper limb function as well as mobility of the patient.

## Limitations of study

Every individuals have different surface area of the hand, but in this study the surface area of the hand is not taken in consideration. Three weeks after a stroke is taken as a base line criteria, but all the participants were not performing the hand function without assistance. And the duration and sample size of the study is small.

Further research is done with excluding of all the limitations. In inclusive criteria instead of taking 3 week after stroke, better to take Brunstoms stage of recovery.And the further research is focused on the ADL.

## Conclusion

The results of my study showed that there is improvement in voluntary activity & decreased motor impairment so I conclude that addition of task oriented activities to conventional physiotherapy in stroke patients will provide better outcome. Further research should be studied with large samples & long duration.

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# Vocational outcome after brain injury

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Gainful employment is an important rehabilitation goal for persons with brain injury. The benefits of working extend beyond financial and social advantage to include the psychological importance of employment. Identifying the factors that contribute to successful vocational rehabilitation will help the rehabilitation professional to implement the rehabilitation program successfully.

It is estimated that nearly 1.5 to 2 million persons are injured and 1 million succumb to death every year in India[1]. Road traffic injuries are the leading cause (60%) of brain injury followed by falls (20%-25%) and violence (10%). Alcohol involvement is known to be present among 15%-20% of brain injuries at the time of injury. Although there is considerable research on the vocational outcomes of individuals with brain injuries, there has been minimal research on the factors affecting their return to work in an Indian set up. A survey carried out by National Sample Survey Organization in the year 1999-2000, showed that of the 397 million working population in India, about 28 million were in the organized sector and the rest (369 million) were working in the unorganized sector[2]. In a developing country like India, finding a suitable job is quite difficult for a normal individual which makes it much more difficult for people with disability. In addition, a stigma[3] always exists towards people with brain injury especially when there are multiple impairments. Continuing need for the medical and family expenses put extreme pressure on the patient and the family. This makes return to work one of the important areas that a rehabilitation team has to explore.

Previous studies done in this field shows demographic characteristics like education level,[4,5] alcohol and substance abuse,[6-8] pre injury work status,[5,9], age[10-13], and socioeconomic status[14]. to be consistently associated with return to work. Stambrook et al[15] evaluated differences in pre- and post injury occupational status for individuals with moderate and severe brain injury; variables contributing to their failure to return to work included low Glasgow Coma Scale (GCS) score on admission, lower pre injury vocational status, increased age, and increased physical and cognitive deficits. Employment rates after brain injury range from 10% to 70% as compared with pre injury employment rates that vary from 61% to 75%, depending on the study[9].

The present study aimed at identifying the key factors that are associated with return to work following brain injury rehabilitation. Understanding the resumption of productive activity after brain injury and a person's subsequent role in the community is integral to identifying treatments, methods, and programs that positively affect that process.

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## Methods

### Inclusion criteria

Previously rehabilitated adults (15-65) with Acquired and Traumatic Brain Injury who attended the weekly brain injury follow up clinic and the yearly follow weekend of the Department of Physical Medicine and Rehabilitation of Christian Medical College, Vellore, India were taken.

### Data collection and variables

Direct interview with persons with brain injury and their family members using general Performa and a standardized cognitive evaluation scale.

### General ProForma

A specifically designed Performa to evaluate participant's socio demographic variables, functional and health related characteristics of individuals were used. Each participant's current employment status and various employments related variables both current as well as at the time of injury were also recorded.

### ACE score

Addenbrooke's Cognitive Examination (ACE)[16] is a 100-item test that assesses six cognitive domains. It is a brief and reliable bedside instrument for early detection of frontal lobe dementia, and is extended from the Mini Mental Status Examination.

### Statistical analysis

The data collected were arranged and tabulated to present the findings of the study. Descriptive statistics (Chi-square test) was used to analyze data. Statistical analysis was performed using SPSS 11.0 for Windows software17.

## Results

Forty people with brain injury of the 47 attended, fulfilled the inclusion criteria and were recruited. Table 1 shows the descriptive characteristics of the brain injured with their employment status and their significance with present employment status following community reintegration. The maximum age was 62 and the minimum age was 15 the Mean was 33.02. The result show that only 52.5% of the patients were employed and factors such as high cognitive level (0.000) change of work following injury (0.000), Problems acquired due to the injury (0.043), good mobility status (0.019) had significant association with return to work. Table 2 shows the mean and SD values of ACE scores when seen with the patient's present employment status.

**Table 1:** The Vocational Outcome and the Factors Studied.

| Sl.No. | Factors | Vocational outcome % | | | *p* value |
|---|---|---|---|---|---|
| | | Employed | Unemployed | Total | |
| 1. | Age | | | | 1 |
| | Below 40 | 37.5 | 32.5 | 70 | |
| | 40 and above | 15 | 15 | 30 | |
| 2. | Sex | | | | 1 |
| | Male | 50 | 45 | 95 | |
| | Female | 2.5 | 2.5 | 05 | |
| 3. | Marital status | | | | 0.735 |
| | Married | 30 | 30 | 60 | |
| | Un married | 22.5 | 17.5 | 40 | |
| 4. | Change of work | | | | 0.00 |
| | Yes | 15 | 0 | 15 | |
| | No | 37.5 | 47.5 | 85 | |
| 5. | Educational status | | | | 0.776 |
| | Secondary | 32.5 | 32.5 | 65 | |
| | Higher secondary | 05 | 7.5 | 12.5 | |
| | Graduate | 10 | 05 | 15 | |
| | Post graduate | 05 | 2.5 | 7.5 | |
| 6. | Problems identified | | | | 0.043 |
| | None | 15 | 7.5 | 22.5 | |
| | Physical | 2.5 | 20 | 22.5 | |
| | Cognitive | 10 | 7.5 | 17.5 | |
| | Behavioral | 25 | 12.5 | 37.5 | |
| 7. | Mobility | | | | 0.019 |
| | Independent without aid | 50 | 30 | 80 | |
| | Independent with aid | 2.5 | 2.5 | 05 | |
| | Dependent | 0 | 15 | 15 | |
| 8. | Substance abuse | | | | 1 |
| | Yes | 2.5 | 2.5 | 05 | |
| | No | 50 | 45 | 95 | |
| 9. | Duration of injury | | | | 0.079 |
| | <1 year | 20 | 25 | 45 | |
| | 1-2 years | 7.5 | 5 | 12.5 | |
| | 3-5 years | 20 | 12.5 | 32.5 | |
| | >5 years | 5 | 5 | 10 | |

## Discussion

Age at injury tends to be a reliable factor in mediating return to work outcomes, with individuals under the age of 40 years generally faring better than those over 40[18,19]. However Gollaher et al[5] failed to find an association between divergent return to work outcomes and age but attributed this to the small percentage of study participants older than 40. In the present study 70% of the participants were below 40 years and 37.5% of them returned to work. This was not statistically significant when seen with current employment status ($p$=1)

Individuals with higher pre injury work status tend to return to work in greater percentages than lower status workers with brain injury, although some studies have failed to find this associations[20]. In the present study, all the participants were employed before the injury and 52.5% of them returned to work after the injury. This explains the fact that persons who are employed before the injury place a greater value on returning to work and will be more aggressive in searching for a job that fit into his or her abilities.

Gender did not have significant association with return to work. The small sample size of female population in our study limited the ability to find statistically significant differences in gender. As brain injury population is generally male dominated, these findings make the present study clinically more meaningful.

It is important for the individuals with brain injury to support themselves and their families. Family support can influence the outcome in terms of identifying and modifying the work situation according to the abilities of the brain

**Table 2:** The Vocational Out Come and The Ace Score.

| ACE Score | Employment status % | | *p* value |
|---|---|---|---|
| | Employed | Un employed | |
| Mean ACE ± SD | 80.67 ± 11.5 | 59.05 ± 28.6 | 0.00 |

injured. The study failed to show any statistical significance when seen against the ($p$=0.735) marital status of the individuals. This could be also because the represented marital status failed in quantifying the support and motivation by the family in a statistical way.

Research has shown that individuals with brain injury often experience difficulty securing and/or returning to competitive employment post injury and maintaining employment for extended periods of time[21-24]. In India, it is very difficult to get supported employment for persons with brain injury. This could be because of the stigma that exists towards people with brain injury and disability. Out of the 52.5 % of employed individuals, 15 % have changed their work to suit their inabilities. It could also mean that the unemployed individuals were not able to find suitable jobs or were refused to be employed by the previous employers.

The education level is a useful predictor in employment outcomes for persons with brain injury. Several investigators[24,25] have cited higher rates of return to employment for individuals with higher levels of education who were working in professional and skilled occupations. They found that they were much more likely to return to work after brain injury than were persons with lower levels of education who were working in unskilled labor positions. In our study, it was seen that 32.5% of the total 65% of those with secondary education had returned to work. This was the highest percentage when compared with the other categories of education (Higher secondary-5%, Graduate-10%, Post graduate-5%). This was totally opposite to the previous studies done. This difference seen in our study because most of our subjects were unskilled laborers before injury and these is the people who comprise majority of our population[2].

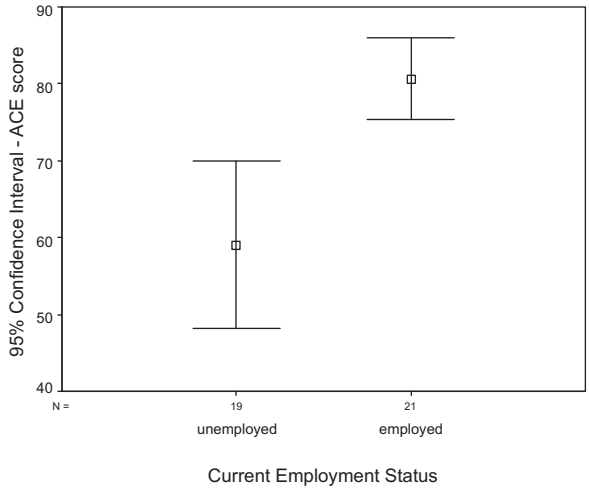
80% of our study population was independent in their mobility without any assistive devices. 50% of them had returned to work, while the other 30% were unemployed. Even though the mobility factor was statistically significant (0.019), the same 30% comprises the majority of the unemployed group. This makes it evident that mobility is not the key factor in return to work for people with brain injury and other factors need to be investigated.

Of the people, not returned work the problems identified were physical 20% behavioral 12.5% cognitive 7.5% and a group without any significant problems as 7.5%. However, 10% of people with cognitive deficits were able to return to work and 25% had any of the behavioral problems. This suggests that the return to work is multifactorial as the previous studies also proved.

Persons with brain injury are frequently intoxicated at the time of injury, that they have a history of more chronic substance abuse problem than the general population[26]. Largest proportion of people who had substance abuse before injury enters a period of moderation or remission after brain injury[8]. The present study showed no significance in substance abuse and return to work.

Vocational status in brain injured has been shown to decrease over time due to decline of the effect of comprehensive rehabilitation process[27]. In the present study the duration of injury was not a significant factor (p=. 079) in

**Fig. 1:** Graph Showing The Current Employment Status of the Brain Injured to their Cognitive Level (ACE Score).




people those who return to work thus contradictory to the previous studies.

Van der Naalt et al[28] found in a cohort of people with mild to moderate brain injury that 73% returned to work, but many reported significant symptoms related to their brain injury. In that study, cognitive complaints were associated with failure to return to work. The significance of 0.00 in our study supports the same. ACE score of the individuals in our study showed that 80.67 was the mean score of those who returned to work while 59.05 was the mean score of unemployed individuals. Fig. 1 shows the Confidence interval of ACE scores with vocational outcome.

## Limitations

Of the 105 patients called for direct interview with the patient and family 64 responded and 47 were attended the review meeting 40 patients met the inclusion criteria The remaining patients can be considered as having less family and social support which made them impossible to attend the review.

## Conclusion

The results of this study have shown that 52.5% of the persons with brain injury are working. Returning to the same job was found to be successful in 37.5%. The main factors that prevented them to work are cognitive impairments and the mobility issues. This shows the need of maintenance of equilibrium between physical, cognitive and vocational rehabilitation adequately and appropriately during the rehabilitation process. Inclusion of few other factors like motivation to return to work and quality of life of the individuals will show the psychological and social dimensions of the vocational outcome of persons with head injury.

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# Effects of isotonic (Dynamic constant external resistance) eccentric strength training at various speeds on concentric and isometric strength of quadriceps muscle

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## Abstract

### Study design

Randomized controlled trial.

### Background and purpose

The velocity of muscular contraction used to perform dynamic muscle actions affect the neural[81,26,48], hypertrophic[41] and metabolic[49] responses to resistance exercise. The purpose of this study was to find out differential training effects of slow and fast eccentric strength training (no concentric contraction) on concentric and isometric strength of the quadriceps muscle**.**

### Subjects

Physically active normal males and females (n=45) in the age group of 18-25 yrs with asymptomatic knee function were included.

### Methods

The subjects were randomly assigned to three groups: Group A (fast eccentric training), Group B (slow eccentric training), Group C (control group with no training). Group A and B underwent eccentric training for a period of 4 weeks for 3days/week, whereas group C acted as a control group with no training.

### Results

A change of 15.01%, 37.71 % and 1.38% was observed in IRM value for Group A, Group B and Group C respectively The isometric strength for Group A improved by 9.78%,8.35% and 8.52% at 15°,45° and 75° respectively and for Group B' improved by 22.7%, 24.58% and 24.16% at 15°, 45° and 75° respectively whereas insignificant changes occurred for Group C. The change in thigh circumference during the study period was found to be insignificant for all the three groups.

### Conclusion

The eccentric training can be used as an effective stimulus to develop concentric and isometric strength for Quadriceps muscles in previously untrained individuals. The significant difference obtained between Group A and Group B indicates that eccentric strength training at slower velocities can produce greater amount of strength gains as compared to training at comfortable natural speed.

## Key words

Eccentric, velocity, strength training, Dynamic constant external resistance.

## Introduction

Muscular strength is a fundamental physical trait necessary for health, functional ability, and an enhanced quality of life. The scientific investigation of resistance training did not evolve until the work of De Lorme & Watkins (1945) who demonstrated the importance of "Progressive Resistance Training"[1,2]. Resistance training has been shown to be the most effective method for developing musculoskeletal strength, and it is currently prescribed by many major health organizations[3,4].

Strength/Resistance training leads to adaptations that enable greater force generation by muscle. These adaptations include enhanced neural function (e.g., greater recruitment, rate of discharge), increased muscle cross-sectional area, changes in muscle architecture, and possibly a role of metabolites for increased strength. The amount of increase in ability of the muscle to produce tension following any resistance training is affected by a large number of parameters used during the training like initial training status, muscle action used, training load used, training volume, rest period between sets and exercises, training frequency, velocity of muscular contraction.

One of several exercise variables considered when attempting to optimize a dynamic resistance-training program is movement velocity. The velocity of muscular contraction used to perform dynamic muscle actions affect the neural[15,18,20], hypertrophic[17] and metabolic[19] responses to resistance exercise. This variable has received increased attention since isokinetic equipment was developed in the 1970's and the concept of velocity specific training was promulgated. The specificity concept holds that training at a specific velocity results in an increase in strength mainly at that velocity. The question of whether or not there is also carryover to other velocities has also been studied in great detail for isokinetic training and very rarely for isotonic (Dynamic resistance training) normally characterized by acceleration.

Another issue related to the movement velocity is alteration of force production by change in movement velocity. Dynamic constant external resistance (so called isotonic) training poses a different stress when examining training velocity. Significant reductions in force production are observed when the intent is to perform the repetition slowly. In interpreting this, it is important to note that two types of velocity contractions exist during dynamic resistance training:

- Unintentional[5] slow velocities are used during high intensity repetitions in which either the loading and/or fatigue are responsible for limiting the velocity of movement.
- Intentional[5] slow velocity contractions are used with submaximal loads where the individual has greater control of the velocity.

It has been shown that concentric force production was significantly lower for an intentionally slow velocity (5s concentric, 5s eccentric) of lifting compared with a traditional (moderate) velocity with a corresponding lower neural activation[6]. These data suggest that motor unit activity may be limited when intentionally contracting at a slow velocity. In addition, the lighter loads required for slow velocities of training may not provide an optimal stimulus for strength enhancement in resistance-trained individuals. Although some evidence dose exist to support its use as a component part of the program in the beginning phases of training for highly untrained individuals[11]. 30% reduction in training load was necessary while using a very slow velocity (10s concentric, 5s eccentric) compared with a slow velocity (2 s concentric, 4 s eccentric)[7].

Compared with slow velocities, moderate (1-2s concentric: 1-2s eccentric) and fast (<1s concentric, 1s eccentric) velocities have been shown to be more effective for enhanced muscular performance (e.g., number of repetitions performed; work and power output, volume)[8,12] and for increasing the rate of strength gains. Recent studies examining training at fast velocities with moderately high loading have shown this to be more effective for advanced training than traditionally slower velocities[9,10].

Westcott et. al in 2001[11] assessed a way to increase the intensity & effectiveness of resistance training by comparing training with a slower repetition speed to training with a conventional repetition speed. Untrained men and women were trained two to three times per week for 8 to10 weeks on a 13 exercise Nautilus circuit performing one set of each exercise. Participants trained using regular speed repetitions for 8 to 12 repetitions per set at 7sec each (2sec lifting, 1sec pause, 4sec lowering) or a Super Slow training protocol where they completed 4 to6 repetitions per set at 14sec each (10sec lifting, 4sec lowering). All of the participants were tested for either the 10RM weight load (regular-speed group) or the 5RM weightload (slow-speed group). Super Slow training resulted in about 50% greater increase ($p<0.001$) in strength for men and women than regular speed training.

Morrissey et. al in 1998[12] studied the early phase differential effects of slow and fast barbell squat training. Two groups of women squatted repeatedly at 2sec up, 2sec down (slow, n=11) or1sec up, 1sec down (fast, n=10), doing three warm up sets and three 8RM sets, 3times per week for seven weeks. Tests included force platform and video analysis of vertical jump, long jump, and maximum squat, and isometric and isokinetic knee extensor testing at speeds from 25º to 125º/sec. The groups improved similarly in many variables with training but showed some differences. In the long jump, the fast group was superior in knee peak velocity, and total body vertical and absolute power. In the vertical jump, fast training affected the ankle and hip more (e.g., average power), and slow training mostly affected knee (average torque). In isokinetic testing, the fast group improved strength most at the faster velocities, while the slow group strength changes were consistent across the velocities tested. Although both slow and fast training improved performance, faster training showed some advantages in quantity and magnitude of training effects.

Young and Bilby in 1993[13] used barbell squat for resistance training and used non-quantified slower and faster velocities in training and testing. Both groups were instructed to "lower the weight in a slow and controlled manner," but the fast group was to "explode upwards as fast as possible," while the slow group was to "raise the bar in a slow and controlled manner so that acceleration is minimized." They measured the squat lift 1RM, vertical jump, maximum isometric lifting force in the squat position and thigh muscle size. After the 7.5 training period, both groups significantly improved in all performance tests, but the degree of improvement did not differ significantly between the two training groups. For the vertical jump, the mean percent change was 5% and 9% for the fast and slow training groups, respectively.

Though above mentioned studies give some insight into the differential training effects of slow and fast concentric phase of exercise, no study examines the differential effects of slow and fast eccentric training in isolation. Therefore in this study we intend to find out differential training effects of slow and fast eccentric strength training (no concentric contraction) on concentric and isometric strength of the quadriceps muscle.

The results of the experiment are relevant to health and fitness practitioners who design training programs to improve performance in athletic and other physically demanding activities, or to restore functional ability after injury.

## Methodology

Physically active normal males and females (n=45) in the age group of 18-25 yrs with asymptomatic knee function were included in the study after they gave their informed consent. Subjects were excluded from the study if they suffered from any neurological or orthopedic problem affecting lower limbs, osteoarthritis of knee, any deformity of knee, hip or back, were under medication (steroids) had any history of fractures, trauma to knee joint or muscles, had referred pain in lower limb due to cause originating from back, were undergoing any simultaneous weight training or conditioning with the training given as part of study. Subjects who had undergone weight training in the recent past 1 year were also excluded[16].

After giving their informed consent, the subjects were randomly assigned to three groups:

Group A: fast eccentric training

Group B: slow eccentric training

Group C: control group with no training

Group A and B underwent eccentric training for a period of 4 weeks for 3days/week, whereas group C acted as a control group with no training.

**Subject positioning and stabilization**

For testing as well as training in all groups subjects were positioned in high sitting position on a Quadriceps chair with back supported and subject restrained by straps at the thigh and pelvis. The felt pad of the inner lever arm of the quadriceps chair was positioned distally on the lower leg of the subject just proximal to medial malleolus. The

axis of the lever arms of the quadriceps chair was adjustable and was aligned with the lateral epicondyle so that a minimum of slippage of the resistance pad occurs against the tibia as the knee flexes and extends through the arc of motion.

**Warm up**

Prior to testing as well as training in all the groups adequate warm up in the form of cycling at a comfortable speed, five quadriceps and hamstrings static stretches, followed by 5-6 active movements were given.

**Testing Procedures**

- 1 Repetition Maximum (Concentric) for Quadriceps

Outer lever arm (OLA) of Quadriceps chair acted as the resistance arm and the calibrated weights were attached to it corresponding to the level just proximal to the medial malleolus. The initial 1RM was determined by trial and error. Incremental loads were added until failure occurred despite verbal encouragement to exert maximal efforts. Failure was defined as a lift falling short of full range of motion[14]. Between every two successive attempts at least a rest of 5min was given and the number of attempts on a single testing session was limited to 5. If 1RM could not be determined in 5 attempts than further testing was carried out on the next day.

- Isometric strength for Quadriceps

The Quadriceps chair with an addition of a strain gauge was used to measure the muscles maximum isometric strength. The outer lever arm of the Quadriceps chair acted as the fixed end with strain gauge attached to it. The other end of the strain gauge was fixed to a fixed rod at the back of the chair. The height of the lever arm was adjustable so was the angle. To obtain the isometric strength at various angles, the inner lever arm was adjusted. The lever arm was kept constant at a pre-determined length. The maximum isometric strength was monitored with the strain gauge installed.

The peak force at the knee angles of 15°, 45° and 75°[25] were measured. The subjects were required to exert force as hard as possible for 3 seconds. The highest stable force were taken and noted. In each test session, 3 trials spaced at an interval of 60 seconds each was taken. The peak forces for the three trials were averaged and taken for analysis. Strong verbal encouragement was provided to motivate the subjects to attain maximum voluntary effort during isometric strength testing.

- Thigh circumference

Measurements of thigh circumference were made at the mid thigh and suprapatellar sites on one occasion before training and one occasion after training. The mid thigh and suprapatellar sites were defined as the location at 50% and 20% of the distance between the lateral knee joint line and the greater trochanter[22]. A flexible tape measure was used and measurements were made with the subject standing in a relaxed position with the feet 9 to 12 inches apart[23]. The average of three measurements was taken to the nearest 0.l cm. Post training measurements were made in ignorance of the equivalent pre training values.

## Training procedures

- Frequency of training and other time considerations

Training was given for 3 days/week for a total of 4 weeks. Each training session consisted of 6 sets of 5 repetitions each of eccentric contractions at 100% of 1 R.M. concentric. A rest of 5 min was given between every two consecutive sets[34].

- Training load assessment and Progression

The IRM was evaluated for all the subjects using concentric contractions. For both the eccentric training groups 100% of the 1 RM load was used for training[34]. 1 R.M. was tested each week and a new training load for the following week was calculated.

- Training Procedure

For both the training groups the calculated loads were attached to the OLA (outer lever arm) of the Quadriceps chair. The weight (attached to the OLA) was lifted to the horizontal position by the investigator. As the subject performed the eccentric contractions subject was required to lower the weight under control from starting horizontal position (full knee extension) to 90° of knee flexion

**Group A:** The subjects were instructed to allow the movement to occur at a comfortable natural controlled speed while the applied load moves the limb in the direction of gravity. The movement throughout the range was smooth

**Group B:** The subjects were instructed to allow the movement to occur at slowest possible controlled speed while the applied load moves the limb in the direction of gravity. The movement throughout the range was smooth.

**Group C:** The subjects in this group did not undergo any training.

The time taken to complete the movement in both the groups was noted in any 3 randomly picked repetitions during each training session.

The subjects were also instructed not to undergo any additional strength training for knee extensors or to start with any new physical activity (e.g. Running, jogging, stair running), in addition to the activities that were a part of his daily routine.

## Results

The three groups were found to be comparable in terms of age, height and weight at the start of the training as summarized in Table 1. The mean velocity for group A was found to be 76.04 (± 12.43) °/sec and for group B was 9.64 (± 2.46) °/sec.

**1 RM Concentric**

There was a time * type of training interaction, F (2, 42) =114.348, p<0.0001. Post hoc analysis revealed that as compared to the control group both, the fast as well as the slow eccentric training group improved with training. However, the slow eccentric training resulted in significantly higher gains in strength as measured by IRepetition Maximum as compared to control as well as fast eccentric training (Fig.1).

**Isometric Strength at 15° Knee flexion**

There was a time * type of training interaction, $F_{(2,42)}$ =37.074, p<0.0001. Post hoc analysis revealed that as compared to the control group both, the fast as well as the slow eccentric training group improved with training.

**Table 1:** Characteristics of the groups.

| Group | Mean age (in yrs) | Mean height (in cms) | Mean weight (in kg) |
|---|---|---|---|
| A | 23.2±1.9 | 164.7±9.5 | 58.3±7.9 |
| B | 22.8±1.8 | 163.1±8.6 | 61.3±8.6 |
| C | 22.9±1.4 | 165±10.1 | 62.2±8.5 |

**Fig. 1:** Comparison of 1Repetition Maximum (concentric) for Group A (fast eccentric training), Group B (slow eccentric training), and Group C (control) pre and post training.

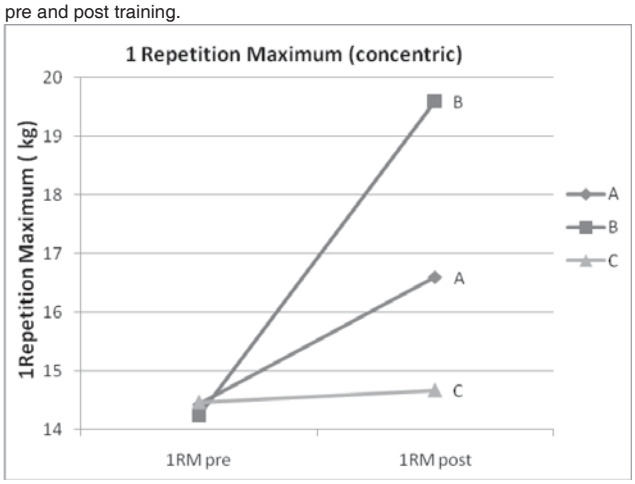
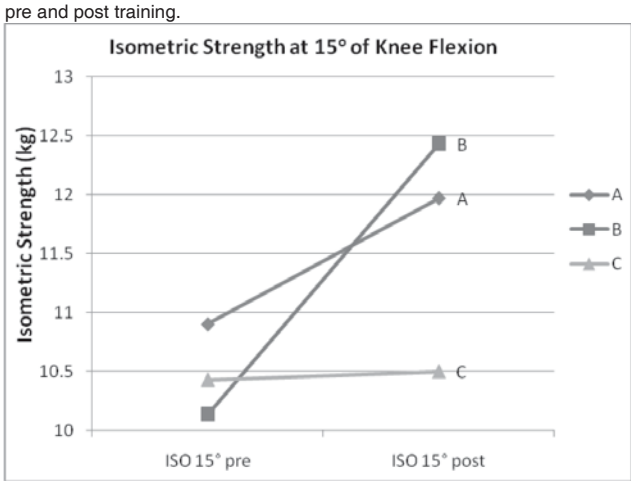



**Fig. 2:** Comparison of Isometric Strength at 15° Knee flexion for Group A(fast eccentric training), Group B (slow eccentric training), and Group C (control) pre and post training.




However, the slow eccentric training resulted in significantly higher gains in strength as measured by Isometric Strength at 15° Knee flexion as compared to control as well as fast eccentric training (Fig.2).

**Isometric Strength at 45° Knee flexion**

There was a time * type of training interaction, $F_{(2,42)}$ = 49.702, p<0.0001. Post hoc analysis revealed that as compared to the control group both, the fast as well as the slow eccentric training group improved with training. However, slow eccentric training resulted in significantly higher gains in strength as measured by Isometric Strength at 45° Knee flexion as compared to control as well as fast eccentric training (Fig. 3).

**Isometric Strength at 75° Knee flexion**

There was a time * type of training interaction, $F_{(2,42)}$ =57.928, p<0.0001. Post hoc analysis revealed that as compared to the control group both, the fast as well as slow eccentric training group improved with training. However, the slow eccentric training resulted in significantly higher gains in strength as measured by Isometric Strength at 75° Knee flexion as compared to control as well as fast eccentric training (Fig. 4).

**Thigh Circumference at 20% and 50% of Thigh length from lateral knee joint line to Greater Trochanter**

Analysis revealed that the slow as well as the fast

**Fig. 4:** Comparison of Isometric Strength at 75° Knee flexion for Group A(fast eccentric training), Group B (slow eccentric training), and Group C (control) pre and post training.

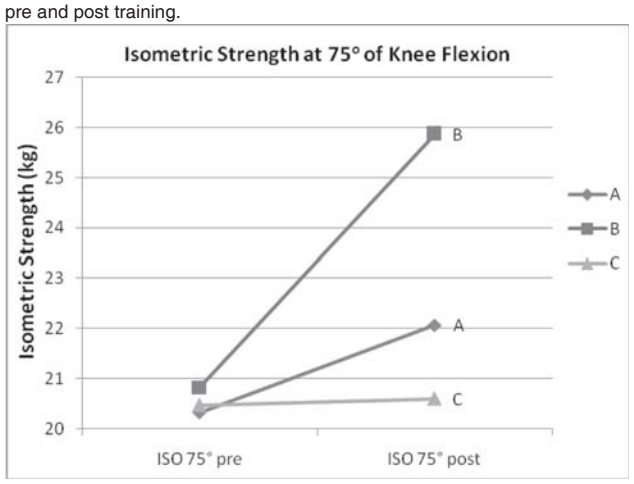
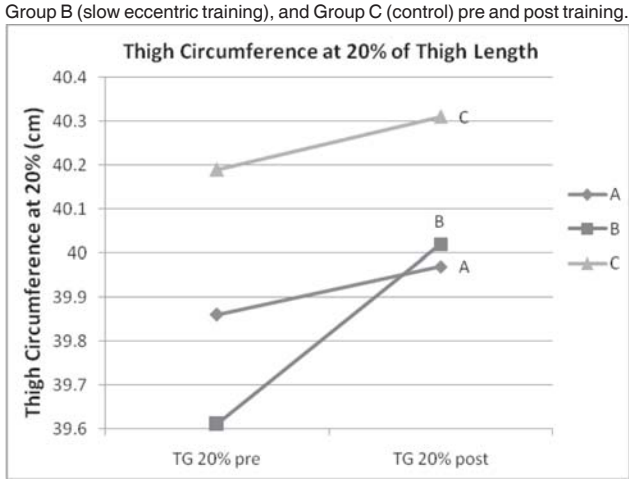



**Fig. 5:** Comparison of Thigh Circumference at 20% of Thigh length from lateral knee joint line to Greater Trochanter for Group A(fast eccentric training), Group B (slow eccentric training), and Group C (control) pre and post training.




eccentric training group did not improve with training as compared to the control group. Therefore, hypertrophy as measured by thigh circumference at 50% was insignificant in all the three groups (Fig. 5 and Fig. 6).

## Discussion of results

Overall results of the study indicate that the eccentric resistance training acts as an effective stimulus for development of both concentric and eccentric strength. Eccentric resistance training was given to Group A and Group B whereas the Group C did not undergo any training and acted as a control group. Group A underwent eccentric training at a comfortable natural speed whereas Group B underwent eccentric training at a slow speed. Improvements in both concentric and isometric strength occurred in both Group A and Group B, following resistance training. Group B gained significantly more as compared to Group A. A change of 15.01%, 37.71 % and 1.38% was observed in IRM value for Group A, Group B and Group C respectively during the study period.

The size of the increase in muscle strength has been shown to be a function of the load imposed on the muscle and on the total duration of the state of contraction. (McDounagh and Davies, 1984)[27]. We suggest that much higher gains in Group B as compared to Group A can be

**Fig. 3:** Comparison of Isometric Strength at 45° Knee flexion for Group A(fast eccentric training), Group B (slow eccentric training), and Group C (control) pre and post training.

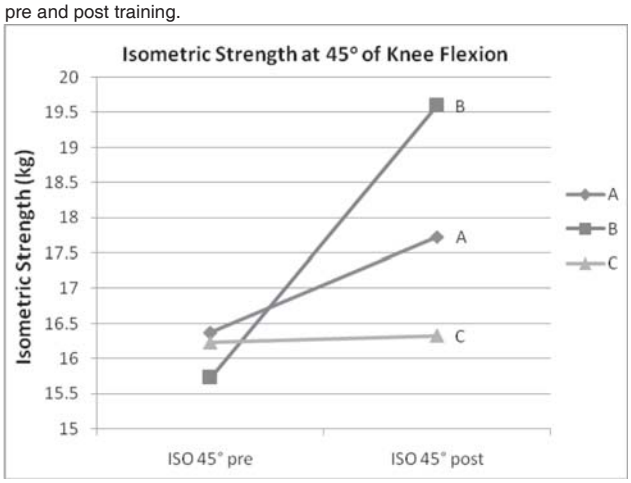
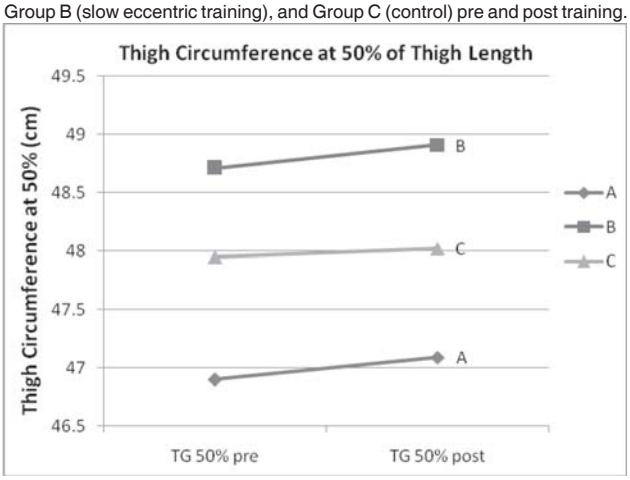



**Fig. 6:** Comparison of Thigh Circumference at 50% of Thigh length from lateral knee joint line to Greater Trochanter for Group A(fast eccentric training), Group B (slow eccentric training), and Group C (control) pre and post training.




explained on the basis of duration of the state of muscle contraction which is much higher for slow training group i.e. Group B.

Increasing the speed of eccentric component of exercise has been advocated to facilitate fast twitch muscle fiber recruitment whereas slow eccentric activation is believed to preferentially recruit slow twitch stabilizing muscles[21]. This is in contrast to the size principle that is the primary determinant of motor unit recruitment during concentric. and isometric contractions. According to size principle[28] slow twitch fibers are recruited first and fast twitch fibers come into action only during very strong concentric and isometric contractions. Therefore greater concentric and isometric strength gains can be expected from the group training at a slow velocity (Group B) as compared to Group A.

The results of the study cannot be compared directly to any of the previous studies due to differences in the study designs used. To the best of our knowledge we have not come across any study comparing the effect of velocity using only the isotonic (dynamic constant external resistance) eccentric contractions. Westcott et. al in 2001[11] compared training with a slower repetition speed to training with a conventional repetition speed. Participants trained using regular speed repetitions for 8 to 12 repetitions per set at 7 sec each (2sec lifting, 1 sec pause, 4sec lowering) or a Super Slow training protocol where they completed 4 to 6 repetitions per set at 14sec each (10sec lifting, 4sec lowering). Super Slow training resulted in about 50% greater increase ($p<0.001$) in strength for men and women than regular speed training. Though there are some studies with results in contrast such as Morrissey et. al in 1998[12]. In their study two groups squatted at 2sec up, 2sec down (slow, n=l1) or 1sec up, 1sec down (fast, n=l0). In isokinetic testing, the fast group improved strength most at the faster velocities, while the slow group strength changes were consistent across the velocities tested. Although both slow and fast training improved performance, faster training showed some advantages in quantity and magnitude of training effects. Though the study compares the effects of training velocity its results cannot be directly compared to the present study due to differences in both the design and testing procedures.

The significant gains occurred in isometric strength at all the three angles (15°, 45°, 75°) for both Group A and Group B whereas insignificant changes occurred for Group C at the end of study period. Group A improved by 9.78%,8.35% and 8.52% at 15°,45° and 75° respectively. Group B' improved by 22.7%, 24.58% and 24.16% at 15°, 45° and 75° respectively. Weir et. al. in 1995,[25] reported significant increase in isometric torque of quadriceps muscle at 45° and 75° below the horizontal plane in high sitting position but statistically significant effects did not occur at 15°. They reported an increase of 15.2% and 15.0% at 45° and 75° of knee flexion and an increase of 8.8% at 15° (statistically insignificant) following 8 weeks of eccentric resistance training to the non-dominant leg. These results were opposite to what can be expected. The training device, that was a lever arm that rotates about an axis, (similar to what was used in the present study) would provide the greatest resistance in the horizontal plane as the moment arm for the torque created by the weights is the greatest at that point. As the weights are lowered, the moment arm decreases and the resistance torque also decreases resulting in decreased stimulus for strength gains. Thus, it can be expected that greatest training effects would occur at joint angles closer to full extension. They did not suggest any mechanism to explain this observation of their study. In the study they also did not specify the speed of movement during the resistance training therefore, assuming that it took place at natural speed results can be compared to Group A only.

The change in thigh circumference during the study period was found to be insignificant at both the test levels i.e. 20% and 50% of thigh length measured from lateral joint line of knee to Greater Trochanter. Significant gains in muscle strength despite of insignificant gains in thigh circumference suggest that the strength gains have resulted from some mechanism other than muscle hypertrophy. This is in concurrence with earlier studies that report that the strength gains in initial 4-6 weeks result primarily from neural adaptations and the muscle fiber hypertrophy is minimal. Moritani and Devaries[26] reported that nervous system plays a significant role in the strength increases observed in early stages of adaptation to training. Phillips in 2000,[29] reported the appearance of muscle hypertrophy only by 6-7 week of training. Due to time restrictions we could not extend our study period therefore, we were not able to find out differential effects of slow and fast training on muscle hypertrophy. Thus, a study with extended period of training is recommended in future to find effects on muscle hypertrophy.

## Future trends

The results of our study have raised more questions than it has answered. The present study utilized only the eccentric muscle action but the effect of the concentric and eccentric actions in combination remain unclear.

Another important aspect is of initial training status of the subjects undergoing training. The present study was conducted on previously untrained individuals and effects on the trained individuals still remain unclear.

An aspect that we will like to address is, the total duration of the state of contraction, which was different for the groups A and B. The future studies can be designed to equalize the total duration of the state of contraction.

## Relevance to clinical practice

The results of the experiment are relevant to health and fitness practitioners who design training programs to improve performance in athletic and other physically demanding activities, or to restore functional ability after injury. The results of the study can help them to design the strength training programs more effectively to gain better and faster results

## Conclusion

The results of the study lead to the conclusion that the eccentric training can be used as an effective stimulus to develop concentric and isometric strength for Quadriceps muscles in previously untrainined individuals. Furthermore, the significant difference obtained between Group A and Group B indicates that training at slower velocities can produce greater amount of strength gains as compared to training at comfortable natural speed. Therefore, the training aimed at strength gains should also consider velocity of movement as one of the important variables that can affect strength gains. Subsequently, our results suggest that training aimed at strength gains for previously untrained individuals should utilize slower velocity of movement to gain faster and better results with due care for delayed onset muscle soreness. The results of our study should be applied with caution when the aim of training is to improve the force generation at higher velocities. The results of the study may not be applicable for training for sports like sprinting, long and high jump requiring force generation at high velocities owing to the speed specificity principle which states that training at a specific velocity results in an increase in strength mainly at that velocity.

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# Application of Ant-Miner algorithm to extract knowledge from star excursion balance test

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## Abstract

Star Excursion balance test (SEBT) is a functional test to assess the dynamic balance and lower body stability. The knee condition plays a significant role on stability, and hence on the results. The SEBT results being high dimensional, gathering information about the knee condition from it becomes very difficult for doctors and physiotherapists. Knowledge extracted from the data will assist the doctors to analyze the SEBT results and diagnose the patients better. In this work, Ant colony based algorithm, Ant-Miner is used to extract knowledge from the data. Rules for classification of the data are obtained and the merit of Ant- Miner is highlighted by the simplicity of the rules.

## Keywords

SEBT, Knowledge Extraction, Ant-Colony Optimization, Ant-Miner, Data Cluster.

## Introduction

Humans use three basic mechanisms to obtain a sense of balance in daily life. The three mechanisms (visual, vestibular, and proprioceptive) interact to maintain posture and impart a conscious sense of orientation. A defect in one of these systems decreases the patient's overall ability to adjust to incongruous stimuli. Proprioceptive function can be tested by a number of balance tests. Star Excursion Balance Test (SEBT) is one such functional test that is used to assess dynamic balance and lower body stability. It, integrates a single-leg stance of one leg with maximum reach of the other leg. Efficacy and reliability of this test has been established previously[1,2]. The SEBT involves a participant to maintain a base of support with one leg, while maximally reaching in different directions with the opposite leg, without compromising the base of support of the stance leg[1,3]. As SEBT tests involves only standing and stretching, they offer a simple, reliable, low-cost alternative to more sophisticated instrumented methods that are currently available. It has been shown that the result pattern for a healthy ankle is different than an injured/ recovered ankle[2,3,1] and that the SEBT results are significantly influenced by the health of the ankle[1]. Since SEBT is a functional test or an index of lower body stability, it is evident that the health of the knee also plays an important role in influencing the results obtained. In this paper, the implication of SEBT results concerning the knee's health is being considered.

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Since the data is high dimensional (eight), it is too intricate for an individual to analyze the data efficiently without any aid. The main reason lies in the fact that a great degree of chaos is embedded in this kind of data and it is hard to comprehend by the human mind. Knowledge Extraction can give fairly good simulations and predictions for such domains. It implies that the system is able to deduce some characteristics and relations which are not visible at first glance. It is this information or the hidden pattern in the presented data that we want to know and express in words. This is the main intention behind extracting knowledge from raw data, which is by nature, very hard to contemplate.

Knowledge Extraction is an interdisciplinary procedure focusing upon methodologies for discovering and extracting implicit, previously unknown and potentially useful knowledge (rules, patterns, regularities as well as constraints) from data. Ideally the rule extraction process results in a symbolic description which closely mimics the behavior of a system in a concise and comprehensible form. In modern world, data is abundantly available in various formats (text, image, audio and video), and has been gathered and stored in massive databases or data warehouses. The challenges lie in extracting knowledge from this data and use it for predicting trends and improving decisions. This simply reflects the importance of Knowledge Extraction methodologies and their applications in the present scenario[4,5,6].

Knowledge can be extracted by implementing various methods like fuzzy based models[7], semantic networks[8], artificial neural networks[9,10,6], Genetic algorithms[11] and Ant Colony Optimization.

Ant-colony optimization algorithm is an evolutionary learning algorithm, the basic algorithm of which was inspired by the behavior of the real ants[12,13,14]. The foraging behavior of ants as a group of simple agents, cooperating with each other to find the shortest way to the food source by exchanging information via pheromone deposited is mimicked in this algorithm. Pheromone acts like a distributed memory for communicating ants with each other. ACO has been initiated by Dorigo which has been successfully applied to several NP-hard combinatorial optimization problems[15] such as traveling salesman, quadratic assignment problem[16], job-shop scheduling[17], vehicle routing[18], telecommunication networks[19], etc and recently to data classification[20].

Knowledge extraction from the SEBT results could offer an elucidation by providing a symbolic link between inputs i.e. SEBT results and outputs/classes. The extraction of easily interpretable knowledge in the form of rules from the large amount of data measured in SEBT is well desirable. This paper proposes using ACO techniques for knowledge extraction from SEBT results. In order to extract

understandable rules from the data repository, a novel technique for classification called Ant-Miner[21] is implemented.

The original idea and goal of this research paper is to use the rules extracted from an ACO in order to serve as an aid to physiotherapists and doctors during their normal every-day practice to analyze their subjects better. When the number of parameters being considered is high, recognition of significant/critical variables is quite difficult. Further, determining the individual effects of these parameters on the outcome becomes too complex. Charts and graphical images can be of some help, but they are not enough for the complex decision variables encountered by specialists and it is very difficult to really comprehend the importance of each variables. The rules extracted from ACO zero in on critical variables and convey a lot of information and will prove to be very useful to professionals in their daily practice.

## Material

### Subjects

A star board was constructed on level ground, in a yoga centre facility using a protractor. Eight lines extending at $45^0$ increments from the centre of the grid were painted. The lines were graduated with the distances from the centre. The 8 lines positioned on the grid are labeled according to the direction of excursion relative to the stance leg: anterolateral (AL), anterior (A), anteromedial (AM), medial (M), posteromedial (PM), posterior (P), posterolateral (PL), and lateral (L) as shown in Fig. 1.

Fifty subjects from various walks of life enrolled in a yoga centre volunteered to undergo SEBT. Two groups-healthy and unhealthy are formed based on their knee condition. Volunteers were grouped into unhealthy, if they have had (1) at least one episode of an acute knee injury but none within the past 6 weeks or, (2) multiple episodes of the knee giving way within the past 12 months. Healthy group consisted of volunteers who had no history of injury to either knee. The number of people selected into both the groups was nearly equal.

## Knowledge acquisition

A verbal and visual demonstration of the SEBT test procedure is given to each subject by the examiner. Each subject is allowed to perform 6 practice trials in each of the 8 directions for each leg to become familiar with the task, as recommended by Hertel et al.[22].

To perform the SEBTs, the subject maintains a single-leg stance while reaching with the contralateral leg (reach leg) as far as possible along the appropriate vector. The subject lightly touches the farthest point possible on the line with the most distal part of the reach foot as lightly as possible in order to ensure that stability is achieved through adequate neuromuscular control of the stance leg. Trunk is kept in upright position i.e., the pelvic and pectoral girdle balance is maintained. The trunk should not tilt either forward or sideward as shown in Fig.2 below. The subject then returns to a bilateral stance while maintaining this position. The examiner manually notes down the farthest distance reached from the centre through the graduations on the grid. Measurements are taken after each reach by the same examiner. Three reaches in each direction are recorded. Subjects are given 15 seconds of rest between reaches. The average of the 3 reaches for each leg in each of the 8 directions is considered. Reach leg (right, left), order of excursions performed (clockwise, counterclockwise), and direction of the first excursion (A, M, L, P) are counterbalanced to control for any learning or order effect. All trials are then performed in sequential order in either the counterclockwise or clockwise directions. Trials are discarded and repeated if the subject (1) does not touch the line with the reach foot while maintaining weight bearing

**Fig. 1:** The 8 directions of the Star Excursion Balance Tests are based on the stance limb.

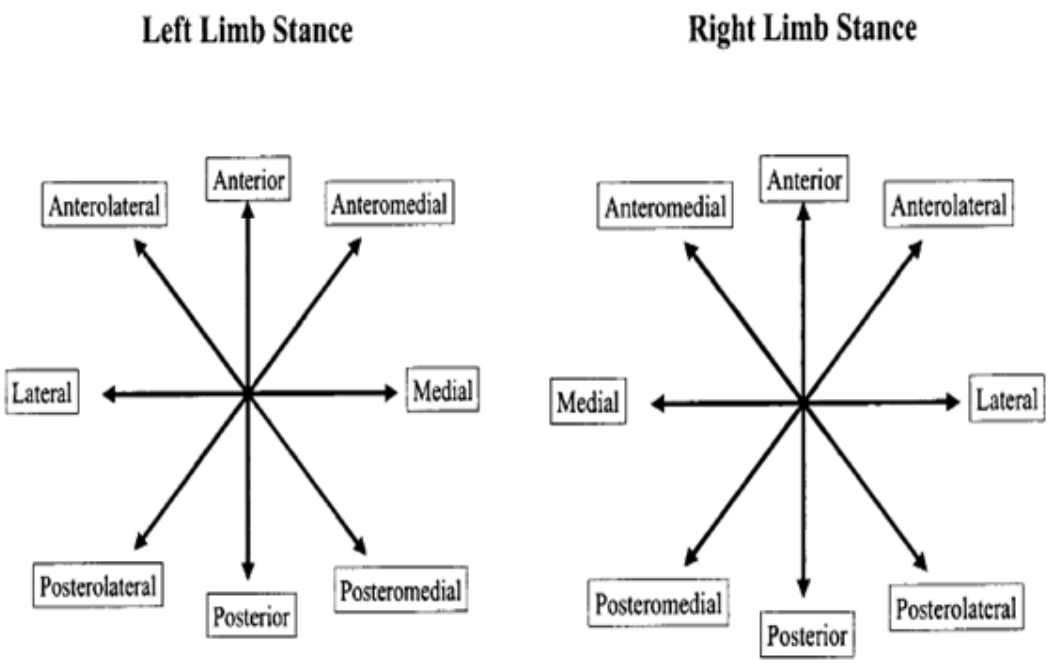


**Fig. 2:** A subject performing the anteromedial-reach component of the Star Excursion Balance Tests.

on the stance leg, (2) lifts the stance foot from the center grid, (3) loses balance at any point in the trial, or (4) does not maintain start and return positions for one full second. If a subject is judged by the examiner to have touched down with the reach foot in a manner that causes the reach leg to considerably support the body, the trial is discarded and repeated. In other words, if the reach foot is used to widen the base of support, the trial is not recorded. The base of support was the stance foot for the entire trial with the fraction of a second in which the reach foot very lightly touched the ground.

Normalization is performed by dividing each excursion distance by the participant's leg length, and then by multiplied by 100[3]. Normalized values can thus be viewed as a percentage of excursions distance in relation to a participant's leg length. The values are verified before it is used to populate the Knowledge Repository. The normalized excursion distances in each of the eight directions are tabulated with their appropriate group. Knowledge is extracted form this data using ACO technique. An extract from the knowledge repository is shown in table.1 below.

## ACO for pattern recognition

The collective intelligence that emerges out of the interactions of a large population of non-intelligent agents governed by simple rules is termed as swarm intelligence. Ant Colony Optimization is an optimization technique based on one of the early studies of swarm intelligence-investigating the foraging behaviour of ants[12,14]. An important and interesting behavior of ant colonies is their foraging behavior, and, in particular, how ants can find the shortest paths between food sources and their nest. While walking from the nest to the food sources and back, ants deposit a substance called pheromone, thus forming a pheromone trail. Ants can smell pheromone, and when choosing their way, they tend to choose, in probability, paths marked by strong pheromone concentrations. The pheromone trail allows the ants to find their way back to the food source (or to the nest). Also, it can be used by other ants to find the location of the food sources found by their nest mates.

It has been shown experimentally that this pheromone

**Table 1:** Extract from Knowledge Repository.

| *A* | *AM* | *M* | *PM* | *P* | *PL* | *L* | *AL* | *CLASS* |
|---|---|---|---|---|---|---|---|---|
| **Training Data** | | | | | | | | |
| 71 | 77 | 71 | 60 | 66 | 60 | 49 | 60 | 1 |
| 66 | 68 | 77 | 87 | 77 | 77 | 41 | 56 | 1 |
| 65 | 65 | 59 | 65 | 65 | 65 | 27 | 54 | 1 |
| 71 | 82 | 87 | 87 | 82 | 77 | 51 | 56 | 1 |
| 78 | 73 | 58 | 73 | 73 | 68 | 39 | 49 | 1 |
| 69 | 0 | 64 | 0 | 78 | 78 | 0 | 0 | 2 |
| 67 | 72 | 67 | 56 | 67 | 50 | 33 | 50 | 2 |
| 64 | 53 | 48 | 53 | 53 | 32 | 0 | 0 | 2 |
| 65 | 65 | 60 | 50 | 60 | 55 | 35 | 55 | 2 |
| 53 | 35 | 0 | 0 | 0 | 0 | 0 | 47 | 2 |
| **Testing Data** | | | | | | | | |
| 65 | 70 | 65 | 59 | 65 | 54 | 29 | 54 | 1 |
| 68 | 74 | 66 | 63 | 63 | 58 | 37 | 58 | 1 |
| 79 | 84 | 84 | 79 | 74 | 79 | 47 | 68 | 1 |
| 70 | 75 | 70 | 75 | 65 | 56 | 37 | 47 | 1 |
| 74 | 79 | 79 | 74 | 79 | 74 | 47 | 68 | 1 |
| 60 | 60 | 60 | 49 | 65 | 43 | 49 | 54 | 2 |
| 68 | 78 | 21 | 0 | 0 | 0 | 0 | 0 | 2 |
| 67 | 78 | 67 | 56 | 0 | 39 | 0 | 0 | 2 |
| 61 | 0 | 0 | 50 | 50 | 56 | 39 | 61 | 2 |
| 67 | 56 | 67 | 51 | 56 | 45 | 34 | 0 | 2 |

Classes: 1 - Healthy, 2 – Unhealthy

trail following behavior can give rise, once employed by a colony of ants, to the emergence of shortest paths. That is, when more paths are available from the nest to a food source, a colony of ants may be able to exploit the pheromone trails left by the individual ants to discover the shortest path from the nest to the food source and back.

These techniques are used to solve a multitude of problems ranging from the classic Travelling Salesman problem to the difficult Data Classification problem. A novel algorithm called Ant-Miner[21], has been proposed which can be used for data mining.

Generation of rules using Ant -Miner:

Ant Miner algorithm can be adopted to obtain the rules that can be used for classifying the given SEBT results. A brief description of Ant Miner algorithm is given below.

In the context of the classification task of data mining, discovered knowledge is often expressed in the form of IF-THEN rules, as follows:

IF <conditions> THEN < class>.

The rule antecedent (IF part) contains a set of conditions, usually connected by a logical conjunction operator (AND). In this paper we will refer to each rule condition as a term, so that the rule antecedent is a logical conjunction of terms in the form:

IF term1 AND term 2 AND...

Each term is a triple <attribute, operator, value>, such as < Attribute1 = 24 >.

The rule consequent (THEN part) specifies the class predicted for cases whose predictor attributes satisfy all the terms specified in the rule antecedent. From a data mining viewpoint, this kind of knowledge representation has the advantage of being intuitively comprehensible for the user, as long as the number of discovered rules and the number of terms in rule antecedents are not large.

Ant-Miner[21] follows a sequential covering approach to discover a list of classification rules covering all, or almost all, the training cases. At first, the list of discovered rules is empty and the training set consists of all the training cases. Each iteration of the WHILE loop of the Algorithm, corresponding to a number of executions of the REPEAT-UNTIL loop, discovers one classification rule. This rule is added to the list of discovered rules, and the training cases that are correctly covered by this rule (i.e., cases satisfying the rule antecedent and having the class predicted by the rule consequent) are removed from the training set. This process is iteratively performed while the number of uncovered training cases is greater than a user-specified threshold, called Max_uncovered_cases.

In the REPEAT-UNTIL loop three main steps are recursively applied:

First, Ant t starts with an empty rule, that is, a rule with no term in its antecedent, and adds one term at a time to its current partial rule. The current partial rule constructed by an ant corresponds to the current partial path followed by that ant. Similarly, the choice of a term to be added to the current partial rule corresponds to the choice of the direction in which the current path will be extended. The choice of the term to be added to the current partial rule depends on both a problem-dependent heuristic function (h)[21] and on the amount of pheromone (t) associated with each term. Ant t keeps adding one-term-at-a time to its current partial rule until one of the following two stopping criteria is met:

1. Any term to be added to the rule would make the rule cover a number of cases lesser than a user-specified threshold, called Min_cases_per_rule (minimum number of cases covered per rule).
2. All attributes have already been used by the ant, so that there is no more attributes to be added to the rule antecedent. Note that each attribute can occur only once in each rule, to avoid invalid rules. such as “IF (Sex = male) AND (Sex = female)”

Second, rule that has been constructed in the previous step (Rt) by Ant t is pruned in order to remove irrelevant terms. Irrelevant terms may have been included in the rule due to stochastic variations in the term selection procedure and/or due to the use of a short-sighted, local heuristic function – which considers only one-attribute-at-a-time, ignoring attribute interactions.

Third, the amount of pheromone in each trail is updated, increasing the pheromone in the trail followed by Ant t according to the quality[21] of rule Rt and decreasing the pheromone in the other trails (simulating the pheromone evaporation). Then another ant starts to construct its rule, using the new amounts of pheromone to guide its search. This process is repeated until one of the following two conditions is met:

1. The number of constructed rules is equal to or greater than the user-specified threshold Number_of_ants, which will be set initially.
2. The current Ant t has constructed a rule that is exactly the same as the rule constructed by the previous Number_rules_converg – 1 ants, where Number_rules _converg stands for the number of rules used to test convergence of the ants.

Once the REPEAT-UNTIL loop is completed, the best rule among the rules constructed by all ants is added to the list of discovered rules, as mentioned earlier, and the system starts a new iteration of the WHILE loop, by reinitializing all trails with the same amount of pheromone.

## Simulation results

The data repository is populated with the normalized SEBT results in an earlier stage, the spurious data is filtered and discarded. The data repository is then divided into two groups: Training data and Testing data. Almost 60% of the data is selected randomly for training and the rest is used for validation. The parameters Number_of_ants, Min_cases _per_rule, Max_uncovered_cases, Number_rules_to_ converge can be varied to extract different set of rules. The various parameters for this implementation are set as follows:

Number_of_ants = 35.

Min_cases_per_rule = 5.

Max_uncovered_cases = 4.

Number_rules_converg = 4.

The ACO based ant-miner algorithm is applied to the training dataset with the above mentioned parameters and the rules are extracted. The rule cluster is described in table 2. Each rule extracted has a quality[21] associated with it, which is a measure of how well the rule can classify the input samples correctly.

The rules are applied to data and classification matrix is generated to evaluate the performance of the rules. The classification matrix is a n x n matrix, where n is the number of classes. A typical entry $q_{ij}$ in the classification matrix shows how many samples belonging to class i have been classified into class j. For a perfect classifier, the classification matrix

**Table 2:** Extracted Rule cluster.

| Rules | Class | Quality |
|---|---|---|
| (A≥36) and (AM≥24) and (PM≥35) and (PL≥52) and (L>18) and (AL>37) | 1 | 95% |
| (PL≤58) and (AL<67) | 2 | 95% |

**Table 3:** Classification Matrices.

| Training Data | | | |
|---|---|---|---|
| | Class 1 | Class 2 | Individual efficiency (%) |
| Class 1 | 20 | 0 | 100% |
| Class 2 | 1 | 19 | 95% |
| Overall Efficiency= 97.5% | | | |

| Testing Data | | | |
|---|---|---|---|
| | Class 1 | Class 2 | Individual efficiency (%) |
| Class 1 | 10 | 2 | 83.5% |
| Class 2 | 0 | 13 | 100% |
| Overall Efficiency= 92% | | | |

is diagonal. However due to misclassification we get off-diagonal elements.

The individual efficiency of class i is defined as

$$q_{ii} / \sum q_{ji} \quad (1)$$

for all j. The overall efficiency is defined as

$$(\sum q_{ii}) / N \quad (2)$$

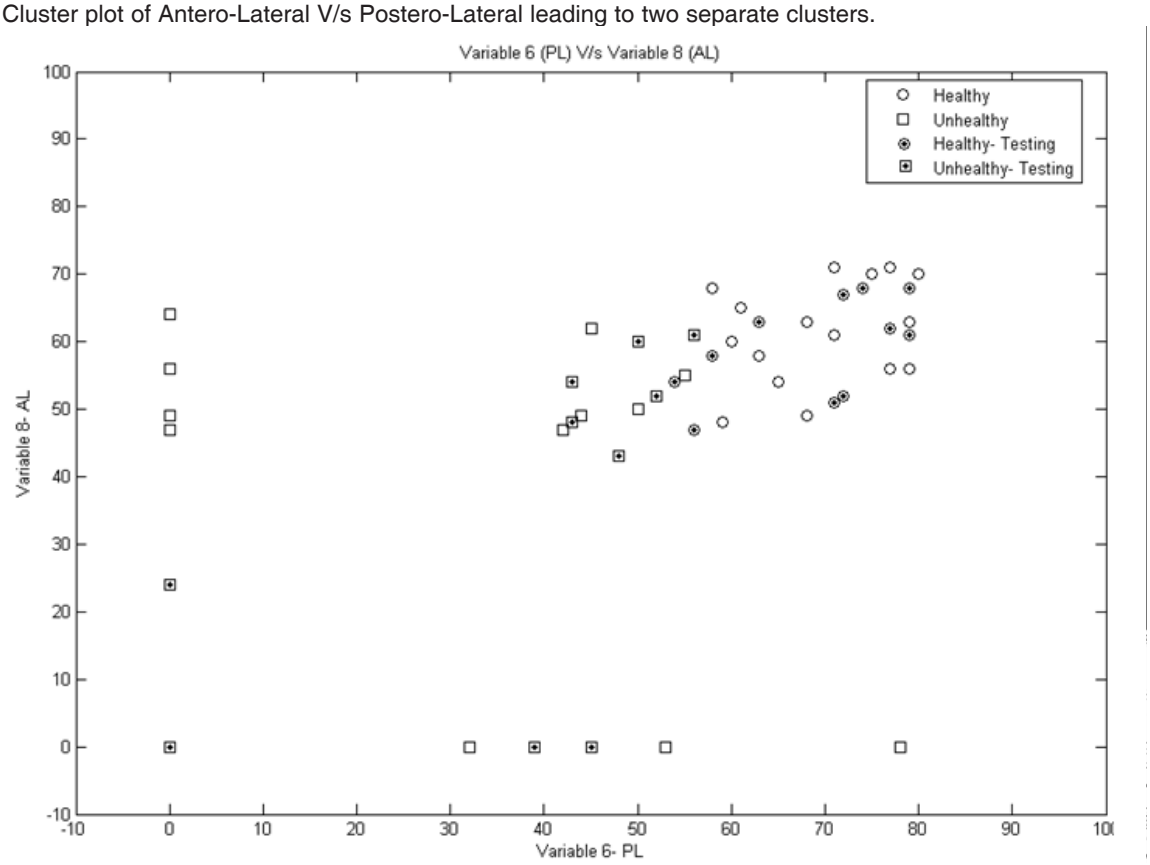
where N is the total number of elements in the dataset.

The rules are used to classify the training data. The results are very impressive; the individual efficiency of classification for class 1 (healthy) is 100% and that for class 2 (unhealthy) is 83.5%. The overall efficiency for the training data is 97.5%. The classification matrix for the testing data is given in table 3.

Next, the classification matrix for the testing data is created to assess impartiality, i.e. how the rules have performed on data other than the set used to form the rules. The outcome of the results for testing datasets is remarkable. The individual efficiency for testing data for class 2 (unhealthy) is 100% and for class 1 (healthy) it is 83.5%. The overall efficiency of classification for the testing data is 92%. This implies that the rules have functioned quite efficiently on data which was not used to formulate them. The classification matrices obtained for both training data and testing data is given in table 3.

It is to be noted that the rule for the unhealthy group has only two terms (corresponding to AL and PL) [Table 2]. This

**Fig. 3:** Cluster plot of Antero-Lateral V/s Postero-Lateral leading to two separate clusters.



means that these two terms are significant in classifying the given element as unhealthy. A cluster plot of AL and PL graphically depicts the knowledge extracted and is showed in Fig 3. It can be inferred from the graph that this fact leads to data clusters to be obtained for these two variables. From the graph, two separate clusters can be observed as expected, with a few overlaps around the value, PL = 56. Thus, given a particular case, its class, healthy or not, can be determined from this graph. This can be used as an aid to determine the health of the knee. This information assists apprentices as well as professionals.

## Conclusion

In this paper, the Ant Colony Optimization algorithm based pattern classification has been implemented successfully. Here, we have used Ant Miner algorithm to evolve rules. The results show that ACO is able to classify SEBT results quite efficiently. The simplicity of the rules generated and the subsequent ease of classification of testing data are notable.

The extraction of rule clusters was intended to allow a person with typical end-user skill level to utilize the rule systems with minimal assistance to draw considerable information about the health of the knee. The outcome from the simulation shows that the proposed approach of knowledge extraction is effective.

This is a generic technique which can be adopted for knowledge extraction and classification of other medical data or any data for that matter. This technique will prove to be of great assistance to professionals in various fields.

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# A study on the efficacy of upper extremity training on pulmonary function, exercise tolerance and dyspnea in chronic obstructive pulmonary disease population

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## Background & purpose of the study

Most of the Researchers have emphasized lower limb training or specific muscle endurance training and inspiratory resistance training. But it is very unfortunate because performance of many everyday tasks requires muscle group used in upper torso and arm postioning. So studies were carried out to analyze the effects of arm exercises in COPD. Ries et al showed that dyspnea and fatigue decreased in COPD patients[29]. Couser et al stated that pulmonary rehabilitation, especially arm exercises would lower the ventilatory requirement for arm elevation despite a lack of improvement in pulmonary function[30]. Belman et al suggested that unsupported arm exercises reinforce the effectiveness of exercise programmes of COPD in terms of pulmonary function test[31,32].

Alfaro et al showed that upper and lower extremity training produces significant increases in FVC and FEV1, although FEV1/FVC were unchanged and improves exercise tolerance in stable COPD[33]. Though so many investigators have studied the effects of upper extremity exercise on exercise performance, dyspnea during exercise, ventilatory muscle endurance, only few researches were carried out with its effect on pulmonary function and dyspnea during activities of daily living. My tiresome searches revealed very few studies that were carried out to find out the efficacy of Upper arm exercise training in COPD population. This effort of mine is to find out the efficacy of Upper arm exercise training in COPD population on Pulmonary functions, Functional Exercise tolerance and Dyspnea so that a quality Physiotherapy treatment could be rendered to the COPD population.

## Methodology

**Research design:** An experimental study design was chosen to determine the effects of unsupported arm exercise training on pulmonary function, functional exercise tolerance and dyspnea in patients with COPD. The study of unsupported arm exercises on COPD patients consist of the following variables. The dependent variables were pulmonary function, functional exercise tolerance and Dyspnea while the independent variable was specific unsupported arm exercises. It is a clinical trial with dependent variables of the study being measured before and after training.

**Setting:** The Research work (Subjects selection, Assessment, Intervention, and Data Collection Procedure) was performed at the TB Government Hospital, outpatient department of Moogambigai college of Physiotherapy and Rehabilitation, Chennai and Sakthi Poly clinic, Aynavaram, Chennai.

**Sampling:** The sampling technique used in this study was Simple Random Sampling. Totally 40 patients were selected for this study and they were randomly allotted into the experimental group and the control group consisting 20 subjects in each group.

## Criteria for selection

**Inclusion Criteria**: Chronic airflow obstruction ($FEV_1$ < 70% predicted, $FEV_1$/FVC < 70% predicted, < 15% improvement in $FEV_1$ after broncho dilatation with 200 µg of Salbutamol inhaled from a pressurized metered-dose inhaler with a spacer), Both Male and Female Sexes were included, Those who were medically diagnosed (by history, Physical Examination, Chest roentgenogram and pulmonary function testing) by a Registered Medical Practioner as COPD, An age of 20 to 80 yr, A stable clinical condition for at least 1 month, Exertion Dyspnea, Patients underwent cardiopulmonary exercise testing and echocardiography before inclusion in the study.

**Exclusion Criteria:** Severe hypertension with dizziness or syncope on exertion, Severe congestive heart failure refractory to medical management , Unstable coronary syndrome, Malignancy with bone instability or refractory fatigue, Neurological disorders, Musculoskeletal problems involving the Upper limb, Acute exacerbations of COPD, Cor pulmonale, End stage hepatic failure, Inability to learn, Psychiatric instability or disruptive behavior, Lack of motivation, Resting Dyspnea, Requirement of supplement oxygen, Co2 retention or use of any mechanical ventilatory support.

## Data collection procedure

40 subjects were selected for the study from the outpatient section of Moogambigai college of Physiotherapy and Rehabilitation, Chennai and Sakthi Poly clinic, Aynavaram, Chennai based on inclusion and exclusion criteria.

Consent of all the subjects were taken after explaining the objectives and the programme of the study and it is attached in Appendix D. Evaluations of the subjects (initially and after 4 weeks) were done using the evaluation chart and it attached in Appendix A.

## Tools for data collection

Evaluation Chart, Spirometry was used to measure pulmonary functions. (FEV1, FVC, $FEV_1$/FVC ratio and PEFR), 6 Minute walk test was used to measure Functional Exercise tolerance, American Thoracic Society Dyspnea Scale was used to measure Dyspnea.

## Programme schedule

**Specific Exercise Programme**

Experimental group was prescribed **The Unsupported arm exercise training**, the Exercise Protocol, as proposed by **Ries & Co workers**[35,67]**,** and it is given below.

- Dowl (weight 500-750g). gms.
- Lift to shoulder level for 2min at a frequency equal to breathing rate.
- Rest for 2min.
- Repeat sequence as tolerated up to 7-8 times (28-32min).
- Monitor dyspnea, heart rate.
- Increase weight (250g) every 5th session, as tolerated.
- Aim for 24 sessions

**Warm up and cool down exercises**

- Arm swinging forward and backward
- Elbow circling Right and Left
- Wrist circling Right and left.

**Duration**

- Duration of exercises : 38 – 42 Minutes.
- Warm up and cool down exercises : 10 Minutes.
- Specific Exercises : 28 –32 Minutes.

**Frequency:** 6 days a week for 24 sessions.

## Results and statistical analysis

FVC - Forced Vital Capacity
FEV1 - Forced Expiratory Volume in one second.
FEV1/FVC ratio - precent of Forced Vital Capacity and Forced Expiratory Volume in one second.

The table 1, reveals the Mean, S.D, T-Test and P Value of various Pulmonary Function Parameters i.e. FVC, FEV1, FEV1/FVC.

The Mean and S.D of pre test value of pulmonary function parameters (FVC, FEV1, FEV1/FVC) between experimental and Control group is statistically not Significant at P>0.05. Hence it clear that the selection criteria was strictly followed so there exist no bias between Experimental and Control group.

The Mean and S.D of post test value of pulmonary function parameters (FVC, FEV1, FEV1/FVC) between Experimental and Control group depicts that experimental group are higher than Control group .Comparison between post test value of Experimental and Control group shows statistically very high significance for FVC (p<0.001), high significance for FEV1 and FEV1/FVC (p<0.01).

Comparison of pre test & post test pulmonary function parameters (FVC, FEV1, FEV1/FVC) between experimental and control group is shown in graph 1a,

**Graph 1a:** Comparison of pre test & post test pulmonary function parameters (FVC, FEV1,FEV1/FVC)between experimental and control group.

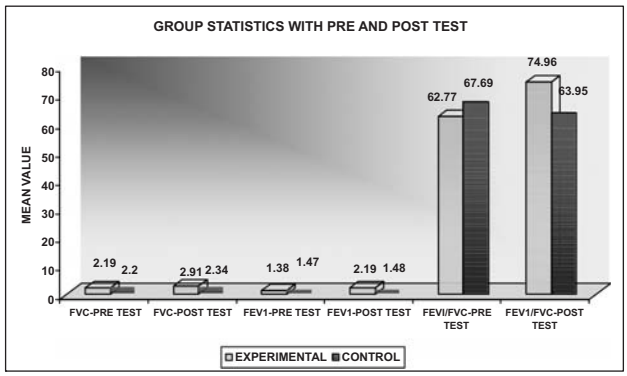



**Table 1:** Comparison of pre test & post test pulmonary function parameters (FVC, FEV1,FEV1/FVC)between experimental and control group.

**Group statistics (T-test).**

| Pulmonary Function Parameters | | Group (N= 20 each.) | Mean | Standard Deviation | T-test | Sig. (2-tailed) | P Value |
|---|---|---|---|---|---|---|---|
| FVC (litres) | Pre value | Experimental group | 2.1955 | 0.6974 | -0.025 | 0.980 | NS |
| | | Control group | 2.2005 | 0.5706 | | | |
| | Post value | Experimental group | 2.1900 | 0.6455 | 4.325 | 0.000 | SS*** |
| | | Control group | 1.4875 | 0.3331 | | | |
| FEV1 (litres) | Pre value | Experimental group | 1.3855 | 0.4887 | -0.660 | 0.513 | NS |
| | | Control group | 1.4760 | 0.3697 | | | |
| | Post value | Experimental group | 2.9155 | 0.6020 | 3.254 | 0.002 | SS** |
| | | Control group | 2.3410 | 0.5109 | | | |
| FEV1/FVC | Pre value | Experimental group | 62.7750 | 8.3701 | -2.187 | 0.065 | NS |
| | | Control group | 67.6950 | 5.5822 | | | |
| | Post value | Experimental group | 74.9676 | 14.0998 | 2.737 | 0.009 | SS** |
| | | Control group | 63.9559 | 11.1726 | | | |

**Table 2:** Comparison of pre test & post test pulmonary function parameters (PEFR)between experimental and control group.

**Group statistics (T-test)**

| Pulmonary Function Parameters | | Group (N= 20 each.) | Mean | Standard (N= 20 each.) | T-test | Sig. (2-tailed) | P Value |
|---|---|---|---|---|---|---|---|
| PEFR (litres) | Pre value | Experimental group | 3.1750 | 1.1352 | 0.236 | 0.814 | NS |
| | | Control group | 3.0995 | 0.8659 | | | |
| | Post value | Experimental group | 3.9210 | 1.0701 | 2.557 | 0.015 | SS** |
| | | Control group | 3.1290 | 0.8793 | | | |

**Table 3:** Comparison of pre test & post test Exercise Tolerance(6 minutes walk test) between experimental and control group.

**Group statistics(T-test**

| Exercise Tolerance Test Parameters | | Group | Mean Deviation | Standard | T-test (2-tailed) | Sig. Value | P |
|---|---|---|---|---|---|---|---|
| 6-minutes walk test (meters) | Pre value | Experimental group | 238.75 | 71.65 | -0.024 | 0.981 | NS |
| | | Control group | 239.25 | 58.23 | | | |
| | Post value | Experimental group | 280.30 | 79.60 | 2.200 | 0.034 | SS* |
| | | Control group | 232.25 | 56.60 | | | |

**Table 4:** Comparison of pretest dyspnea grading between experimental and control group.
Group * ATSDS - Pre Value

**Crosstab**

| | | | ATSDS - Pre Value | | | | |
|---|---|---|---|---|---|---|---|
| | | | Slight | `Moderate | Severe | Very Severe | Total |
| Group | EXPERIMENTAL GROUP | Count | 4 | 13 | 2 | 1 | 20 |
| | | % within Group | 20.0% | 65.0% | 10.0% | 5.0% | 100.0% |
| | CONTROL GROUP | Count | 4 | 14 | 2 | | 20 |
| | | % within Group | 20.0% | 70.0% | 10.0% | | 100.0% |
| Total | | Count | 8 | 27 | 4 | 1 | 40 |
| | | % within Group | 20.0% | 67.5% | 10.0% | 2.5% | 100.0% |

**Table 5:** Comparison of posttest dyspnea grading between experimental and control group.
Group * ATSDS - Post Value

**Crosstab**

| | | | ATSDS - Pre Value | | | | |
|---|---|---|---|---|---|---|---|
| | | | None | Slight | Moderate | Severe | Total |
| Group | EXPERIMENTAL GROUP | Count | 1 | 11 | 6 | 2 | 20 |
| | | % within Group | 5.0% | 55.0% | 30.0% | 10.0% | 100.0% |
| | CONTROL GROUP | Count | | 1 | 12 | 7 | 20 |
| | | % within Group | | 5.0% | 60.0% | 35.0% | 100.0% |
| Total | | Count | 1 | 12 | 18 | 9 | 40 |
| | | % within Group | 2.5% | 30.0% | 45.0% | 22.5% | 100.0% |

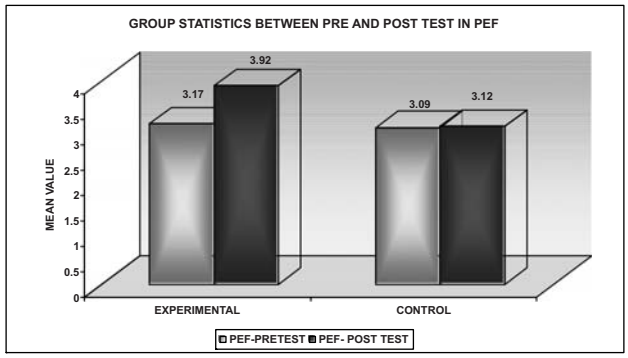
**Table 6:**

**Chi-Square Tests**

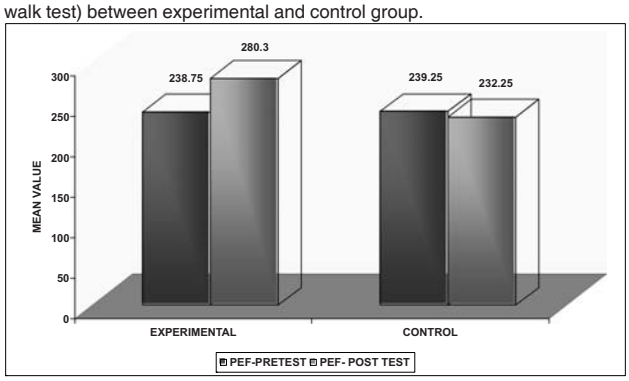
| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 14.111[a] | 3 | .003 |
| Likelihood Ratio | 16.118 | 3 | .001 |
| Linear-by-Linear Association | 11.560 | 1 | .001 |
| N of Valid Cases | 40 | | |

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is .50.

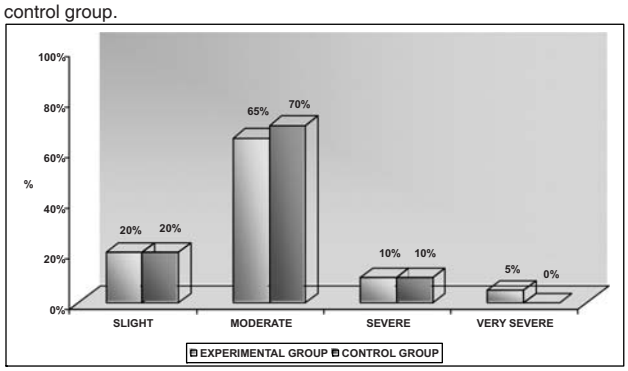
**Graph 2a:** Comparison of pre test & post test pulmonary function parameters (PEF) between experimental & control group.



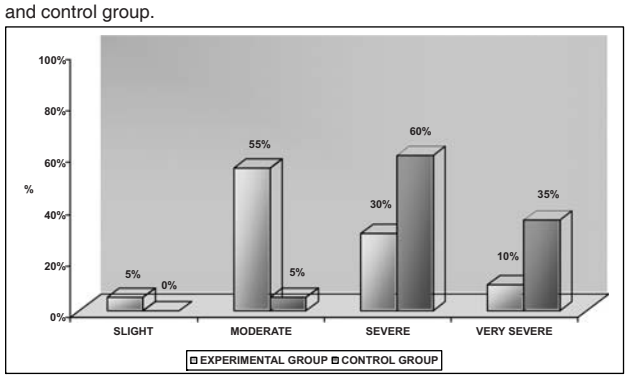

**Graph 3a:** Comparison of pre test & post test Exercise Tolerance(6 minutes walk test) between experimental and control group.




**Graph 4a:** Comparison of pretest dyspnea grading between experimental and control group.




**Graph 5a:** Comparison of posttest dyspnea grading between experimental and control group.




PEFR - Peak Expiratory Flow Rate.

The above table reveals the Mean, S.D, T-Test and P Value of Pulmonary Function Parameter, PEFR. The Mean and S.D of pre test PEFR between experimental and Control group is statistically not Significant at P>0.05. The post test value of Mean and S.D of experimental group are higher than Control group. Comparison between post test value of Experimental and Control group shows statistically high

significance for PEFR (p<0.01).

Comparison of pre test & post test pulmonary function parameters (PEFR) between experimental and control group is shown in graph 2a,

The above table reveals the Mean, S.D, T-Test and P Value of Exercise Tolerance Test Parameters (6-minutes walk test).The Mean and S.D of pre test 6-minutes walk test between experimental and Control group is statistically not Significant at P>0.05.So there exist no bias between Experimental and Control group. The post test value of Mean and S.D for 6-minutes walk test between Experimental and Control group depicts that experimental group are higher than Control group. Comparison between post test value of Experimental and Control group shows statistically high significance (p<0.01).

Comparison of pre test & post test Exercise Tolerance (6 minutes walk test) between experimental and control group is shown in graph 3a,

The above table reveals the pre test Dyspnea grading between experimental and Control group is statistically not Significant at P>0.05. It is inferred that the pre test Dyspnea grading was found to be equal between Experimental and Control group.The post test Dyspnea grading between experimental and Control group is statistically Significant at P<0.05. It is inferred that the post test Dyspnea grading was found to be not equal between Experimental and Control group.

Comparison of pre test and posttest dyspnea grading between experimental and control group is shown in graph 4a, 5a.

## Discussion

The importance of upper extremity in human beings is for manipulative purpose and skilled movements. The second being the ability to provide easier excursion of the thoracic wall. The primary inspiratory muscle is diaphragm and intercostals. The accessory muscles - sternomastoid, subclavius, pectoralis major and minor, serratus anterior, upper and lower trapezius, lattismus dorsi which share common anatomic arrangement are inactive during normal breathing. They have an extra thoracic anchoring point and a ribcage insertion. If they are fixed on their extra thoracic anchoring point, they can exert a pulling force on the ribcage. They partake in ventilation during strenuous circumstances. The hyperinflation of the thorax in patient with COPD places the inspiratory muscles at a mechanical disadvantage because it decreases the radius of curvature of the diaphragm and the length of its fibers. The COPD patients change their breathing pattern from one of predominately. So there is decreased respiratory muscle pressure generating capacity. So when the drive and load are increased, respiratory become more important in patient with poorly functioning diaphragm in patients with COPD. So improving the function of the muscles should prove beneficial to patients with ventilatory limitation[35].

There are few studies on the effects of unsupported arm training in the rehabilitation of patients with COPD. In India, the purpose of the present study is to focus the effect of 4 weeks upper extremity exercise on pulmonary function, Exercise tolerance and dyspnea in COPD patients. The pulmonary function parameters like Forced Vital Capacity(FVC), Forced Expiratory Volume in 1st second (FEV1), FEV1 / FVC, Peak Expiratory Flow Rate (PEFR), Exercise tolerance and dyspnea grading were measured in experimental and control before and after the study period of 4 weeks. The results of the study clearly showed the benefits of upper extremity exercise for patients with COPD. There is improvement in the pulmonary function, Exercise tolerance and dyspnea in patients after completion of the programme.

From table 1 and 2 it is inferred that the Mean and S.D of pre test pulmonary function parameters (FVC, FEV1, FEV1/ FVC, PEF) between experimental and Control group is statistically not Significant at P>0.05.The Mean and S.D of post test pulmonary function parameters (FVC, FEV1, FEV1/ FVC, PEF) between experimental and Control group is statistically Significant at P<0.05.The pre and post-test pulmonary function parameters in experimental group are statistically significant i.e., there is significant improvement in pulmonary function parameters after the training programme in experimental group. The pre and post test pulmonary function parameters like FEV1, FVC, FEV1/ FVC, PEF in control group are statistically non-significant. There is no significant change observed in these parameters. But FEV1, FEV1%, FEV1 / FVC ratio showed changes in the values of FEV1 and FEV1 / FVC. It showed decline in values of FEV1 and FEV1 /FVC ratio. As the control group received no support over and above their usual medical care, and there was no reason for the patients to expect an improvement in the results. The pulmonary function parameters between the experimental and control group are statistically significant i.e., there is significant improvement in pulmonary function parameters in experimental group when compared to control group. These findings were supported by Alfaro et al stating that upper and lower limb training showed significant increases in FVC and FEV1, although FEV1/FVC were unchanged[33]. Ramirez Venegas et al showed a significant increase in FEV1 by including upper and lower extremity training programme in their study[36].

From Table 3, it is proved that pre test value of 6-minute walk test between experimental and control group is statistically non-significant. There is significant improvement in the post test value between experimental and control group. These findings were supported by Levine S et al Suggested that the improvements noted in ADL, psychologic status (PS), and exercise tolerance (ET)[37]. Rick Carter et al stating that 6-minute walk test is the best measure to asses exercise capacity in patient with COPD[38]. Sherra solway et al the 6-minute walk test is currently the test of choice when using functional walk test for Clinical or research purpose[16]. Zu wallack et al observed an inverse relationship between degree of improvement and the baseline 12-minute walking distance[39].

From table 4, 5 & 6 it is proved that the pre test Dyspnea grading between experimental and Control group is statistically not Significant at P>0.05. The post test Dyspnea grading between experimental and Control group is statistically Significant at P<0.05. There is significant improvement in dyspnea grading in the experimental group at the end of the study. These results are parallel to the results of Sivori et al showed that upper and lower extremity training improved dyspnea, endurance and maximal static mouth pressure. The group trained with upper limits showed a remarkable improvement in dyspnea scale, endurance test and maximal static mouth pressure[40].

Results of this study showed statistical significance for the changes observed in dyspnea, pulmonary function parameters and exercise tolerance test embossed by the upper extremity training programme.

These positive training responses seen in pulmonary function can be attributed to the increase in respiratory muscle strength and endurance which is shown by Epstein et al, who stated arm training increase maximal inspiratory pressure and so ventilatory muscle training could be induced for muscles of ribcage that hinge on shoulder girdle[41]. Keens et al showed that arm exercise program could be used to train ventilatory muscles. The reduction in dyspnea can be attributed to the improvement in pulmonary function parameters especially FEV1 and increase in respiratory muscle strength[43].

Since upper-limb training is generally safe, does not necessarily require use of specialized equipments, and is easily incorporated into most exercise programme; the American Thoracic Society recommend that upper limb training be included routinely as a component of the rehabilitation of patients with COPD[28]. Hence it is strongly recommended that upper limb exercises training could be incorporated in pulmonary rehabilitation of patients with COPD.

## Conclusion

As the incidence of COPD increases, the challenge to the Physiotherapist to that illness and to help patient cope increases as well. This study proved the beneficial effects of 4 weeks upper extremity training programme in patients with COPD on

- Pulmonary Function.
- Functional Exercise Tolerance.
- Dyspnea.

Employing this programme to COPD patient, greater benefits can be drawn. Hence it is strongly recommended that upper extremity training programme should be regard as a main stay of rehabilitation for patient with COPD.

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# Standing balance: Quantification and the impact of visual sensory input

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## Abstract

### Aims

This experiment aims at quantifying the standing balance of subjects using Inertial Measurement Unit (IMU), and to estimate the importance of visual sensory input for balance and stability of subjects.

### Methods

A Total of 24 subjects participated in the tests. Mean age of the participated subjects is 44±20 years. In this work, we propose a system consisting of an IMU, a wobble board and a motion display system for real-time visual feedback for standing balance measurement. The standing balance is measured for two experimental conditions; with real time visual feedback and without visual feedback along the sagittal plane and the coronal plane. The display unit gives the real time orientation of the wobble board, based on which the subject applies necessary corrective forces to maintain neutral position. This helps in estimating the importance of visual sensory input for balance and stability of each subject. The subject is made to stand on the wobble board and the angular orientation of the wobble board is recorded for every 0.1 second time interval. The signal is analyzed using discrete Fourier transform. We quantify balance and stability using power spectral density.

### Results & conclusions

The subjects have better stability with real-time visual feedback as compared to stability without feedback along both the plane. This methodology is extremely useful in quantifying the standing balance of a subject, based on which, suitable physical therapy/ exercises can be suggested to the subject. The technique of visual feedback helps in enhancing the stability and can play crucial role in sports rehabilitation and geriatrics.

### Keywords

Balance, Stability, Vision, Power spectral density, Display unit, Inertial measurement unit.

## Introduction

Good stability and balance are necessary in order to independently perform acts of daily living and to avoid falls causing injuries and hospitalization. If we're off balance, we'll be excessively stiffening our muscles to compensate; these habits of stiffening will be interfering with the working of our whole body and the efficiency of our delicate balancing mechanism. Increased risk of falls has been correlated with impaired balance[1]. Subjects who demonstrate poor balance have nearly seven times as many ankle sprains as subjects who have good balance[2]. Maintaining a good balance requires inputs from visual, somatosensory and vestibular inputs[3]. The visual system has been shown to be important in the postural control by means of various tests[4,5,6]. A higher demand on somatosensory and vestibular information is vital for subjects with visual impairments to maintain stability [7,8]. In aged subjects, standing balance is mostly dwindled due to poor or absent visual feedback[9,10,11]. Difficulties with postural control and inadequate static balance have been reported in adolescents with visual impairments[10]. In Most of the cases, falls do not result in major physical injury or fatality, but the psychological impact of a fall can create fear in the subjects of further falling, which augments self-restriction of activities, therefore ensuing in a decline of physical and social activities, a higher danger of falling, and hence leading to increased dependence and a degeneration in overall quality of life[12,13,14,15]. It has been found that, training on balance and muscle function is salutary for health, physical competency and for the quality of life[16,17].

A great deal of work has been carried out to estimate standing balance of a person; by measuring the variation of CG of the body[18], comparing the change in the position of foot from the neutral position etc. In this experiment we are using an IMU, Wobble board and a real-time visual display system to measure the standing balance of a subject and to estimate the importance of visual sensory input for stability of the subject. The data recorded is treated as a signal and its power/ stability value is estimated using power spectral density. With this data suitable exercise or physical therapy can be suggested to the subject to help improve the subject's overall stability and balance.

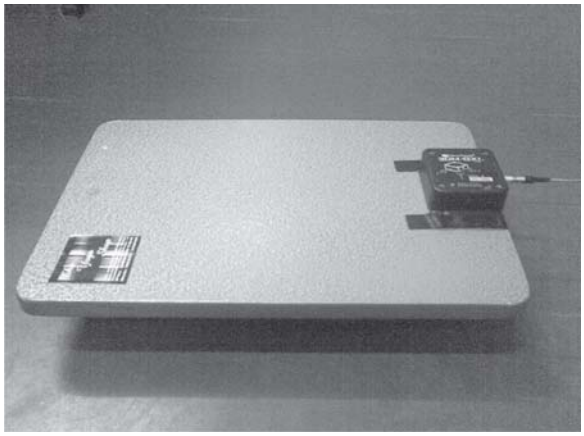
## Equipments

For this test we are using: Inertial Measurement Unit (IMU) to measure the angular orientation, a wobble board, and a personal computer to provide real-time visual feed back to the subject.

IMU 3DM-GX1 shown below in Fig.1, combines three angular rate gyros with three orthogonal DC accelerometers, three orthogonal magnetometers, multiplexer, 16 bit A/D converter, and embedded microcontroller, to output its orientation in dynamic and static environments, which operates over the full 360 degrees of angular motion on all three planes. This is mounted on the wobble board to measure its angular orientation in equal time intervals.

**Fig. 1:** Inertial Measurement Unit (IMU).


**Fig. 2:** Wobble Board Top Surface. The IMU is attached to the top surface of the wobble board.



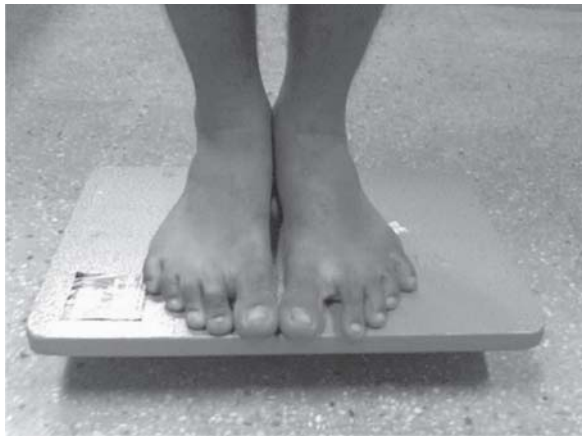
The wobble board used is a wooden rectangular plate with semi-cylindrical bottom as shown below in the Fig.2 and Fig.3. The subject stands on the upper portion, which is a flat, non-slippery surface. The bottom side, which rests on the ground, has a semi-cylindrical surface along the board length. This allows the board a total of 60 degrees of movement, ± 30 degrees of movement along longitudinal plane. Wobble board is mainly used for exercise to enhance balance stability[19].

## Methods

A total of 24 subjects participated in the tests of which 18 subjects are male subjects and 6 are female subjects. Mean age of the participated subjects is 44±20 years. Informed consent was obtained from all the subjects who participated in the experiment. Detailed instructions of the tests are given to all the subjects and each subject is given one practice run. The wobble board with IMU attached to it is placed on flat ground and the IMU is initially set to read zero degree. After providing suitable instructions, the subject is made to stand bare feet on the wobble board, with hands straight down, head kept straight, along the sagittal plane as shown in Fig.4 below.

**Fig. 3:** Wobble Board Bottom Side, with semi-cylindrical surface.

**Fig. 4:** Sagittal plane Movement.



The neutral position for the wobble board is when the board's flat surface is perfectly in parallel with respect to the ground. The wobble board is an unstable platform; the subject looses balance as soon as he/she stands on the wobble board. The subject tries to balance the wobble board about neutral position by applying suitable corrective force. The angular orientation of the wobble board is recorded for two different experimental conditions;

1. With real-time visual feedback: A personal computer/ visual display system is placed at a distance of one meter from the subject exactly aligned to the line of sight. The visual display system gives real time orientation of the wobble board; this is used to provide real time visual feed back to the subject, based on which, the subject tries to balance the wobble board about the neutral axis.
2. Without visual feedback: In this experimental condition, the subject tries to balance the board to neutral position without the aid of visual feedback system, with eyes open and head kept straight, facing a plane wall at a distance of 2.5 meters.
   This experiment is repeated along the coronal plane as shown in Fig.5.

## Measurement and data collection

The angular orientation of the wobble board is recorded at every 0.1 second time interval by the IMU. The data is recorded directly into the computer with the help of the software provided with the IMU. In each test, the data is

**Fig. 5:** Coronal plane Movement.

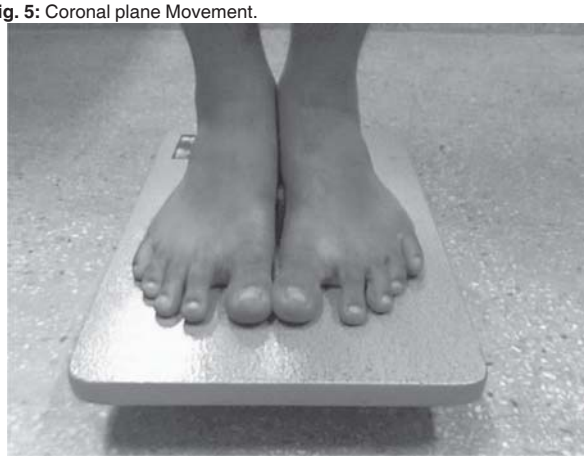
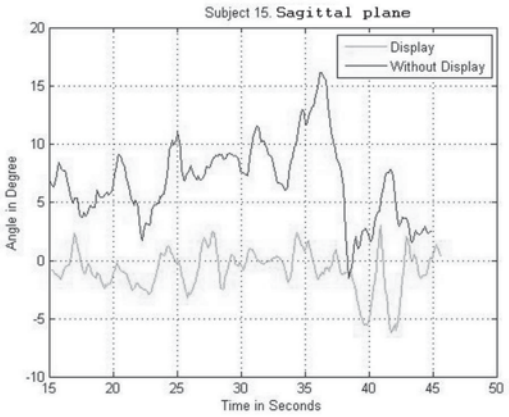


**Fig. 6:** Subject 15-Typical run along sagittal plane. Total time period considered is 30 seconds. X-axis indicates time in seconds (15sec to 45 sec). Y-axis indicates the angular orientation of the wobble board in degree.




recorded for a total time of 50 seconds for each subject. Initial 15 seconds and the last 5 seconds of the recorded data are not considered during analysis because of the subject getting on and off the wobble board respectively. The angular changes of the wobble board about the neutral axis for sagittal plane is shown below in Fig. 6 and for the coronal plane is shown in Fig.7 respectively.

Data analysis:

The data obtained, i.e. the angular orientation of the wobble board with respect to time can be treated as a signal. For any given random signal, power spectrum describes how the power of a signal or time series is distributed with frequency[20]. Power spectrum is used for varied application from identifying noise in a given signal to estimating the systolic blood pressure to analyzing the colour characteristics of a particular light source. To analyze the data, Discrete Fourier Transform (DFT) is used. DFTs are extremely useful because they reveal periodicities in input data as well as the relative strengths of any periodic components[20]. The results of Fourier transform of the data is a complex vector output. The magnitude of the Fourier transform output squared is called the estimated power spectrum[20].

Now consider the test data as a signal, in which the angular degree of the wobble board's movement can be treated as the amplitude of the signal. Since the signal power is dependent on the board's angular degree (amplitude) and the rate of change of angle of the board, we can say that smaller the rate of change and smaller the angular

**Fig. 7:** Subject 15-Typical run along coronal plane. Total time period considered is 30 seconds. X-axis indicates time in seconds (15sec to 45 sec). Y-axis indicates the angular orientation of the wobble board in degree.

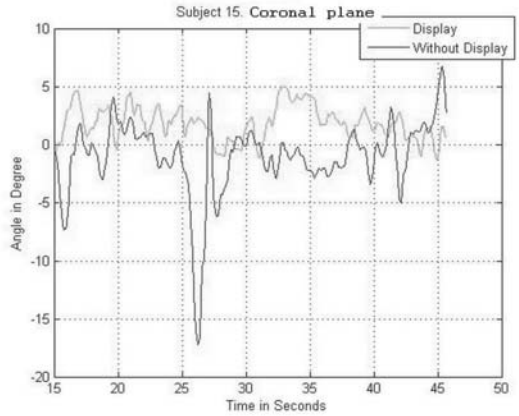
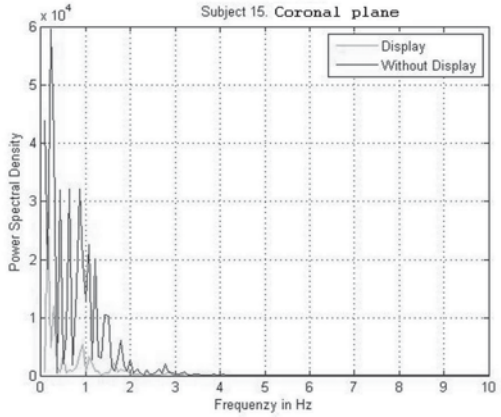



**Fig. 8:** Subject 15-Typical run along coronal plane. X-axis Frequency in Hz. Y-axis indicates Power Spectral Density PSD.




variation of the wobble board from the neutral point, smaller its power. Hence, the test data with smaller power refers to more stability. In this test, the data from each trail can be treated as a signal and its power/ stability value within a specific frequency range is obtained by integrating power spectrum within that frequency range. The Fig.8 below shows power spectral density versus frequency plot for one subject, with and without real-time Visual feedback in the coronal plane.

## Results

The balance tests along sagittal and coronal plane are conducted for each subject and the respective power/ stability values are estimated. Fig.9 below shows the comparison of the power/ stability values of the tests along sagittal plane and coronal plane, with and without real time visual feedback.

From the Fig.9 it is apparent that the subjects have better stability with real-time visual feed back as compared to stability without feedback along both the planes. The subjects have shown 35% better stability along sagittal plane and 62% better stability along coronal plane with real-time visual feedback as compared to stability without visual feedback. Subjects have displayed maximum stability along the coronal plane with real-time visual feedback.

The Table.1 and Table.2 shown below indicates the power/ stability value along sagittal plane and coronal plane respectively, as a comparison between most stable subject

**Fig. 9:** Mean power/ Stability value along sagittal plane and coronal plane with real time visual feedback and without feedback is shown. Lower power indicates better stability.

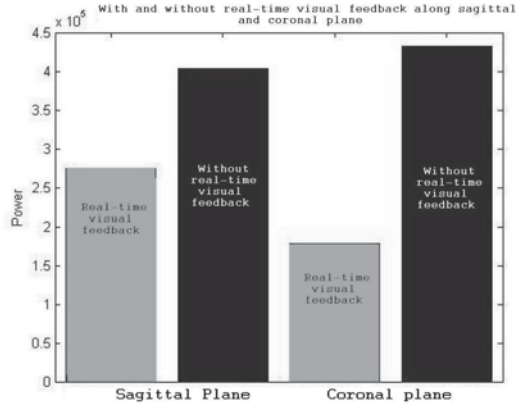



**Table 1:** Comparison of Power/Stability values along sagittal plane with real-time visual feedback and without feedback.

| SAGITTAL PLANE POWER / STABILITY VALUE | | | |
|---|---|---|---|
| SAGITTAL PLANE With real-time visual feedback | | SAGITTAL PLANE Without real-time visual feedback | |
| Subject | POWER ($x10^5$) | Subject | POWER($x10^5$) |
| Mean power/ stability value | 2.7447 | Mean power/ stability Value | 4.0328 |
| Subject 15 (Maximum Stability) | 0.89192 | Subject 9 (Maximum Stability) | 1.54262 |
| Subject 7 (Least Stability) | 8.88734 | Subject 21 (Least Stability) | 10.9326 |

and least stable subject with respect to the mean power/ stability value of all the subjects. It can be seen that subjects have displayed better stability with real-time visual feedback in both the test cases.

## Discussions and conclusions

From the test results it can be seen that, on an average, subjects have shown better stability with real-time visual feedback. The use of a real-time visual feedback system will assist the subjects to balance better on an unstable platform. The stability of subjects can be improved with suitable exercises on an unstable platform[19] with the aid of a real-time visual feedback. In this experiment, the aid of real-time visual feedback also helps in estimating the importance of visual sensory input for standing balance of each subject. In the world of sports, it is extremely useful to asses the stability of sports persons, as subjects who demonstrate poor balance have nearly seven times as many ankle sprains as subjects who have good balance[2]. Balance and walk impairments in elderly citizens has increased the risk of falls, which constitutes to a majority of accidental casualty and injury-related visits to hospitals [21]. The psychological impact of a fall can create fear in the subjects of further falling and can dwindle the subjects overall social activity. As a result, it is crucial to look into improper balance in order to identify elderly citizens at risk of a fall, and to reduce balance impairment. This experimentation technique can also be used as a screening tool in population based studies to measure the standing balance of subjects; identify individuals with a balance dysfunction and in clinical rehabilitation. Standing balance measurement will help in clinical practice to estimate a subject's current stability and can be used as a reference to monitor improvement in neuromuscular function of patients

**Table 2:** Comparison of Power/ Stability values along coronal plane with real-time visual feedback and without feedback.

| CORONAL PLANE POWER/STABILITY VALUE | | | |
|---|---|---|---|
| CORONAL PLANE With real-time visual feedback | | CORONAL PLANE Without real-time visual feedback | |
| Subject | POWER ($x10^5$) | Subject | POWER($x10^5$) |
| Mean power/ stability Value | 1.7845 | Mean power/ stability Value | 4.3287 |
| Subject 20 (Maximum Stability) | 0.80364 | Subject 16 (Maximum Stability) | 1.70057 |
| Subject 2 (Least Stability) | 7.31739 | Subject 21 (Least Stability) | 11.1391 |

with injuries to the lower extremities undergoing rehabilitation. This can also be used to estimate the difference in stability between left leg and right leg of a subject. From the test results obtained, we can also compare the stability of one subject with another subject, for example, the stability of a subject with leg injuries or related problems can be compared to a healthy subject's stability value.

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# Effect of exercise on functional independence after abdominal surgery in the elderly

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## Abstract

### Background

Aging is associated with increased prevalence of multiple diseases, with decline of the functional reserve of many organs and systems and a progressive restriction in personal and social resources. Therefore this designed to clarify the effect of exercise on recovery.

### Methods and design

A prospective cohort of 174 consecutive patients recruited from General surgery department of El-Mataria Teaching Hospital, Cairo, Egypt, with 68.2±5.3 years (60 to 75 years), underwent open abdominal surgery, they were randomly divided into; Mobilizing Group (MG= 80); Non-mobilized group (NMG=75). After surgery MG participated in mobility program; range of motion exercise, sitting out of bed, trunk flexibility exercises, upper limb elevation exercise using bottles and walking exercise. Non-mobilized group (NMG=75) instructed to keep their activity level without changes. The primary assessment includes; Time Up and Go Test (TUGT), Functional reach test (FRT) and hand grip strength. There were no significant difference in TUGT, FRT, and grip strength between MG and NMG group preoperatively and at 1 and 3 weeks, postoperatively with significant decline in functional recovery.

### Results and conclusion

There were significant differences at 6 weeks, 3 and 6 months postoperatively with greater improvement in functional recovery to preoperative level for mobilizing group. Surgical treatment can be offered to elderly patients 60 years old but with predictable decline in functional independence. Collaboration between surgeon and physiotherapist for establishing an effective rehabilitation program may be helpful for restoring their function independence.

### Key words

(geriatric, abdominal surgery, rehabilitation.

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## Background

In Egypt; the elderly population represented about 6.3% from the total population. This will increase to11.5% by the end of 2025 year, with greater percentage 86% for those ranged in aged between 60 to 70 years old from total percentage of geriatric population, with life expectancy of 71 years[1].

These change in patients' demographic result in increasing older patients' presentation for surgery and postoperative care. Advance in surgical practice and introduction of minimally invasive surgical approaches enable the sicker patients to be eligible for surgery with less morbidity and mortality rates. Therefore rehabilitation of surgical patients is becoming an increasingly important component of surgical care in the 21st century[2].

Despite these facts; there are few data to guide the expectations of patients, families and clinicians about the natural history of recovery in functional independences following major abdominal operation in elderly people. Most earlier research focus on short term recovery (e.g. anesthesia interventions, cognitive recovery, pulmonary complications, open versus laparoscopic procedures), while long term recovery of functional independence were less[3].

Postoperative disability has an incidence of 38 to 69% in elderly hospitalized medical and surgical patients and associated with changes in mood, coordination, muscle strength, balance, and work tolerance[5,6]. Moreover aging is associated with increased prevalence of multiple diseases, with decline of the functional reserve of many organs and systems and a progressive restriction in personal and social resources[7,8].

Therefore physiotherapists have been particularly concerned with the role of early mobilization and exercise that might play a role in treating the effects of acute illness and acute deconditioning on elderly medical and surgical patients during and after hospitalization[5].

Physiotherapy treatment for patients after open abdominal surgery consists of a variety of interventions(e.g lung expansion exercises, secretion clearance techniques, limb exercises and progressive mobilization programs) intended to improve cardiopulmonary and / or physical functions and reduce incidence of postoperative pulmonary complications, which may have positive effects on depression and anxiety level[8-10]. However there is no standard definition for early mobilization, and it has been reported to include; moving in bed, sitting out of bed, standing, ambulating on the spot, hallway ambulation, and low intensity exercises[11,12].

Studies have examined the positive effect of conventional rehabilitation (conditioning, ambulatory training, transfer and balance training) and inpatients

multidisciplinary programs on function[13], Nevertheless, such study were not performed on elderly people with acute medical illnesses. A recent trial has shown that passive mobilization of lower limb during critical illness could prevent the loss of muscle mass in adult, but the effects on function were not investigated[14].

Also little research details the course of full recovery to preoperative levels of independence after major abdominal operations. Previous studies are relatively small; assess recovery over shorter follow up or few time points and use limited self-report measures of functional status[15,16].

While using performance-based measures (Time Up and Go Test, Functional Reach Test and grip strength) may capture impairment and functional limitation more accurately than self-reported conditioning and self-reported activity of daily living.

We conducted a prospective cohort study to systematically describe the course of long term recovery to preoperative levels of functional independence following exercise after major abdominal operations in elderly patients.

## Methods

One hundred and seventy four patients underwent abdominal surgery at general surgery department of El-Mataria Teaching Hospital were enrolled in the study from August 2007 through July 2008. Participants were excluded if they were too medically unwell to ambulate or exercise, (e.g. intubated and ventilated within 24 hours postoperatively) or a condition for which mobilization was contraindicated (e.g. deep vein thrombosis, or developed major postoperative complications), unable to understand written or verbal instructions or, were not willing to participate, and not available for postoperative care.

Of 174 patients, 155 patients completed the study, and randomly divided into two groups. Mobilizing Group (MG=80) participated in standardized program of early mobilization. Non-mobilized group (NMG=75) instructed to perform range of motion to decrease risk of joint contractures and joint stiffness. From day 2, patient started to ambulate 3 times daily to the point of mild fatigue with or without assistive devices (walkers, canes) until time of discharge. At home the patients instructed to keep their activity level without changes from before the study.

In a preadmission clinic: preoperative history, examination and investigations were done considering preoptimization of medical conditions that may require cross specialty involvement and high dependence care for all patients. Surgical procedures were explained in details to the patient to create excellent doctor-patient rapport. Physical therapy assessments are performed and informed written consent was obtained.

## Assessment procedures

Nurses and caring doctors were blind to the study groups. The postoperative care of each group was identical. The primary assessment includes; Time Up and Go Test (TUGT), Functional reach test (FRT) and hand grip strength. The assessments were measured preoperatively ($T_0$), one week postoperatively ($T_1$), three weeks ($T_2$) , six weeks ($T_3$), three months ($T_4$), and six months ($T_5$) .

Time Up and Go Test (TUGT); that contain different component for coordination, balance, burst lower extremity strength for rising from a chair, and ability to turn 180 degrees in clockwise and counter-clockwise direction. The TUGT was measured using procedure adapted from Podsiadlo and, Richardson[17,18]. Equipment included arm chair, tape measure, tape, stop watch. Begin the test with the patient sitting correctly in a chair with arms, the patient's back should resting on the back of the chair and wears their regular footwear. The chair should be stableand positioned such that it will not move when the subject moves from sitting to standing. Place a piece of tape or other marker on the floor 3 meters away from the chair so that it is easily seen by the subject. Instructions: "On the word GO patient will stand up, walk to the line on the floor at your regular pace, turn around and walk back to the chair and sit down. Therapist calculates time (in seconds) spent in performing such activity.

Functional Reach Test (FRT); the function reach test was measured using procedure adapted from those described by DeWaard[17,19]. Equipment included a Westcoot meter stick (Acme United Corporation, Fairfield Conn) affixed to a wall with Velcro, and aligned horizontally with the floor surface. Measurement was recorded in centimeter (cm).

Patients performed the functional reach test by standing perpendicular to, but not against the wall on which the meter stick was affixed and stood with their feet placed 10 cm apart as measured between the medial malleoli of each ankle. The meter stick was adjusted to the level of each patient's acromion process. Patients were asked to flex their right shoulder to the level of the meter stick while keeping the contralateral upper extremity at their side in a neutral position. Next, the therapist assessed and adjusted postural alignment in this position to prevent excessive shoulder protraction or retraction and made note of the starting point by evaluating the tip of the patient's middle finger in relation to the meter stick. Patients were then instructed to reach as far forward as possible without losing their balance, talking a step, or touching the wall. This position was maintained for 3 seconds, after which the therapist again noted the position of tip of the patient's middle finger in relation to the meter stick. The displacement of the tip of the patient's middle finger between the starting and ending positions was recorded to the nearest 0.1 cm as the magnitude of the patient's functional reach test.

Hand grip strength; Hand grip is a surrogate measure of upper-limb muscle strength and has been shown to predict functional decline and overall mortality in older adults. Hand grip strength is measured in Kilograms using hand healed dynamometer (Sammons Perston Sangamon, Chicago, USA). It provides simple adjustment for five-size position and permits maximal isometric contraction. The dynamometer was set on second handle position which is used to measure strength of intrinsic and extrinsic hand muscles. The patient was instructed to assume the setting position with back support while dominant limb placed in shoulder adduction and internal rotation, elbow flexion, forearm in mid position and wrist in neutral position, and then instructed to squeeze the dynamometer as mush as possible. The tests performed three trials and the mean value was recorded as a test value for establishment of reliability[20].

## Therapeutic procedures

Preoperatively, all patients were educated about the role and benefit of early mobilization, and encouraged to

perform it within 24 hours postoperative. The patients in MG participated in mobility program that implemented and supervised by the physiotherapists and consisted of exercises for the upper limb, lower limb, and trunk. The exercise program was supervised twice daily, five days per week and approximately 20 to 30 minutes for each exercise session during hospitalization period[8].

On post operative day 1 & 2; Range of motion exercise (ROM): ankle planter and dorsiflexion and knee flexion extension exercise, sitting out of bed for 5 minutes and walk 5 and 15 m without assistance respectively.

On postoperative day 3-6; Trunk flexibility exercises consisted of;(1) flexion and extension, (2) lateral bending, and (3) rotation. The initial starting position of exercise was sitting on chair. Each patient was instructed to lean forward, and then return to staring position (for flexion and extension), bend to the right and then to the left for lateral bending, and to rotate the trunk slowly to right and then to the left for trunk twisting exercises. Rising from chair motion exercises while gripping parallel bars. Each patient was instructed to slowly stretch the muscle to a point of slight discomfort, and hold that position for 10seconds with six repetitions[22].

Upper limb elevation exercise using free bottles latter in each hand and moved both upper limbs up and down, back and forth in the sitting position on chair, after that walking 30 m without assistance[23].

From postoperative week 1 to 4; trunk flexibility exercises, upper limb elevation, walking activity performed three times weekly according to the modified protocol of Pesanelli et al[24], as following;

Trunk flexibility exercise was performed from standing position for six times and increased by 3 repetitions per week. The time for holding the position was increased by two seconds each week, therefore the final trunk flexibility exercises were 15 repetition, and the count for holding was 16 seconds at the end of rehabilitation period.

Upper limb elevation exercise using bottles field with (500, 750, 1000, 1250 ml of water, for 1st, 2nd, 3rd, and 4th weeks postoperative respectively) in each hand and moved both upper limbs up and down, back and forth in the sitting position on chair,

Progressive walking activity on treadmill with 1 .19 m/s (2.7 mph),0° incline, 1.32 m/s (3.0 mph), 0° incline and 1.32 m/s (3.0 mph), 5° incline for 1st, 2nd, and 3rd, and 4th weeks postoperative respectively.

## Data analysis

Mean and standard deviation used for continuous variables and relative frequency for categorical variables. One way ANOVA was used for comparative analysis of within group variables, with Scheff test as a post- hoc test[24]. The mean changes between two groups were assessed with unpaired t test. The level of significant assumed at (Pd" 0.05). All analysis was performed using Statistical Package of Social Science (SPSS) version 15.

## Results

### Study Cohort and follow up

Of one hundred and seventy four patients entered the study, 5(2.87%) of them died (two of them died during surgical intervention and three died during postoperative period, from sever sepsis and malnutrition) and 14(8%) didn't complete the study. Therefore only 155 patients completed the study. Patients' data were available for 733 (94.58%) of the 775 total postoperative assessments, with 90% of patients had at least 4 to 5 possible postoperative assessments.

**Table 1:** Demographics Characteristics and Types of Operation in all patients.

| Variables | MG | NMG Mean ± SD | p-value Mean ± SD |
|---|---|---|---|
| Age (years) | 69±6 | 67±4.5 | 0.57† |
| BMI(Kg/m²) | 26.41±1.29 | 26.92±1.32 | 0.9† |
| Types of operation N(%) | | | |
| Open cholecystectomy | 16(20%) | 13(17.3%) | 0.59† |
| Abdominal exploration | 9(11.25%) | 8(10.7%) | 0.89† |
| Inguinal hernias | 20 (25%) | 18(24%) | 0.9† |
| Incisional hernia | 9(11.25%) | 6(8 %) | 0.6† |
| Par-umbilical hernia | 8(10%) | 11(14.7%) | 0.6† |
| Splenectomy and devascularization | 11(13.75%) | 9(12%) | 0.6† |
| Miscellaneous | 7(8.75%) | 10(13.3%) | 0.87† |
| Type of anesthesia N(%) | | | |
| General anesthesia | 50(62.5% ) | 43(57.3%) | 0.66† |
| Local anesthesia | 20(25% ) | 18(24%) | 0.83† |
| Neuroaxial anesthesia | 10((12.5%) | 14(18.7%) | 0.4† |
| Surgical duration | 45.15±8.56 | 48.2±7.3 | 0.2† |
| Total | 80 | 75 | |

BMI=Body mass index, ± SD=Standard deviation. † non-significant (P>0.05)

### Baseline characteristics

Table 1 shows baseline demographic and operative characteristics (age, body mass index, types of operation, type of anesthesia and surgical duration) between MG and NMG were comparable with non statistical significant differences (P>0.05).

### Course of recovery

Fig. 1 shows the recovery time curves, number of patients assessed for TUGO, FRT, grip strength, andSf-36 questionnaires.

**Fig. 1:** Functional recovery after major abdominal operation for mobilizing and Non- mobilizing groups.

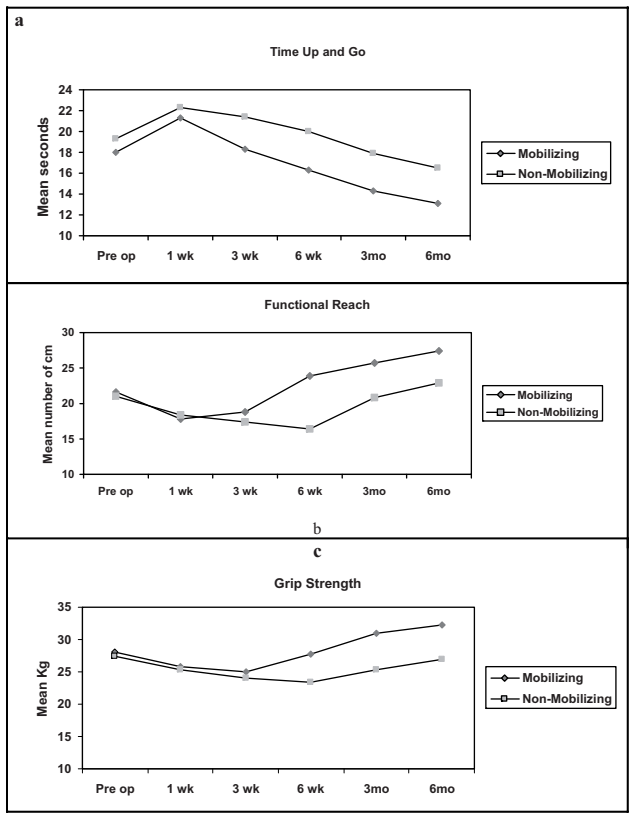

**Table 2:** Mean values of parameters between mobilizing & non mobilizing groups.

| Time of assessment | Groups | TUGT (sec) | FRT (cm) | Grip Strength (Kg) | P-value |
|---|---|---|---|---|---|
| $T_0$ | MG | 18±2.1 | 21.6±4.32 | 28±5.2 | P>0.05 |
| | NMG | 19.3±3.2 | 21±5.9 | 27.4±10.7 | |
| $T_1$ | MG | 21.3±6.9 | 17.8±5.1 | 25.8±9.6 | P>0.05 |
| | NMG | 22.3±4.9 | 18.4±5.7 | 25.4±10.6 | |
| $T_2$ | MG | 18.31±6.9 | 18.8±5.1 | 25±5.6 | P>0.05 |
| | NMG | 21.4±3.7 | 17.4±3.8 | 24±9.6 | |
| $T_3$ | MG | *16.3±7.4 | *23.9±3.7 | *27.7±4.6 | P<0.01 |
| | NMG | 20±3.7 | 16.4±3.3 | 23.4±6.8 | |
| $T_4$ | MG | *14.3±4.7 | *25.7±4.9 | *30.9±5.6 | P<0.01 |
| | NMG | 17.9±7.3 | 20.8±3.9 | 25.5±6.8 | |
| $T_5$ | MG | *13.1±3.2 | *27.4±3.2 | *32.2±3.2 | P<0.01 |
| | NMG | 16.5±3.5 | 22.9±3.6 | 27±5.5 | |

* indicated significant differences between MG&NMG (P<0.01)
preoperatively ($T_0$), one week postoperatively ($T_1$), three weeks ($T_2$), six weeks ($T_3$), three months ($T_4$), and six months ($T_5$).
TUGT=time up and go test, FRT=functional reach test.
MG=mobilizing group
NMG=non-mobilizing group

Regarding TUGT; significant increases were observed in the TUGT from 18±2.1seconds and 19.3±3.2 seconds preoperatively ($T_0$), versus 21.3±6.9seconds 22.3±4.9second at one week PO ($T_1$) for mobilizing and non-mobilizing groups respectively. While there were significant decrease in TUGT to 16.3±7.4seconds at six weeks PO ($T_3$), 14.3±4.7seconds at three months PO ($T_4$), and 13.1±3.2 seconds at six months PO ($T_5$), with rate of changes was 9.4% at ($T_3$), 20.6% at ($T_4$), and 27.2% at ($T_5$). For non-mobilizing group, there were non significant decrease in TUGT at six weeks PO ($T_3$), 20 ±3.7 seconds and at three months PO ($T_4$) 17.9±7.3seconds, and at six months PO($T_5$), 16.5±3.5seconds with rate of changes of 3.6% at ($T_3$), 7.25% at ($T_4$), and 14.5% at ($T_5$).

Functional Reach Test; the FRT decreased significantly from 21.6±4.32cm and 21±5.9cm preoperatively ($T_0$), 18.8± 5.1cm to 17.4±3. 8cm at three weeks PO ($T_2$) for mobilizing and non mobilizing groups respectively. For mobilizing group observed significantly increased of FRT, at six weeks ($T_3$) to 23.9±3.7cm, 3 months PO ($T_4$) 25.7±4.9cm, with maximum significant increase at six months PO ($T_5$) 27.4±4.6cm, compared with preoperative baseline, with rate of changes was 10.64% at ($T_3$), 18.98% at ($T_4$), and 26.85% at ($T_5$). For non-mobilizing group the FRT increased nearly to preoperative value at three months PO ($T_4$), 20.8±3.9cm and increased significantly to 22.9±3.6cm at six months PO ($T_5$), respectively, with rate of changes was 9.4% at ($T_5$).

The grip strength; the mean grip strength fell from 28.0±5.2kg and 27.4±10.7kg preoperatively ($T_0$), to 25±5.6kg and 24±9.6kg at three weeks PO ($T_2$) for mobilizing and non mobilizing group. A gradually significant increased of grip strength observed at three months PO ($T_4$) 30.9±5.6kg, and six months PO ($T_5$) 32.2±3.2kg (P<0.001), with rate of changes was 10.35% at ($T_4$), and 15% at ($T_5$), for mobilizing group. The grip strength remained significantly worse through six weeks PO ($T_3$), to three months PO ($T_4$), 23.4±6.6kg and 25.4±9.6kg respectively, and strength reach the preoperative value at six months PO ($T_5$) 27 ±7.6kg for non mobilizing group.

## Discussion

As medical and surgical problems affecting elderly patients cover multiple fields and require a coordinated approach among medical and surgical professionals, elderly patients often have multiple additional needs: social, psychological, economic, rehabilitative, and nursing when they become disabled after surgery. The postoperative functions of patients such as activity of daily living and QoL are important among the outcomes of surgical treatment and rehabilitation for the elderly. However there have been only a limited number of reports on the natural course of recovery of functional independence[26].

We have conducted a prospective study with special reference to the postoperative functions of patients 65 years or older who underwent major abdominal surgery. Standard tools were used for the preoperative, and postoperative evaluation of physical conditions, (time up and go test, functional reach test and grip strength), and quality of life so that the results obtained from this study can be widely applied to elderly abdominal surgical patients.

The systematic review of the previous study[27,28], on the postoperative recovery of functional dependence showed that elderly patients frequently showed a transient decrease in (TUGT, FRT, and grip strength) immediately after surgery, at one and three weeks after surgery, which is in agreement with results of this work that demonstrated gradual decline in functional dependence during this period in both groups. These may attribute to physiological disturbance that may occur in the immediate postoperative period, and interfere with patients' recovery. In addition significant symptom distress (e.g. pain, fatigue, nausea, vomiting), and functional status influencing the patient's recovery postoperatively[29].

However, patients displaying a decrease at one week or at three weeks after surgery, there was difference in the postoperative long-term recovery observed at 6 months in functional dependence when compared with immediately postoperative level between the patients who involved in exercise therapy program with more return to the preoperative level of functional dependence in mobilizing group compared with non mobilizing group.

Ferrucci et al[30] reported similar findings. Either some complications or accidental events that occur after a transient recovery or less effective physical rehabilitation at home and in outpatient clinics may be responsible for the disability.

Timonen[31] reported that a multi-component training program that included strength training after an illness was an effective form of rehabilitation woman older than 75 years old, and that its beneficial effects lasted for at least 9 months after training, and concluded that aged patients may need more active and intensive rehabilitation that includes exercise at home, at outpatient clinics, or in nursing homes to restore and stimulate their function after discharge.

In the mobilizing group, FRT reported significant difference than non mobilizing group that may be due to the raising from chair exercise that reinforce muscles strength of the lower limb as well as whole through improvement of strength of abductor and adductors groups of the hip joints, flexor and extensor groups of hip and knees joints, leading to improvement of lower limb stability. In addition, repetition of standing and sitting motion improved dynamic balance.

Fukunaga[32,33] described that the most effective exercises to reinforce lower limb muscle strength in the elderly is rising from-chair or rising from bed exercises, and the ability of quick rising is the most important capacity in daily life for the elderly. He also said that rising from chair motion, which is repetition of the simple motion of standing up from the chair and sitting again, is highly safe without requiring

excessive flexion and extension of hip and knee joints. In addition, rising from chair motion in the mobilizing group improved both aspects of endurances and quickness which is important for balance activity of the elderly. The grip strength significantly increased ($P<0.05$) , these results are considered to be the effect of combined motion training used in this study such as exercise of the upper limb s as whole with grasping the PET bottles, and grasping the bar while rising from chair instead of training for individual muscles.

Of the patients 69 years old or older who underwent major abdominal surgery, only those involve in rehabilitation program that involved relatively simple, easy, safe, and low load exercise, which composed of muscle strength flexibility exercises, and physical endurance such as rising from chair showed a return and maintenance of their functional independence after surgery when compared with those who underwent surgical procedures alone. This indicates that surgical treatment can be offered to elderly patients 69 years old or older but with predictable decline in functional independence while establishing of an effective rehabilitation program may be helpful for restoring their function and thereby preventing the disability. It has been established that regular physical activity contributes to the well-being of the elderly and reduces morbidity by avoiding, minimizing or reversing many of the physical, psychological and social hazards that often accompany advancing age[34,35].

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# Response rate to a survey in India

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## Abstract

### Background & objective

Response rate to a survey in India varied from 23% to 43.2%, in studies done on practitioners. If this is the response rate from the practitioners in India, it is a logical assumption that the response from the patient population would be similar. The aim of this article is to describe the response rate to a survey in India. Our study was to collect data regarding morbidity of individuals with paraplegia in India, as there is no reliable database existing.

### Methods

The study was done by three methods: i) by sending the questionnaires to the addresses retrieved from the medical record section ii) by sending the questionnaires to the Directors and the Heads of the Departments of Physiotherapy of various institutes all over India and iii) by personal visits to various centers, specialized in spinal cord injury or paraplegia, all over India.

### Results

Response rate was 100% when personal visits were made, 33.8% with direct patients' mailings and 8.7% with institutes' mailings.

### Interpretation

Response rate was poorer with institutes' mailings than with that of direct patients' mailings.

### Key words

Postal survey, Questionnaire based survey, Survey.

## Introduction

One of the most popular methods for collecting descriptive data is the survey approach. A survey is composed of a series of questions that are posed to a group of subjects, usually with the intent of generalizing sample responses to describe a larger population[1].

Questionnaires are structured surveys that are self administered using pen and paper. The advantages of using questionnaires are many. They are generally more efficient than interviews because respondents complete them on their own time. Written forms are standardized, so that everyone is exposed to the same questions in the same way, reducing potential bias from interactions with an interviewer. Respondents to questionnaire can take time to think about their answers and to consult records for specific information. Questionnaires also provide anonymity. The major disadvantage is the potential for misunderstanding and misinterpreting questions or response choices[1].

The most common way of distributing questionnaires is through the mail. Mailed questionnaires are economical but one of the primary disadvantages is that the return rate is often quite low. Response from 60% to 80% of a sample is usually considered excellent. Realistically, researchers can expect return rates between 30% and 60% for most studies[1].

Data from primary and secondary research have indicated that prenotifying recipients, personalizing questionnaires and providing follow up letters improve response rates. Other potentially useful techniques include the color of questionnaires, sponsorship from academic institutions, inclusion of return envelopes and utilizing monetary and non-monetary incentives. In contrast, provision of pens, the use of covering letters, assurances of anonymity and stating deadlines do not increase rates of return. Studies have reported conflicting findings regarding the effect of "help the researcher" type appeals in covering letters and the provision of return postage, although the type of return postage provided appears to influence response[2].

Response rate to a survey in India was reported to be 23%[3], 43.2%[4], in studies done on medical practitioners. But there was no literature on survey done on patients in India for comparison.

The aim of this article is to describe the response rate to a survey in India, by using three different methods. Our study was to collect data regarding morbidity of individuals with paraplegia in India.

## Materials and methods

**Study design**

A questionnaire based survey

**Study population**

Patients with paraplegia living in the community and rehabilitation centers in India.

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**Inclusion criteria**

The subjects included in the study were patients with paraplegia of any cause, both the genders with an evidence of complete cord lesion and having age group equal to or above 18 years.

**Procedure**

The ethical committee of MCOAHS, Manipal Academy of Higher Education, approved the study. The survey was done by means of a questionnaire, which was devised, by the authors. It was distributed to all the staff members and the post-graduate students of Department of Physiotherapy, Manipal for content validity. The questionnaire was modified based on the response and was pilot tested on five subjects for comprehensibility. The final draft of the questionnaire consisted of three sections: first section included the demographic information, the second section and the third section included the morbidity and the employment after injury.

The questionnaire was translated into different languages: Hindi, Kannada, Tamil, Malayalam, Marathi, Telugu, Gujarati, Assamese, Oriya and Bengali by parallel back translation.

The study was done by three methods:

I) By sending the questionnaires to the addresses retrieved from the medical record section of KMC, Manipal and Mangalore and from the database of Nina foundation, Mumbai.

II) By sending the questionnaires to the Directors and the Heads of the Departments of Physiotherapy of various institutes all over India. The institutes were identified from the MCI website.

III) By personal visits to various centers, specialized in spinal cord injury or paraplegia, all over India. These centers were selected based on convenience and co-operation from the center heads.

**Method I**

The addresses of the subjects were collected from the medical record section of KMC, Manipal (1994-2005) and KMC, Mangalore (1997-2004) under the codes of G82.0 (flaccid paraplegia), G82.1 (spastic paraplegia), G82.2 (unspecified paraplegia) and T133.0 (Fractures of thoracic and lumbar vertebra).

Two hundred and fifty addresses were collected from the medical record section based on the inclusion criteria but only twenty four subjects were sent the questionnaire due to inadequate addresses. Further, one hundred and twenty four addresses of the patients with paraplegia were got from Nina foundation. All of these one hundred and twenty four individuals were sent the questionnaire by mail. The mail package included: a covering letter, an informed consent, a questionnaire form in the regional as well as in English languages and a reply stamped envelope. Patients were given a time period during which they were requested to send it back. One reminder was sent to the patients after the specified date had passed.

**Method II**

A packet of questionnaires in the regional language and English were sent to the Directors and the Heads of the Departments of Physiotherapy of the institutes, identified from MCI website, in order to cover all the major centers in India (Trivandrum, Calicut, Vellore, Chennai, Bangalore, Goa, Hyderabad, Ahmedabad, Vadodara, Kolkata, Orissa, Indore, Rohtak, Shimla, Kota, Patna, Dehradun and Jaipur).

**Method III**

Due to the poor return rate and inadequacy of the information of addresses, it was decided to visit various centers in India personally. The centers visited were working for specialized for the patients with SCI and were located in New Delhi, Kirkee, Mumbai, Chandigarh, Mohali, Bangalore, Tirupathi, Ahmedabad and Vadodara.

The permission to conduct the study was taken from the Medical Superintendent/Director of the various centers visited. Patients falling into the inclusion criteria were selected and their consent was taken. Then, the questionnaires were distributed to these patients and they were requested to complete it. The completed questionnaire was collected by the tester personally.

## Results

**Response rate**

The total numbers of completed questionnaires received were 278. The response rate was 100% when personal visits were made, 33.8% with direct patients' mailings and 8.7% with institutes' mailings. Response rate by various methods is depicted in fig. 1. For ease of reporting, the country was divided into four zones. The percentage of return rate from each zone was as follows: 60% from North, 40.9% from South, 50% from West and 15.4% from East. This is described in table I.

## Discussion

Even though we sent the questionnaires to all parts of India, the response rate was different from different parts of India. As shown in table I, response rate was the maximum from the North when questionnaires were sent to the patients by mail and it was only from two institutes in the East that we received responses when questionnaires were sent to the various institutes all over India.

Return rate was poorer when the questionnaires were sent to the institutes than to the patients. The possible causes for poor response rate can be due to the following reasons:

i) Institutes' mailings

The Institutes' mailings showed the least response rate (8.7%). The possible reasons could be that

- Institutes may not have received the mail packet.
- Institutes were not research oriented.
- Postages may have got lost as they were not sent on an individual's name.

**Fig. 1:** Response rate of questionnaires using three different methods.

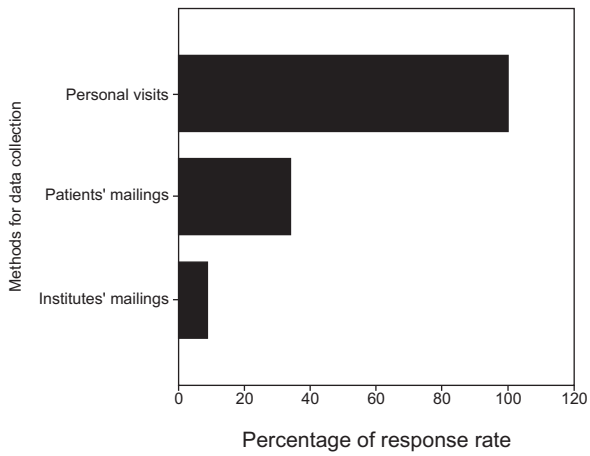

**Table 1:** Response rate of questionnaires using the three different methods. (n=278)

| Area | Number and % of return rate | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Centres visited | | Direct patient mailings | | | | Institute mailings | | |
| | No. of patients | % | No. of patients | I | E | % | No. of institutes | % | No. of patients |
| North | 43 | 100 | 12/20 | 06 | 06 | 60 | 1/7 | 0 | 76 |
| South | 15 | 100 | 26/61 | 19 | 07 | 40.9 | 0/6 | 0 | 00 |
| East | 01 | 100 | 1/2 | 01 | 00 | 50 | 1/3 | 33.4 | 12 |
| West | 99 | 100 | 11/65 | 06 | 05 | 15.4 | 0/7 | 0 | 00 |
| Total | 158 | 100 | 50/148 | 32 | 18 | 33.8 | 2/23 | 8.7 | 88 |

Note: I: Included; E: Excluded
North: Jammu and Kashmir, Punjab, Harayana, Chandigarh, Himachal Pradesh, Uttaranchal, New Delhi, Madhya Pradesh, Bihar, Jharkhand and Chattishgarh.
South: Karnataka, Tamilnadu, Andhra Pradesh and Kerala.
East: Orissa, West Bengal, Assam, Sikkim, Manipur and Arunachal Pradesh
West: Maharashtra, Goa, Gujarat and Rajasthan.

- At the time of receipt, the patients may not be available.
- Some institutes don't entertain studies from outside.

ii) Direct patients' mailings

Direct patients mailings showed a better response (33.8%) than that of institutes' mailings. But it was still not very good. The possible reasons could be:

- Inadequate addresses.
- Change in the address.
- Illiteracy
- Death of the patient.
- Mail was sent from an unfamiliar person.
- No incentives were offered.

## Conclusion

Though an attempt was made to cover the whole nation, we were not able to collect the substantial amount of data, due to poor response rate from the various institutes all over India and fair response from the direct patients' mailings. In order to obtain a greater amount of data, it would be necessary to do a longitudinal or multi-centre study. The advantage of doing a longitudinal study would be familiarity with the person, better response rate, direct explanation of the purpose. The response rate is normally better when an individual is admitted to a hospital than when he is at home after the discharge. Educational level and motivation of the individual play a very important role. The advantage of a multi-centric study would be co-operation from all the centers, working at different places for the same cause and thus making a data substantial enough to represent the whole population.

## Implications

- Use of address cards while visiting the hospitals as most of the addresses of the patients taken by the registry clerk are still inadequate[5,6,7].
- The institutes should be research oriented to encourage even the studies done by other institutes.


## Acknowledgement

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# Efficacy of chest physiotherapy in reversing atelectasis following paediatric heart surgery - A case report

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## Abstract

Pulmonary complication is the most common following heart surgery. Chest Physiotherapy plays a major role in preventing and correcting postoperative pulmonary complications. This case study describes the importance of having round the clock chest physiotherapy following post paediatric cardiac surgery.

## Key words

Chest physiotherapy, cardiac surgery, pulmonary atelectasis.

## Introduction

Atelectasis is one of the commonest post operative complications occurring after an open heart surgery[1]. Chest Physiotherapy (CPT) has been widely accepted throughout the world as an important measure to prevent and to correct post operative atelectasis. Around 1/4$^{th}$ of deaths occurring within 6 postoperative days are related to PPC (Post Pulmonary Complication). The management of posto-perative atelectasis in children may be more challenging when compared to adults, because of various physiological mechanisms which include greater density of sub mucosal glands, increased airway wall compliance, lower functional residual capacity and fewer collateral air way channels[2]. Apart from these, psychological factors and difference of motivation levels in children also make the management of post operative atelectasis difficult. Selection of chest physiotherapy techniques remains still exploratory[3,4]. Appropriate selection and effective administration of chest physiotherapy will be beneficial in managing postoperative pulmonary atelectasis. This case study explains the benefits of CPT in paediatric cardiac surgery.

## Case description

A 4 year old girl admitted in Fr Muller Medical College Hospital for ASD and VSD closure. She underwent on pump surgical closure of ASD and VSD with pericardial patch. After the surgery she was shifted to the main ITU in the evening at around 3.30pm. Status of the patient was stable, she was on ventilator support, in PRVC mode, $FiO_2$ = 60%, PEEP = 5cm $H_2O$. Patient was hemodynamically stable. Preoperative physiotherapy was given as per the routine protocol.

## Post operative day one

The child was stable in the morning and her X-ray was normal. The morning ABG reading was also normal (pH = 7.38, $PaO_2$ = 134, $PCO_2$ = 36, $HCO_3$ = 24) with $FiO_2$ = 40%. The child was weaned and extubated during the day's first visit in the morning. She was receiving 6L of oxygen through a face mask. She was hemodynamically stable after extubation and was encouraged to perform deep breathing exercises and assisted cough in an upright position.

By afternoon she developed tachypnea which was progressive in nature. On evaluation by physiotherapist, there was reduced air entry in the middle and lower zone of the left lung. The child was tachypneic (38b/min), and saturation started falling (up to 80%) with 6L oxygen support. ABG report showed respiratory acidosis with hypoxemia. (Ph = 7.28, $PaO_2$ = 60, $PCO_2$ = 46, $HCO_3$ = 28). Chest X-ray showed middle and lower lobe collapse in the left lung zones (Fig. 1). Immediately chest physiotherapy was started with postural drainage, percussion and vibration followed by manual stimulation of cough. The session lasted for 40 minutes. Vitals were monitored continuously during the physiotherapy session. The same procedure was repeated after an hour. Post physiotherapy ABG showed marked improvement in the $PaO_2$ (84 mm Hg), the saturation was maintained between 92% - 94% with 6L oxygen support through mask.

Chest physiotherapy was administered every second hour throughout the night. The child's status had improved by the early hours of the morning. Tachypnea had reduced markedly (RR = 28b/min, HR = 102b/min), saturation also improved by 98% with 2L of oxygen support.

**Fig. 1:** Chest X rays shows the collapse of the left lung.

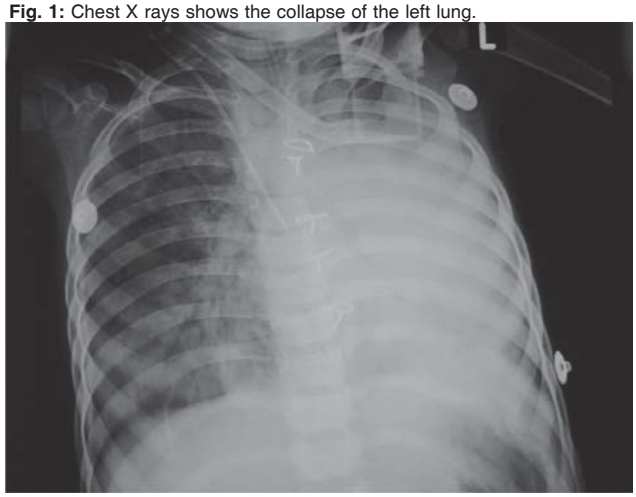
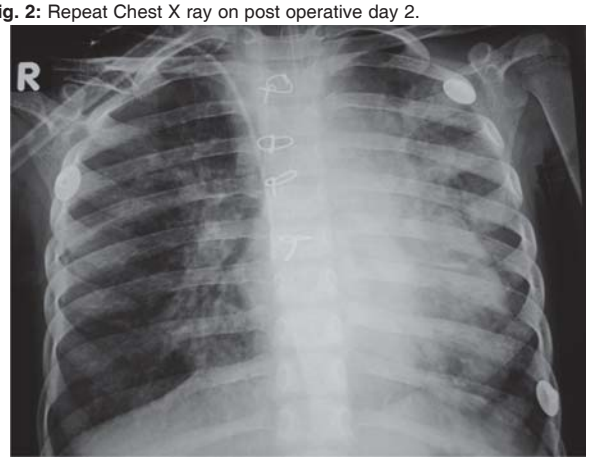


**Fig. 2:** Repeat Chest X ray on post operative day 2.




## Post operative day two

The child was stable in the morning and X-ray showed marked improvement in the air entry in the left lung zones (Fig. 2). Hemodynamical variables were also stable. (HR = 92/min, RR = 26/min, $SpO_2$ = 99% with 2L oxygen) Arterial lines were removed by 9am and the patient was mobilized within the ICU. The child was attended to every three hours with postural drainage, percussion, vibration (PDPV) and cough stimulation along with monitored ambulation. By evening she was active and able to start oral fluids and was more co-operative for exercises.

## Post operative day three

By noon the child was shifted to the wards and was treated thrice daily there with regular chest physiotherapy and aerobic exercises.

## Discussion

This case study explains the importance of round the clock chest physiotherapy service in postoperative ICU's. Since the child was not cooperative initially, PDPV had been administered followed by positioning. The positioning of the child was decided based on the chest X-ray and the vitals, as suggested by Polacek et al[5]. Left side up position is maintained for a longer time along with two hourly postural drainage[6]. It was possible to adopt the prone position along with a head down tilt since there was continuous monitoring.

Once the child was cooperative, forced expiratory techniques were administered by using the spiroballs which served as an added motivation to her[2].

Postural drainage was considered since the child was not able to follow instructions and also there was a reduction in the oxygen saturation. The immediate improvement in the oxygen saturation can be attributed to the gravity effect on the lung[7]. Though there is limited evidence for the effect of Chest physiotherapy following cardiac surgeries, Intensive physiotherapy was recommended by Jenkins S et al that intensive physiotherapy should be considered if the respiratory condition deteriorates[8]. Since there was sudden decreased in the oxygenation vigorous physiotherapy was considered. The child was mobilised early in order on the basis of recent research evidence[9].

## Conclusion

This case study proves the efficacy of Chest Physiotherapy in managing the post operative pulmonary complications in children. We need to have a well designed randomised controlled trail in this regard. Round the clock physiotherapy service may be useful in managing the post operative pulmonary complications.

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# Effect of deep breathing exercises and incentive spirometry in the prevention of post operative pulmonary complications in the patients of cancer esophagus undergoing esophagectomy

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## Abstract

### Purpose

The purpose of this study was 1) to evaluate the efficacy of deep breathing exercises over no chest physiotherapy 2) to evaluate the efficacy of incentive spirometry over no chest physiotherapy 3) to evaluate the efficacy of deep breathing exercises over incentive spirometry.

### Inclusion criteria

Both sexes i.e. male & female were included in the study. Adults undergoing any type of esophagectomy for carcinoma of esophagus were also included because this population of adults represents with similar probable mechanisms for the development of pulmonary complications i.e. above the age of 18 years. Middle aged people& old people were also included in the study because they are more prone to develop post operative pulmonary complications after anesthesia. Patients who gave their written consent for conducting this study on them.

Patients who were not referred for physiotherapy even after esophagectomy were included in control group.

Only those patients who were assessed & examined preoperatively & for the initial 5 post operative days were included. Cooperative patients who followed the given instructions (such as the use of I.S.) properly.

### Methods

Three groups of patients were made keeping 10 patients in each group. Group 1 patients were given deep breathing exercises manually, group 2 patients were asked to do incentive spirometry only& group 3 was control group. Deep breathing exercises were given in lying position with the head end of bed raised to 30-40 degrees. Incentive spirometry was given in sitting position with foot supported. The study was conducted in the post surgical unit of Rajiv Gandhi Cancer Institute & Research Center Sector 5 Rohini New Delhi -85 (India). Chest expansions at axilla, nipple & xiphisternum, Single breath count, Peak expiratory flow rate & oxygen saturation were the dependant variables.

### Results

It was found that deep breathing exercise and Incentive spirometry are more effective than no chest physiotherapy. The results of the study further suggests that comparison of the two modalities i.e. Incentive spirometry & deep breathing exercises revealed no stastically significant difference among them.

### Conclusion

The results of the study concluded that deep breathing exercises& incentive spiromety should be recommended as treatment modalities in the prevention of post operative pulmonary complications in the patients of carcinoma esophagus undergoing esophagectomy.More studies with greater sample population are required for the generalization of the results.

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## Introduction

The surgical removal or excision of a part of esophagus is known as esophagectomy.

Esophagectomy is done in those patients who have severe symptoms and in whom medical therapy has failed. Such patients show disorders of esophageal motor function. Some of the commonly used esophagectomies are – Ivor-Lewis esophagectomy or Partial Oesophago Gastrectomy, Transhiatal Esophagectomy, Endoscopic Trans- Mediastinal Esophagectomy, Mcknown Three Phase Total Esophagotomy, Radicle En-Bloc Esophagectomy[14,18].

It was found that in Barrots esophagus, the end result of medical treatment is often a conversion of the patient from one with pure acid reflux to one who still experiences regurgitation and choking from blend gastric contents. Indeed symptomatic relief may allow tissue damage to progress unnoticed so that the advancement of the disease is actually accelerated. For this reason, esophagectomy is an appropriate recommendation at any interval after recognitionof these changes.

Esophagectomy is done to control symptoms such as pharyngeal regurgitation & chronic aspiration.If complete necrosis of esophagus occurs during castic esophageal burns than esophagectomy is the treatment of choice. Esophagectomy is also done, during thoracic esophageal perforation, during traumatic rupture or crush injury of the esophagus, during benign tumors of esophagus as this tumor may convert to malignant phase[15,16,18].

In malignant tumors, esophagectomy is done to remove tumors and to restore the continuity by the interposition of stomach, jejunum & colon. Most patients with esophageal cancers present with advanced disease and may not be cured with therapeutic modalities presently available. Many

patients in initial stages or with localized tumors are maximally prone for the spread of these tumors to other parts of the body, if untreated. For these reasons esophagectomy is done in esophageal cancers aiming primarily at achieving the permanent relief of dysphasia. Generally two types of esophageal cancers are seen, squamous cell carcinoma & adrenocarcinoma.In both of these, the treatment of choice is esophagectomy[14,13,12].

During the immediate post operative period after esophagectomy, pulmonary complications often occur. Pulmonary complications continues to be the vexing problems during the post operative period in patients undergoing esophagectomy[19,20]. These post operative pulmonary complications remain the most frequent cause of post operative morbidity. Patients with chronic obstructive pulmonary diseases, obesity, advanced age, heavy smokers, and cardiovascular disease are highly predisposed to develop such complications. It was found that post operatively severe morphological & functional alterations of the lungs may occur[17,18].

In the immediate post operative period, post operative pain, the effect of anesthesia & analgesics inhibits the ventilation, spontaneous cough function & the free movts of the patients.

During the past two decades attempts have been made to prevent the post operative pulmonary complications by early use of antibiotics, early ambulation, prophylactic treatment by heparin, intermittent positive pressure breathing, blow bottles, continuous positive airway pressure, etc[13,12]. Chest physiotherapy, deep breathing exercise and incentive spirometry along with other treatments had been used as an important adjunct to prevent these post operative pulmonary complications. Many studies in the past have proven the efficacy of chest physiotherapy[2,1,3]. Recently sustained maximal inhalations using incentive spirometry have achieved considerable popularity[8,7]. Various researches have been done to evaluate the superiority of any one chest physiotherapy modality or technique over another[5,4,6].

## Post operative pulmonary complications

Patients undergoing upper abdominal or thoracic surgeries have a higher risk of post operative pulmonary complications as compared to lower abdominal surgeries.

A patient is diagnosed as having post operative pulmonary complications if he shows at least one temperature reading higher than 98.6 degree F, pulse rate more than 120 beats/ minute, respiratory rate more than 24 breaths/min., increased coughing, increased sputum production, dyspnea, a positive clinical examination & X-ray findings. Any patient showing any three above symptoms is diagnosed as having post operative pulmonary complications Some of the commonly occurring post operative pulmonary complications are as follows. Hypoxemia**,** Atelectasis, Pulmonary Embolism, Aspiration Pneumonia, Nasocomial Pneumonia, Pulmonary Collapse, Pulmonary Infections, Chylothorax or Pleural Effusion, Respiratory Failure, Pulmonary Edema.

## Incentive spirometer

Incentive spirometry (IS) is a lung expansion technique designed to mimic natural sighing or yawning by encouraging patients to take slow deep breaths. It is a simple and relatively safe method of preventing atelectasis in alert patients who are predisposed to shallow breathing. (i.e. Patients recovering from thoracic or upper abdominal surgery, chronic obstructive pulmonary distress (COPD) patients recovering from other surgery, patients immobilized or confined to bed). The only contraindication of incentive spirometry involves patients who are confused, uncooperative. or unable to effectively deep breath (i.e. vital capacity <10 ml/kg or inspiratory capacity <1/3 predicted value).

## Methods

### Sample

30 Subjects (22 Males and 8 Females) who underwent esophagectomy for Carcinoma of esophagus at Rajiv Gandhi Cancer Institute & Research Centre, Rohini, Delhi, and met the inclusion criteria (refer to Inclusion criteria in the abstract) were included in the study. The mean age of these patients were 53.4 ± SD years.

Generally the carcinoma of esophagus is found at 3 sites i.e. upper 1/3$^{rd}$ of esophagus, middle 1/3$^{rd}$ of esophagus, lower 1/3$^{rd}$ of esophagus. Out of 30 patients, 4 patients had carcinoma at middle 1/3$^{rd}$ esophagus and 26 patients at lower 1/3$^{rd}$ esophagus.

## Sex ratio

| Total | Male | Female | | | | |
|---|---|---|---|---|---|---|
| T/t Gps | DBE gp | IS gp | Ctr gp | DBE gp | IS gp | Ctr gp |
| 30 | 7 | 8 | 7 | 3 | 2 | 3 |

DBE = Deep Breathing Exercises Group
IS = Incentive Spirometer Group
Ctr = Control Group

## Design

The study is of a mixed design in which a total of 30 subjects were randomly divided into three equal groups (group 1 receiving Deep Breathing Exercises, group 2 receiving Incentive Spirometery and group 3 patients formed a control group). All the 3 groups were compared for within subjects and between subjects differences in the dependent variables.

All the 3 groups received treatment at a predecided frequency of treatment (please refer to Protocol) and data for dependent variables was collected in the morning and evening of each post operative day for 5 days.

## Dependant variables

### Chest expansion

The spreading out of the chest anteroposterior, mediolateral as a result of deep inspiration is known as chest expansion. The normal chest expansion is 3 - 7.5 cm in normal persons. Chest expansion is more in athletes. Chest expansion is used for knowing the pulmonary or inspiratory status of the patient.

The aims of chest expansion in the post operative patients are to Improve the ventilation, to increases the effectiveness of cough mechanism, to prevent pulmonary impairments, to improve the strength, endurance, coordination of respiratory muscles, to maintain or improve

chest & thoracic spine mobility, correct inefficient or abnormal breathing pattern, to promote relaxation, to teach the patient how to deal with shortness of breath attacks, to improve overall functional capacity of the patient, improve gas exchange & oxygenation.

In our study the role of chest expansion is to see whether the decreased chest expansion post operatively has returned to its normal on 5th post operative day or no. This in turn gives us the pulmonary or inspiratory status of the patient.

**Technique**

Chest expansion at axilla,nipple,xiphisternum signifies the apical, nippal,xiphisternal expansion. The examiner placed the tape measure around the chest at all the three levels respectively. The patient was asked to exhale as much as possible and the examiner took a measurement. The patient was then asked to inhale as much as possible and to hold it while the second measurement was taken. Than the difference between the two measurements was taken & noted as expansion.

**Single Breath Count**

Single breath count is a modified form of dyspnea index described by Sadowsley S.H., Rohrkemper KF and Quon Sym[2] This single breath count gives us an estimate of the pulmonary status of the patient. The normal single breath count is more than or equal to 35 in a healthy non-athlete male. Generally this count is more in an athlete.

Technique – This involves noting the number to which a patient could count to a maximum in one breath, after taking a deep breath.

**Peak Expiratory Flow Rate**

The maximal airflow rate achieved while forcefully expelling air from the lungs, following maximal inspiration expressed in liters/minute is known as peak expiratory flow rate. Peak expiratory flow rate is a measurement which tells us whether bronchioles are in spasm & if yes, their severity. Peak expiratory flow rate is a simple method of measuring airway obstruction & it helps in detecting moderate or severe disease.

**Technique**

Insert the mouthpiece into the pocket peak flow meter and make sure that the cursor is returned the lowest reading end of the slot. The patient is asked to sit upright. Hold the peak flow meter with fingers & thumb of one hand. Do not place the other hand over the meter. Take a deep breath as much as possible & put the mouthpiece in the mouth gripping with lips & teeth. Blow out as hard and fast as possible in a short sharp blast. Remove meter from mouth and read results from the calibrated scale. Three reading of P.E.F. are made. The highest reading among the three is recorded as the patient's P.E.F. An interval of at least half a minute is necessary between the three readings[9].

**Oxygen Saturation**

A measurement of the amount of oxygen, bound to hemoglobin compared with hemoglobin's maximum capacity for binding oxygen is known as oxygen saturation

**or**

Oxygen content of blood divided by oxygen capacity expressed in volume percent in k/a oxygen saturation. It is also written as

$$\%o_2 \text{ saturation} = \frac{ml o_2 \text{ bound to hemoglobin} \times 100}{\text{Maximum ml of } o_2 \text{ hemoglobin}}$$

is capable of binding

Oxygen saturation is expressed in percentage. Normal oxygen saturation of a person in greater than or equal to 96%. Oxygen saturation is measured by pulse oximetry. Pulse oximetry is a non-invasive method of measuring arterial oxygen saturation ($spo_2$), amount of $o_2$ bound to Hb

Technique: Before taking the oxygen saturation readings, the patient is asked to lie down in supine position for 5 minutes & is asked to relax himself completely. Now the probe of the pulse oximeter is attached to the finger or earlobe or toe. Switch on the pulse oximeter. It will show the oxygen saturation readings in percentage & the heart rate readings per minute. Note the pre treatment readings. Now the patient is treated (either by deep breathing exercise or by incentive spirometer) as per the required time & after giving this treatment, note the post treatment readings. Now finally the patient is asked to relax himself completely[10].

## Instrumentation

Wright's pocket peak flow meter is used to measure the peak expiratory flow rate of the patients. Tailors measuring tape is used for measuring the chest expansion at axilla, nipple, xiphisternum. Nellcor puritan Bennett 190 pulse oximeter is used to measure the arterial blood oxygen saturation of the patients.

## Protocol

**Treatment Protocol of Deep Breathing Exercise**

Preoperatively the patient is taught how to do these exercises. Post operatively the breathing exercises are given for 2 times in an interval of 6 hours i.e. Morning & evening.

Repetitions – 15 repetitions of each exercises are given at each sittings i.e. 15 repetitions bd. (morning, evening) up to 5 post operative days.

**Treatment Protocol of Incentive Spirometer**

Preoperatively the patient is taught how to do the incentive spirometer. Post operatively the incentive spirometer is done each hourly for 8 waking hours of the day. The patient is asked to do it at its own. Repetitions – 15 repetitions of maximum inspirations each hourly are given upto 5 post operative days. No treatment was given for control group patient.

## Procedure

**Three groups were taken**

**Deep Breathing Exercise Group**

Preoperatively the patient is taught how to do the deep breathing exercise so that there might be no problem post operatively. The following deep breathing exercises are done by deep breathing exercise group.

Diaphragmatic breathing exercises with & without resistance, Segmental breathing exercise with & without resistance such as lateral costal breathing exercise, Posterior basal breathing exercise, right middle lobe or lingual expansion, apical breathing exercise, pursed lip breathing exercises.

Some specific exercises were given to increase the breathing capacity of the patients. These include exercises to mobilize one side of chest, exercises to mobilize the upper chest & stretch the pectoral muscles, exercises to mobilize upper chest & shoulders, exercises to increase

the expiration during deep breathing, wand exercises, coughing exercises like therapist assisted coughing, self assisted coughing, splinting. Cough is an important part of airway clearance so each patient is taught how to cough & its significance.

Active range of motion exercises to the shoulders, trunk, helps to expand the chest, facilitates deep breathing, stimulates cough reflex.

Humidification, nubilisation were also used for the clearance of secretions.

**Incentive Spirometer Group**

Preoperatively the patient is taught how to do the incentive spirometer so that there might be no problem post operatively.

Incentive spirometer increases the volume of inspired air and is used to prevent alveolar collapse in post operative conditions & to strengthen the weak inspiratory muscles. It has 3 balls. The balls will rise according to the amount of sucked air. Capacity of 1st ball is 600 cubic centimeters (c.c.). Capacity of 2nd ball is 900 cubic centimeters (c.c.). Capacity of 3rd ball is 1200 cubic centimeters (c.c.).

**Procedure**

The patient is comfortably sitting in supine or upright sitting position & is asked to take 3-4 slow, easy breaths & than exhale maximally with the 4th breath. The patient is than asked to put the mouthpiece of spirometer in the mouth & hold the instrument in his hand. Finally the patient is asked to maximally inhale through the spirometer & hold the inspiration for 5 sec. & than exhale completely. This sequence is than repeated.

**Control Group**

A preoperative, post operative day 1-day 5, evaluation of the patient is done for all the dependant variables and for the development of post operative pulmonary complications.

No incentive spirometer & no deep breathing exercise were given to this group of patients.

## Data acquisation

**Chest Expansion**

Chest expansion was measured by the measuring tape. The readings were taken into centimeters. These readings were taken at three levels (i.e. Axillary, nipple, xiphisternum). In case of females, the level of nipple differs so in females, the 5 thoracic intercostals space was measured. These readings were taken preoperatively, daily upto 5th post operative days.

Preoperatively normal chest and expanded chest were measured and noted at all the three levels. The difference between the two measurements (i.e. Normal & expanded chest) was taken and noted as actual expansion. Postoperatively on day 1normal chest and expanded chest was measured & noted in the morning pretreatment at all the three levels. The difference between the two measurements (i.e. Normal & expanded chest) was taken and noted as expansion. In the morning and evening, normal chest and expanded chest was measured and noted post treatment at all the three levels. The difference between the two measurements (i.e. Normal & expanded chest) was taken & noted as expansion.

On post operative day two, day three, day four, day five, normal chest and expanded chest were measured and noted at all the three levels in the morning and evening post treatment. The difference between the two measurements (i.e. Normal & expanded chest) was taken and noted as expansion.

In case of control group no treatment is given to the patient but still the chest expansion was taken. Preoperatively the normal and expanded chest was taken at all three levels and noted. The difference between the two measurements (i.e. Normal & expanded chest) was taken and noted as expansion.

Post operatively on day one, normal chest and expanded chest were taken at all the three sites in the morning and evening. The difference between the two measurements (i.e. Normal & expanded chest) was taken and noted as expansion. On post operative day two, day three, day four and post operative day five normal chest and expanded chest were taken at all the three sites in the morning and evening. The difference between the two measurements (i.e. Normal & expanded chest) was taken and noted as expansion.

**Single Breath Count (S.B.C.)**

Single breath count was obtained by noting the number to which a patient could count verbally to a maximum in one breath after taking a deep breath. These reading were noted in one single breath. These reading were taken preoperatively, daily upto 5th post operative days.

Preoperatively the normal single breath count was noted.

Post operatively on day one, single breath count was noted in the morning pre- treatment and in the morning and evening post treatment.

On post operative day two, day three, day four, post operative day five, single breath count was noted in the morning and evening post treatment.

In case of control group no treatment is given to the patient but still single breath count was noted. Preoperatively the normal single breath count was noted.

Post operatively on day one, single breath count was noted in the morning, in the evening on post operative day two, day three, day four, post operative day five, single breath count was noted in the morning and evening.

**Peak Expiratory Flow Rate**

Peak expiratory flow rate was measured by the Wright's pocket peak flow meter. These reading were taken in liters/minute. These reading are taken preoperatively, daily upto 5th post operative days.

Three maximal peak expiratory flow rate reading were taken and the best one of the three is noted as the patients peak expiratory flow rate.

Pre operatively the normal peak expiratory flow rate was noted.

Post operatively day one, peak expiratory flow rate was measured and noted in the morning pre treatment and in the morning and evening post treatment.

On post operative day two, day three, day four and post operative day five, peak expiratory flow rate was measured and noted in the morning and evening only post treatment. In the control group no. treatment is given to the patient but still peak expiratory flow rate is measured.

Preoperatively the normal peak expiratory flow rate was noted. On post operative day one, peak expiratory flow rate values were measured in the morning and in the evening.

On post operative day two, day three, day four and post

operative day five, the peak expiratory flow rate values are measured and noted in the morning and evening daily.

**Oxygen Saturation ($SPO_2$)**

Oxygen saturation was noted using pulse oximeter. The oxygen saturation readings were taken in percentage. These readings were taken preoperatively, daily up to 5th post operative days.

Preoperatively normal oxygen saturation of the patient was read and noted.

On post operatively day one, oxygen saturation was read and noted pre treatment and post treatment in the morning, pre treatment and post treatment in the evening. Same was done on post operative day two, day three, day four and post operative day five.

In case for control group no treatment was given but still oxygen saturation was taken.

Pre operatively the normal oxygen saturation of the patient was read and noted.

On post operative day one, the oxygen saturation was read and noted in the morning and evening. Same is done for post operative day two, day three, day four and post operative day five.

## Data acquisition for monitoring post operative pulmonary complications

Each of the thirty patients were also read, measured & noted for blood pressure, heart rate, pulse rate respiratory rate, body temperature, production of sputum pre operatively & daily up to 5th post operative day in the evening post treatment. Blood pressure was recorded by the nurses with the help of sphygmomanometer in mmhg.

Heart rate was recorded by the pulse oximeter per minute, pulse rate was recorded manually per minute, respiratory rate was noticed by standing near to the patient per minute.Body temperature was recorded by the thermometer in faranhite. All these above measures are recorded from the chart of the patient to monitor for the development of post operative pulmonary complications. The patients were also assessed daily for the following measures to look for the post operative pulmonary complications.

Chest auscultation was done by the stethoscope, production of sputum, dyspnea done visually, routine x ray of the chest. These measures were noticed daily in the evening post treatment.

## Data analysis

Mean & standard error of mean (SEM) were calculated for all the variables at each level of measure for all the three groups. Analysis of variance (ANOVA) and scheffe's multiple range tests were done to compare the three groups and to analyze differences at each level of measure. Scheffe's multiple range test incorporated in itself the analysis of significance of each measure in between levels of measure.

## Results

**1. Chest Expansion At Axilla By Measuring Tape**

As is evident in the graph, the chest expansion at axilla improved in both, group 1 and group 2 patients i.e. patients who received deep breathing exercises and those who received incentive spirometry. However the chest expansion at axilla remained almost at the same level in the control group i.e. group 3.

The mean of chest expansion at axilla improved from 1.1 cm ± 0.2 cm to 5.8 cm ± 1.0 cm (which is almost equal to pre operative chest expansion i.e. 5.8 cm ± 1.0) in group 1 and from 1.25 cm ± 0.3 cm to 5.3 cm ± 0.7 cm (which is almost equal to preoperative chest expansion i.e. 5.4 cm ± 0.7 cm) in group 2. The mean of chest expansion at axilla of control group reached from 1.15 cm ± 0.2 cm to 2.5 cm ± 0.4 cm (which is less than preoperative day chest expansion i.e. 5.9 cm ± 0.5 cm). One way anova revealed that the improvement of chest expansion at axilla was significant in both group 1 and group 2 from post operative day 1 post treatment morning levels onwards ($p<0.05$). This is evident from f and p values in table 1. Furthermore scheme's multiple range test revealed that the improvement in group 1 and group 2 was significantly greater than group 3 during the course of treatment (i.e. $p<0.004$ and $p<0.001$ respectively).When we compared group 1 and group 2 scheffe's multiple range test revealed that there was not a statistically significant difference between group 1 and group 2 patients.

**2. Chest Expansion At Nipple By Measuring Tape**

As is evident in the graph, the chest expansion at nipple improved in both, group 1 and group 2 patients i.e. patients who received deep breathing exercises and those who received incentive spirometery. However the chest expansion at nipple remained almost at the same level in the control group i.e. group 3. The mean of chest expansion

**Fig. 1:** Pop days post T/t Vs chest expansion at axilla in CMS.

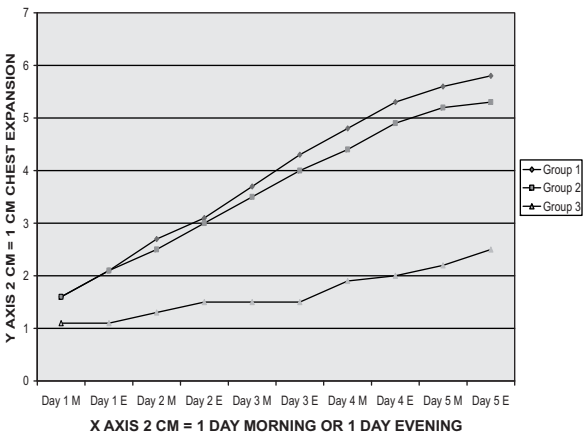



**Fig. 2:** Pop day post T/t Vs chest expansion at nipple in CMS.

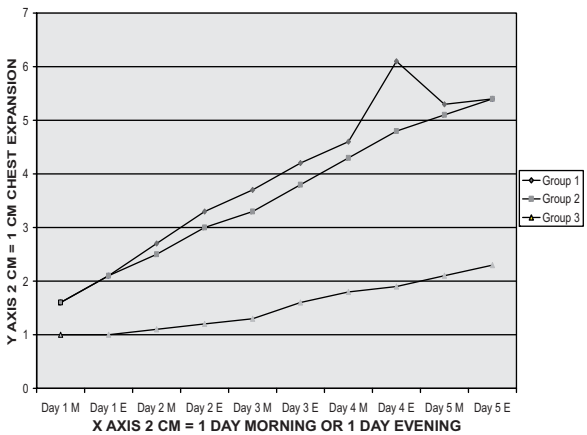


**Fig. 3:** Pop day post T/t Vs chest expansion at xiphisternum in CMS.

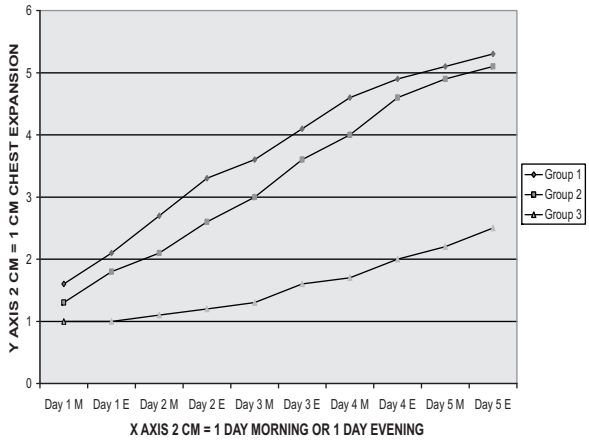



**Fig. 4:** Pop days post T/t Vs peak expiratory flow rate in L/M.

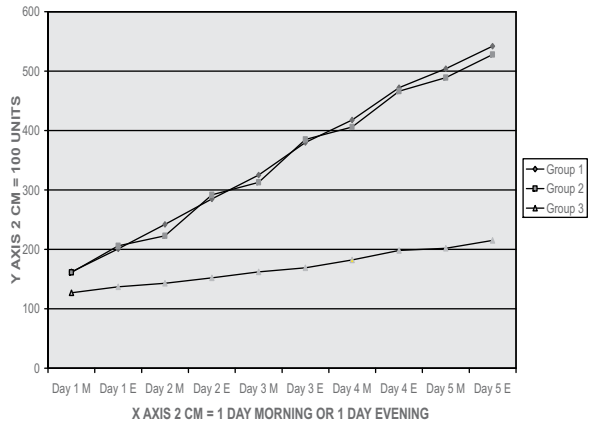



**Fig. 5:** Pop days post T/t Vs single breath count.

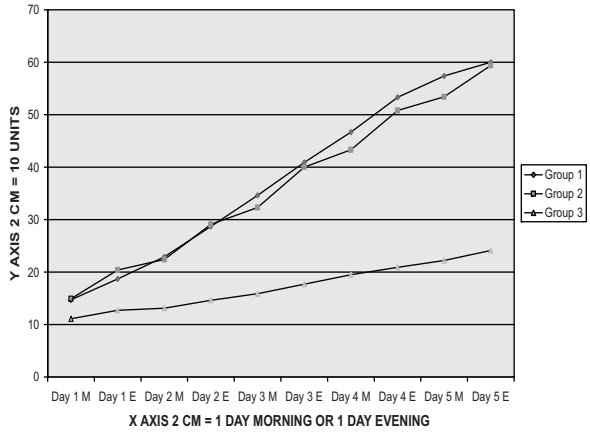
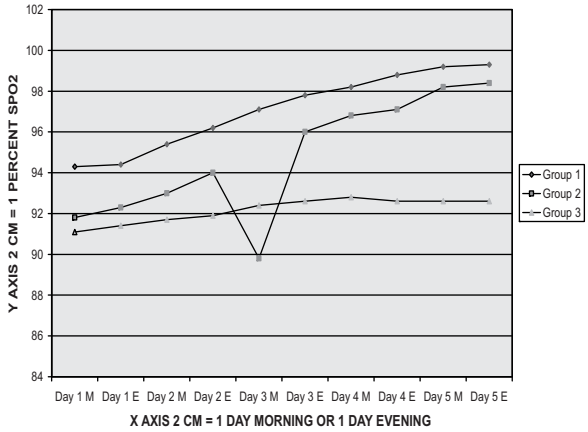



**Fig. 6:** Pop days post T/t vs oxygen saturation in %.




at nipple improved from 1.1 cm ± 0.3 cm to 5.4 cm ± 0.9 cm (which is almost equal to preoperative day chest expansion i.e. 5.4 cm ± 0.9cm) in group 1 and from 1.2 cm ± 0.3 cm to 5.4 cm ± 0.7 cm (which is almost equal to preoperative chest expansion i.e. 5.7 cm ± 0.9 cm ) in group 2. The mean of chest expansion at nipple of control group reached from 1.0 cm ± 0.1 cm to 2.3 cm ± 0.2 cm (which is less than preoperative chest expansion i.e. 5.6 cm ± 0.7 cm).One way anova revealed that the improvement of chest expansion at nipple was significant in both group 1 and group 2 from post operative day 1 post treatment morning levels onwards ($p<0.05$). This is evident from f and p values in table 2.

Furthermore Scheffe's multiple range test revealed that the improvement in group 1 and group 2 was significantly greater than group 3 during the course of treatment (i.e. $p<0.001$ and $p<0.002$ respectively).When we compared group 1 and group 2 Scheffe's multiple range test revealed that there was not a statistically significant difference between group 1 and group 2.

**3. Chest Expansion At Xiphisternum By Measuring Tape**

As is evident in the graph, the chest expansion at xiphisternum improved in both, group 1 and group 2 patients i.e. patients who received deep breathing exercises and those who received incentive spirometry. However the chest expansion at xiphisternum remained almost at the same level in the control group i.e. group 3.The mean of chest expansion at xiphisternum improved from 1.15 cm ± 0.2 cm to 5.3 cm ± 1.15 cm (which is almost equal to preoperative chest expansion i.e. 5.3 cm ± 1.15) in group 1 and from 1.05 cm ± 0.15 cm to 5.1 cm ± 0.6 cm (which is almost equal to preoperative day chest expansion i.e. 5.3 cm ± 0.7 cm ) in group 2. The mean of chest expansion at xiphisternum of control group reached from 1.05 cm ± 0.15 cm to 2.55 cm ± 0.3 cm (which is less than preoperative day chest expansion i.e. 5.4 cm ± 0.5 cm). One way anova revealed that the improvement of chest expansion at xiphisternum was significant in both group 1 and group 2 from post operative day 1 morning post treatment levels onwards ($p<0.05$). This is evident from the relevant f and p values in table 3. Furthermore Scheffe's multiple range test revealed that the improvement in group 1 and group 2 was significantly greater than group 3 during the entire course of treatment ($p<0$ and $p<0.017$ respectively).

When we compared group 1 and group 2 Scheffe's multiple range test revealed that the improvement in group 1>than in group 2 on post operative day 1 morning and evening post treatment, post operative day 2 morning and evening post treatment, post operative day 3 morning and evening post treatment, post operative day 4 morning post treatment. However on post operative day 4 evening post treatment, post operative day 5 morning and evening post treatment level there was not a statistically significant difference between group 1 and group 2 (i.e. group 1 & group 2 were almost same).

**4. Peak Expiratory Flow Rate By Peak Flow Meter**

As is evident in the graph, the peak expiratory flow rate improved in both, group 1 and group 2 patients i.e. patients who received deep breathing exercises and those who received incentive spirometery. However the peak

expiratory flow rate remained at a low level in the control group i.e. group 3. The mean of peak expiratory flow rate improved from 132.5 l/m ± 39.1 l/m to 542 l/m ± 61.6 l/m (which is near to preoperative peak expiratory flow rate value i.e. 553 l/m ± 71.3 l/m) in group 1 and from 139 l/m ± 31 l/m to 528 l/m ± 45.1 l/m (which is near to preoperative peak expiratory flow rate value i.e. 550 l/m ± 45.9 l/m ) in group 2. The mean of peak expiratory flow rate of control group reached from 127 l/m ± 21.6 l/m to 215 l/m ± 30.6 l/m (which is less than preoperative peak expiratory flow rate value i.e. 560 l/m ± 44.9 l/m). One way anova revealed that the improvement of peak expiratory flow rate was significant in both group 1 and group 2 from post operative day 1 post treatment morning levels onwards ($p<0.05$). This is evident from the relevant f and p values in table 4. Furthermore Scheffe's multiple range test revealed that the improvement in group 1 and group 2 was significantly greater than group 3 during the course of treatment (i.e. $p<0.05$ and $p<0.001$ respectively). When we compared group 1 and group 2, Scheffe's multiple range test revealed that there was not a statistically significant difference between group 1 and group 2 i.e. group 1 and group 2 were almost same.

**5. Single Breath Count**

As is evident in the graph, the single breath count improved in both, group 1 and group 2 patients i.e. patients who received deep breathing exercises and those who received incentive spirometery. However the single breath count remained at a low level in the control group i.e. group 3. The mean of single breath count improved from 12 ± 2.7 to 60 ± 6.l (which is near to preoperative single breath count value i.e. 61.2 ± 6.6) in group 1 and from 12.4 ± 3.6 to 59.4 ± 3.8 (which is near to preoperative single breath count value i.e. 63.7 ± 4.6 ) in group 2. The mean of single breath count of control group reached from 11.1 ± 2.0 to 24.1 ± 4.1 (which is less than preoperative single breath count value i.e. 61.5 ± 3.8). One way anova revealed that the improvement of single breath count was significant in both group 1 and group 2 from post operative day 1 post treatment morning levels onwards ($p<0.05$). This is evident from the relevant f and p values in table 5. Furthermore Scheffe's multiple range test revealed that the improvement in group 1 and group 2 was significantly greater than group 3 during the course of treatment (i.e. $p<0.036$ and $p<0.026$ respectively). When we compared group 1 and group 2, Scheffe's multiple range test revealed that there was not much statistically significant improvement between group 1 and group 2 i.e. group 1 and group 2 were almost same.

**6. Oxygen Saturation of Arterial Blood By Pulse Oximeter**

As is evident in the graph, the oxygen saturation ($SPO_2$) of arterial blood improved in both, group 1 and group 2 patients i.e. patients who received deep breathing exercises and those who received incentive spirometery. However the oxygen saturation remained almost at the same level in the control group i.e. group 3 patients. The mean of oxygen saturation of arterial blood improved from 92.3% ± 2.8% to 99.3% ± 1.2% (which is almost equal to preoperative day oxygen saturation i.e. 99.1% ± 1.3%) in group 1 and from 90.6% ± 1.34% to 98.4% ± 0.84 (which is almost equal to preoperative day oxygen saturation i.e. 98.6% ± 0.96%) in group 2. The mean of oxygen saturation of arterial blood of control group reached from 91.1% ± 0.99% to 92.6% ± 0.7% (which is less than preoperative day oxygen saturation i.e. 98.4% ± 1.07%). One way anova revealed that the improvement of oxygen saturation was significant in both, group 1 and group 2 from post operative day 1 morning post treatment onwards ($p<0.05$). This is evident from the relevant f and p values in table 6. Scheffe's multiple range test revealed that the improvement in group 1 was significantly greater than group 3 during the course of post treatment ($p<0.004$ respectively). Furthermore the test revealed that improvement in group 2 was significantly greater than group 3 during the course of post treatment (the improvement in group 2 was not significantly greater than group 3). When we compared group 1 and group 2, the Scheffe's multiple range test revealed that the improvement in group 1>than in group 2 on post operative day 1 morning and evening post treatment, post operative day 2 morning and evening post treatment, post operative day 3 morning and evening post treatment, post operative day 4 morning and evening post treatment. However at the conclusion of the study period i.e. Post operative day 5 morning and evening post treatment, there was not a statistically greater improvement between group 1 and group 2.

## Discussions of results

The results of our study revealed that in chest expansion at axilla, nipple, xiphisternum group 1 and group 2 was significantly greater than group 3. When group1 and group2 were compared the Scheffe's multiple range test revealed that both the group i.e. deep breathing exercise group & incentive spirometery group were same at axilla and nipple but group 1 was significantly greater than group 2 in chest expansion at xiphisternum. This is possibly because of the fact that diaphragm breathing improved more in half lying position.

In peak expiratory flow rate, group1, group 2 were significantly > group 3. When group 1 and group 2 were compared, the Scheffe's test revealed that both groups were almost similar by the end of the study.

In single breath count, group 1, group 2 were significantly greater than group 3. When group 1 and group 2 were compared the Scheffe's test revealed that both groups were almost the same by the end of the study period.

These findings of no significant difference between deep breathing exercise group & incentive spirometer group are similar to the findings of Iverson et al, Dohi & Gold. In oxygen saturation group 1 was significantly better than group 3 but group 2 did not significantly differed from group 3.

When group 1 & group 2 were compared group 1 was significantly better than group 2. It is possibly because deep breathing exercises were performed in half lying (Fowler's position). They caused a better V/Q matching than induced by incentive spirometery which was performed in the sitting position.

In post operative day 5 evening post treatment the results of the dependent variables revealed that both group 1 and group 2 patients i.e. patients who received deep breathing exercise and those whose who received incentive spirometery reached their preoperative pulmonary functional levels. It was also revealed from the results that the control group patients did not reached their preoperative pulmonary functional levels on 5$^{th}$ post operative day evening. All the patients in the control group developed post operative pulmonary complications.

Scheffe's multiple range test revealed that the improvement in group 1 and group 2 was significantly greater than group 3 during the course of treatment except in oxygen saturation where the test revealed that group 2 did not significantly improved than group 3 upto post operative day 2 morning post treatment.

Furthermore when we compared group 1 and group 2, the Scheffe's multiple range test revealed the group 1 and group 2 were almost same during the course of treatment except in oxygen saturation and chest expansion at xiphisternum. Where group 1 was significantly > than group 2 up to post operative day 4 evening post treatment in oxygen saturation & upto post operative day 5 post treatment morning in chest expansion at xiphisternum level. On post operative day 5 morning and evening post treatment in $SPO_2$ and post operative day 4 evening post treatment, post operative day 5 morning and evening post treatment in chest expansion at xiphisternum level, again the two group i.e. group 1 and group 2 were same.On the basis of the results we accept the null hypothesis.

## Conclusion

The result of this study suggests that deep breathing exercises are more effective than no physical therapy & incentive spirometery therapy is also more effective than no physical therapy. In order for incentive spirometery to be effective they must be used regularly as prescribed by the therapist. The results of the study further suggests that comparison of the two modalities i.e. incentive spirometery and deep breathing exercises revealed no statistically significant differences among them. Finally we conclude that deep breathing exercises and incentive spirometery should be recommended as treatment modalities in the prevention of postoperative pulmonary complications in the patients of carcinoma esophagus undergoing esophagectomy. More studies with greater sample population are required for the generalization of the results.

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# Energy expenditure during wheelchair propulsion in different levels of paraplegics using physiological cost index

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## Abstract

### Background & objective

Wheelchair is considered as an efficient means of locomotion with optimal independence for a subject with paraplegia. This study was aimed to evaluate the energy expenditure during standard wheelchair propulsion in different levels of paraplegics using Physiological Cost Index (PCI). It also aimed to correlate the energy expenditure to various levels of spinal injury and to the duration since wheelchair use.

### Methodology

Male subjects with paraplegia (n =24) between T7 to T12 spinal level injury, who were using wheelchair were included in the study. Patients were given 5 minutes rest at the starting line in order to attain a steady resting heart rate, which was measured by the palpation of radial pulse. Subjects were instructed to propel the wheelchair at their normal propulsion speed on a standard leveled corridor (walkway of 25 m) for a minimum duration of 5 minutes to attain a steady physiological heart rate. At the end of 5 minutes, they were instructed to stop and steady propulsion heart rate was measured.

Energy expenditure (PCI) was calculated by: PCI (beats/meter) = Steady propulsion heart rate – Resting heart rate (beats per min) / Propulsion speed (meter/min).

### Results

Descriptive statistics was used to calculate the mean and standard deviation of PCI in different levels of paraplegics. Pearson correlation was used for correlating the PCI values to level of injury and weeks since use of wheelchair. Mean PCI during wheelchair propulsion was 0.67 (SD ± 0.37) beats/meter. There was no correlation between different levels of spinal injury and energy expenditure (p value = 0.511), but there was a strong correlation between weeks since use of wheelchair after injury and energy expenditure (p value = 0.000).

### Interpretation & conclusion

The mean PCI during wheelchair propulsion in different levels of paraplegics (T7-T12) was found to be 0.67 (SD± 0.37) beats/meter. There is a strong correlation between the duration since use of wheelchair and the energy expenditure. This suggests that with longer usage, wheelchair propulsion may become a more energy efficient form of ambulation in paraplegics.

## Key words

PCI; wheelchair propulsion; energy expenditure.

## Introduction

Spinalcord injury (SCI) is one of the leading causes for disability in ambulation. Individuals with cervical injury and upto T8 level are dependent on wheelchair for their ambulation. Individuals below that level can ambulate with KAFOs and a pair of crutches but are still dependent on wheelchair for their long distance ambulation. Most individuals with SCI rely on a wheelchair as their primary means of locomotion at their home and community[1].

Energy expenditure is an important parameter in the assessment of orthotic treatment or during wheelchair prescription in paraplegics[2]. Energy cost studies have been used to compare the efficiency of different wheelchairs and to document the demands of wheelchair propulsion in subjects with various impairments. Researchers have compared wheelchair propulsion using arm cranks and hand rims, front and rear location of the large wheels, various surfaces, different starting techniques, standard and sports or light weight wheelchairs and various speeds of wheelchair propulsion[3]. Estimation of energy cost of ambulation provides functional efficiency of the user, locomotor efficiency of the wheel chair and potential benefit of the propulsion system[4].

The most commonly used physiological parameter for the assessment of energy expenditure has been the measurement of oxygen uptake. However in clinical situations involving rehabilitation of paraplegics this method proves to be impractical[2]. Both speed and heart rate have been used as indicators of efficiency and energy cost of locomotion but their combined use was first reported by MacGregor in 1979, who highlighted the problems of factors other than work load which may cause heart rate variability. He introduced a new method of finding the energy expenditure and it was termed as Physiological Cost Index (PCI). It is calculated as net heart rate (working heart rate - resting heart rate)/ speed of ambulation (distance in meter/time in minutes), thus yielding a PCI in net beats per meter. As minimal equipment is used to administer the PCI, it is proposed as a low cost, low technology alternative to the use of gas and calorimetric analysis equipment during gait analysis which may be impractical or unavailable in clinical departments[5].

Keeping in view the above, the purpose of this study was to evaluate the energy expenditure during standard wheel chair propulsion in different levels of paraplegics using physiological cost index (PCI). Further this study was extended to find the association between PCI and different

levels of paraplegia and also to find the association between PCI and duration since wheel chair use.

## Methodology

This study consisted of 24 spinal cord injury male patients between T7-T12 levels with a mean age of 37 (SD±6.6). Prior to the participation in this study, the individuals were explained about the procedure and were made to sign an informed consent form for their voluntary participation. After considering the inclusion and the exclusion criteria the individuals were assessed for their Physiological Cost Index. Subjects were identified from Kasturba Medical College, Manipal and Government District Wenlock Hospital, Mangalore.

The subjects who were included in the study had been already trained for wheel chair propulsion for a minimum duration of 3 weeks. Subjects with any cardio-respiratory abnormalities, any musculoskeletal abnormalities preventing appropriate seating or propulsion of wheelchair, any other neurological problems (eg: diabetic patients with peripheral neuropathy), pain in the upper limb and patients with bed sore were excluded from the study.

A standard wheel chair was used on which the subject was seated with a cloth belt tied at the level of ASIS to prevent him from sliding from the seat. Another cloth belt was tied horizontally just above the foot rest in order to prevent the legs from slipping from the foot rest during wheel chair propulsion. Patients were given 5 minutes rest at the starting line in order to attain a steady resting heart rate.[6] It was measured by palpation of radial pulse[7]. Subjects were instructed to propel the wheel chair at their normal propulsion speed on a standard leveled corridor (which had a walkway of 25 m) for a minimum duration of 5 minutes to attain a steady physiological heart rate[8]. At the end of 5 minutes, they were instructed to stop and immediately the steady propulsion heart rate was measured by the palpation of the radial pulse. The distance traveled by the patient was measured by calculating the number of rounds covered by the patient multiplied by 25 meters (walk way distance) and the extra distance was measured using an inch tape.

Energy expenditure during wheel chair propulsion using PCI was calculated by the following method:- Physiological cost index (beats/meter) = Steady propulsion heart rate – Resting heart rate (beats per min)/propulsion speed (meters/min) where in the speed was calculated as total distance covered(m) / time(min). The data obtained was then grouped depending on the patient's level of lesion for further statistical analysis.

**Table 1:** Correlation between PCI and different levels of thoracic injury (T7-T12).

| | Mean | SD | Pearson correlation coefficientr | p value |
|---|---|---|---|---|
| **PCI (beats/meter)** | 0.67 | 0.37 | 0.141 | 0.511 (Not significant) |
| **Thoracic level of injury** | 9.5 | 1.8 | | |

**Table 2:** Correlation between PCI and duration since use of wheelchair in different levels of thoracic injury (T7-T12).

| | Mean | SD | Pearson correlation coefficientr | p value |
|---|---|---|---|---|
| **PCI (beats/meter)** | 0.67 | 0.37 | -0.761 | 0.000 (highly significant) |
| **Duration since use of wheel -chair (weeks)** | 36.5 | 32.2 | | |

**Graph 1:** Correlation between PCI (beats/meter) and duration since use of wheelchair (weeks) in different levels of thoracic injury (T7- T12).

## Results

Descriptive statistics was used to calculate the mean and standard deviation of PCI in different levels of paraplegics. Mean PCI during wheelchair propulsion was 0.67 (SD ± 0.37) beats/meter.

## Discussion

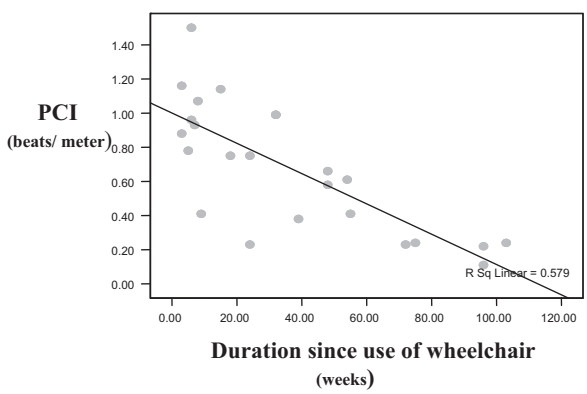
This study consisted of only male paraplegics to avoid any gender influences on energy expenditure. All the subjects were below the level of T6 as patients above this lesion have no control over their sympathetic system which leads to loss of control in heart rate and blood pressure which may affect the heart rate index[2]. Patients in our study were between thin to moderately built on observation. We could not measure the Body Mass Index as we could not weigh the patients due to inability to stand. All subjects had a minimum of three weeks prior training in using wheelchair; this was done to avoid any influence of training effect.

In both the study settings, the corridor was 25 meter long and was of cemented floor. All the patients used a standard wheelchair with removable arm rest. This was done to control the effect of type of wheelchair and the friction of surface on energy expenditure as much as possible. There are many factors in the wheelchair design that may influence the energy expenditure such as stiffness of the frame, the bearing, the size of the pushrim, the type of tyre, the wheelcamber and the height of the seat position. In our study these factors were maintained constant so that it didn't influence the energy expenditure between the subjects[3].

Claire E Beekman et al studied the energy expenditure between standard and light weight wheelchair using VO2 max and they concluded that the energy expenditure was significantly less in tetraplegics when using a light weight wheelchair but there was no significant difference for paraplegics between standard and light weight wheelchair[3]. In Indian population most of the paraplegics use only a standard wheelchair for ambulation due to difficulties in affordability. Due to the above given reasons it was decided to use a standard wheelchair in our study.

The subjects were advised to propel the wheelchair in their self selected speed and propulsion technique. Different

**Graph 1:** Correlation between PCI (beats/meter) and duration since use of wheelchair (weeks) in different levels of thoracic injury (T7- T12).



propulsion techniques have different mechanical efficiency which may have affected the energy expenditure but was still not controlled as any new training might affect the energy expenditure. In our study 20 patients used arcing method of propulsion and four patients used semicircular propulsion. The patients who used semicircular propulsion were distributed among different levels (T7-1, T8-1, T10-1 and T12-1) of thoracic injury.

A self selected speed is thought to better reflect the demands during daily propulsion, where the patient is able to change to the pattern that is most energy efficient for him/her[3]. The results suggested that the mean PCI during wheelchair propulsion was 0.67 (SD ± 0.37) beats/meter. But this value cannot be generalized to all paraplegic population due to the small sample size.

There was no significant correlation between different levels of spinal cord injury and PCI. This may be because the muscles used during propulsion may not have highly differed between various levels of spinal injury. Mulroy SJ et al studied the muscular activity and found that the shoulder girdle muscles contribute to a greater extent for the propulsion of wheelchair. They identified functional synergies: push (anterior deltoid, pectoralis major, supraspinatus, infraspinatus, serratus anterior, biceps) and recovery (middle and posterior deltoid, supraspinatus, subscapularis, middle trapezius, triceps).[9]In our study both the patient groups had these shoulder girdle muscles preserved. The difference between both the groups was mainly in the amount of preservation of trunk muscles.

The effect of trunk muscles during wheelchair has been studied by Yang Y S where fourteen unimpaired subjects propelled a test wheelchair on a dynamometer system at two steady state speeds of 54 m/min and 108 m/min and acceleration from rest to their maximum speed. Lower back/abdominal surface electromyography and upper body movements were recorded for each trial. They concluded that both abdominal and back muscle groups' activity was significantly lower in slow speeds[10]. In our study most of the patients propelled in their self selected speed and the average velocity of propulsion was 29.2 meters/min which did not reach high velocities. So the trunk muscles may have not played a significant role in propulsion due to which lesion at different levels at the thoracic spine may not have altered the PCI.

There was a very strong correlation between duration since use of wheelchair to PCI. Longer the duration since use of wheelchair lesser was the energy expenditure. This may be because of the improved cardiovascular efficiency with longer usage, increased muscle power in the propelling muscles and due to the effect of motor learning as less muscle activity is required with improved learning. Rodgers et al in their study have documented the improvement in mechanics of propulsion with training.[11] This suggests that with longer usage, wheelchair propulsion may become a more energy efficient form of ambulation in paraplegics.

Limitations of the study were that it consisted of a smaller sample size and the propulsion technique was not controlled. Further studies can be conducted including patients with similar duration of wheel chair training for homogeneity. Patients can also be instructed to propel the wheel chair in a higher velocity to analyze the effect of trunk muscle activity on energy expenditure (PCI).

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# Introduction and validation of 'bodygraph' for measurement of cervical lateral flexion

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## Abstract

A new Goniometer cum posture evaluation tool 'Bodygraph' was developed; it consisted of a full-round goniometer and a fixation rod designed to hold it in different positions. The device features a fixation strap that fixes the bodygraph with the body of the patient. The advantage of this novel tool is that it can be used for both goniometry and posture evaluation. The purpose of this study was to test criterion validity and reliability of 'Bodygraph'. Measurements of cervical lateral flexion Range of Motion were taken on the 'Bodygraph' in two different setting for validity and reliability analysis. Fifty eight young healthy subjects (35 males & 23 females; mean: age – 23.05 yr. height – 1.64 mtr. BMI – 20.65) participated in criterion validity analysis study and sixty young healthy individuals (36 males & 24 females; mean: age – 23.65 yr. height – 1.65 mtr. BMI – 21.45) participated in reliability analysis. Observations for validity study were taken by an anatomist. A radiograph was taken concurrently to serve as the 'gold standard' for criterion validity study. Observations for reliability analysis were taken by three physiotherapists on four occasions. The Pearson product-moment correlation coefficient 'r' value for criterion validity of 'Bodygraph' was found to be 0.74 (p-value 0.000). The Intraclass Correlation Coefficient ICC value for Intratester reliability of 'Bodygraph' ranged from 0.96 to 0.98 (p-value 0.000). ICC value for Intertester reliability of 'Bodygraph' was found from 0.81 to 0.97 (p-value 0.000). The study concluded that the 'Bodygraph' can be considered to be valid and reliable for measurement of Range of Motion of cervical lateral flexion.

## Introduction

Evaluation of joint range of motion and posture are key concerns for a physiotherapist in musculo-skeletal assessment of patient. A variety of methods like visual estimation, universal goniometer, electro-goniometer, (fluid / gravity) inclinometer or measuring tape are available to make these assessments. Universal Goniometer ($360^0$) for JROM and visual estimation for posture evaluation is found to be the common practice. High acceptance and widespread usage of Universal Goniometer is commendable, the author of this manuscript inspired by the basic design of a Universal Goniometer developed 'Bodygraph' – a new clinical assessment tool.

The 'Bodygraph' (see illus.) is an innovative tool to measure angles, lengths and levels on body for musculo-skeletal assessment. Primarily it preserves all of the functions of Universal goniometer and in addition it is basic posture evaluation equipment also. It also features an independent alignment cum fixation strap mechanism. A

number of clinical requirements, mechanical references, ergonomic capability and aesthetic perspective were analyzed to formulate the final design of the equipment. It was recognized that pocket-size, light-weight and simple features of universal goniometer make it so popular among clinicians. Design of 'bodygraph' preserves these key features ensuring that its more applicability has minimally affected the key advantages of universal goniometer. In addition it is a special Cervical Goniometer with Improved Scale

Since 'bodygraph' was claimed to benefit in clinical assessment procedures; it necessitated testing its validity and reliability within its scope of application. Satisfactory validation of 'bodygraph' would not only establish it as a logical tool but also provide information about precision of its outcome. To introduce it as a new cervical goniometer testing of 'Bodygraph' for movement - cervical lateral flexion was considered in this study. The side of the movement was selected right arbitrarily. The research analysis was carried in two independent studies; study1 was conducted to test criterion validity (a radiograph was taken concurrently to serve as the 'gold standard') and study 2 for intratester and intertester reliability of 'Bodygraph'. The two studies were conducted in two independent setups. This study was designed, coordinated, monitored and compiled by the Principal Investigator (author of this article) and the observations were taken by qualified professionals (referred to as 'the testers').

Cervical lateral flexion[3,4,5] in this study refers to the movement when head is turned right side in frontal plane (right ear approaches towards right shoulder). However it is a gross motion contributed by movements at atlanto-

occipital, atlanto-axial joint and coupled movement of spinal motion segments between $C_2 – C_7$. Average Range of motion of cervical lateral flexion is 45 degrees[6]. The technique of measurement of Cervical lateral flexion (right side) was adopted in principle from a standard textbook[6], however to apply it with 'Bodygraph' (which is a novel tool) along with fixation of the strap were worked upon on logical basis only.

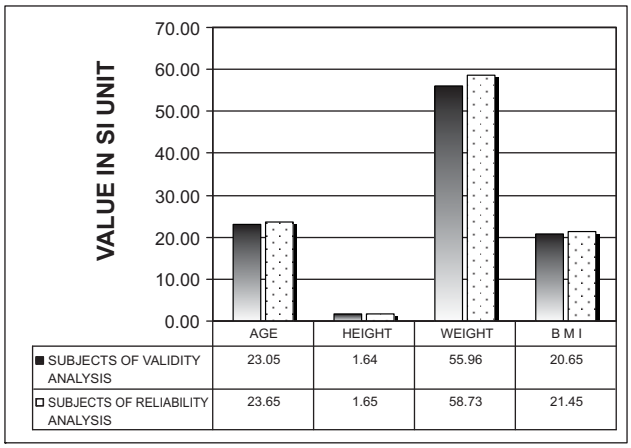
## Subjects and population

Young healthy individuals were considered as the population for this study. Sample was selected on the principle of incidental sampling 61 subjects participated in this study 1, (males – 38 and females – 23) and 60 subjects (males – 36 and females – 24) participated in the study 2. However, data of only 58 trials (35 males and 23 females) could be analyzed for study 1(excluding the invalid radiographs) for correlation. Subjects were considered suitable for inclusion in the study only if there was, Normal and pain free ROM of neck and shoulder, Good motivational level for participation in the study, Age between 13 to 35 years and Height 1.44 m to 1.90 m. Subjects were excluded from the study if they had, Limited Range of Motion of neck and shoulder, Abnormal end feel other than soft tissue stretch, Any mental or psycho-emotional deficit, Any stiffness, pain, tenderness, swelling, and trigger point in or around neck and shoulder, Previous history of any surgery in the area of concern and Pregnancy.

## Materials & method

Study 1 was a correlational, cross-sectional study that compared measurements of neck position estimated on 'Bodygraph' and 'Radiograph'. Radiographic[9,12,20,22,25] measurements were considered as the 'gold standard' for this study. Both the measurements were taken in a predefined standard neck position that was maintained passively by an external support 'The Prop'. The tester of this study was a qualified Anatomist. Tester was kept blind regarding the subject identification and corresponding measurement. The Bodygraph alongwith a prop, 'O' shaped lead radio-opaque marker, X-ray Machine, X-ray film and developing material, Stationary protractor and Wooden stool were used to perform the test. Near identical research setting was maintained for taking measurement on all subjects. All measurements were performed by the same tester (and personnel) in single day. To ensure (standardization of position[12]) no subsequent movement of head between the two measurements recorded; a firm 'Prop' - right sided support was made. All (61) subjects were measured by the Bodygraph for cervical lateral flexion of right side and Radiograph (P-A view) was taken concurrently in the same position. The angle measured by Bodygraph was noted; radiographs were developed and the angle for cervical lateral flexion of right side was measured on it. The two measurements (one on 'Bodygraph' and other on Radiograph) were enlisted against each other by the principal investigator for all trials. Out of 61 trials performed 3 x-rays were invalid thus the remaining 58 trials were considered for the data analysis.

Study 2 used standard Reliability (Test-Retest) protocol. It was a correlational, longitudinal study analyzing relationship between different variables of the study. The observations were taken by three qualified physiotherapists 'The Testers'. Testers were kept blind regarding the subject identification and corresponding measurement. The observations were taken on total four occasions i e two sessions in a day for two days. All (60) subjects were measured by the Bodygraph for cervical lateral flexion of right side by three testers (Physiotherapists) on four separate occasions to collect the data for reliability nalysis of the Bodygraph. The 12 measurements thus recorded were enlisted against their corresponding subject, tester and session.

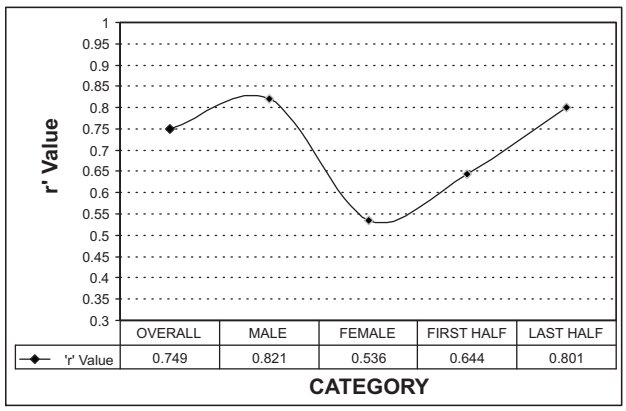


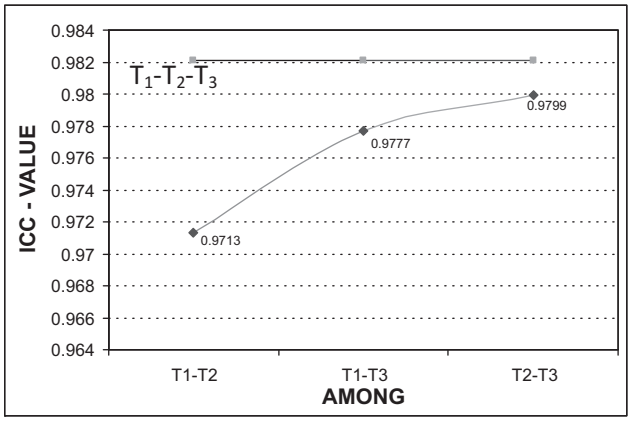

**Sample Demographics**

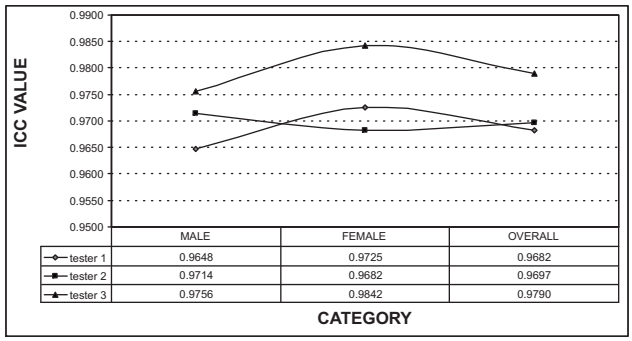
## Results

The Pearson product-moment correlation coefficient 'r' value for criterion validity of 'Bodygraph' was found to be 0.749 (p-value 0.000) when all 58 trials were correlated. The 'r' value was found 0.821 (p-value 0.000) when 35 measurements taken only on male subjects were correlated. The 'r' value was found 0.536 (p-value 0.008) when 23 measurements taken only on female subjects were correlated. The 'r' value was found 0.644 (p-value 0.000) when first half of the trials were correlated. The 'r' value was found 0.801 (p-value 0.000) when last half of the trials were correlated.

Intraclass correlation coefficient (ICC) based on ANOVA - Repeated Measures (Alpha model – Method II) was used to estimate the intratester & intertester reliability. Intratester reliability - The ICC for overall intratester reliability of tester 1 (T1) was 0. tester 2 (T2) was 0.and tester 3 (T3) was






0.9790. Intertester reliability Analysis - The ICC between tester 1, 2 & 3 was 0.9821 (p-value - 0.000). between tester 1 and tester 2 was 0.9713, between tester 1 and tester 3 was 0.9777 and between tester 2 and tester 3 was 0.9799

## Discussion

Criterion validity and reliability (intratester and intertester) of 'Bodygraph' can be considered satisfactory to good. Previous studies have documented - 'r' value for criterion validity of different goniometers from 0.390 to 0.98 (Gogia PP[12], Petherick[13], Brosseau Lucie[22]), ICC value for intratester reliability from 0.85 to 0.99 (Boone DC[7] Stuart Love[18] MacDermid[19] Brosseau Lucie[22] Jan Lucas Hoving[26]) and ICC value for intertester reliability from 0.53 to 0.99 (Boone DC[7], Rothstein[10], Gogia PP[12], Petherick[13], MacDermid[19], Brosseau Lucie[22], Linda Engh[24], Jan Lucas Hoving[26]). Notably Parallelogram Goniometer (a novel tool) was documented[9] with intratester reliability ICC=0.85 to 0.96, intertester reliability ICC=0.43 to 0.88 and criterion validity r = .33 to 0 .77. Results of our study are similar to these findings. Also comparing the data of validity study analysis it was also found that agreement between the two variables improved in the later half of the study suggesting better correlation on practice and adaptation of the tester with the equipment and the research setting. The higher correlation of variables in male subjects may be attributed to the better fixation of the 'Bodygraph' in males. In addition 'Bodygraph' was found easy to apply and handle. It was also found that an acclimatized observer can obtain more valid measurements by this 'Bodygraph'. It was concluded that 'Bodygraph' has satisfactory criterion validity and reliability within the generalizability of this research study.

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# Patterns of morbidity in spinal cord injured earthquake victims and its implications in activities of daily living (ADL)

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## Abstract

### Aim

To demonstrate the patterns of morbidity and its association with the demographic characteristics and activities of daily living status in paraplegic patients in the earth quake victims.

### Method

Samples collected from their medical records from year 2001-2005, which were followed and treated by the rehabilitation professionals during Gujarat earth quake.

### Results

Morbidity patterns were classified. No significant association between the morbidity and demographic characteristics, and no significant association between the morbidities found. But significant association between ADL and co morbidities, like catheter, depression, pressure ulcer and pain were found.

### Conclusion

Reducing the complications will have a significant impact on their quality of life and improve ADL. ADL independence also play a vital role in reducing the complications. Innovative approaches are needed to reduce the complications in these individuals who live in remote villages where modern treatment approaches are out of reach.

### Key words

Spinal cord injury, morbidity patterns, Activities of Daily Living, quality of life.

## Introduction

January 26th 2001, was witness to an earth quake measuring 6.9 on Richter scale devastated a large area of northwestern India in the state of Gujarat. Millions were directly and indirectly affected by this killer quake. 1, 66,000 people were injured, 13,811 died, and 8, 68,000 houses were damaged. Among the injured survivors thousands were victims of spinal cord injuries.

Pressure ulcers, urinary tract infection, depression etc, are the most serious, life-long complication of spinal cord injury (SCI) which can result in long term disability often with profound effects on the quality of life of the affected individuals and their carers[1]. More than 95% of these patients reported at least one secondary problem & more than half (58%) reported three or more. In general the number and severity of complications varied with the time since injury[2]. There is a lot of data available on the details of the earth quake, but there is no data available on the morbidity of the Spinal Cord Injury patients affected in this earthquake

Despite improvement in Spinal cord injury medical management, rehospitalization rates remains high, with an increased incidence in condition associated with genito urinary system, respiratory complications & diseases of the skin[3]. Presence of psychological distress was also reported as the highest prevalent complication[4]. Quality of life is also affected in Spinal cord injuries[6].

Pressure ulcers are one of the most common & potentially serious complications of spinal cord injury. If they develop they may interfere with the initial rehabilitation and reintegration into the community, as well being a source of morbidity & mortality. Persons with spinal cord injury develop pressure ulcer at some point in their lifetime[7,8,9,10,11]. Associated risk factors include level & severity of the injury, gender, ethinicity, marital status, employment status, educational achievement, tobacco, alcohol use, nutritional status & possible depression.

The complications of Spinal cord injury have a significant effect on general health and quality of life. This study was undertaken to demonstrate the characteristics, presence, description, of pressure ulcers, bladder problems, pain, Activities of Daily living status and psychosocial problem and its association with the demographic characteristics in paraplegic patients in the earth quake affected region of Gujarat. There is also a need to find their morbidity trends as compared to the other traumatic spinal cord injury. But we afraid there still lies oceans of statistics and misery remain unnoticed.

Complications of Spinal Cord injury can be very much related with Activities of daily living. Complications like bladder bowel problem, pain, psychosocial problem can be reduced if a person is independent in Daily living.

Activities of Daily living can be improved if the complications can be reduced. The concept of independent in Activities of Daily living is very minimal in India as compared to the developed countries. But there were no studies on association between Activities of daily living and complications to address this issue. Hence in this study it was proposed to find the association between level of activities of daily living and morbidities trends in the earth quake victims.

In India, most of the patients have shorter length of stay due to economic reasons in hospital & rehabilitation varies from area to area. After discharge many go for alternative medicine too. But the rate of rehospitalization has increased with more complications. These could be the reasons for their dependency in the Activities of Daily living. Through

this study the factors associated Activities of Daily in spinal cord injury were identified. This may pave the way to optimize rehabilitation and enhance their quality of life and prevent further complication in spinal cord injuries and make them independent in Activities of Daily living.

## Aim of the study

To demonstrate the patterns of morbidity and its association with the demographic characteristics and activities of daily living status in paraplegic patients in the earth quake affected region of Gujarat.

## Methodolgy

## Study design

Retrospective longitudinal study.

## Subjects

In the present study 94 Individuals who had sustained spinal cord injury as a direct result of the earth quake and were treated at a rehabilitation center at kutch were included they were regularly followed up by the community based rehabilitation professional team for the time period of four years 2001 to 2005.

## Settings

Community based rehabilitation center at kutch district which include the taluka of Bhuj, Anjar, Bhachau, Mandvi, Mundra, Nakhtrana, and Rapar taluk of Gujarat state, India.

## Procedures

In this study the medical records of the rehabilitation centers was reviewed to obtain data of spinal cord injury patients in the earth quake, all details of complication was collected for each patient. These included daily notes of nurses and therapists, physicians, and surgeons.

The following information was retrieved from the records, demographic status, presence and number of pressure ulcers, size and duration of each ulcers, treatment (topical dressings, debridement, referral for hospital admission or surgery), Outcomes in terms of healing status, non - healing, urinary incontinence status- intermittent or continuous catheter. Psychosocial problems (behavior problems & depression),pain status in different parts of body. Activities of Daily living status – independent, dependent, vocational status (independent, dependent).

## Data analysis

Data was analyzed using SPSS software package version 10.0. Descriptive statistics were obtained for all study variables morbidity data like details of pressure ulcer, urinary incontinence and depression was also obtained. Frequency tables were constructed for categorical variables, Means, standard deviations, and ranges were calculated for all continuous variables. Association between the demographic status and the complications like catheter, pain, psychosocial problems, pressure ulcers and Activities of daily living was analyzed using Chisquare test. Level of significance (p value) was set at d"0.05 with CI of 95%.

## Results

### Demographic Characteristics

Demographic information included the person's age, sex, and complications are summarized in Table 1.

### Characteristics of Study Population

The ages ranged from as young as 7 years to and as old as 75 years of age and majority of the victims were female 72 percentages In this study there was no significant association between the morbidity and demographic characteristics were noted and also there was no significant association between the morbidities was found. There was significant association between activities of daily living and comorbidities, like catheter, depression, pressure ulcer and pain (Table 2).

### Characteristics of Pressure Ulcers

Of the 94 victims 20 percent developed pressure ulcers ( decubitus, any site) during the 4 years studied of that 55 percent of the subject had unhealed pressure ulcers at one site and about 45 percent of them had pressure ulcers at two or more unhealed sites and for whom plastic surgery was suggested by surgeons. Stage IV pressure ulcers were the most prevalent in 61 percentages of subjects.

### Distribution of complications

The percentage of the distribution of the complications is summarized in the (Graph 1).

## Discussion

In patients with urinary incontinence 87% of them were on intermittent catheterization and 13 % of victims were on

**Table 1:** Demographic Characteristics.

| Charecteristics | Female (n=68) Mean age 33.9(12.9) | | Male(n=26) Mean age 30.6(11.2) | |
|---|---|---|---|---|
| | Frequency | percentage | Frequency | percentage |
| Pressure sores | 12 | 17.6 | 8 | 30 |
| UTI | 9 | 13.2 | 3 | 11 |
| Depression | 9 | 13.2 | 3 | 11 |
| Continuous catheter | 35 | 51.4 | 20 | 76 |
| ADL dependent | 17 | 25 | 5 | 19 |
| Pain | 22 | 32.3 | 6 | 23 |

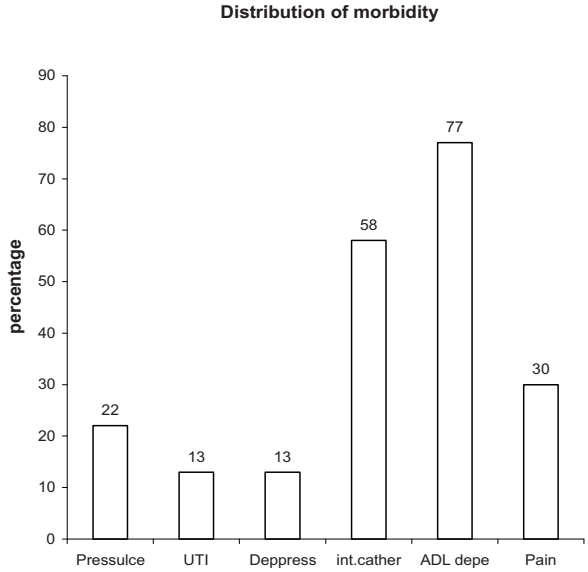

**Table 2:** Association between morbidities.

| | Age | ADL | Sex | pain | Pressure ulcer | UTI | Catheter |
|---|---|---|---|---|---|---|---|
| **Age** | | .147 | | | | | .262 |
| **Sex** | | .383 | | | | | .072 |
| **Pain** | .488 | .000 | .269 | | | | .226 |
| **Pressure ulcer** | .654 | .051 | .135 | .196 | | | .005 |
| **Depression** | .359 | .001 | .565 | .001 | .076 | .044 | .000 |
| **UTI** | .748 | .030 | .565 | .001 | .076 | | .007 |

continuous catheter. There was no gender difference in the incidence of urinary incontinence. Male patients were more affected by pressure ulcers than female. This (6:4) ratio of large percentage of male patients having pressure ulcers could be due to the larger percentage of male patient who were dependent in their ADL activities once they had suffered from SCI . Female patients were more independent in their ADL compared to males and they had to do their activities of daily living by themselves. This trend was attributed to culture where men tended to demand and receive greater care than women. The occurrence of pressure ulcers is common long term secondary medical complication in person with SCI. The percentage number of pressure ulcers in subjects was consistent with earlier studies in which prevalence ranged 17 to 33 percentage in persons with SCI residing in community[2,3].

In patients with depression 55% were female and 45% males. This shows that women were affected more by depression than male paraplegic. The higher percentage of female subjects diagnosed with depression could be due to most of the fact that women were divorced after becoming a SCI. This was not the case with men again the culture and attitude of the society can be attributes to this problems. The large-scale death, destruction of infrastructure, disintegration of social support networks, sources of livelihood and ongoing uncertainty about the future caused by the earthquake tend to adversely affect the mental health (and psychosocial well-being) of individuals and communities. This correlates with the cross sectional study done in AIIMS, New Delhi, for the presence of complications. They found that psychological distress was the highest prevalent complication with seven patients having suicidal ideas, followed by neurogenic bladder dysfunction, spasticity, pain & pressure ulcer in that order[4].

Pressure ulcers, urinary tract infection, depression etc, are the most serious, life-long complication of spinal cord injury (SCI) which can result in long term disability often with profound effects on the quality of life of the affected individuals and their carers[1].

Incidence of secondary complications following spinal cord injury was studied in 1996 in USA. Data was collected from 348 patients with post acute spinal cord injury. More than 95% of these patients reported at least one secondary problem & more than half (58%) reported three or more. Statistical analysis indicated that in general the number and severity of complications varied with the time since injury. Obesity, pain, spasticity, urinary tract infection & pressure ulcers were common[2].

The various causes for morbidity in patients with paraplegia that were addressed in the study by Nalina Gupta were as follows in order of decreasing frequency pain, continuous use of catheter, stiffness, pressure sores, surgeries due to any of the morbidities, postural hypotension, fracture & respiratory complications. Use of catheter was associated with the inability to ambulate. Incidences of surgery were seen more in non-ambulatory group. Also they found that there is a significant association between various demographics & morbidities. They suggested to give more emphasis for rehabilitation all over India. They concluded that the most common cause for morbidity was pain. Ambulation reduced the incidence of secondary complications [5].Identifying rates, causes and patterns of morbidity is important for future resource allocation and targeting preventative measures. For instance, the late complication of pressure sores in a small subgroup of young males, consuming disproportionately large resources, warrants further research to better understand the complex psychosocial and environmental factors involved and to develop effective counter-measures[15].

Complications of Spinal Cord injury can be very much related with Activities of daily living. Complications like bladder bowel problem, pain, psychosocial problem can be reduced if a person is independent in Daily living and Activities of Daily living can be improved if the complications can be reduced. The concept of independent in Activities of Daily living is very minimal in India as compared to the developed countries. But there were no studies on association between Activities of daily living and complications to address this issue. These data provide baseline information for determining morbidity and demographic data of paraplegic in the Gujarat earth quake victims. Reducing the complications like pressure ulcers, urinary infection and depression among the victims will have a significant impact on their quality of life in these patients.

In India, most of the patients have shorter length of stay in hospital & rehabilitation varies from area to area. After discharge many go for alternative medicine too. But the rate of rehospitalization has increased with more complications. These could be the reasons for their dependency in the Activities of Daily living. Through this study the factors associated Activities of Daily in spinal cord injury were identified. This may pave the way to optimize rehabilitation and enhance their quality of life. This may again indirectly prevent the increase of further complication in spinal cord injuries and make them independent in Activities of Daily living.

The data provided here in this study gives baseline information about the patterns of pressure ulcers, urinary tract infection, depression in spinal cord injury and its association with the demographic characteristics. Reducing the complications like pressure ulcers, urinary tract infection and depression among the victims will have a significant impact on the quality of life in these patients in the future

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# Dominance of sensory inputs in maintaining balance among acute and subacute stroke patients

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## Abstract

### Purpose of the study

Stroke leads to hemiparesis which further leads to poor balance. Established fact behind this balance problem is motor weakness and this study focuses on the influence of sensory system over imbalance among these subjects. The objective of the study was to analyze the influence of visual, vestibular and somatosensory systems in maintaining balance among acute and sub acute stroke patients using the CTSIB (Clinical Test For Sensory Integration and Balance) test & in addition to determine whether there are any alterations in the dominance of sensory inputs among sub acute stroke patients.

### Metbods

A total of 31 patients with hemiparesis secondary to unilateral CVA were tested. Subjects were divided into an acute (A) and a sub acute (B) group. Study design: Descriptive study. Timed performances under six different conditions were compared across the two groups using the CTSIB. The CTSIB is a timed test in which the postural sway is measured while the subject stands quietly under 6 different conditions that alters the availability and accuracy of visual, vestibular and somatosensory inputs for postural orientation.

### Results

Patients in the acute group demonstrated a poor score in all compliant surface conditions and a very low score in conditions 5 and 6 with a mean score of 5.56 and 8.25 respectively, whereas those of the sub acute groups have a higher mean of 23.73 and 28.93 respectively. When comparing the scores between the two groups using two way ANOVA, it was found that there was a statistically insignificant difference in conditions 1, 2 and 3. A statistically significant difference was noted in condition 4 ($P < 0.05$) and high level of significance was noted in conditions 5 and 6 between the groups with P value of $< 0.001$.

### Discussion and conclusion

based on the results of this study it was concluded that patients with acute hemiplegia rely excessively on their visual system for maintaining balance and this becomes a natural compensatory strategy for coping with poor balance. Dominance or excessive reliance on the visual system among these patients causes suppression and masking of two other systems (vestibular and somatosensory). Unmasking of the influence of somatosensory system is seen in sub acute patients and this unmasking can occur as early as 1 to 5 months following stroke.

## Introduction

Stroke is defined as a rapidly developed clinical sign of focal disturbance of cerebral function of presumed vascular origin and of more than 24 hours of duration. CVA or stroke is a major public health problem that ranks in top 4 causes for death in most countries and is responsible for larger population of burden of neurological disorders[1].

Susan B. O Sullivan (2001) states clinically a variety of deficits are possible including impairments of sensory, motor, perceptual and language function and they vary depending on the area of the brain involved and the severity of the lesion[2]. The clinical picture may extend between a very minimal sensory or a motor deficit in one extreme to death on the other extreme. In between these two extremes there may be a varying amount of sensory deficits, cognitive deficits, and motor deficits involving one half of the body. Motor disturbances are aggravated by sensory impairments among patients with hemiplegia. Balance problems are thought to be common in stroke and they have been implicated by poor recovery in activities of daily living (ADL), mobility and increase in falls[3,4,5].

Balance is the ability to control the body mass or centre of mass or integrated sensory and musculoskeletal system and is modified within the CNS in response to changing internal and external environmental conditions[6]. The upright postures like sitting, standing or walking requires proper functioning of central balancing mechanisms. Afferent impulses of widespread origins, including signals from the periphery, play important roles in eliciting and guiding responses, while efferent pathways carry messages to the muscles for the execution of the balancing act. Damage to any one of the central mechanisms or interruption anywhere along the sensory or motor may lead to an inability to maintain body's COG within base of support, but, no one system directly specifies the position of COG[7]. Shumway Cook (1986) stated information's from the vestibular system is a powerful source in maintaining postural control and it provides the CNS with information about the position and movement of the head with reference to gravity and inertial force providing gravitoinertial frame of reference for postural control. The visual inputs report information regarding the position and motion of head with respect to supporting surface. And the somatosensory system provides CNS with position and motion information about body with reference to supporting surface and in addition provides information about the relationship of body segments to each other. Each sense provides the CNS with specific information about position and motion of the body. Thus each sense provides

a different frame of reference for postural control[8,9].

The differing roles of sensory inputs is controversial but it is likely that they are co-ordinated in a task related manner which is dependent on environmental circumstances. Winter et al (1990) stated that the redundancy present within the sensory systems in the maintenance of balance enables not only the verification of inputs which may be conflicted but also allows for compensation[10]. Work done by Richard D Di Fabio (1991) stated that disease alters one sensory modality then balance reaction can be compensated through the use of remaining sensory inputs[11].

Studies done in past have explained the phenomenon underlying lack of balance and its recovery post stroke. Disorders of sensory interaction have been proposed to be one of the causes for balance and postural instability following cerebral or hemispheric lesion. A consistently greater amount of postural sway is noted post stroke[12,13] and recovery of functional balance and mobility were noted 1 month following the lesion[14]. Visual input dependence is stated to be one of the important factor in lack of balance among these patients and in addition there is masking of inputs of the other two systems (somatosensory and vestibular).These causes put together leads to a poor sensory interaction at the CNS leading to poor balance[15].

In the literature reviews done there is a clear lack of evidence of the influence of sensory inputs in maintaining balance among sub acute Stroke patients, thus this study aimed at determining, which sensory input / system do patients with acute and sub acute stroke rely more in maintaining balance or postural stability and in addition to finding out whether there is an alteration or change in the dominance of sensory input between these two groups of stroke subjects.

## Methodology

### Participants

A total of 31 patients with hemiparesis secondary to unilateral CVA were tested. Subjects were selected from inpatient and outpatient services of Sri Ramachandra Hospital, Chennai, India. The design was a descriptive study to determine the dominance of sensory input in maintaining balance among acute and sub acute stroke patients. Subjects were recruited using a convenience sampling. To be included in the subjects had to have, good comprehension, infarcts of MCA and ACA territories of either sides, normal vision and pre morbid vestibular function, grade 3, 4 & 5 of, sitting to standing component of Motor Assessment Scale, maintain an upright posture without the assistance of an orthotic device or manual support for a period of 30 seconds & medically stable.

**Fig. 1:** Foam, scarf to blind vision, stop watch and dome.

Patients were excluded if, impaired balance or ambulatory status prior to the CVA, lesions affecting both sides of the brain and impaired propreoceptive function of extremities secondary to Diabetes Mellitus. Informed consents were obtained from all subjects. Subjects were divided into an acute (A) and a sub acute (B) group with 16 subjects in group A and 15 in group B. Sub acute subjects were defined as those who were diagnosed to have hemiplegia 1 to 5 months after the onset of stroke.

### Outcome measures

The CTSIB test was used to assess the contribution of sensory inputs (vision, vestibular, somatosensory) for maintenance of balance. The test attempts to isolate the various sensory contributions, by either removing or distorting (via sway referring the visual surround or the surface platform) the visual, vestibular and/or somatosensory inputs needed for postural control. The resultant 6 conditions progress from the most stable (eye open, solid support surface) to the least stable (sway referenced vision and surface). Conditions are as follows:
Condition 1: Eye open + Firm surface
Condition 2: Eye closed + Firm surface
Condition 3: Visual conflict + Firm surface
Condition 4: Eye open + Compliant surface
Condition 5: Eye closed + Compliant surface
Condition 6: Visual conflict + Compliant surface

The support surface condition consisted of a hard flat floor and 27.5*25*6 inches foam that reduces the quality of surface orientation input. The visual conflict dome was a custom made Japanese lantern dome covered with translucent mica. A stop watch was used to record the amount of time the subject maintained initial equilibrium position in each conditions.

Test interpretation: A poor score in conditions 1 and 2 indicated that the subject made poor use of somatosensory reference, a poor score in conditions 4 and 1 indicates that the subject uses poor visual reference, a poor score in conditions 5 and 1 indicates the subject makes poor use of vestibular cues and a poor score in conditions 2, 3, 5 and 6 with inaccurate visual cues worse than no visual cue indicates the subject relies on visual cues even when they are inaccurate.

The Motor Assessment Scale (MAS) was used to recruit patients. The MAS is a brief and easily administered assessment of eight areas of motor function and one item related to muscle tone. Each item is scored on a scale from 0 to 6[16]. For the purpose of this study sit to stand component was taken and subjects falling in grade 3, 4 and 5 were

**Table 1:** Baseline characters.

| Variables | | Group A | Group B |
|---|---|---|---|
| Number of cases | | 16 | 15 |
| Age | | 61.50 +/- 6.29 | 59.93 +/- 7.63 |
| Sex | Male | 14 | 10 |
| | Female | 2 | 5 |
| Side of lesion | Right | 7 | 3 |
| | Left | 9 | 12 |
| Type of lesion | | Ischemic | Ischemic |
| Site of lesion | MCA | 12 | 8 |
| | ACA | 1 | 1 |
| | Ganglio capsular | 2 | 6 |
| | Brain stem | 1 | 0 |
| Time since stroke (days) | | 5.75 +/- 2.14 | 61.50 +/- 6.29 |
| MAS score | 3 | 5 | 0 |
| | 4 | 11 | 8 |
| | 5 | 0 | 7 |

included.

Sitting To Standing Component (MAS)

3. Gets standing. (do not allow uneven weight distribution or help from hands).
4. Gets to standing and stands for 5 seconds with hips and knees extended. (do not allow uneven weight distribution).
5. Sitting to standing to sitting with no stand-by. (do not allow uneven weight distribution. Full extension of hips and knees).

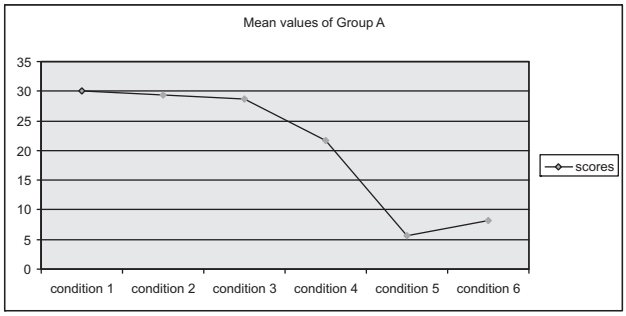
**Procedure**

Baseline characters described at the beginning of the study were age , sex, side of lesion, type of lesion, site of lesion, time since score and Motor Assessment Score (MAS) as mentioned in table 1. The test was conducted in a well lighted, quiet room, the procedure was explained to the patient in his/her own language, the subject was instructed to maintain upright posture in each condition for a period of 30 seconds. The order of conditions was kept standard for all the subjects. Subjects were instructed to clasp his/her unaffected hand on to the opposite shoulder and maintain an upright posture in each condition for a period of 30 seconds. Safety of the patient was reassured. Help was taken to prevent any fall while testing. (Pictures shown in appendix).The time was noted if the subject takes his/her hand off the shoulder to prevent fall before termination of the test that is before 30 seconds. 3 trials were taken and the scores were averaged. A preliminary pilot study was conducted on 4 subjects with 2 in each group to check the feasibility of the study.

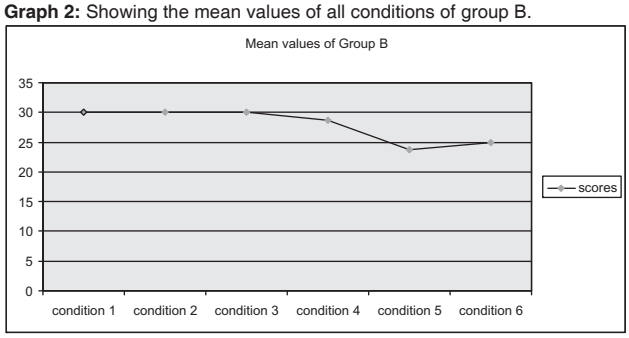
## Statistical analysis

Data's were analyzed by using SPSS for Windows version 11.5 (Statistical package for social sciences). The CTSIB scores of all the subjects were compared within the group using repeated measure ANOVA and between the groups using two way ANOVA test. . Bon ferroni correction was used to compare the difference between scores of 6 conditions within each group. The confidence interval was set as 95%.

**Graph 1:** Showing mean values of all conditions of group A.




**Graph 2:** Showing the mean values of all conditions of group B.




## Results

Results of 31 patients were reviewed with 16 subjects in acute group (14 male and 2 female) and 15 in sub acute group (10 male and 5 female). Mean age of subjects of the group A was 61.5 and that of group B was 59.93. The demographic data of all subjects studied, is shown in table 1. Mean value of the scores of all six conditions are shown in graphs 1 & 2 respectively. Score of condition 1 (i.e 30) was taken as a standard to compare the results of other conditions within the same group. Results show a significant difference between condition 1 and conditions 3, 4 & 5 among subjects of group A as shown in table 2. Comparison between conditions of group B showed a statistically significant difference in conditions 5 & 6 alone when compared with the mean value of condition, as shown in table 3. Comparison between the conditions of the 2 groups revealed an insignificant difference between the first 3 conditions (firm surface) and a significant difference between the groups in the next three conditions (compliant surface), with a moderate level of significance (0.005) in condition 4 and high level of significance (0) in the last 2 conditions, as shown in table 4 and graph 3.

## Discussion

The CTSIB is an inexpensive and easily administered test for standing balance, and it can be used for all neurological conditions including stroke. The results of this

**Graph 3:** Comparing the scores between the 2 groups.

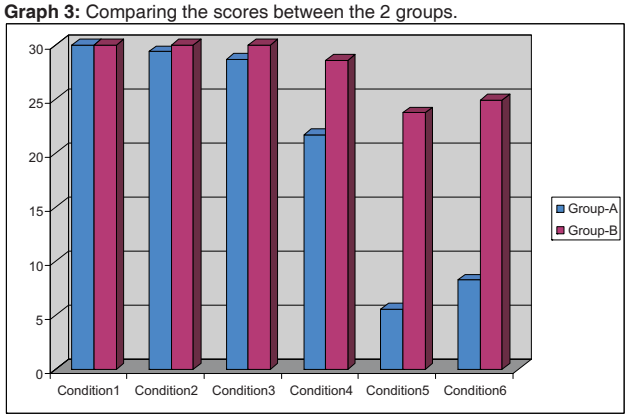



**Table 2:**

| Condition | Mean difference | P value |
|---|---|---|
| (1,2) | -0.625 | 1.0 |
| (1,3) | -1.313 | 1.0 |
| (1,4) | -8.313 | 0.02* |
| (1,5) | -24.438 | <0.001*** |
| (1,6) | -21.15 | <0.001*** |

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

**Table 3:**

| Condition | Mean difference | P value |
|---|---|---|
| (1,2) | - | - |
| (1,3) | - | - |
| (1,4) | -1.4 | 1.0 |
| (1,5) | -6.27 | <0.001 |
| (1,6) | -5.07 | <0.001 |

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

**Table 4:**

| Condition | Group | Mean | Std dev | P value |
|---|---|---|---|---|
| 1 | A | 30 | 0 | 0.34 |
| | B | 30 | 0 | |
| 2 | A | 29.38 | 2.25 | 0.29 |
| | B | 30 | 0 | |
| 3 | A | 28.69 | 2.63 | 0.06 |
| | B | 30 | 0 | |
| 4 | A | 21.69 | 12.35 | 0.04* |
| | B | 28.60 | 3.92 | |
| 5 | A | 5.56 | 7.23 | 1.404e-08*** |
| | B | 23.73 | 5.61 | |
| 6 | A | 8.25 | 9.15 | 2.321e-06*** |
| | B | 24.93 | 6.33 | |

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

**Condition 1:** Eye open + Firm surface.

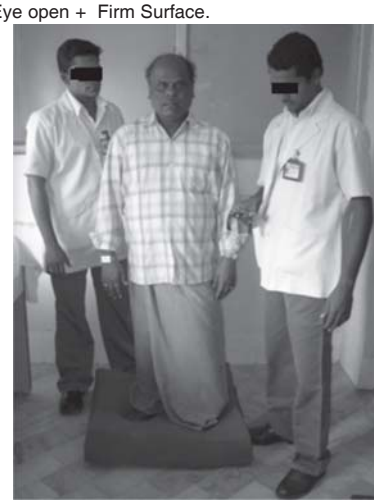
**Conditon 2:** Eye closed + Firm Surface**.**

study has shown that subjects having both acute and subacute stroke have a near normal score in all three stable surface conditions (conditions 1,2 & 3), whereas with the introduction of a compliant surface the stance duration reduced in both groups. Thus these findings suggest that the ability of hemiplegic patients to integrate sensory information for balance is compromised, and visual inputs provide a compensatory mechanism for balance control when support surface is unstable.

Tests done on sub acute stroke patients have shown

**Condition 3:** Visual conflict + Firm Surface.

**Conditon 4:** Eye open + Firm Surface.



**Conditon 5:** Eye closed + Compliant Surface.

that the scores on compliant surface had increased and, this increase in score denotes the improved ability of the individual to integrate his/her sensory inputs in maintaining balance. Richard P Di Fabio studied the standing balance of hemiplegic patients using the Sensory Organization Test

**Conditon 6:** Visual conflict + compliant surface.

(SOT) in which he identified that bilateral stance was reduced signifying a compromise in the ability to integrate somatosensory information from the lower extremity in maintaining balance among subjects with cerebro vascular acciedents[17]. Dietz V (1992) in his discussion on the interaction between central programs and afferent inputs stated the influence of visual system predominance, when afferent inputs from the other systems are reduced, irrespective of the cause. This occurs, for example, in patients with an impaired somatosensory system following neuropathy, in bilateral loss of vestibular function or even in healthy subjects during space flight[18]. for the above mentioned reasons effective treatment of balance deficits requires identification of the inaccurate sensory organization. If the imbalance is due to inaccurate sensory orientation information sensory specific balance training which increases the reliance of visual system like use of ambulatory aids can be used[19].

In contrast to this statement, Isabelle V. Bonan et al (2004) stated though patients with hemiplegia rely excessively on the visual system, sensory specific balance training with deprived visual system improves the inputs from somatosensory system and concluded stating visual reliance in hemiplegic patients are reversible[20].

Most of the previous studies have studied the influence of different sensory systems in maintaining balance among stroke patients. Only few studies had tried comparing acute and chronic stroke patients and have concluded that the influence of somatosensory system increases in chronic patients. The objective of this study was to find the influence of each sensory system among these 2 groups and to determine how fast does unmasking of somatosensory and vestibular systems takes place among stroke patients. Results of our study suggests that immediately following stroke all patients rely excessively on their visual system for maintaining balance and when subjects were examined 1 and 5 months after stroke, there was an increase in scores on all compliant surface conditions, indicating an increase in the inputs from somatosensory system. This increase can be one of the most important factors for the better balance performance of patients after 1 month following stroke.

Thus unmasking of the somatosensory and vestibular systems brings about an improvement in balance among these patients which is evident from a higher CTSIB scores. so strategies which facilitates early unmasking of these sensory systems are strongly recommended for early recovery from balance dysfunctions among stroke patients.

## Conclusion

Balance dysfunctions following stroke may be caused due to sensory organization disorders in addition to motor weakness involving one half of the body. Patients with acute hemiplegia rely excessively on their visual system for maintaining balance and this becomes a natural compensatory strategy for coping with poor balance. Dominance or excessive reliance on the visual system among these patients causes suppression and masking of two other systems (vestibular and somatosensory). Unmasking of the influence of somatosensory system is seen in sub acute patients and this unmasking can occur as early as 1 to 5 months following stroke.

Further studies need to be done using computer assisted force platforms to assist in objectively determining the amount of sway in each condition in addition to the time variable.

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# Stress in undergraduate physiotherapy students at KIPT

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## Abstract

### Purpose

The purpose of this study was to findout the intensity of stress in undergraduate (BPT) physiotherapy students and it's correlation with their academic performance.

### Design

Co-relational study design.

### Setting

An undergraduate & postgraduate physiotherapy-training center named Karnataka Lingayat Education Society's Institute of Physiotherapy (KIPT), Belgaum, Karnataka state, India 590010.

### Participants

147 undergraduate physiotherapy students of 1 to 4th year & interns of Indian & Nepalese ethnic origin during 2008.

**Interventions:** Nil

**Main outcome measures:** Stress score.

### Methods

Stress was measured with a nonspecific stress questionnaire with 20 questions so that maximum calculated stress score could be 100.

### Results

The intensity of stress was in the range of 36 to 92 in undergraduate physiotherapy students and interns with an average of 64.11 ±10.62. There was no significant correlation between academic performance and stress score. Average stress scores among the undergraduate physiotherapy students of different academic years and interns did not vary significantly.

### Conclusions

The data indicate that undergraduate physiotherapy students at KIPT suffer from high intensity of stress irrespective of their academic year in the institute and there is no correlation between academic performance in terms of their percentage of marks scored in previous academic year and stress. Consequently it is proposed that this physiotherapy institute could take appropriate steps for prevention of undue stress and thereby stress related problems.

### Keywords

Physiotherapy; Stress; Undergraduate; Academic performance.

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## Introduction

There is an increasing concern about the stress in health education and training especially in medical, dental, nursing and to certain extent physiotherapy education. Stress during physiotherapy education is inevitable. Although stress is not necessarily a symptom of more formal anxiety or depressive disorders it can be a precursor to these problems. Conversely stress can have a number of beneficial effects.

In addition to humanitarian reasons for concern about stress, high levels of stress may have a detrimental effect on the mastery of the academic curriculum. However, there is deficit of the information regarding the amount of stress in undergraduate physiotherapy students. This study examined the stress in undergraduate physiotherapy students in relation to their academic year in physiotherapy institute and its correlation with academic performance in terms of their percentage of marks obtained in previous academic year.

Literature review suggests pile of information on stress in various medical and non-medical undergraduate students[1-12,19-28] but there is lack of the stress related information pertaining to physiotherapy students and hence it's not clear whether or not physiotherapy students suffer from overstress, causative factors of their stress, stress related illnesses, coping strategies etc. Sarid O et al[13] studied the academic stress, immunological reaction and academic performance among students of nursing and physiotherapy. They found that health status and health behavior remained fairly stable during the examination stress period. Balogun JA[14] investigated the proposed link between academic performance of students and burnout and found that there was no significant correlation between cumulative grade point average and training of emotional exhaustion, depersonalization and personal accomplishment.

Supe A N[15] investigated stress in medical students at Seth GS Medical College, Mumbai, India and found that 73% of medical students perceived stress and the stress has not been associated with the academic year in school.

## Method

## Subjects

Subjects were undergraduate physiotherapy students (first to fourth year and intern) at KLES Institute of Physiotherapy / KIPT (formerly Department of Physiotherapy, JN Medical College), Belgaum, Karnataka state, India 590010. In this institute the mode of selection for physiotherapy course (BPT) is on merit basis, however the minimum requirement for the admission is 50% marks in HSC or 10+2 examination. A total of 216 students were present as per the college office record at the time of study, however only 147 students (11 male & 136 female) participated in this study thus yielding a response rate of 68.05%. Remaining students were absent on the day of data collection and didn't participate in this study due to a variety of reasons such as unofficially left the course, repeaters, failures, preparing for the forthcoming internal examination by staying away from regular lectures and practical, health problem, their personal reason or didn't wish to participate in this study. Age of the subjects varied from 17 to 24 years with an average age of 20.04 ± 1.64. Out of 147 subjects, only three were of Nepalese ethnic origin while others were Indian.

## Instrument

A nonspecific stress measurement instrument with 20 questions was used to find out the stress score. The 20 statements used for the assessment of stress were selected from an instrument that was available on www.releasetechnique.com as a free stress test. Every question had five answer options like strongly disagree, disagree, Am certain, agree & strongly agree. These answers were rated with 1 to 5 so as to get the highest score of 100. Along with this questionnaire, subjects were requested to provide the details about academic year, percentage marks scored in previous academic year, mode of entry, gender, etc. Percentage of marks scored in previous academic year was asked since this study was performed after one month of starting of academic training of respective year and hence the marks scored in that academic year could not be available at this time. Total score obtained from each instrument was graded as very low (15-29), low (30-44), moderate (45-59), high (60-79) & very high 80-100.

## Procedure

Participation in the study was voluntary and an informed consent was obtained. Chairman of institutional review board approved this study. The participating students were briefed about the aim of study, instructed to avoid putting up any mark on questionnaire that could identify them and guaranteed confidentiality. The questionnaire was distributed by researcher with the help of a clerical assistant in lecture hall at 9.00AM after one month of starting of their academic milestone in that year or internship and were collected back for analysis once they were duly filled by the participants.

## Data analysis

Data analysis was done with Graph Pad InStat demo version software downloaded from www.graphpad.com. Academic year (1 to 4$^{th}$ and intern) served as an independent variable. Stress score calculated from subject's duly completed instrument served as dependent variable. The mean stress score of academic years was analyzed with ANOVA and the percentage of marks obtained in previous academic year was analyzed to find out correlation between stress score and academic performance.

## Results

Majority of the physiotherapy students (71.42%) at KLES Institute of Physiotherapy Belgaum perceived high stress (fig. 1). Intensity of stress varied from 36 to 92 with an average of 65.40±1.07, however there was no significant difference in average stress in various academic levels. (ANOVA p 0.8397). There was no significant correlation in the perceived stress and academic performance in terms of percentage of marks scored in the previous academic year. (Table no. 1 & fig. 2). Stress in male and female students did not vary significantly in an academic level as well as across all academic levels. (Table no.2)

However, the academic performance in terms of their percentage of marks in the previous academic year varied significantly ($p<0.0001$) in all academic levels. The intensity of stress in terms of sub grades such as very high, high, moderate and low was variable in different academic levels (table no 3 and figure3 to 7). The numbers of female subjects (109/147) were more than male subjecs and thus may help to verify the general statement that female outnumber the male in physiotherapy teaching institutes across this province of India. There were four additional incomplete instruments where the information pertaining to academic score, gender & age was not provided and hence they were discarded from data analysis.

**Table 1:** Academic levels, stress & percentage of marks.

| Academic levels | I BPT | II BPT | III BPT | IV BPT | Intern | Inference |
|---|---|---|---|---|---|---|
| Average age in years | 18.11 ±0.84 | 19.581±1.27 | 20.48 ±1.197 | 20.84±1.156 | 22.31± 0.70 | - |
| Sample size | 27 | 43 | 35 | 26 | 16 | - |
| Average Stress | 64.11 ±10.62 | 66.30±9.57 | 65.71±9.85 | 66.46±6.92 | 64.43 ± 7.97 | P0.8397 NS ANOVA |
| Median stress | 63 | 67 | 67 | 66 | 66 | Passed normality test (p >0.10 |
| Range of stress | 43 -83 | 48-92 | 36- 86 | 53 - 79 | 48 - 75 | - |
| Average % Marks in previous academic year | 67.97±10.99 | 60.00±3.64 | 60.42±4.10 | 65.81 ± 4.32 | 61.69± 2.48 | P<0.0001Extremely Significant |
| Correlation in percentage & stress | 0.06 | -0.2621 | -0.05241 | - 0.033 | 0.3253 | - |
| P value | 0.7347 NS | 0.895NS | 0.7650 NS | 0.8726 NS | 0.2189 NS | - |

**Table 2:** Gender wise stress.

| Academic year | Male | Female | P | Inference |
|---|---|---|---|---|
| I | 68.71 ±9.34 | 62.5=±10.78 | 0.1882 | NS |
| II | 70.71±5.43 | 64.90±10.08 | 0.1498 | NS |
| III | 67.11±5.64 | 65.23±10.99 | 0.6283 | NS |
| IV | 67.14 ± 2.79 | 66.21 ± 7.98 | 0.768 | NS |
| Intern | 68.2 +±7.19 | 62.72± 8.02 | 0.2133 | NS |
| p | 0.7298 | 0.7508 | | NS |

**Table 3:** Stress intensity level in % and academic levels.

| Academic Level | Very high | High | Moderate | Low |
|---|---|---|---|---|
| I BPT | 3.70(1) | 74.07(20) | 14.81(4) | 7.40(2) |
| IIBPT | 9.30(4) | 67.44(29) | 23.25(10) | - |
| IIIBPT | 5.71(2) | 65.71(23) | 25.71(9) | 2.85(1) |
| IVBPT | - | 80.76(21) | 19.23(5) | - |
| Intern | - | 75(12) | 25(4) | - |

**Fig. 1:** Overall stress levels in undergraduate physiotherapy students.

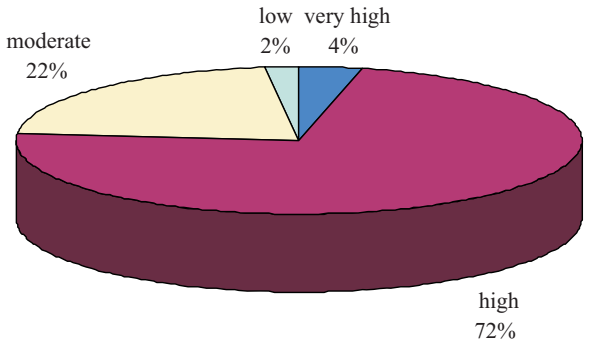



**Fig. 2:** Overall stress and academic performance correlation.

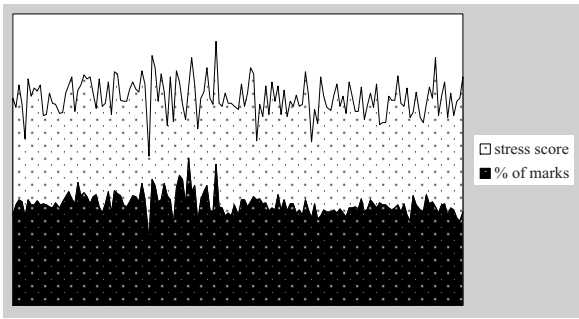



**Fig. 3:** Stress in I BPT students.

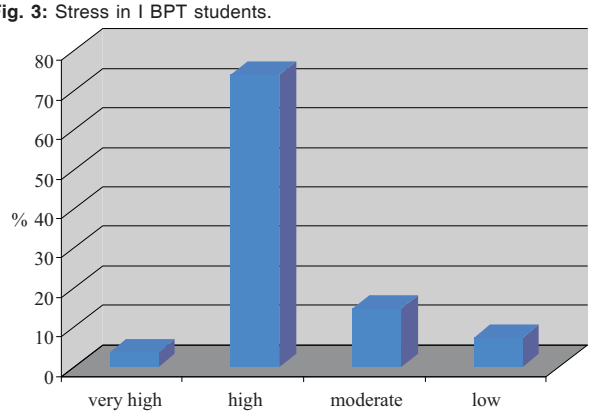



**Fig. 4:** Stress in II BPT students.

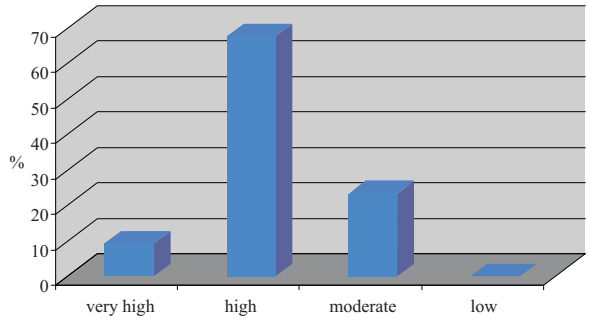



**Fig. 5:** Stress in III BPT students.

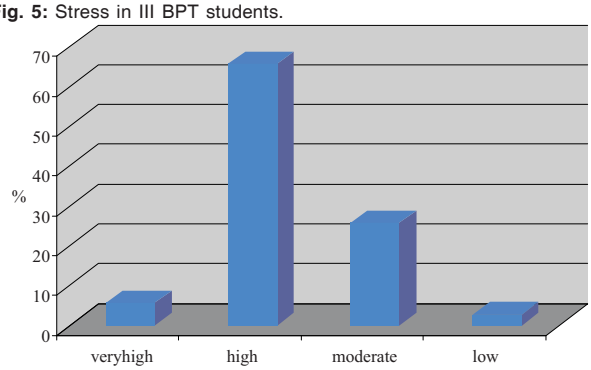



**Fig. 6:** Stress in IV BPT students.

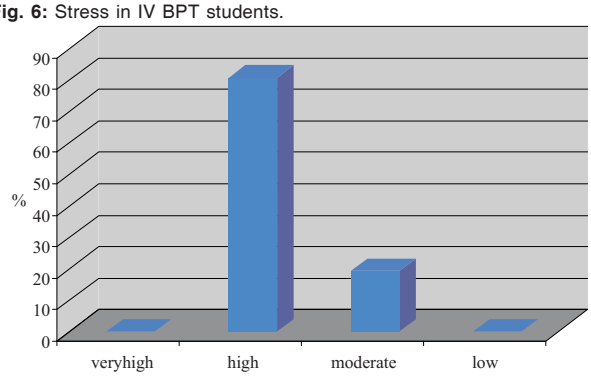
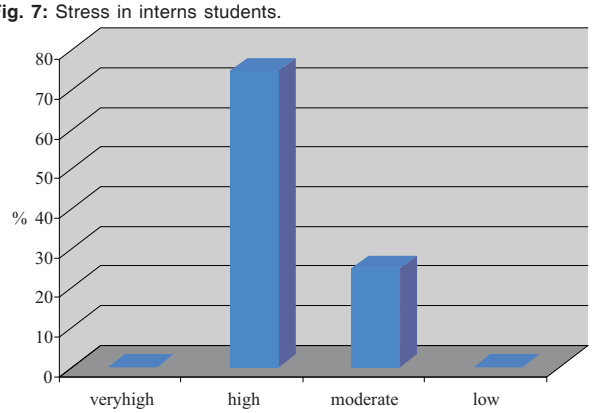



**Fig. 7:** Stress in interns students.




## Discussion

This study confirmed the common perception that there is considerable amount of stress in undergraduate physiotherapy students at KLES institute of Physiotherapy, Belgaum. On the other hand, it showed that academic performance in terms of percentage of marks in previous year, academic level, age & gender is not associated with stress.

The results of this study are partly in accordance with the previous studies performed by Sarid O et al[13], Balogun JA[14] and Supe AN[15]. However, Sarid O et al[13] studied academic stress, immunological reaction and academic performance among students of nursing and physiotherapy during the examination stress period. Balogun JA[14] investigated the proposed link between academic performance of physical therapy students and burnout. Supe A N[15] concluded that perceived level of stress did not vary

with the level of MBBS, but it may be noted that his study was confined to medical undergraduate students.

High amount of stress in undergraduate physiotherapy students could have been due to variety of reasons. However, this study could not find out the cause of high stress amongst these students. Different contributing factors for this high stress could be physical factors, academic factors, social factors, emotional factors, personality factors, limited use of coping styles etc. Tracy Stecker[16] found that the stress varies with in particular coping styles such as expressive coping style (complaining, crying, being alone, altering sleep patterns and rationalizing), a cognitive coping style (problem solving, not thinking about problems and looking at the big picture), an escapist style (yoga, watching TV or movies, altering sleep and eating habits), a social support style (talking with friends and family and exercising), and a hedonistic style (using drugs & alcohol, sex, humor and sports).

The stress did not vary significantly in various academic levels from first year to internship and hence it may be though that only academic and clinical training may not necessarily produce the stress but other factors may be responsible for this. However, it could be noted that the instrument used was nonspecific and didn't take academic factors pertaining to curriculum such as performance in internal examinations, clinical encounters, percentage of attendance, syllabus covered, competition amongst students etc into consideration. This study has taken percentage of marks scored in previous academic year as an indication of academic performance since the study was performed at the beginning of their new academic level after one month and for intern students there is no examination. The reference for this consideration was in form of a study by Bohannon RW[17], in which the author concluded that grades in score might reflect a common underlying construct that is academic performance of physical therapy students.

The results of this study are somewhat contradictory to the study done by Stewart SM et al[18] who found negative correlation between academic performance before and during medical school and the stress levels but his study involved prospective analysis of medical students of first two years only and not physiotherapy students.

The amount of stress in an academic level did not vary as per the gender and this could be due to the same level of education, training, institutional environment and other common factors responsible for the stress. Even stress in male and female students across the same and other academic levels did not vary significantly. It may be due to biological factors and environmental factors such as gender specific habits, common rooms, hostels etc.

High-level but statistically non-significant stress percentage to some extent was observed in first, fourth and internship academic levels. This could be possibly due to arrival of new first year students at physiotherapy institute who were weaker in their academic performance prior to beginning of their training, new change in their educational training, transitional changes due to transfer from junior college to professional institute and getting adjusted to the people and place. In fourth year it could be due to their increased self study hours, aspirations of scoring more marks in this academic level of training since at few places aggregate of percentage of marks scored in all four years is considered for admission to postgraduate courses as well as for placement purposes and due to this fourth year BPT academic level is perceived as final chance of scoring higher percentage in addition to this there is no carry over for failed subjects and hence possibility of losing one term, change in the curriculum level that mainly focuses on physiotherapy management of various patients. Surprisingly, there was also more stress in intern students and this could be possibly due to their aspirations about job or postgraduate studies and new responsibilities of treating the patients under supervision as well as independently.

Present study had several limitations. It was not clear how unique these findings are to this culture and population. Subjects were recruited from the single physiotherapy-teaching institute. The number of subjects is not extremely large, making it statistically complicated to perform additional subgroups analysis of repeater, odd batch, carry over, eligible and regular students, which might provide further information. There is potential of sampling bias in studies where participation is voluntary and some students do not participate. We used only self-reported measure of the stress. Psychometric properties of questionnaire were unknown. Finally presence or absences of correlations do no indicate causation, and other intervening variables may have played role in our findings. This study was restricted to the stress and its relationship with academic performance. It is quite possible that this relationship might change over the period of time, as stressors are likely to change as the time passes, when students interact more with patients where interpersonal qualities take on greater prominence. In summary, this study presents empirical evidence regarding the nonexistence of any interrelationship between stress and academic performance and the academic year in physiotherapy training at KLES Institute of Physiotherapy.

Consequently it is proposed that this physiotherapy institute could take appropriate steps for prevention of undue high stress and thereby stress related problems for undergraduate physiotherapy institute especially for the students who enter with high stress with a program that educates these students on awareness about the stress, coping styles and individual sessions focusing on the practice of coping strategies for identified vulnerable students. Since this study suggests the fact that physiotherapy training is highly stressful the next step is to begin systematic follow up of this study over next few years so as to find out if the stress varies over the period of time in same students, whether it is related to their academic performance in internal examinations, final university examinations, nonacademic factors, coping styles used, develop systematic interventions and these could be explored in future investigations.

## Conclusion

The data indicate that undergraduate physiotherapy students at KIPT suffer from high intensity of stress irrespective of their academic year in the institute and there is no correlation between academic performance in terms of their percentage of marks scored in previous academic year and stress. Consequently it is proposed that this physiotherapy institute could take appropriate steps for prevention of undue stress and thereby stress related problems.

## Key messages

- Undergraduate physiotherapy students suffer from high stress.
- Stress in Physiotherapy students is not associated with their academic performance and academic level.
- Physiotherapy teaching institutes could initiate steps for the prevention of undue stress.


## Acknowledgements

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# Comparison of lower limb and trunk muscle strength training on balance in elderly population

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## Abstract

### Objective

To compare the effect of lower limb strengthening with trunk muscle strengthening on balance in elderly.

### Design

Quasi experimental design.

### Setting

Prayas old age home, Jalandhar.

### Population & sampling

24 Elderly subjects of both sexes in age group of 60-80 years and having functional reach less than 10 were selected by convenient sampling method and assigned in to two groups.

### Intervention

Trunk muscle strengthening was given to Group A and lower limb muscle strengthening was given to Group B, for 30 minutes/ 4 days a week/ one month.

### Main outcome measure

Subjects muscle strength and functional reach were assessed on day 0 and then on 30th day in the same environmental condition.

### Results and conclusions

The Analysis reveals that there is significant effect in trunk and lower limb muscle strengthening on functional reach and muscle strength in elderly population. However the improvement in functional reach between Group A and Group B fail to achieve the significance.

### Key words

Elderly, Balance, Trunk muscle strength training, lower limb strength training.

## Introduction

Aging refers to the time sequential detoriation that occurs in most animals including weakness, increased susceptibility to disease and adverse environmental conditions, loss of mobility and agility, and age related physiological changes[1]. Fall risk has been shown to increase with reduced lower extremity joint moments, weakness on Manual muscle testing and difficulty arising from a chair [2, 3, 4]. Previous studies have shown decrements in muscle mass, force production per cross sectional area of muscle, and isokinetic joint moments in several lower extremity muscle groups with usual[5]. Recent studies have shown that more than half of community-dwelling elderly people over the age of 62 years report a fear of falling[6]. The ability to maintain control of posture is critical for the successful performance of most daily activities. Visual, vestibular, and somatosensory signals are sent to the central nervous system, which can adjust body sway and posture by integrating this information and by controlling skeletal muscles to appropriately generate joint torques and adjust joint angles. Impairment in any component of the postural control system can lead to instability and falls in older people[8]. In both[9, 10] cross-sectional and longitudinal studies lower extremity muscle weakness has been identified as a risk factor contributing to falls in older people. Balance and muscle force deteriorate with aging[11, 12] and it has been suggested that a decrease in the ability to generate force in the lower-extremity muscles contributes to balance impairment. In the elderly, impairments of balance have serious health implications. Poor balance is associated with an increased risk of falling[13], and fall-related injuries have significant individual and societal costs[14]. Balance impairments are also associated with poorer mobility measures in the elderly population[15]. Strength is a major factor in maintaining balance, gait &deviation of which leads occurrence of falls[17]. Loss in muscular strength occurs at an approximately rate of 12-45% per decade after age of 50 years. Maximum isometric force decreases, the muscle fatigue more rapidly and rate of tension development is slower. Concentric contractions are more affected by age related changes in the neuromuscular system than are eccentric contractions. Changes in skeletal muscle affect the functional capacity of muscles. Strength contributes to balance by producing muscle stretch, which could enhance neuromuscular control by increasing proprioception sensitivity to stretch. A significant relationship exist between strength and balance in subjects with muscle weakness. When poor posture exists, many unfavourable changes takes place altering the structure of the parts, disturbing their normal relations and the normal muscular balance is lost. It is found that elderly people with history of falls had less than half of the knee and ankle strength than non fallers. The difference was more prominent at ankle than knee and was most pronounced in the ankle Dorsiflexors[16]. Many trunk muscles seem to be anatomically and physiologically suited for high endurance capacity but there is considerable variability between muscles and individuals. Extensors have

greater isometric strength than flexors. Strength and endurance of trunk muscles help to maintain the correct posture and balance. The main core muscles are Rectus abdominis, Multifidus and Transverses abdominis. The core muscles of trunk are also affected by ageing and leads to reduction in functional abilities in performing activities of daily living[18]. The older adult should focus on increasing and maintaining the lower extremity strength and power across a range of intensities in order to decrease the functional limitation and disability[19]and as well as the strengthening of the trunk muscles[18]. Strengthening of the functional group of muscles together more effectively improve the balance than the strengthening of specific muscles in isolation[20]. Resistance training may help to improve the strength but sometime fail to improve the gait velocity and balance in elderly frail patients. Khan KM (2004) concluded that resistance training and agility training improves the balance confidence in women with low bone mass. Strength affects balance & that strengthening exercises even when they do not produce measurable changes in strength can improve balance or reduce falls of risk in older adults[21-23]. Cartner ND et al (2002)[26] found that community based exercise program reduces risk factors for falls in old women with osteoporosis by improved dynamic balance and strength. The Functional Reach Test (FRT) was designed to measure the limits of stability in an anterior direction. The maximal distance that subjects can reach forward horizontally while maintaining a fixed base of support is measured[7]. Lower-extremity muscles and trunk muscle strength was evaluated using a strain gauge. Studies have shown the strain gauge to be a reliable tool for clinical measure testing[24, 25]. Many studies have been conducted to show the individual effect of lower limb strength training and trunk muscle strength training to improve the balance of geriatrics subjects. Hence this studies aims to analyse the effectiveness of

(i) Lower limb strengthening on balance in elderly people.
(ii) Trunk muscle strengthening on balance in elderly people.
(iii) And compare the effect of lower limb strengthening with trunk muscle strengthening on balance in elderly.

## Methods

## Subjects

A total of 24 elderly subjects were recruited from Red Cross old age home, Jalandhar between November 2007 to April 2008 by convenience sampling method. They volunteered to take part in the study and met the following inclusion criteria:

- Age group of 60-80 yrs
- Both male and female geriatric subjects
- Elderly with score less than 10 inches on functional reach measure
- No known neurological symptoms which affects balance

**Exclusion criteria**

- Subjects with cardio-respiratory symptoms which will hinder strength training.
- Subjects with Musculoskeletal/ Neurological problem of lower limb or spine (Apart from age- related changes)
- Uncooperative patients.

All participants gave their written informed consent before participation in the study. Before initiation of the study, institutional review board approval was obtained.

## Measurement tools

**1. Strain Gauge [24, 25] (Muscle strength evaluation)**

**Lower limb muscle strength evaluation**

The muscle strength was measured on dominant leg. All muscle groups were tested in midrange of joint motion. One practice session was given prior to testing of each movement. Best of three was taken as muscle strength and used for data analysis. Each trial lasted for 4-5 seconds. Rest period of 60 seconds was given between each trial. Table with detachable seat was used.

The force of the hip extensors muscles was tested with subject positioned in prone and his knee flexed to 90 degrees. The subject was asked to grasp the edges of the testing plinths .The strap of strain gauge was applied around posterior surface of the thigh just proximal to knee joint. For hip flexors patient was positioned in supine position. Knee extensors muscle strength was tested with subject positioned in high sitting with hip flexed to 90 degree. The strap of strain gauge was applied over distal tibia for extension. Ankle dorsi flexors muscle forces was tested with subjects positioned supine with hip and knee extended and ankle in neutral. Strap is placed proximal to the metatarsophalangeal joints.

**Trunk muscle strength evaluation**

The subjects were in seated positions with their backs in 90 degree in reference to hips. A strap was placed just around subject's chest below the Axilla and subjects are instructed to flex or extend the trunk, the 3 repetitions are done and best reading is taken.

**2. Functional Reach Test[7].**

Functional Reach test is a measure of balance and is the difference, in inches, between arm's length and maximal forward reach, using a fixed base of support.

## Treatment groups

The subjects were divided into two groups; 10 in each, Group A received lower limb muscle strength training and Group B received trunk muscle strength training. All subjects were evaluated before commencement of training and at the end of the 30th day by functional reach test and strain gauge.

**Treatment Protocol**

Group A- Lower limb muscle strength training.

Before strength training program proper warm up was given for a period of 5 minutes in the form of free exercise and stretching. The following exercise were given for 30 min each day, 4 days in a week for duration of 1 month

1. Hip flexion- supine lying
2. Isometrics to quadriceps
3. Isometrics to hamstrings
4. Step up exercises
5. Standing on uneven surface
6. Knee Extension Exercise- high sitting
7. Ankle Dorsiflexion- sitting
8. Hip extension exercise- Prone lying
9. Hip abductor- side lying

**Group B- Trunk muscle strength training**

Before strength training program proper warm up was given for a period of 5 minutes in the form of free exercise and stretching. The following exercises were given for 30 min each day, 4 days in a week for duration of 1 month.

1. Pelvic bridging
2. abdominal curls
3. Seated back extension
4. walls squats with ball

All the subjects were measured with functional reach test and strain gauge before the start of the training period and at the end of 30th day of training.

## Data analysis

Comparisons were made between group A and group B with Functional reach test and stain gauge values. The significance of changes with in a group was estimated using paired t-test and in between two groups by using unpaired t-test. The significance (Probability-P) was selected as 0.05. The statistical software SPSS 11.0 Systat 8.0 was used for analysis.

## Results

**Table 1:** Mean and standard deviation of subject's age.

| | Group A Mean ±SD | Group B Mean ±SD |
|---|---|---|
| **Age** | 72.08±4.16 | 69.33±4.14 |

**Table 2:** Paired t-test: Mean and standard deviation of Functional reach test.

| FRT (in inches) | Group A Mean ±SD | Group B Mean ±SD |
|---|---|---|
| At baseline | 7.34±0.60 | 7.83±0.57 |
| After 30 days | 8.29±0.80 | 8.82±0.58 |
| Paired t-value | 9.25 | 10.84 |

**Table 3:** Paired t-test: Mean and standard deviation of Lower limb Muscle strength (In Kg).

| Muscle Group | Group A Mean ±SD | | Paired t-value |
|---|---|---|---|
| | Pre test | Post test | |
| Hip Flexor | 8.12±1.04 | 8.58±1.10 | 6.16 |
| Hip Extensor | 7.41±0.97 | 7.83±0.96 | 3.45 |
| Knee Flexors | 7.04±1.28 | 8.00±1.49 | 6.66 |
| Knee Extensor | 7.75±1.51 | 8.50±1.62 | 6.51 |
| Ankle DF | 3.68±0.44 | 4.58±0.63 | 3.84 |

**Table 4:** Paired t- test: Mean and standard deviations of Trunk Muscle Strength (In Kg).

| Muscle Group | Group B Mean ±SD | | |
|---|---|---|---|
| | Paired t-value | Pre test | Post test |
| Trunk Flexor | 7.97±3.83 | 8.87±3.94 | 6.86 |
| Trunk Extensor | 10.85±3.51 | 11.87±3.67 | 9.42 |

**Table 5:** Unpaired t-test: Mean and standard deviation of Functional reach test.

| Muscle Group | FRT : Mean ±SD ( in inches) | |
|---|---|---|
| | Group A | Group B |
| Mean± SD | 8.29±0.807 | 8.82±0.589 |
| T-value | 1.85** | |

**less than the tabulated value (2.075)

## Discussion

The present study which compares the functional reach after lower limb muscle strengthening with that of trunk muscle strengthening in elderly people. The hypothesis that one group would gain more improvement in functional reach as compared to other group cannot be accepted on the basis of finding in this study, our primary finding was that lower limb and trunk muscles strengthening results in improvement in functional reach in elderly population. It appears from the result of study that strengthening of muscle group in trunk and lower limb had very similar improvements in the functional reach. The strengthening exercises had positive effect on muscle strength in both the groups as both groups have P value more than 0.05. It has been well established that aging is associated with a loss in muscle strength (Resnik HE) [27]. Muscle strength is lost not only in radial muscle i.e. lower limb muscle but also to the trunk muscles or core muscles of body, making balance difficult. There are also deficits in neurological, vestibular and visual system (West CG). It is a combination of the two and the resulting lack of reflex coordination that leads to the loss of balance and poor gait in older individuals (Stevens JA). This loss in reflex ability as well as muscle strength in the lower limb and trunk muscle reduces functional ability of people over 60 yrs of age (Fujiwara). The resistance training is recognized as beneficial for the health, the most appropriate technique is still controversial (Bryant) [20]. It is well established that progressive resisted exercises in elderly people produces the strength that result from the increased motor unit activation of trained muscles and hypertrophy of muscle fibres (Hakkinen) [28]. This is supported by previous study done by Laidlaw DH[29] strength training improves the steadiness of slow lengthening contractions performed by older adults. According to them maximum voluntary contractions increase in heavy load muscles. These improvements were associated with reduced level of muscle activation especially during the lengthening contractions. Frontera WR et al., [30] concluded that strength gains in older adults were associated with muscle hypertrophy and an increase in myofibrillar protein turnover. Daubney et al [31] found that the distal muscle force measure may be able to contribute to the prediction of functional balance scores. According to them Ankle dorsi flexors and hip extensor forces were lower in subjects reporting falls and force of ankle dorsiflexor predicts fall status. Deepak Kumar [33], concluded that age is negatively related to balance performance and with muscle force production. The torque production of hip extensors and knee extensors can serve to predict balance performance on certain scales and have significant contribution in maintenance of older adults. Nelson SE[34] support the results of lower limb that, the progressive strengthening of the lower limb muscle and upper limb muscles will lead to improved functional reach test measure and timed get up and go test in the elderly population who are at risk of falls. The results in trunk muscle group shows that there is significant improvement in muscle strength in both the muscle groups and significant improvement in functional reach measure and dynamic balance in elderly people who got trunk muscle strengthening. According to Goldberg A [16], controlling the flexing trunk is critical in recovery from a loss of balance and avoiding falls. The trunk repositioning error is more in balance impaired group in older individuals as compared to normal people. A study done by Jerrold S, Petrofsky [32] supports the result obtained from the present study that the strengthening of the core muscles i.e. Rectus abdominis, Transversus Abdominis and back Extensor muscle will lead to the improvement in the functional reach in all the three directions i.e. Forward reach, right and left reach in elderly

populations of age group more than 65 years. The exercises given to the elderly population should be supervised one i.e. the exercises given to the elderly population should be under the supervision of the physical therapist and should not be unsupervised. It is supported by Donat H[35] and they concluded that supervised group exercise is more effective at reducing the risk factors related to falling of the older adults living in a nursing home than in an unsupervised home exercises. To prevent falls in elder adults, we should focus on strengthening of functional group of muscles together as compared to the single muscle in isolation. It is proved by Brown[36] in a group of 16 healthy elderly adults and concluded that no correlation between the strength of individual muscle and balance performance and a fair correlation between the strength of functional group of muscles combined (hip extensors, knee extensors and plantar flexors together) and balance. Although no significant difference were noted in the clinical outcome between the trunk muscle and lower limb muscle strengthening groups in this study, we can still consider the value of trunk muscle strengthening in improving the functional reach in older adults. The therapist should not concentrate on just lower limb muscle for prevention of falls in older individual and both trunk and lower limb should be considered equally.

## Conclusion

Twenty four elderly people with reduced functional reach were investigated to compare the effect of lower limb strengthening with trunk muscle strengthening on balance in elderly. The result showed significant changes in functional reach and muscle strength in both the groups. However improvement in functional reach between both the groups fails to achieve the significance. It is concluded that, lower limb and trunk muscle strengthening have positive effect on balance improvement in elderly however no significant differences in clinical outcome between two groups were detected. Therapists have to concentrate on both lower limb and trunk muscle strengthening in improving balance in elderly population.

## Limitations

- Lesser number of subjects
- No matched age groups
- Previous treatment history was variable
- Patients varied in their musculoskeletal and neurological status.
- Strain Gauze calibration was low

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# Effect of auricular transcutaneous electrical nerve stimulation on experimental pain threshold

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## Abstract

### Background

Physical therapists often administer pain-relieving treatment to patients, suffering from pain of various etiologies and Transcutaneous Electrical Nerve Stimulation (TENS) is one of the widely used non-invasive treatments for pain used by us.

Acupuncture points on the auricle of the ear & the peripheral acupuncture sites are sometimes used for treatment with Acupuncture-type TENS.

This study is an attempt to combine to ancient (Auriculotherapy) & modern (Physiotherapy-using acupuncture like TENS) method to produce an analgesic effect.

### Aim & objectives

1) to examine the effect of high intensity low frequency Transcutaneous Electrical Nerve Stimulation at auricular acupuncture points on experimental pain threshold measured at wrist and
2) to determine the changes in effect over time.

### Materials and methods

30 healthy females were assigned randomly to one of the three treatment groups. Group I (n=10) received TENS to appropriate auricular points for wrist analgesia. Group II (n=10) received TENS to inappropriate (placebo) auricular points & Group III (n=10) received no TENS. We measured the pain threshold at the wrist after an electrical stimulus during one pretreatment and four post treatment time periods

### Results

Group I was the only group that had statistically significant increase ($p<0.05$) in pain threshold with a latent period of 10 minutes. This increase remained significant for all post treatment measurements for this group.

### Conclusion

Thus we conclude that high intensity, low frequency TENS applied to appropriate auricular points can increase pain thresholds.

### Key words

Electro acupuncture, Auricular Transcutaneous Electrical Nerve Stimulation, Wrist analgesia.

## Introduction & background

Approaches to pain management have evolved & changed over years, and till now there is tremendous research being directed into this field. Many modern methods are undesirable or detrimental such as surgery, which is invasive, or use of drugs, which may be addictive.

Physical therapists often administer pain-relieving treatment to patients, suffering from pain of various etiologies and TENS is one of the widely used non-invasive treatments for pain used by us. Clinical studies have reported significant decrease in pain following the application of high intensity, low frequency TENS "Acupuncture-type TENS" and Electroacupuncture[9,27] Acupuncture points on the auricle of the ear & the peripheral acupuncture sites are sometimes used for treatment with Acupuncture-type TENS.

The term auriculotherapy is used often in reference to various methods of stimulating the external ear for therapeutic purposes. << Hyangti Ney Zing>> the oldest written source of Chinese medicine points out the close energy relation of auricle to entire human organism including the internal organs[21].

See Fig. 1: Auriculotherapy points

Controversies abound over the existence of somatotopic distribution of points on the auricle[21] and whether the stimulation of auricle abounds to more than placebo effect conflicting information, however exist about the persistence of analgesia after the removal of stimulation[16,25].

On the strength of observational evidence adduced in support of similarity between the floor of the Auricle & Embryo, Nogier proposed that a somatotopic arrangement of the ear similar to that to an inverted fetus existed on the auricle[21].

Ear points appear to be functionally related to the parts of the body they represent. Changes in auricular appearance, increased point tenderness or decreased resistance to electrical current may relate to knowing an unknown pathological condition elsewhere in the body[21].

In a controlled, double-blind study by Oleson et al, 40 patients with musculoskeletal pain were examined by a physician conducting the auricular diagnosis without any prior knowledge of patients medical conditions. The concordance between medical diagnosis & auricular diagnosis was 72.5%. This evidence further supports the somatotopic arrangement of auricular points[19].

The afflicted zones and points of correspondence are most commonly stimulated by massaging them manually with spiked rollers, or diagnostic sticks, with microneedles & surface stimulators of natural or artificial type. Bloodletting can also be provided and sometimes electrical devices or low power lasers as and when appropriate[21].

In a study which compared the effects of TENS &

Acupuncture (for treatment of patients with low back pain) results stated that both methods appear to be equally effective, and probably have same underlying mechanism of action. However the mean duration of pain relief was 40 hours after Acupuncture & 23 hours after electrical stimulation[15].

**The purpose of this study**

Was to examine the effects of two different auricular TENS treatments on experimental pain threshold and their effect over time (24 hours in this study).

**We tested the following Hypothesis**

1. Increase in experimental pain threshold (measured at the wrist) after an auricular TENS treatment to the appropriate auriculotherapy points will be greater than increase in pain threshold of the control group measure before & after a rest period.
2. Increase in experimental pain threshold (measured at the wrist) after an auricular TENS treatment to the appropriate auriculotherapy points will be greater than increase in pain thresholds after an auricular TENS treatment to inappropriate (placebo) points.

## Materials & methodology

## Study population

30 healthy women ranging in age from 20 to 40 years (mean age = 26yrs) participated in this study.

All the subjects were free from neurological or musculoskeletal pain at the wrist that might have influenced their response to TENS. Women who had pacemakers or who were pregnant were not accepted in this study as TENS is contraindicated in such cases. The subjects did not know the anticipated effects of the procedure and were not familiar with the locations of Auriculotherapy points.

## Materials

1. Direct Galvanic current was used to measure the experimental cutaneous pain threshold. The stimulating electrode was a disc electrode with a diameter of 1 cm and the dispersive steel electrode was 5cms x 4cms placed in lint pad moistened with tap water.
2. The "Microstimulator Genius" was used to stimulate the auricular points transcutaneously. It delivered a stimulus frequency of 8Hz with pulse duration of 0.5 msec duration. The dispersive electrode was 41/2cms x 3cms metal electrode. Active electrode was 2mm in diameter (used for stimulating auricular points).

## Methodology

Subjects were assigned randomly to one of the 3 predetermined treatment groups.

| | |
|---|---|
| GROUP I N = 10 | Received TENS to four points on the auricle appropriate for treatment of wrist pain (wrist, shenmen, lung & dermis) |
| GROUP II N = 10 | Received TENS to four inappropriate ear points that are not associated with analgesia at wrist. (eye, face, tongue and mandible) |
| GROUP III N = 10 | Were Controls & received no TENS treatment |

We cleaned areas of skin used as electrode placements sites with ether to reduce skin impedance. The room temperature was maintained at 23 degree Celsius. Notermans S. L. et al concluded that effect of skin temperature on pain threshold was minimal and values appeared to be rather constant provided that the room temperature was maintained between 20 & 25 degree Celsius[17]. The subjects removed any jewellery on their left ear, right upper limb and around the neck.

Subjects were positioned supine on treatment table till post treatment 30 minutes reading was taken. After that the subjects were mobile but were informed not to engage in vigorous physical activity till final reading (post 24 hours reading) was taken. We placed the dispersive electrode of the DC machine on the subjects back with the superior border of the electrode at C7 level. To familiarize the subject with the stimulus sensation, we applied electrical stimulation using the disc electrode to the dorsum of their right wrist before the actual procedure began.

Before the administration of auricular TENS treatment (or rest period for control group), we determined the baseline cutaneous pain threshold for each subject. We moistened the stimulating point electrode with water and placed it ventrolaterally on the subject's left wrist at the distal end of the radius.

The stimulus intensity was gradually increased till the subject first reported painful sensation. We recorded the stimulus intensity, on the DC machine at this point as pain threshold. We performed the procedure 3 consecutive times and recorded the pain threshold values to determine mean pain threshold of each subject

After we determined their pain thresholds the subjects in Group I & Group II received auricular TENS to their left ear. The subject tightly grasped the dispersive electrode from the "Microstimulator Genius" in their left hand. We located the stimulation points on the auricle by referring to the ear point's chart. Then the intensity of electrical stimulus was turned up slowly until the subject said that no further increase in intensity was tolerable. Each point was stimulated for 60 seconds at the highest intensity the subject could tolerate. (Fig. 2 & 3)

The control group rested quietly on the treatment table for the duration of 10 minutes, which was the maintained length of time required to treat individual subject in Group I & II.

After TENS or rest period we measured pain thresholds 3 times at the wrist in all subjects at each of the following post treatment time intervals.

1. immediately post treatment
2. 10 minutes post treatment
3. 30 minutes post treatment
4. 24 hours post treatment.

We used the mean pain thresholds in Data analysis.

## Results & observations

**We used paired t-test for within the group comparison t-value (within group)**

p = (0.05) t = 2.26 t > 2.26 = significant t < 2.26 non significant

| | Group I | Group II | Group III |
|---|---|---|---|
| Pre-post | 0.092 | 0.195 | 0.425 |
| Pre-post 10 mins | **2.55** | 0.238 | 0.852 |
| Pre-post 30 mins | **3.067** | 0.024 | 0.768 |
| Pre-post 24 hours | **3.334** | 0.146 | 0.681 |

**Table 1:** Mean Pain Thresholds pre & post treatment.

Group I

| | AGE | PRE | POST | POST 10 mins. | POST 30 mins. | POST 24 hours |
|---|---|---|---|---|---|---|
| MEAN | 25 years | 8.398 (+/- 2.059) | 9.228 (+/- 2.109) | 10.931 (+/- 2.158) | 11.6 (+/- 2.336) | 1.766 (+/- 2.226) |

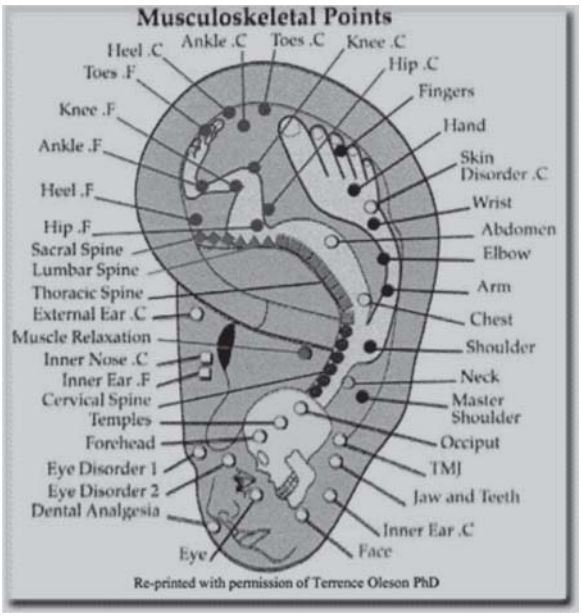
Group II

| | AGE | PRE | POST | POST 10 mins. | POST 30 mins. | POST 24 hours |
|---|---|---|---|---|---|---|
| MEAN | 28 years | 9.132 (+/- 1.082) | 9.298 (+/- 1.823) | 9.299 (+/- 1.798) | 9.148 (+/- 1.678) | 9.032 (+/- 1.740) |

Group III

| | AGE | PRE | POST | POST 10 mins. | POST 30 mins. | POST 24 hours |
|---|---|---|---|---|---|---|
| MEAN | 26 years | 9.566 (+/- 1.341) | 9.332 (+/-0.966) | 9.064 (+/-1.153) | 9.097 (+/- 1.247) | 9.131 (+/- 1.369) |

**Fig. 1:** Showing Auriculotherapy points representing the body parts.




We compare the pre-post treatment, pre-post 10 minutes, pre-post 30 minutes and pre-post 24 hours values for each group separately.

t-test for within group comparison revealed that group II & III did not show any significant change in their mean pain threshold.

A statistically significant (t > 2) increase in mean pain threshold occurred only in group I, which received stimulation of appropriate auricular points.

The increase in mean pain threshold of 0.83 milliAmperes (0 minutes post-treatment), 2.533 (10 minutes post-treatment), 3.202mA (30 minutes post-treatment) and 3.302mA (24 hours post-treatment) represent increases in pain threshold of 9.883%, 30.16%, 38.12% and 39.31% respectively occurred in Group I.

The results of this study support the results obtained by other investigators suggesting that delay to the maximum onset of analgesia (in our study 10 minutes) occurs after acupuncture and high intensity low frequency current and this analgesia may even persist for hours or days after removal of the stimulus[16,25].

**We used unpaired t-test for between group comparison t -value (between groups)**

p = (0.05) t > 2= significant t < 2 non significant

**Fig. 2:** Selected auriculotherapy points for Group I & Group II.

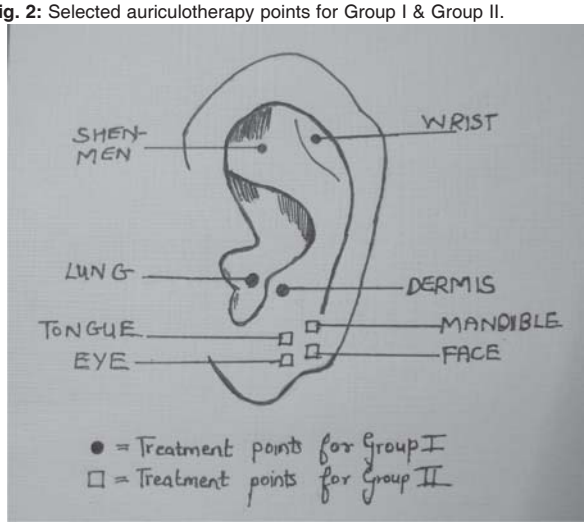



**Fig. 3:** Showing stimulation to the ear point with electrode.

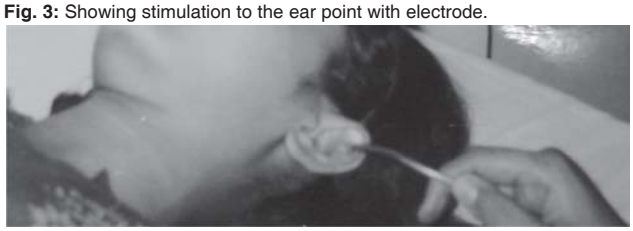
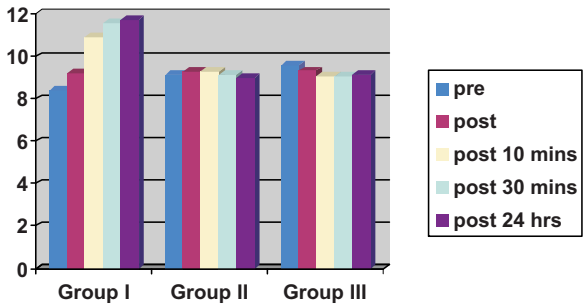


**Fig. 4:** Showing the mean pain thresholds comparisons between the 3 groups.




| | Group I | Group II | Group III |
|---|---|---|---|
| Pre | 1.127 | 1.509 | 0.62 |
| Pre-post | 0.079 | 0.193 | 0.05 |
| Pre-post 10 mins | 1.841 | **2.418** | 0.516 |
| Pre-post 30 mins | **2.676** | **2.960** | 0.07 |
| Pre-post 24 hours | **3.430** | **3.193** | 0.14 |

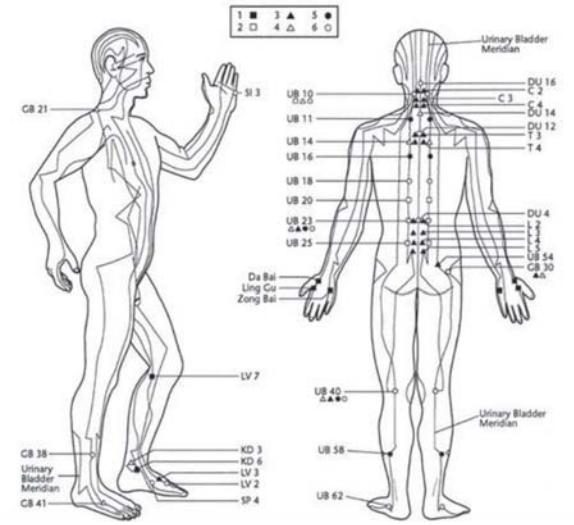
Comparison between Group I and Group III shows that there is a treatment effect at the end of 10 minutes, 30 minutes and 24 hours post treatment.

Comparison between Group I and Group II shows that there is a treatment effect at the end of 30 minutes and 24 hours post treatment.

Group II & III comparison shows that the placebo is non significant.

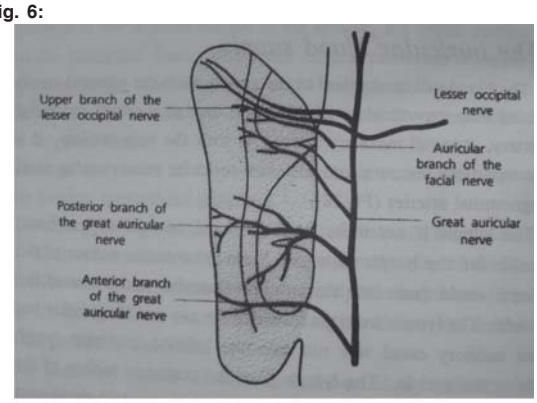
The comparison of group I & II (Table 5), which shows significant t-values (post 30 mins & post 24 hours). The results support the work of other investigators who stated that placebo effect cannot be totally responsible for an analgesic effect resulting from intense peripheral stimulation.

Fig. 5:




Meridian System

Fig. 6:




Nerve Supply to Auricle

## Discussion

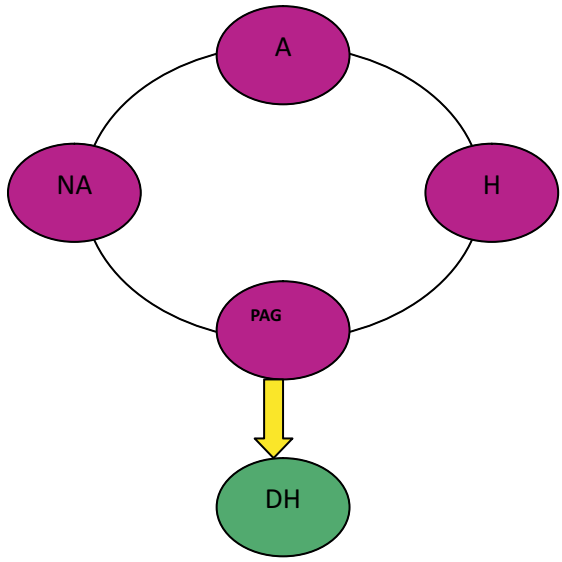
The following hypothesis has been proposed to explain the mechanism of action of auricular electroacupuncture.

- The auricle has an abundant sensory innervation including the branches from the facial, trigeminal, glossopharangeal, vagus & major and minor occipital nerves. Because many of the ear points are located near one or more of these nerves, stimulation of the ear points may result in an increased input to midbrain reticular formation and central segmental – central gray area, which may mediate descending inhibitory mechanisms[9]. (Fig. 6)
- The Chinese believe that therapeutic effects of Auriculotherapy occur through stimulation of the Meridian system. The auricle has links with Yang Meridians in the area embracing the neck & back of the head i.e. all main energy routes of the body would reach the auricular area directly or indirectly[21]. (Fig. 5)

**Role of Endogenous Opioids (EOPS) in the production of Acupuncture Analgesia (AA)**

Pomeranz & Chiu (1976) were the first to report that naloxone blocks the development of AA and to conclude that it would therefore seem reasonable to assume that this

Fig. 7:




type of analgesia is EOP mediated[24]. Mayer et al (1977) one year later confirmed that this also applied to humans. They did this by means of an experiment showing that the analgesic effect of acupuncture on electrically induced tooth pulp pain in man is similarly reversed by naloxone[14].

Zhou et al (1981) showed, in experiments on rabbits that it required an injection of only 1 microgram of naloxone into the Periaqueductal Grey area of the midbrain, or either the Nucleus Accumbens in the Amygdala in the limbic system or the Habenular nucleus situated in the dorsomedial aspect of the thalamus, to block the effect of Electro acupuncture more than 70 %. These sites are therefore of considerable importance with respect to the EOP mediated electro acupuncture[28].

**Changes in EOP cerebrospinal fluid (CSF) levels in response to acupuncture**

In the first such study Sjolund et al (1977) collected CSF from lumbar punctures in patients with chronic pain treated with Acupuncture like TENS & observed a doubling of CSF levels of these peptides after 30 minutes of the treatment[27].

Clement Jones et al (1980 found after delivering low frequency analgesia for 30 minutes that although the cerebrospinal fluid concentrations of metenkephalin remained unchanged, those of beta-endorphin rose after this type of stimulus had been applied.

**Role of Serotonins (5-Hydroxytryptamine) in the development of AA**

As the brainstem structures which form the upper part of the descending pain inhibitory system are linked to the dorsal horns by the axons in the dorsolateral funiculus which have serotonin as their neurotransmitter, and as it is this descending system which is brought into action when A-delta nerve fibers are stimulated with dry needles, it is not surprising that the development of acupuncture analgesia is influenced by alterations in the CNS serotonin levels.

Han and his colleagues published several papers showing that analgesia produced by this means is significantly attenuated when cianserin, the serotonin receptor blocker, is microinjected into any of these forebrain nuclei (Han 1989) or is potentiated with the administration

of clomipramine, which blocks its degradation and potentiates the effect of AA (Han & Terenius 1982).

Finally, in view of what has been learnt from the various animal experiments, it is hardly surprising to find that the simultaneous interference with both the serotonin and opioid system results in a dramatic decrease or even complete abolition of the analgesia induced by electroacupuncture (Han et al 1980 & Zhou ete al 1982)[1,28].

**Is it necessary to carry out acupuncture stimulation at specific sites?**

From the review of all randomized trials of acupuncture, Lewith and Machin (1983) have estimated that the response rates for real Acupuncture, sham acupuncture & true placebos in these trials have on an average been 70%, 50% & 30% respectively. The results of these trials therefore seem to confirm the random insertion of needles anywhere in the body produces a certain amount of analgesic effect but the degree of this is increased if needles are inserted into specific sites[11].

The greater effectiveness of stimulating specific points as compared to sham points must largely be because the former have richer supply of A-delta nerve fibers.

**Possible mechanisms responsible for prolonged pain relief following Acupuncture**

Han (1987) suggested that this prolonged pain relief may occur following acupuncture, as a result of it causing a serotonin and metenkephalin mediated circuit to develop in a neuronal loop made up of arcuate nucleus of the hypothalamus, the nucleus accumbens (NA), the amygdala (A), the habenular (H), together with the periaqueductal grey (PAG) and nucleus raphe magnus (NRM) at the upper end of the descending inhibitory system is enabled to block any noxious input to the spinal cord for a long period of time. (see fig. 7 below).

Another very important matter to be taken into consideration when attempting to explain acupuncture's ability to provide prolonged pain relief is that movements are often markedly restricted by the pain and once the latter has alleviated by some form of peripheral nerve stimulation therapy, such as acupuncture or TENS, the consequent restoration of movements with stretching of the tissues lead to activation of the low threshold mechanoreceptors and, thus helping to ensure the suppression of pain is maintained. It is for this reason once pain has been relieved by acupuncture the patient should be encouraged to exercise the affected part whilst at the time avoiding any overloading of muscles.

**Han's proposed mesolimbic loop of analgesia**

[A neuronal circuit involving the nucleus accumbens (NA), the amygdala (A), the habenular (H) and the upper parts of the descending inhibitory system, the with the periaqueductal grey (PAG) and nucleus raphe magnus (NRM), which are connected to the dorsal horn (DH) by the dorsolateral funiculus (DLF)].

Another very important matter to be taken into consideration when attempting to explain acupuncture's ability to provide prolonged pain relief is that movements are often markedly restricted by the pain and once the latter has alleviated by some form of peripheral nerve stimulation therapy, such as acupuncture or TENS, the consequent restoration of movements with stretching of the tissues lead to activation of the low threshold mechanoreceptors and, thus helping to ensure the suppression of pain is maintained. It is for this reason once pain has been relieved by acupuncture the patient should be encouraged to exercise the affected part whilst at the time avoiding any overloading of muscles.

In our study the thresholds have been checked and remain elevated till 24 hours post treatment. Extension of this study could be to find out the time required for which the thresholds remain elevated.

Other investigators have presented evidence suggesting that stimulation of auricular points and body points in combination may be an effective method of alleviating pain. The use of different combinations of auricular and body points should be explored further.

Experimentally induced pain may differ from clinical pain and its response to peripheral stimulation and clinical studies should be undertaken to determine whether such differences exist. Further clinical studies are required to determine efficacy of auricular TENS, in contrast to localized TENS (to painful area) should be undertaken.

## Conclusion

**Hence we conclude that**

1. Increase in experimental pain threshold (measured at the wrist) after an auricular TENS treatment to the appropriate auriculotherapy points is greater than increase in pain threshold of the control group measure before & after a rest period.
2. Increase in experimental pain threshold (measured at the wrist) after an auricular TENS treatment to the appropriate auriculotherapy points is greater than increase in pain thresholds after an auricular TENS treatment to inappropriate (placebo) points.

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# Comparative Analysis of Knee-laxity measurements by a left-hand- and a right-hand-dominant physiotherapist in patients with Anterior Cruciate ligament injuries and healthy control group

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## Abstract

The purpose of the study was to analyze and compare KT-1000 knee laxity as examined by a left-hand- and a right-hand-dominant physiotherapist in a group of patients with an anterior cruciate ligament (ACL) injury and a group of patients, 2 years after ACL reconstruction. The other aim was to measure and analyze knee laxity in a group of persons without any known knee problems. A cross-sectional examination of two groups of patients pre-operatively and post-operatively after ACL reconstruction and examination of healthy controls on two different occasions was performed. 22 patients who were scheduled for ACL reconstruction and 20 patients who attended a 2-year follow-up examination were included in the study. In the ACL-deficient group, 14 patients had a right-sided ACL injury and 08 patients a left-sided ACL injury. The corresponding figures in the post-operative group were 13 patients with a right-sided ACL injury and 07 patients with a left-sided ACL injury. 20 healthy persons without any known knee problems served as controls. One left-hand- and one right-hand-dominant experienced physiotherapist performed all the examinations. To be able to evaluate the intra and inter-reliability of the examiners the controls were examined at two occasions. The left-hand-dominant physiotherapist measured significantly higher absolute laxity values in the left knee, both injured and non-injured ones, compared with the right-hand-dominant physiotherapist. This was found irrespectively of whether the patients belonged to the ACL deficient or the post-operative group. In the healthy control group, the right-hand-dominant physiotherapist measured significantly higher knee-laxity values in the right knee compared with the left-hand-dominant physiotherapist. Correspondingly, the left-hand-dominant physiotherapist measured significantly higher knee laxity values in the left knee. We conclude that KT-1000 arthrometer laxity measurements can be affected by the hand dominance of the examiner. This might affect the reliability of KT-1000 arthrometer measurements.

## Keywords

ACL injury - Knee laxity measurement - Left-/right-hand dominance of Physiotherapist.

## Introduction

To quantify anterior–posterior knee laxity, several arthromeres have been developed[1,4,9,22,33]. The KT-1000 arthrometer was developed to provide an objective measurement in the sagittal plane for the translation of the tibia relative to the femur and it is currently the most frequently used arthrometer[8,10].

Factors that may affect knee-laxity measurement when using the KT-1000 are knee angle, force applied, muscle relaxation and tibial rotation[5,6,9,11,15,18,21,24,26,27,33,36]. To our knowledge, the consistency between reliability tested left-hand- and a right-hand-dominant examiner has not yet been analyzed. As the hand dominance might possibly cause a methodological error.

**The aims of the study were**

1. To analyze and compare the anterior absolute and side-to-side KT-1000 laxity in the right and left knee examined by a left-hand- and right-hand-dominant physiotherapist in a group of patients with an anterior cruciate ligament (ACL) deficient knee and a group of patients 2 years after ACL reconstruction.
2. To measure and analyze the anterior absolute and side-to-side knee laxity in a group of persons without any known knee problems, examined by a left-hand- and right-hand-dominant physiotherapist.

Our hypothesis was that no significant differences in KT-1000 arthrometer knee-laxity measurements would be found between a left-hand- and a right-hand-dominant physiotherapist.

## Patients and methods

22 patients (20 males and 2 females) with a mean age of 27years who were scheduled for ACL reconstruction and 20 patients (19 males and 1 female) with a mean age of 26 years who attended a 2-year follow-up examination were included in the study. In the ACL-deficient group, 14 patients had a right-sided ACL injury and 08 patients a left-sided ACL injury. The corresponding figures in the post-operative group were 13 patients with a right-sided ACL injury and 07 patients with a left-sided ACL injury. 20 healthy persons without any known knee problems served as controls. One left-hand- and one right-hand-dominant experienced physiotherapist performed all the examinations.

**The inclusion criteria for the study were**

All patients had a normal contra lateral ACL.

Patients with posterior cruciate ligament injuries and patients who had re-injured their ACL or injured their contra lateral ACL during the follow-up period were excluded from the study.

All the reconstructions using the arthroscopic assisted technique, semitendinousus and gracilis autografts and interference screw fixation. Associated intra-articular injuries, such as meniscal ruptures and cartilage lesions, were addressed at the time of the index operation.

## Healthy control group

20 healthy persons without any known knee problems

on side, 18 males and 2 females, with a median age of 26 years, served as controls.

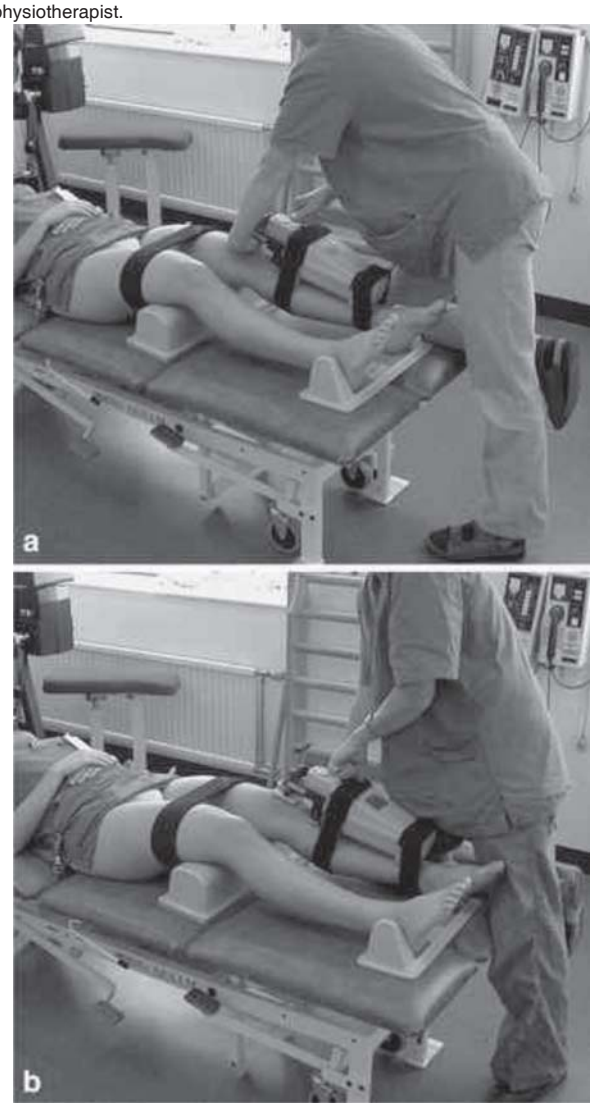
## Physiotherapist examiners

One left-hand-(RPT/L)- and one right-hand-(RPT/R)-dominant experienced physiotherapist performed all the examinations of the patients in the ACL deficient, and the post-operative group, as well as the examination of the healthy persons.

The left-hand-dominant physiotherapist performed all the KT-1000 arthrometer measurements pulling with the left hand and, in the same way, the right-hand-dominant physiotherapist performed all the measurements pulling with the right hand (Fig. 1a, b). The intraclass correlation coefficients (ICC) between the RPT/L and RPT/R for the absolute KT-1000 measurements were between 0.71 and 0.86. The intra-reliability for the absolute measurements on the right and left knee in the healthy control group were 0.83–0.94 for RPT/L and 0.71–0.86 for RPT/R.

The KT-1000 examinations of the patients were performed at hospital in the morning, while the healthy controls were examined in the afternoon at a gym just before exercise[38]. The re-test of the healthy controls was performed a median of 7 (3–7) days after the first examination.

**Fig. 1: a**. KT-1000 arthrometer measurements as performed by one right-hand dominant physiotherapist.
**b.** KT-1000 arthrometer measurements as performed by one left-hand dominant physiotherapist.




## KT-1000 Arthrometer examination Procedure

The instrumented KT-1000 examination was performed with the patient/person in the supine position. Both legs were placed on a thigh support with the knees in 30° of flexion. a) Footrest and a strap around the thighs kept the legs in a neutral position[12,25]. The arms were placed alongside the body and the patient/person was asked to relax (Fig. 1a, b). The instrument was calibrated to zero before each displacement test. The anterior displacement of the tibia in relation to the femur was registered at 89 N. The readings of the needle position were only accepted if the needle returned to 0 ± 0.5 mm, when the tension in the handle was released. In patients, the non-injured leg was always tested first. The left or right knee was randomly tested first in the healthy control group. The patients, as well as the healthy controls, were randomly tested first by either the RPT/L or RPT/R. At least three measurements of each knee were performed and the average value was registered. Both physiotherapists were blinded to each other's test results, as well as to the aim of the study.

## Statistical methods

Distributions of variables are given as means, medians, ranges and standard deviations (SD) when applicable. The Kruskal-Wallis non-parametric one-way analysis of variance was used for comparisons between the three groups in terms of age. For comparisons between the RPT/L or RPT/R, the Mann-Whitney U test was used for analysing the KT-1000 arthrometer measurements. The chi square test was used to compare the groups in terms of gender. For comparisons within the control group between the left and right side, Wilcoxon's signed rank test was used. All the significance tests were two-tailed and were conducted at the 5% level. The reliability is expressed as intraclass correlation coefficient (ICC).

## Results

There were no significant differences between the study groups in terms of age or gender.

The absolute values for the anterior displacements of the injured and non-injured knees, and the side-to-side differences in the ACL-deficient group and post-operative group for right-sided and left-sided ACL injured patients are presented in Tables 1 and 2. The absolute values for the anterior displacements of the right and left knees, together with the side-to-side differences in the healthy control group, are presented in Table 3.

The RPT/L measured significantly higher laxity values in the left knee than RPT/R. This was found in the injured and non-injured knees in both the ACL-deficient group and the post-operative group.

In the healthy control group, the RPT/R measured significantly higher knee-laxity values in the right knee. The RPT/L measured significantly higher knee-laxity values in the left knee on all test occasions in the healthy control group (Table 3).

At all occasions, the numerical side-to-side laxity value

**Table 1:** Summary of all the KT-1000 anterior absolute and side-to-side difference measurements (mm) for the patients with a right-sided ACL injury, in the pre-operative and the post-operative group.

| Right-sided ACL injury | | RTP/L Mean (SD) | RTP/R Mean (SD) | RPT/L versus RPT/R *P* value |
|---|---|---|---|---|
| ACL-deficient group (*n* = 14) 89 N | Injured side (R) | 7.5 (2.4) | 7.4 (2.5) | 0.75 |
| | Non-injured side (L) | 5.4 (3.0) | 4.0 (2.5) | **0.002** |
| | Side-to-side difference | 2.1 (2.6) | 3.4 (3.3) | **0.006** |
| Two-year follow-up group (*n* = 13) 89 N | Injured side (R) | 7.5 (2.5) | 7.0 (2.7) | 0.33 |
| | Non-injured side (L) | 5.4 (2.1) | 4.0 (1.7) | **0.004** |
| | Side-to-side difference | 2.1 (2.3) | 3.0 (2.6) | 0.08 |

**Table 2:** Summary of all the KT-1000 anterior absolute and side-to-side difference measurements (mm) for the patients with a left-sided ACL injury, in the pre-operative and in the post-operative group.

| Left-sided ACL injury | | RTP/L Mean (SD) | RTP/R Mean (SD) | RPT/L versus RPT/R *P* value |
|---|---|---|---|---|
| ACL-deficient group (*n* = 08) 89 N | Injured side (L) | 7.0 (3.3) | 5.8 (2.9) | **0.02** |
| | Non-injured side (R) | 5.3 (2.2) | 4.8 (2.0) | 0.24 |
| | Side-to-side difference | 1.7 (2.8) | 1.0 (2.6) | 0.18 |
| Two-year follow-up group (*n* = 07) 89 N | Injured side (L) | 7.1 (2.8) | 5.4 (2.3) | **0.007** |
| | Non-injured side (R) | 6.3 (2.7) | 5.6 (2.3) | 0.34 |
| | Side-to-side difference | 0.8 (3.2) | 0.2 (2.7) | 0.09 |

was higher for RPT/L if the left side was injured; correspondingly the numerical side-to-side laxity value was higher for the RPT/R if the right side was injured (Table 1, 2).

## Discussion

We were not able to verify our hypothesis that no significant differences in KT-1000 arthrometer knee-laxity measurements would be found between a left-hand- and a right-hand-dominant physiotherapist.

One interesting finding was that, the RPT/L measured significantly higher laxity values for the left knee compared to the RPT/R, irrespective of whether or not the left knee was injured, both in the ACL deficient and the post-operative group. The side-to-side differences in the right-sided ACL injured group were consistently higher for the RPT/R, but they were only statistically significant in the post-operative group. Correspondingly, the side-to-side differences were numerically higher fort the RPT/L in the left sided ACL deficient groups. However, without being statistically significant. This is in line with a previous study in which another right-hand-dominant physiotherapist examined a group of ACL injured patients[31]. One explanation for these statistical non-significant findings might be the small number of patients in the groups. Unfortunately, the present study was interrupted before the planned number was met because the RPT/R moved to another country.

In the healthy control group, there was a difference between the two examiners. The RPT/R measured significantly higher laxity values in the right knee, while the RPT/L measured significantly higher values in the left knee. Furthermore, the right knee-laxity measurement was significantly higher compared with the left knee when measured by the RPT/R. This is in line with a previous study in which another right-hand-dominant physiotherapist examined knee laxity in 33 healthy controls[31]. In several studies, the absolute laxity measurements of the right and

**Table 3:** Summary of all the KT-1000 anterior absolute and side-to-side difference measurements (mm) in the healthy control group (*n* = 20).

| | | RPT/L Mean (SD) | RPT/R Mean (SD) | RPT/L versus RPT/R *P* value |
|---|---|---|---|---|
| First test 89 N | Right knee | 4.2 (1.9) | 4.9 (1.9) | **0.01** |
| | Left knee | 4.1 (1.8) | 2.9 (1.7) | **<0.001** |
| | Side-to-side difference | 0.1 (1.6) | 2.0 (1.9)** | **<0.001** |
| Second test 89 N | Right knee | 4.1 (1.8) | 4.9 (2.1) | **0.005** |
| | Left knee | 3.9 (1.6) | 2.8 (1.6) | **<0.001** |
| | Side-to-side difference | 0.2 (1.4) | 2.1 (2.0)** | **<0.001** |

The RPT/R measured significantly higher laxity values in the right knee compared with the RPT/L

The RPT/L measured significantly higher laxity values in the left knee compared with the RPT/R

The RPT/R measured significantly higher laxity values in the right knee compared with the left knee

* A significant difference was found between the right and left knee ($P < 0.01$); ** ($P < 0.001$)

left knee using the KT-1000 arthrometer have been reported to be comparable[2,9,26]. However, no statistical analyses were performed in any of these studies.

Using the KT-1000 arthrometer, Hang et al.[14] and Skinner et al.[34] analysed the differences in laxity between the left and the right knee and found no significant differences. On the other hand, Rosene et al.[29] found a significant increase in laxity in the left knee compared with the right in male athletes, but not in females. Torzilli et al.[37] analysed healthy men and found increased laxity in the right knee, while Karageanes et al.[19] found increased laxity in the right knee in female athletes throughout the menstrual cycle. In none of these studies was the hand dominance of the examiner discussed.

The instructions for the KT-1000 arthrometer include and primarily describe factors that might affect knee-laxity measurements. These factors are related to the patient, the knee angle, the force applied, muscle relaxation and tibial rotation. No comments are, however, made on the position of the examiner, or the hand that should be used during the examination procedure[8,9]. In the present study, we have shown that the hand dominance of the examiner is also a factor that can affect the measurements.

The strength of this study is a cross-sectional and blinded for the aim design. However, to analyse the reliability of the KT-1000 arthrometer it would have been of interest to compare more than one left-hand- and right-hand dominant examiner. However, to find several left-hand dominant physiotherapists experienced with the KT-1000 arthrometer was not possible.

## Conclusion

We conclude that KT-1000 arthrometer laxity measurements can be affected by the hand dominance of the examiner.

This might affect the reliability of KT-1000 arthrometer measurements.

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# The effect of bobath concept & conventional therapy on the functional re-education in patients with hemiplegia following MCA stroke

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## Research question

Is there any Evidence based treatment technique for the functional independence of stroke patients?

## Objective

To find out the efficacy of the Bobath concept used for the functional re-education of the patient with Hemiplegia following stroke over the conventional therapies (traditionally used combined techniques).

## Study design

An experimental comparative study.

## Setting

Stroke unit NIMHANS Bangalore.

## Participants

- This study consist of 25 post stroke patients.
- Duration of Post-stroke minimum of 1 week to 10 days.
- Ages of the patients ranged between 30 to 60 years
- Side of lesion - both the Right and Left.

This study was conducted only after evaluating patients completely to suit them into the study group.

## Methods

**Control group - A**

12 patients were treated by using the conventional approach for the period of one month from the date of inclusion to the study.

**Experimental group - B**

Remaining 13 patients were treated using the Bobath concept for the same period of one month.

## Post test

Both control and Experimental group were assessed by the Barthal Index after one month of continuous treatment.

## Results

The result of this study showed that a speed of functional recovery is more in the patients belonging to Bobath group as compared to conventional group. Thus this study conclusively emphasis that Bobath concept is more valid for the faster recovery of functional activities in the patients following stroke.

## Conclusion

1 The Bobath concept and conventional therapeutic approaches are highly controversial in the aspects of principles and techniques and also their effects and uses. A comparative study to judge the effectiveness of both the techniques upon the functional re-education of the stroke patients was conducted with 25 patients. Who were belonged to MCA type of age between 30 to 60 years and evaluated their functional outcome with Barthal Index. This 25 patients irrespective of age and sex were selected for the study by using random sampling lottery method, grouped into two named as controlled group (A) and experimental group (B). Group A underwent conventional therapy and group B Bobath approach. The individual functional outcome were measured, analyzed and interpreted using both paired and unpaired –t- test.

The result of paired –t- test at 5% level of significance showed that a speed of functional recovery is more in the patients belonging to Bobath group. Where as the result of unpaired –t- test at the same 5% level of significance showed that there is no significant statistical difference in the effects produced by both the groups upon their functional activities. Thus study conclusively emphasis that Bobath concept is more valid for the faster recovery of functional activities in the patients following stroke than conventional therapy. In order to stabalise this study, a study with large sample and longer duration is suggested and also being recommended.

## Key words

Stroke, Hemiplegia, Conventional therapy, Bobath concept, Functional independence.

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## Introduction

Hemiplegia is the major observable sign of stroke, and defined as the paralysis of one half of the body, including may or may not be the face on the contralateral side to the lesion. The post stroke patients who are surviving will have the resultant functional disabilities in their ADL functions. Thereby the patients will become more dependent in their day-to-day daily living activities. The extent of functional dependency varying considerably according to level, size and type of lesion.

Rehabilitation is a process of bringing back the disabled patients from the fully disabled state to the normal (or) near normal level (WHO) There are numerous Neuro Rehabilitation approaches existing in practice of Physiotherapy, namely conventional approaches and

Neuro Physiological approaches like, Bobath, PNF, Bronstorm, Rood and etc.

In this study the investigator tries to find out the efficacy of conventional and bobath techniques by taking the two groups of patients consists of total thirty patients, fifteen in each group. Before starting a treatment all the patients where functionally assessed by the standardized functional assessment scale. Called Barthel index, which has got more intarator reliability value. Thus this study was under taken to functionally reeducate the patients with Hemiplegia following stroke using bobath and conventional therapy and to find out the efficacy.

## Materials and methodology

Skills of Bobath Concept, Shoulder Wheel, Skate Roller, Quadriceps Table, Static Cycle, Rowing Mechine, Parallel Bars, Hand Girpper, Mat, Bedsheets, Pillows.

## Measurements

Barthel Index - Maximum Score 100

The study design followed in this study is pre & post test design. The total number of patients were 30, 15 in each group. Group-A under gone conventional physiotherapy treatment and group-B the bobath exercises, for the period of one month from the date of inclusion to the study. After the completion of one month of physiotherapy treatment both the control and experimental group were assessed by the barthal index. The samples selected were based on convenient sampling with the post stroke duration of one week, age ranges between 45 to 60 years. This study was conducted for six months in two different Neuro centers one is the stroke intensive care unit NIMHANS Bangalore, and in Dept Of Physiotherapy Krishna Hospital. Karad. Paired and unpaired t test were utilized for analysis.

**Table I:** Functional assessment score – control group.

| S. NO | SIDE OF LESSION | BARTHEL INDEX (CONTROL GROUP) | |
|---|---|---|---|
| | | PRE TEST | POST TEST |
| 1 | LT | 40 | 85 |
| 2 | RT | 0 | 35 |
| 3 | RT | 35 | 75 |
| 4 | LT | 40 | 90 |
| 5 | RT | 0 | 30 |
| 6 | LT | 35 | 80 |
| 7 | LT | 30 | 80 |
| 8 | LT | 5 | 35 |
| 9 | RT | 30 | 85 |
| 10 | RT | 20 | 45 |
| 11 | LT | 10 | 55 |
| 12 | LT | 25 | 75 |
| 13 | RT | 0 | 40 |
| 14 | LT | 10 | 55 |
| 15 | LT | 30 | 75 |

**Table II:** Functional assessment score – experimental group.

| S. NO. | SIDE OF LESSION | BARTHEL INDEX (EXPERIMENTAL GROUP) | |
|---|---|---|---|
| | | PRE TEST | POST TEST |
| 1 | LT | 10 | 35 |
| 2 | RT | 10 | 55 |
| 3 | RT | 10 | 30 |
| 4 | LT | 10 | 35 |
| 5 | RT | 25 | 50 |
| 6 | LT | 30 | 70 |
| 7 | LT | 10 | 35 |
| 8 | LT | 35 | 75 |
| 9 | RT | 15 | 55 |
| 10 | RT | 30 | 70 |
| 11 | LT | 25 | 65 |
| 12 | LT | 25 | 65 |
| 13 | RT | 10 | 55 |
| 14 | LT | 10 | 55 |
| 15 | LT | 25 | 65 |

## Data presentation, analysis, and interpretation

The analysis of data includes comparisions of outcomes of both controlled and experimental groups for the purpose of deriving the conclusion.

## Results

**Table III:** Mean standard deviation and unpaired t test values.

| GROUP | PRETEST MEAN | S.D | PRETEST 't' VALUE | POST MEAN | S.D | POST TEST 't'VALUE |
|---|---|---|---|---|---|---|
| CONTROL | 22.5 | 15.15 | 0.56 | 64.16 | 22.56 | 1.091 |
| EXPERIMENTAL | 19.58 | 9.65 | 0.56 | 55.00 | 18.34 | 1.091 |

**Table IV:** Unpaired 't' test.

| BARTHEL INDEX | S.D | t test value | Level of Significance |
|---|---|---|---|
| Pre test | 12.70 | 0.56 | P>0.05 |
| Post test | 20.55 | 1.091 | P<0.05 |

**Table V:** Paired 't' test.

| BARTHEL INDEX | S.D | t test value | Level of Significance |
|---|---|---|---|
| Pre test | 13.88 | 10.39 | P>0.05 |
| Post test | 9.02 | 12.96 | P<0.05 |

## Discussion

This study compares the effects and uses of conventional and Bobath concept for the functional re-education of patients following stroke. In case of unpaired –t- test the results obtained at 5% level of significance is accepting the Null Hypothesis because the t value remain less than that of table value. (i.e. 1.091, 2.201)

In a former study by Sterm and associates, concluded that patients who were treated with conventional therapy did just as well as patients treated with PNF and Bronstorm techniques. Another study conducted by Dickstein and Colleagues compared conventional treatment, PNF and Bobath techniques found that there is no significant difference in outcome.

In the same way the current study also shows that there is no stastistical significance in outcome.

But when pre test and post test data of individual techniques were analyzed using paired –t- test. The result obtained at 5% level of significant shows that Bobath concept as significant difference in the outcome then that of conventional techniques. The percentage of difference between the two techniques are. It really emphasis that patients who belongs to group receiving Bobath approach showed a faster improvement than the conventional group for a given period of time.

The time or early regaining of functional activities is very much useful during the intensive care management of stroke patients. The prolonged hospitalization will affect not only the patients, but also the family. In such circumstances this study will be benefited for the therapists who are practicing Physiotherapy in stroke rehabilitation.

## Evidenced based treatment approach

Any approach which is evidence based might be more attractive in the society. There by the Bobath concept also

belongs to the best among the evidence based treatment approach in U.K. (CSP Jounal June 2001) A advantage of this study in it provides an evidence for the therapists who are working in stroke rehabilitation center.

## Conclusion

1. The Bobath concept and conventional therapeutic approaches are highly controversial in the aspects of principles and techniques and also their effects and uses. A comparative study to judge the effectiveness of both the techniques upon the functional re-education of the stroke patients was conducted with 25 patients. Who were belonged to MCA type of age between 30 to 60 years and evaluated their functional outcome with Barthal Index. This 25 patients irrespective of age and sex were selected for the study by using random sampling lottery method, grouped into two named as controlled group (A) and experimental group (B). Group A underwent conventional therapy and group B Bobath approach. The individual functional outcome were measured, analyzed and interpreted using both paired and unpaired –t- test.

The result of paired –t- test at 5% level of significance showed that a speed of functional recovery is more in the patients belonging to Bobath group. Where as the result of unpaired –t- test at the same 5% level of significance showed that there is no significant statistical difference in the effects produced by both the groups upon their functional activities. Thus study conclusively emphasis that Bobath concept is more valid for the faster recovery of functional activities in the patients following stroke than conventional therapy. In order to stabalise this study, a study with large sample and longer duration is suggested and also being recommended.

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