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Comparison between long reach balance training versus short reach balance training on the functional performance of spinal cord injury patients

Baljeet Kaur*
Jaskirat Kaur†

ABSTRACT

Background and purpose: Impaired sitting balance in people with spinal cord injury is related to defective motor performance. For individuals with paraplegia, most functional activities, such as eating, dressing, and transferring, is performed in a seated position. Thus ability to balance while reaching a variety of objects both within and beyond arm's length is critical to independent living. The purpose of this study was to evaluate the effect of long reach balance training and short reach balance training and to compare these training programs to see how these affect the functional performance of spinal cord injury patients.

Methods: 30 subjects with low thoracic spinal cord injury were recruited into two groups randomly. Group one participated in long reach balance training and group two participated in short reach balance training. Functional performance of these patients was measured using seven items of the Spinal Cord Independence Measure including dressing, mobility in bed, transfers-bed to wheelchair, transfers-wheelchair to toilet tub, mobility indoors, mobility moderate distances, mobility outdoors. Modified Functional Reach Test scores for both the groups were also taken prior and after the training.

Results: After training both the groups showed significant improvement in all the seven items of Spinal Cord Independence Measure and also significant improvement in Modified Functional Reach Test. Long reach balance training group was found to be better in improving dressing, mobility in bed, mobility outdoors and modified functional reach test score. In other four items of Spinal Cord Independence Measure both groups were found to be equally effective.

Conclusion: This study provides evidence that both the training programs are effective in improving functional performance of patients with spinal cord injury. For improvement in dressing, mobility in bed and mobility outdoors long reach balance training is more effective.

Keywords: Sitting Balance, Long Reach Balance Training, Short Reach Balance Training

INTRODUCTION

The ability to balance while reaching a variety of objects both within and beyond arm's length is critical to independent living.[1,2] Impaired sitting balance in people with spinal cord injury is related to defective motor performance. To maintain postural stability the center of body mass should be maintained over the base of support in a position or during changes in position.[4]

For individuals with paraplegia, most functional activities, such as eating, dressing, and transferring, is performed in a seated position. Any limitations in the ability to safely shift the centre of gravity toward stability limits may limit wheelchair mobility and activities of daily living. So sitting balance is very important for functional independence for people who cannot stand. While

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sitting balance is important to assess, clinical measures have been neglected.[5]

Performance of seated reaching tasks requires the coordinated motion of the trunk and upper limbs.[8,9] The lower limbs play an active role in sitting balance while reaching. Several factors have been identified that influence the contribution of lower limbs to balance in sitting and they are reach distance, direction of reach, seat height, and extent of thigh support.[10,11,12]

Healthy subjects are able to reach significantly further when the feet are in contact with the ground compared with when they are not.[9] In Spinal cord injury patients the postural muscle function loss is compensated by using parts of sensorimotor system which is still intact. In complete paraplegics since their lower limbs are not active they adopt different postural adjustments to face the balance changes due to reaching movements. Spinal cord injury subjects make alternative use of non-postural muscles like Latissimus Dorsi and Trapezius muscle to maintain sitting balance. High and low spinal cord injured subjects also reveal a difference in the way they control their sitting balance during reaching. High thoracic spinal cord injury subjects use more alternative postural muscles than low thoracic spinal cord injured subjects during reaching.[13,14,15]

Reach distance also has a significant impact not only on the active contribution of lower limbs but also on spatiotemporal coordination of body segments. Thus there are different control strategies while reaching within and beyond arm's length. For reaching to targets placed within arm's length requires only elbow and shoulder movements and for targets placed beyond arm's length movement of elbow, shoulder, along with trunk takes place.[16]

Although balance training in spinal cord injured subjects has been done in the previous years but studies on comparison of the effect of long reach balance training and short reach balance training in this population is lacking. So the current study focuses on long reach balance training and short reach balance training of spinal cord injured subjects. Individuals with spinal cord injury have to spend most of their time in a wheelchair and they have to perform everyday activities from a sitting position so this study tries to determine how long reach balance training and short reach balance training affect the functional performance of spinal cord injured subjects.

METHODS

Selection and description of participants

Thirty spinal cord injury patients were recruited from Indian Spinal Injury Center, New Delhi, in the study. To participate, subjects had to meet the following criteria: (1) Subjects with age between 20-60 years.[18] (2) Subjects with ASIA impairment grade A and B. (3) Subjects with level of injury from T7 to T12.[18] (4) Subjects should be able to maintain static balance atleast for 30 seconds.[18] (5) The subject's upper extremity should be without any deformity.[7] (6) Each subject should have an active 90 degrees of shoulder flexion.[7] (7) Subjects with Spasticity of grade 1+ or less on the Modified Ashworth Scale.[19] Exclusion criteria for the subjects included: (1) Subjects with any orthopedic conditions and any other neurological conditions. (2) Subjects with any psychiatric disorder. (3) Subjects with complications such as pressure sores, autonomic dysreflexia, orthostatic hypotension, contractures and heterotopic ossification. There were no significant differences between the groups in terms of age, weight, level of injury, arm length, trunk length.

Technical information

A pretest and posttest experimental design was used. The subjects were invited to participate in the study and then were randomly assigned to the two groups. A detailed explanation of the procedure was given to the patients after which they signed the informed consent. Subjects were then assessed on the seven items of Spinal Cord Independence Measure including dressing, mobility in bed, transfers- bed to wheelchair, transfer wheelchair to toilet tub, mobility indoors, mobility moderate distances and mobility outdoors, and subjects were also assessed on Modified Functional Reach Test prior the training and at the end of two weeks of training.

For the sitting balance training the subjects in both the groups were given the same set of reaching activities but at different reach distances. For the long reach balance training group the objects for reach activities were placed at 140% of the arm's length. And for short reach balance training group the objects for reach activities were placed at 50% of arm's length. During the activities, subjects reached to contact or grasp, transport, lift, or maneuver objects. The activities include –

1. Grasping/transporting/lifting a glass of water;
2. Grasping/transporting/lifting a cylinder (35 mm diameter and 95 mm height).
3. Grasping/transporting/lifting a cone (7cm diameter and 17.5 cm height).
4. Maneuvering a pen and paper.

When performing the tasks the patients were instructed to reach with one hand at one time whereas other hand was not allowed to take support. Also the patient was free to use any strategy for balancing. Each training session lasted for half an hour. Training program consisted of 10 sessions spread over a period of two weeks.

STATISTICS

Statistics was performed using SPSS software version 10.5. A student's t-test was used to analyze the difference between Group one (Long Reach Balance Training Group) and Group two (Short Reach Balance Training Group) on seven functional items of Spinal Cord Independence Measure and Modified Functional Reach Test. Intra-group analysis between pre-intervention scores and post-intervention scores was done using paired t-test for both the groups. A significance level of <_0.05 was fixed.

RESULTS

The analysis of the pre-intervention scores of the seven items of Spinal Cord Independence Measure and Modified Functional Reach Test between group one and group two showed no significant difference indicating that the two groups were matched in the seven items of spinal cord independence measure and modified functional reach test prior to training. The comparison of the pre-intervention scores and post-intervention scores of group one showed significant difference in all the seven items of spinal cord independence measure – dressing (t= -12.13, p= 0.00), mobility in bed (t= -14.64, p= 0.00), transfer- bed to wheelchair (t= -8.26, p= 0.00), transfer- wheelchair to toilet tub (t= -6.96, p= 0.00), mobility indoors (t= -4.00, p= 0.00), mobility moderate distances(t= -3.23, p= 0.00), mobility outdoors (t= -4.58, p= 0.00) (Table 1.1, figure 1.1,1.2,1.3) and also there was significant difference in the scores of Modified Functional Reach Test(t= - 17.59, p= 0.00). (Table 1.1, figure 1.4)

The comparison of the pre-intervention scores and post-intervention scores of group two showed significant difference in all the seven functional tasks – dressing (t= -6.98, p= 0.00), mobility in bed (t= -17.49, p= 0.00), transfer- bed to wheelchair (t= -6.87, p= 0.00), transfer- wheelchair to toilet tub (t= -5.53, p= 0.00), mobility indoors (t= -3.06, p= 0.00), mobility moderate distances(t= -6.20, p= 0.00), mobility outdoors (t= -7.48, p= 0.00) (Table 1.2, figure 1.5,1.6,1.7) and also there was significant difference in the scores of Modified Functional Reach Test(t= - 17.09, p= 0.00). (Table 1.2, figure 1.8)

Thus indicating that both the groups showed marked improvement in functional performance and in functional reach in sitting following long reach balance training and short reach balance training for group one and group two respectively.

The comparison of post-intervention scores of dressing between group one (Mean= 4.06, SD= 0.79) and group two (Mean= 2.60, SD= 0.91) revealed significant difference with t-value= 4.69 and p= 0.00. Post intervention scores of mobility in bed between group one (Mean= 4.13, SD= 1.35) and group two (Mean= 2.93, SD= 0.79) also revealed significant difference with t-value= 2.95, and p-value= 0.00. (Table 1.3, figure 1.9, 1.10). The comparison of post-intervention scores of mobility outdoors between group one (Mean= 1.80, SD=0.41) and group two (Mean=1.40, SD= 0.63) revealed significant difference with t-value= 2.50 and p-value=0.05. (Table 1.3, figure 1.11) The comparison of post-intervention scores of Modified Functional Reach Test between group one (Mean= 30.98, SD= 5.08) and group two (Mean= 22.92, SD= 3.11) revealed significant difference with t-value= 5.24 and p-value= 0.00. (Table 1.3, figure 1.12).

Table 1: comparison between pre-intervention scores and post-intervention scores of group one for dressing, mobility in bed, transfer- bed to wheelchair, transfer wheelchair to toilet tub, mobility indoors, mobility for moderate distances, mobility outdoors and modified functional reach test. (paired t-test)

Variable	Pre-intervention scores Group one N=15		Post-intervention scores Group one N=15		t-value	p-value
	Mean	SD	Mean	SD		
Dressing	1.20	1.01	4.06	0.79	12.13*	0.000
Mobility in bed	1.80	1.26	4.13	1.35	14.64*	0.000
Transfer-bed to wheelchair	0.40	0.50	1.66	0.48	8.26*	0.000
Transfer- wheelchair to toilet tub	0.33	0.48	1.40	0.63	6.96*	0.000
Mobility indoors	1.40	0.50	1.93	0.45	4.00*	0.001
Mobility moderate distances	1.26	0.59	1.80	0.41	3.23*	0.006
Mobility outdoors	1.00	0.75	1.80	0.41	4.58*	0.000
Modified functional reach test	17.13	5.27	30.98	5.08	-17.59*	0.000

*significant at 0.05

Group one – long reach balance training group
Group two – short reach balance training group

Table 2: comparison between pre-intervention scores and post intervention scores of group two for dressing, mobility in bed, transfer- bed to wheelchair, transfer- wheelchair to toilet tub, mobility indoors, mobility for moderate distances, mobility outdoors and modified functional reach test. (paired t-test)

Variable	Pre-intervention scores Group two N=15		Post-intervention scores Group two N=15		t-value	p-value
	Mean	SD	Mean	SD		
Dressing	0.86	0.74	2.60	0.91	6.98*	0.000
Mobility in bed	0.86	0.83	2.93	0.79	17.49*	0.000
Transfer- bed to wheelchair	0.33	0.48	1.53	0.51	6.87*	0.000
Transfer- wheelchair to toilet tub	0.26	0.45	1.06	0.45	5.53*	0.000
Mobility indoors	1.40	0.50	1.80	0.41	3.06*	0.009
Mobility moderate distances	1.06	0.45	1.80	0.41	6.20*	0.000
Mobility outdoors	0.60	0.63	1.40	0.63	7.48*	0.000
Modified functional reach test	15.56	3.42	22.92	3.11	17.09*	0.000

*significant at 0.05

Group one – long reach balance training group
Group two – short reach balance training group

Table 3: comparison between post-intervention scores of group one and group two for dressing, mobility in bed, transfer- bed to wheelchair, transfer- wheelchair to toilet tub, mobility indoors, mobility for moderate distances, mobility outdoors and modified functional reach test. (unpaired t-test)

Variable	Post intervention scores Group one N=15		Post intervention scores Group two N=15		t-value	p-value
	Mean	SD	Mean	SD		
Dressing	4.06	0.79	2.60	0.91	4.69*	0.000
Mobility in bed	4.13	1.35	2.93	0.79	2.95*	0.007
Transfer- bed to wheelchair	1.66	0.48	1.53	0.51	0.73N.S	0.473
Transfer- wheelchair to toilet tub	1.40	0.63	1.06	0.45	1.65N.S	0.110
Mobility indoors	1.86	0.51	1.80	0.41	0.39N.S	0.410
Mobility moderate distances	1.80	0.41	1.80	0.41	0.00N.S	1.00
Mobility outdoors	1.80	0.41	1.40	0.63	2.05*	0.051
Modified functional reach test	30.98	5.08	22.92	3.11	0.80*	0.000

*significant at 0.05 N.s – not significant

Group one – long reach balance training group
Group two – short reach balance training group

Figure 1.1

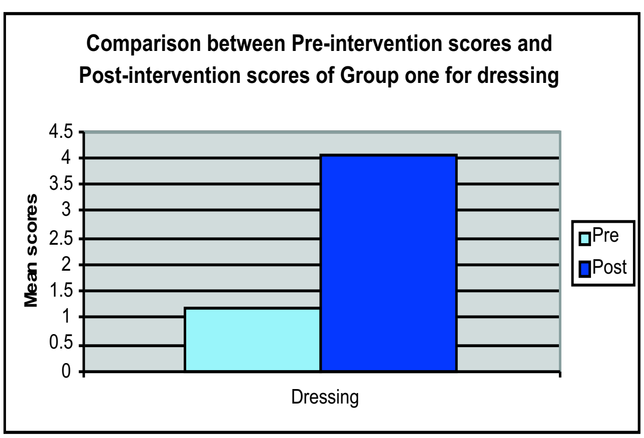


Figure 1.2

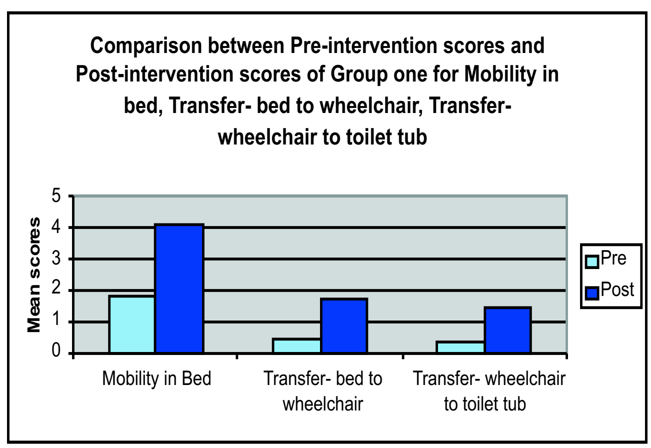


Figure 1.3

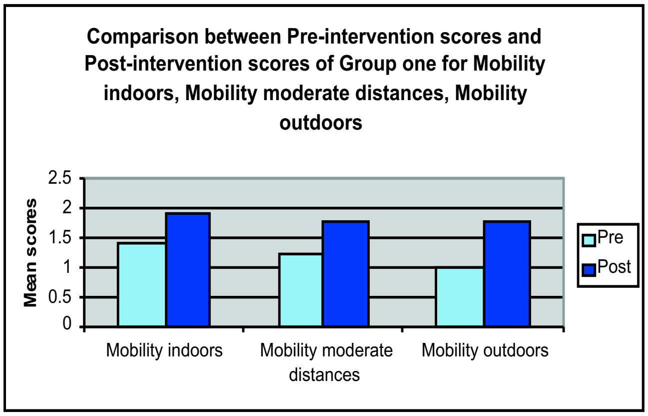


Figure 1.6

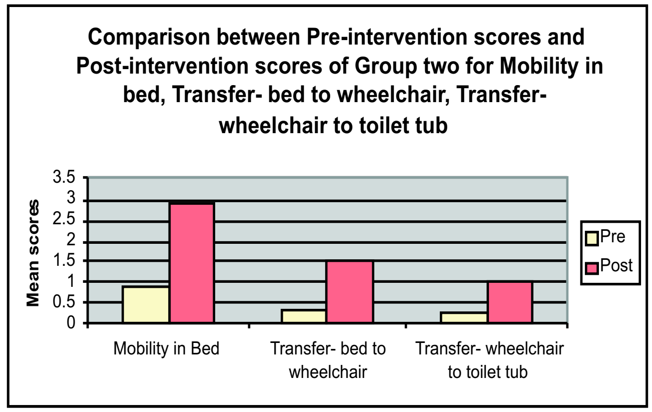


Figure 1.4

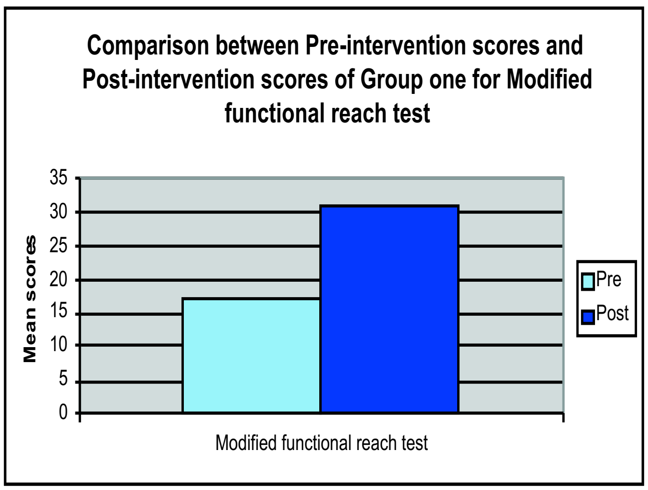


Figure 1.7

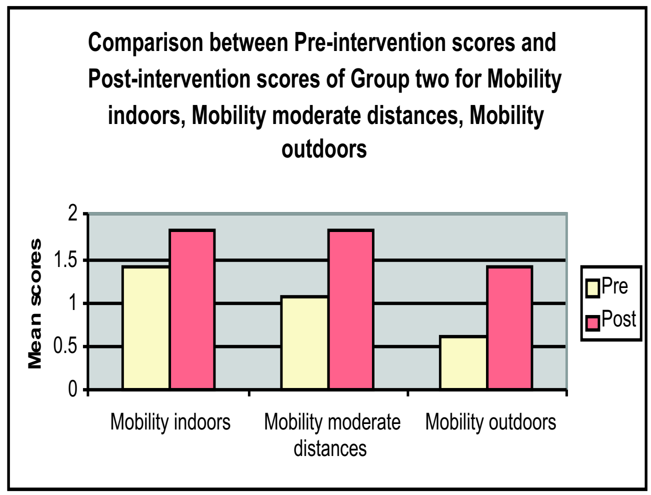


Figure 1.5

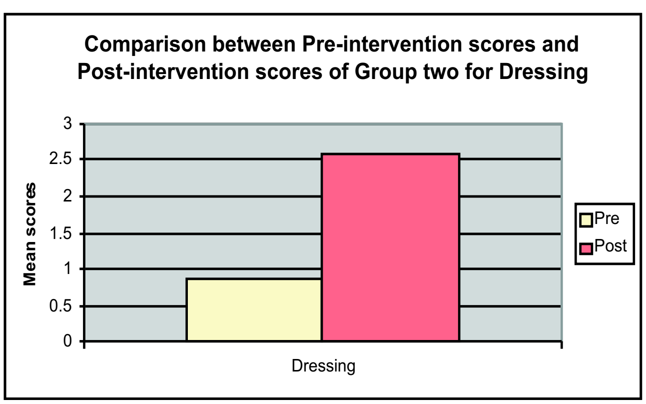


Figure 1.8

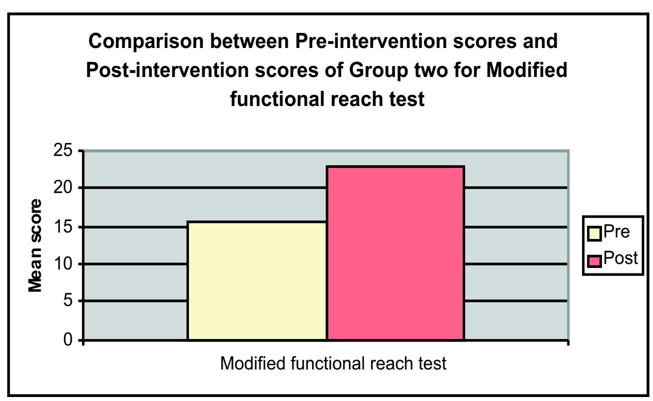


Figure 1.9

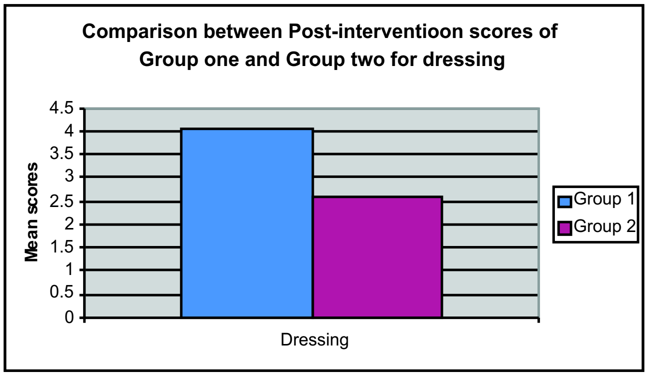


Figure 1.10

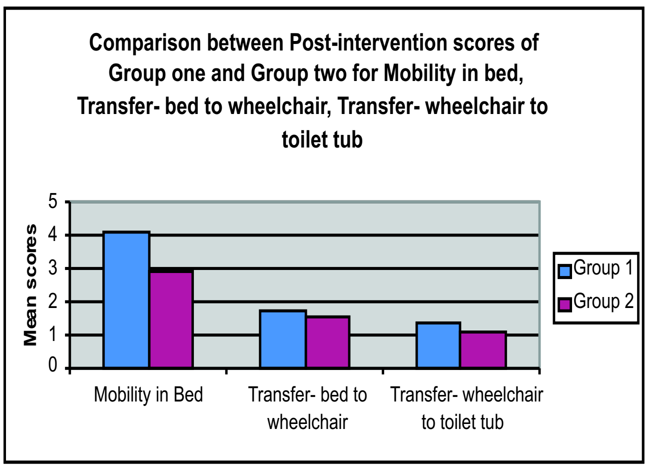


Figure 1.11

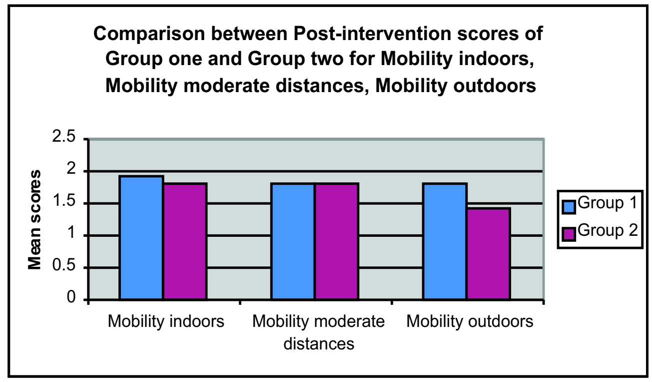
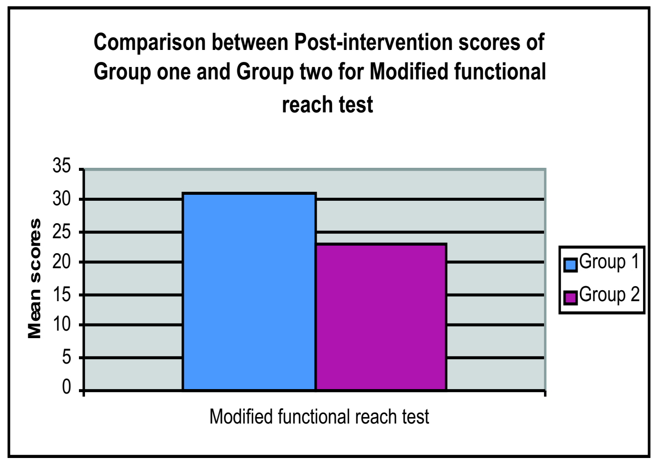


Figure 1.12



The comparison post-intervention scores of transfer- bed to wheelchair between group one (Mean= 1.66, SD= 0.48) and group two (Mean= 1.53, SD= 0.51) revealed no significant difference with t-value= 0.73 and p-value= 0.47. The comparison of post-intervention scores of transfer-wheelchair to toilet tub between group one (Mean= 1.40, SD= 0.63) and group two (Mean= 1.06, SD= 0.45) revealed no significant difference with t-value= 1.65 and p-value= 0.11. The comparison of post-intervention scores of mobility indoors between group one (Mean= 1.93, SD= 0.45) and group two (Mean= 1.80, SD= 0.41) revealed no significant difference with t-value= 0.84 and p-value= 0.41. The comparison of post-intervention scores of mobility moderate distances between group one (Mean= 1.80, SD= 0.41) and group two (Mean= 1.80, SD= 0.41) revealed no significant difference with t-value= 0.00 and p-value= 1.00.

Thus indicating that the long reach balance training group, group one, performed better than short reach balance training group in functional tasks of dressing, mobility in bed and mobility outdoors. Also there was better performance of long reach balance training group than short reach balance training group in modified functional reach test. In all the rest of the functional tasks there was no significant difference between the two groups.

DISCUSSION

The ability to perform reaching tasks while seating is fundamental to an individual's independence and quality of life.[20] Reaching to targets at various distances from the body is common action which perturbs balance since it involves complex interactions between the arm, upper body and the base of support which is provided by the pelvis and thighs on the seat and feet on the floor.[21]

In this study the subjects included in both the training groups were low paraplegic patients with their level of injury from D7 to D12 because low thoracic spinal cord injury subjects differ from the high thoracic spinal cord injured patients in terms of their reaching strategy. High thoracic spinal cord injured subjects use a more passive and simple strategy to compensate for the lost sensorimotor functions whereas low thoracic spinal cord injured subjects use a more active and complex strategy for maintaining sitting balance while reaching.[13,14,21] There is also a significantly greater composite maximal weight shift during reaching activities in low spinal cord injury subjects than high spinal cord injury subjects.[18] Thus it was thought that low spinal cord injury subjects would be better able to perform the training programs. All the spinal cord injury subjects included in the study were of grade A or B according to the ASIA impairment scale. Many studies over the years has supported the fact that lower limbs play an active role in maintaining sitting balance while reaching forward and there is greater contribution of lower limbs in sitting while reaching beyond arm's length.[9,10,11,17] So the present study wanted to investigate how long reach balance training and short reach balance training will affect the sitting stability of a spinal cord injured subject with no muscle power in lower limbs i.e. ASIA grade A and B. Tasks for the pre-intervention and post-intervention assessment of the functional performance were chosen because these are the most essential tasks for self-care and mobility at home and outdoor which require skill and balance. Safety of the subjects was given the utmost importance, the therapist stood besides the patient during the whole training sessions.

On comparing the pre intervention scores and post intervention scores of Group one, results showed that there was significant improvement in dressing (upper body and lower body), mobility in bed, transfer-bed to wheelchair, transfer-wheelchair to toilet tub, mobility indoors, mobility moderate distances, mobility outdoors, and also significant improvement in modified functional reach test score.

Results of Group two also showed significant improvement in the all the Spinal Cord Independence Measure items included in the study and also there was improvement in the modified functional reach test score after the training of two weeks thus training with reaching activities given at 50% of arm's length also improves the functional performance of paraplegic patient.

The results of the post-intervention scores of group one and group two revealed that there was significant difference between the scores of dressing (upper body and lower body), mobility in bed, mobility outdoors and modified functional reach test. For dressing, group one improved in both upper body dressing and lower body dressing whereas group two improved only in upper body dressing. Results of Chiung-Ling Chen et al 2003, supported the results of the present study. Chiung-Ling et al showed a significant correlation between dressing upper body and dressing lower body with sitting balance. Upper body dressing correlated with static sitting balance while lower body dressing correlated with dynamic sitting balance.[18] In the present study group one could have improved in dynamic sitting balance to a greater extent than group two which could be a reason why group one improved both in upper body and lower body dressing and group two improved in upper body dressing only.

The item of mobility in bed also requires a good sitting balance as it includes activities like supine to sit and push-ups in sitting. Group one, long reach balance training group, after the training of two weeks was better able to perform these activities than group two, short reach balance training group.

Group one improved significantly greater than group two in Modified Functional Reach Test scores, which could be a direct result of reaching training at 140% of arm's length which requires the patient to self-perturb their sitting balance to a greater extent than in patients of group two who were given training at 50% of arm's length. Also the reaching at 140% of arm's length requires the patient to use strategy which involves movement of elbow, shoulder and also of trunk which is very similar to the strategy used while performing the modified functional reach test.[16,21] Thus training sitting balance at long reach and short reach both improves the functional performance of paraplegic patients. Both the trainings also improve the modified functional reach test scores. Out of the two training programs long reach balance training program improved dressing, mobility in bed, mobility outdoors and modified functional reach test scores to a greater extent than short reach balance training group.

Clinical implications

Long reach balance training and short reach balance training both improved the functional performance of the patients so both types of training should be included in their rehabilitation. Also the strategies of reaching involved in both types of training are different so both training should be given to patients. Activities used for training in the study were task specific so they should be incorporated in the rehabilitation of Spinal Cord Injury patients.

Future researches

In the present study low paraplegics were recruited, in future studies high and low paraplegics both can be trained with this type of training to see how these training affect performance of high paraplegics, also investigation can be done to examine the difference between high paraplegics and low paraplegics in response to this type of training. Long and short reach balance training can be given to complete and incomplete spinal cord injury patients to see how this training affects their performance. A more elaborate examination can be done using EMG and GRF analysis in incomplete spinal cord injury patients. Also study with a larger sample size can be done. Effect of long and short reach balance training can be seen on other ADL tasks.

Limitations of the Study

1. The sample size of the study is small
2. The effect of trunk orthosis or support worn by the patients during the training sessions was not included.
3. Motivation level of the patients was not assessed.
4. Due to lack of the clinical tools available for measuring balance in sitting, Modified Functional Reach Test was used as one of the outcome variable for measuring balance, the strategy of which bears similarity with the long reach balance training given to group one.

CONCLUSION

The study concludes that the long reach balance training and short reach balance training has an effect on the functional performance of spinal cord injury patients since both the groups improved in their functional performance and also in modified functional reach test after two weeks of training. On comparing the two training protocols long reach balance training was better in three functional items of Spinal Cord Independence Measure – dressing, mobility in bed and mobility outdoors. It was also found to be better in Modified Functional Reach Test. But in other four functional items of Spinal Cord Independence Measure both the training programs were equally effective.

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Effect of age on the nerve conduction velocity and H-Reflex in normal subjects and formulating age correction formula and testing the reliability of existing formula

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Narkeesh**

ABSTRACT

Many studies have been done on effect of age on H-reflex and motor nerve conduction velocity but all have controversial results. In this study effect of age on H-reflex and MNCV of Tibial and CPN was studied on 50 healthy normal subjects which were divided five age groups which are 10-20, 20-30, 30-40, 40-50, 50-60, with 5 males and 5 females in each group. The F-value for any of the variable was not significant against table value 2.57 and the correlation values show that in Gp1 there is significant correlation between tibial and CPN LD, in Gp2 H-latency and tibial LD, in Gp3 between H-latency and tibial LD, CPN MNCV and tibial NCV, H-latency and CPN LD, CPN MNCV and tibial MNCV, in Gp4 between H-latency and CPN LD and in Gp5 significant correlation not between any of the values. It was concluded that there is no significant effect of age on H-reflex and MNCV of tibial nerve and CPN and there is no significant difference in the values of H-reflex and CPN MNCV between both the sexes except tibial MNCV. The age correction formula for H-latency could not be created because of little variations in the mean values.

Key words Age, H-reflex, tibial motor nerve conduction velocity (MNCV), common peroneal nerve (CPN) MNCV, latency difference (LD) sex.

INTRODUCTION

The process of myelination is age dependent and begins *in utero,* with nerve conduction velocity approximately one half of normal adult values in a full term infant. Premature infants have very slow nerve conduction velocity (Cerra and Johnson,1962). As the myelination progresses, the nerve conduction velocity attains the adult value by 3-5years of age. The conduction velocity begins to decline after 30-40 years. Conduction velocities decrease slightly with age in adults, most likely as a consequence of the normal loss of motor and sensory neurons that occur with ageing.

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Nerve conduction studies (NCS) are performed to diagnosis disorders of the peripheral nervous system and to detect neurologic response of demyelination and axon loss. Nerve conduction velocity (NCV) measurements are a type of NCS, and are primarily of three types: motor, sensory and mixed

MISHRA AND KALITA; SULLIVAN AND SCHMITZ

Awang Saufi M. et al demonstrated a significant decrease in nerve conduction velocity with increasing age. Y.L. Lo et al also showed a decreasing trend of sensory amplitudes with increasing age. Also Marco A. S. F. found an increase in H-latency with increasing age. But Sadeghi Shahram et al did not found a significant correlation between age and latency of H- reflex.

These statements give lot of confusion regarding effect of age on electric properties of nerves. In order to improve the diagnostic yield of electrophysiological studies in individual patients, I have studied the effect of age on easily elicitable late respone H-reflex and tibial and CPN MNCV. So that, obtained database can be used in the formulation of age correction formula.

H-REFLEX :HOFFMAN

described the H- reflex in 1918 and hence it is named as H-reflex. The H- reflex is a monosynaptic reflex elicited by sub maximal stimulation of the tibial nerve and recorded from the calf muscle.

MOTOR NERVE CONDUCTION VELOCITY (MNCV)

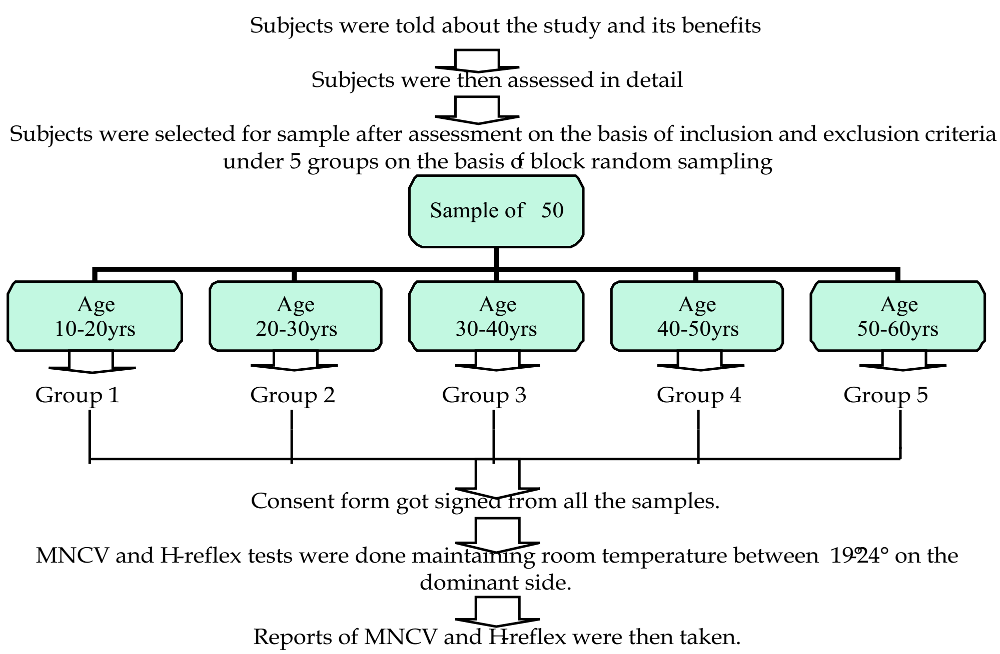
It is defined as the speed with which motor axons of a mixed nerve conducts an impulse, which was recorded (evoked potential) from a distal muscle innervated by the nerve.

METHODS

Study was performed on 50 male and female subjects were taken from the city Patiala which were divided into five age groups age group of 10-20, 20-30, 30-40, 40-50, 50-60. This was an comparison and correlation study, which was performed in the Punjabi university, Patiala in Neurophysiology lab of Department of Physiotherapy. Study was performed in accordance with ethical consideration of the institute and their consent was taken prior to the study.

TESTING EQUIPMENT AND PROCEDURE

Nerve conduction studies were performed on (Neuroperfect) EMG/NCV/EP system, EMG 2000; Medicaid system ISO (9001:2000) certified. Before beginning with the procedure, the subjects who were selected on the basis of convenient block sampling by applying inclusion criteria were



Parameters studied: H-latency, H/M for H -reflex, CPN latency difference and CPN MNCV, tibial latency difference and tibial MNCV for motor nerve conduction velocity.

explained the entire procedure in detail. They were then assessed according to the assessment chart.

PROCEDURE

The subject was made to lie prone comfortably on a plinth. They were given a 5 minute time for relaxation and her all physical activities was stopped prior to test. Any Metallic ornaments on the limb were removed. The right leg was exposed from foot to popletial fossa. The resistance of the skin of forearm was reduced using cotton dipped in alcohol. The room temperature was noted. The electrodes were placed first on the right leg to record H-reflex.

PICK UP ELECTRODE

on point of bisection on the line connecting the popliteal crease and the proximal flare of the medial malleolus.

REFERENCE ELECTRODE

over Achilles tendon**. Ground electrode** between site of stimulation and pickup.

STIMULATING ELECTRODE

the cathode is proximal and is placed over the tibial nerve in the popliteal fossa at the level of the popliteal crease. The sub maximal stimulation was given to the tibial nerve distally at the level of the popliteal crease and a motor response was recorded from the medial position of soleus muscle. A square wave pulse of 1ms duration is used for preferential stimulation of large sensory fibers. The stimuli are adjusted so as to evoke maximum H-response amplitude. By increasing the stimulus strength to supramaximal maximum M response can be reordered and 3 M responses are measured for analysis. H/M ratio which is measured from peak to peak amplitude. The latency of H reflex is measured from the stimulus artifact to the first deflection from baseline.

In prone position positions of active and reference electrodes are changed for recording of tibial motor nerve conduction velocity at distal points.

PICK UP ELECTRODE

over abductor hallucis slightly below and anterior to navicular tuberosity. Reference electrode: 2cm distal to active electrode. Ground electrode: between stimulation and pickup sites.

STIMULATING ELECTRODE

Distal stimulation – behind and proximal to the medial malleolus Proximal – in the popliteal fossa along the flexor crease of the knee slightly lateral to the midline of the popliteal fossa.

Latency as the first deflection from the baseline when stimulation was given at distal point was calculated as L1 and at proximal point was calculated as L2 and amplitude of compound muscle action potentials as peak of wave was measured. Then the motor nerve conduction velocity was calculated by multiplying the distance between distal and proximal stimulation point and latency difference between L1 and L2. MNCV values were calculated by using the formula.

Then the subject was made to lie supine comfortably on a plinth with leg and foot supported. Right leg was exposed upto knee level. Then motor nerve conduction velocity of common peroneal nerve is to be recorded for distal latency. Pick up electrode: over extensor digitorum brevis. Reference electrode: 2cm distal to active electrode. Ground electrode: between stimulation and

$$\textbf{Conduction Velocity (m/sec)} = \frac{\textbf{Distance}}{\textbf{Proximal latency - Distal Lat}}$$

pickup sites. Stimulating electrode Distal stimulation – ankle, 2cm distal to the fibular neck. Proximal stimulation – at the neck of fibula and 5-8cm above the fibular neck.

Latency as the first deflection from the baseline when stimulation was given at distal point was calculated as L1 and at proximal point was calculated as L2 and amplitude of compound muscle action potentials as peak of wave was measured. Then the motor nerve conduction velocity was calculated by multiplying the distance between distal and proximal stimulation point and latency difference between L1 and L2. MNCV values were calculated by using the formula.

$$\textbf{Conduction Velocity (m/sec)} = \frac{\textbf{Distance}}{\textbf{Proximal latency - Distal Latency}}$$

RESULTS AND DISCUSSION

Mean and standard deviation for H-latency and H/M is 28.9340±0.6651 and 0.466±3.847 respectively, for tibial MNCV and LD 44.902±1.0141 and 8.494±0.23 respectively, for CPN MNCV and CPN LD 46.644±2.3637 respectively. Using ANOVA it was found that there is no significant difference between H-latency, H/M, Tibial LD, Tibial MNCV, CPN LD, CPN MNCV. This proves the null hypothesis of this study, that there are no significant changes in MNCV and H-reflex with increasing age of the age group of 10-60.

Karl Pearson Correlation values show that in Gp1 there is significant correlation between tibial and CPN latency difference, in Gp2 H-latency and tibial latency difference, in Gp3 between H-latency and tibial latency difference, CPN MNCV and tibial NCV, H-latency and CPN latency difference, CPN MNCV and tibial MNCV, in Gp4 between H-latency and CPN latency difference and in Gp5 significant correlation not between any of the values.

Comparison between both the sexes was also done in the study using t test which shows that significant difference between both sexes was found in males and females in tibial MNCV but insignificant difference was found in H-latency, H/M, CPN MNCV, CPN LD, tibial LD. Age correction formula could not be formulated because of very less variation in the values.

Table 1: Mean and standard deviation

	Mean	N	Std. Deviation	Std. Error Mean
Leg length	89.3380	50	5.2897	.7481
BMI	22.9602	50	1.8534	.2621

Table 2: Mean and Standard deviation

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1					
	H-latency	28.9340	5	.6651	.2974
	H/M	.4660	5	3.847	1.720
Pair 2	CPN Lat diff	6.9960	5	.1006	4.501
	CPN MNCV	46.6440	5	2.3637	1.0571
Pair 3	Tibial lat diff	8.4940	5	.2300	.1028
	Tibial MNCV	44.9020	5	1.0141	.4535

The table 1 describes the Mean and Standard deviations of BMI and leg length of all age groups.. mean and Standard deviation of leg length is 89.3380±5.2997, BMI is 22.9602±1.8534.

The table 2 describes the Mean and Standard deviations of all the values of H-reflex and MNCV recorded. Mean and Standard deviation of H-latency is 28.9340±0.6651, H/M is .4660±3.847, CPN Latency difference is 6.9960±0.1006, CPN NCV is 46.6440±2.3637, Tibial latency difference is 8.4940±0.23, Tibial NCV is 44.902±1.0141.

The table 3 describes the difference between the H-latency of the five age groups. There is a significant increase in H-latency noted between 1st (27.97±1.22) and 5th (29.4±0.99) group. The F-value is 1.27 which is less then table value (2.57).

The table 4 describes the difference between H/M of the five age groups. There is significant difference between 1st (0.47±0.23) and 3rd (0.52±0.51) group but not much significant between 1st (0.47±0.23) and 5th (0.48±0.22) group. The F-value is 0.133 which is less then the table value(2.57) The table 5 describes the difference between latency difference of Common Peroneal nerve of the five age groups. The F-value is 0.126 which is less then the table value(2.57).

The table 6 describes the difference between motor nerve conduction velocity of Common Peroneal nerve of the five age groups. The F-value is 1.166 which is less then the table value(2.57).

The table 7 describes the difference between latency difference of Tibial nerve of the five age groups. The F-value is 0.317 which is less then the table value(2.57).

The table 8 describes the difference between motor nerve conduction velocity of Tibial nerve of the five age groups. The F-value is 0.355 which is less then the table value(2.57).

Table 3: ANOVA - H-latency

Groups	Count	Sum	Average	Variance
Group 1	10	279.74	27.974	1.496204
Group 2	10	285.01	28.501	6.706121
Group 3	10	294.11	29.411	4.872388
Group 4	10	293.99	29.399	3.349454
Group 5	10	294	29.4	0.9864

ANOVA

Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	17.69954	4	4.424885	1.270747	0.295526	2.578737
Within Groups	156.6951	45	3.482114			
Total	174.3947	49				

Table 4: ANOVA - H/M

Groups	Count	Sum	Average	Variance
Group 1	10	4.73	0.473	0.054201
Group 2	10	4.23	0.423	0.068401
Group 3	10	5.28	0.528	0.261618
Group 4	10	4.44	0.444	0.18376
Group 5	10	4.89	0.489	0.051788

ANOVA

Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	0.066092	4	0.016523	0.1333	0.969316	2.578737
Within Groups	5.57791	45	0.123954			
Total	5.644002	49				

This was an comparison and co-relational study done to see the effect of age on H-reflex and MNCV. This study was designed to study the changes in motor nerve conduction velocity of tibial and common peroneal nerve, H-reflex, H/M in males and females with increasing age. By reviewing literatures it was found that there is decrease in excitability in spinal pathways with

Table 5: ANOVA - CPN latency difference

Groups	Count	Sum	Average	Variance
Group 1	10	69.49	6.949	0.218232
Group 2	10	70.39	7.039	0.56201
Group 3	10	71.09	7.109	2.181632
Group 4	10	68.5	6.85	0.703089
Group 5	10	70.64	7.064	0.528316

ANOVA

Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	0.425748	4	0.106437	0.126914	0.971935	2.578737
Within Groups	37.73951	45	0.838656			
Total	38.16526	49				

Table 6: ANOVA – CPN MNCV

Groups	Count	Sum	Average	Variance
Group 1	10	470.75	47.075	12.34883
Group 2	10	473.72	47.372	9.499818
Group 3	10	488.05	48.805	28.76965
Group 4	10	473.91	47.391	21.8719
Group 5	10	425.94	42.594	166.9851

ANOVA

Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	223.4612	4	55.86529	1.166411	0.338293	2.578737
Within Groups	2155.277	45	47.89505			
Total	2378.739	49				

Table 7: ANOVA – Tibial latency difference

Groups	Count	Sum	Average	Variance
Group 1	10	82.87	8.287	1.092734
Group 2	10	84.86	8.486	2.583493
Group 3	10	86.12	8.612	2.272396
Group 4	10	88.21	8.821	0.285543
Group 5	10	82.87	8.287	1.887312

ANOVA

Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	2.065092	4	0.516273	0.317844	0.86455	2.578737
Within Groups	73.09331	45	1.624296			
Total	75.1584	49				

Table – 8 ANOVA – Tibial MNCV

Groups	*Count*	*Sum*	*Average*	*Variance*
Group 1	10	451.11	45.111	23.59254
Group 2	10	455.39	45.539	31.48112
Group 3	10	447.8	44.78	24.33942
Group 4	10	432.41	43.241	28.29594
Group 5	10	458.59	45.859	37.79274

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	41.39024	4	10.34756	0.355582	0.838788	2.578737
Within Groups	1309.516	45	29.10035			
Total	1350.906	49				

Fig 1: Graph of Mean, Standard deviation and Standard error of Leg Length and BMI

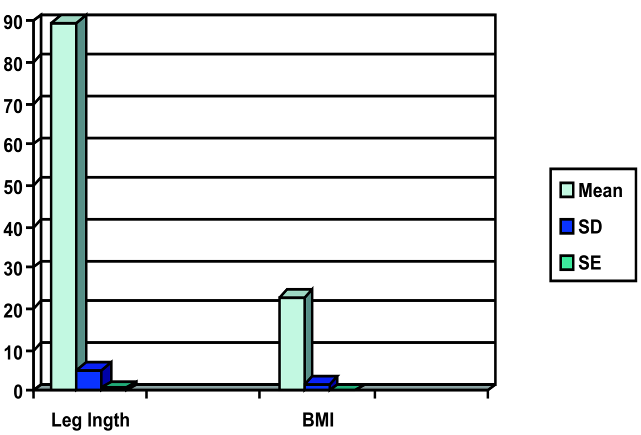


Fig 2: Graph of Mean, Standard deviation and Standard error of H- latency and H/M

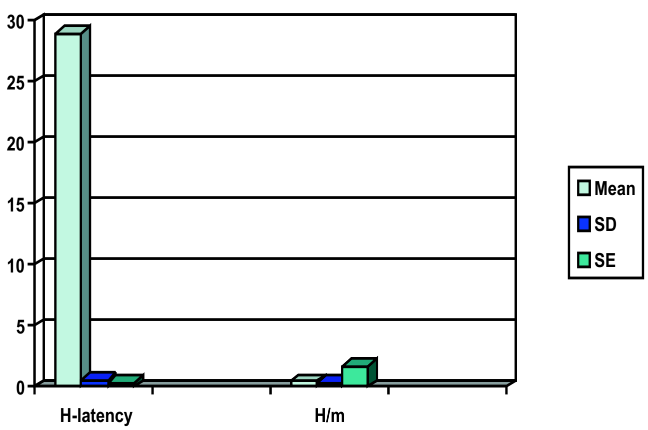


Fig. 3: Graph of Mean, Standard deviation and Standard error of CPN latency difference and CPN MNCV.

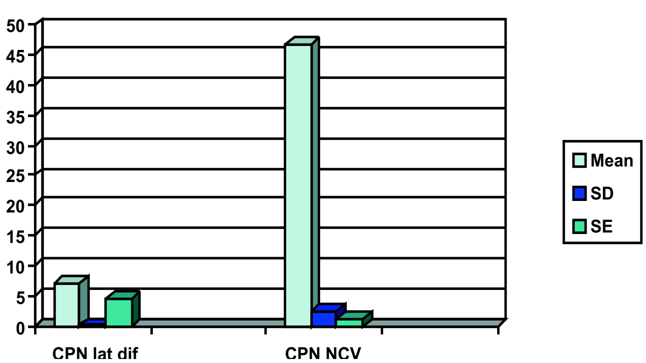
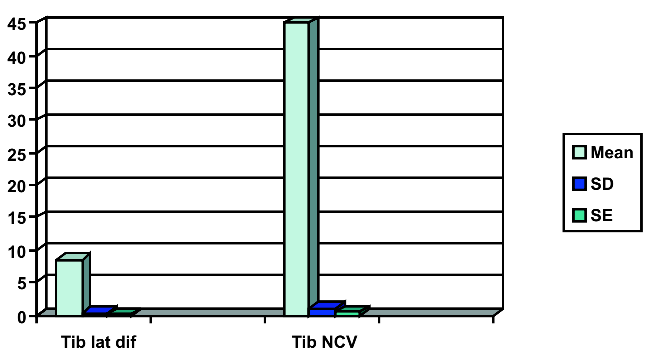


Fig. 4: Graph of Mean, Standard deviation and Standard error of Tibial Latency. Difference and Tibial MNCV.



increasing age, increase in latency of H-reflex and decrease in nerve conduction velocity with increasing age.

According to the null hypothesis of this study the age does not have impact either over MNCV or H-reflex, and this study will not formulate age correction formula for either MNCV or H-reflex and the existing formula of H-reflex is not reliable which says :

H-latency = 0.46 {leg length(cm)} + 9.14 + 0.1 {age(years)}[43]

Earles D et al indicated significant increase in presynaptic inhibition with increasing age and similarly Solange G. Garibaldi and Anarmali nucci found significant relationship between age and sensory nerve conduction velocity of ulnar nerve but Shahram Sadeghi et al in their study said that there is no correlation between latency of H-reflex and age and Maro Arco Aurelio Smith Filgueria said that there is no age influence in H reflex parameters for subjects in the range of 20 to 40 years of age.

In this study Using ANOVA it was found that The F-value for H-latency is 1.27, for H/M is 0.133, for CPN MNCV is 1.16, for CPN LD is 0.126, for tibial MNCV is 0.355 and tibial LD 0.317 against table value 2.57 and thus there is no significant difference between H-latency, H/M, Tibial LD, Tibial MNCV, CPN LD, CPN MNCV. This proves the null hypothesis of this study, that there are no significant changes in MNCV and H-reflex with increasing age of the age group of 10-60.

But the results of my study do not demonstrates the significant effect of age on H-reflex and MNCV as demonstrated by other researches like Nam Sunwoo who in his study on 639 Korean adults over 20years of age demonstrated that physiological factors like age, sex, and height effect nerve conduction velocity independently.

In contrast, the review of literature that supports my study are by Marco aurelio smith filgueria who said that there is no age influence in H reflex parameters for subjects in the range of 20 to 40 years of age, even Mohamed Sufi Awang et al did not find any significant effect of age on nerve conduction velocities except for median nerve uptill 60years of age. Taylor PK said that there is a non-linear effects of age on nerve conduction, out of his 25 sets of data 3 sets did not show any dependence on age of conducion velocity, amplitude and duration.

These partially contradicting results may be attributable to less age range, the evidences are there which strongly suggests that as age increases beyond 60yr, human muscle undergoes continuous denervation and reinnervation, due to an accelerating reduction of functioning motor units (Jan Lexell,1997). The age range upto 65yrs is considered young adult range based on the classification system defined by Seccombe and Ishii-Kuntz. It was also observed that Spinal cord CVs showed little change until approximately age 60, and declined sharply thereafter (Dorfman LJ, Bosley TM). One another study said that there is no age influence in H reflex parameters for subjects in the range of 20 to 40 years of age Marco aurelio smith filgueria Another factor attributable to these results is the active lifestyle of the subjects taken under this study, the subjects were all healthy, normal, independent, all were capable walkers, able to walk continuously Gordon R. Chalmers and Kathleen M. Knutzen they all were working under different occupations and thus not much significant changes were found in nerve conduction velocity and H-reflex parameters, insignificant changes show that there is no significant demyelination in the nerves leading to normal conduction in the nerves as young people.

Another finding of this study is that there is difference in male and female in findings of tibial nerve MNCV but insignificant in other parameters which is in general agreement with Henry C. Tong et al who said that there is no significant change in nerve conduction parameters on the basis of gender.

In the end, we conclude that there is no effect of age on motor nerve conduction velocity and H-reflex upto 60yrs of age and also the sex plays a minor role in the findings of H-reflex and motor nerve conduction velocity as its effect was found only on the motor nerve conduction velocity of the tibial nerve and the age correction formula could not be formulated because of very less variation in the values and the existing formula of the H-latency is proved to be unreliable.

CONCLUSION

From the ANOVA insignificant changes in all parameters was found with increasing age, value of F for H-latency 1.270747, for H/M 0.1333, for CPN latency difference 0.12914, for CPN NCV 1.166, for tibial latency difference 0.317, for tibial NCV 0.355. and correlation study it was suggested that the alternate dose not hold valid and null hypothesis can be drawn from the conclusions and values of t-test for difference in sex for H-latency -4.169, for H/M -2.39, for CPN latency difference -4.392, for CPN NCV 0.317, for tibial latency difference -4.059 which are all insignificant but for tibial NCV is 1.6867 which is more then the table value (1.677) and thus it shows a significant difference in males and females in tibial NCV–

From this study, we conclude that

1. There are no significant changes in H-reflex with increasing age upto 60yrs.
2. There are no significant changes in MNCV with increasing age upto 60yrs.
3. There is no significant sex role in MNCV and H-reflex.
4. The existing formula of H-latency is not reliable.

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Effects of commonly adopted body positions on pulmonary function in normal males of different age groups

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Abstract

One of the major roles of respiratory physiotherapy is to clear the airway secretions. In the recent past many newer techniques has been developed and utilized by the therapist. Patient positioning plays a major role while performing these techniques. The force productions of the respiratory muscles are greatly influenced by gravity along with other biomechanical factors. The subjects with respiratory disorders commonly adopts slumped sitting in the hospitals due various factors., **Methods** This study was conducted to find out the effect of commonly adopted positions (Upright sitting, Supine, Prone lying, and slumped sitting). All the measures which surrogate forceful expiration along with measures to check lung mechanics (FEV1,FVC,PEFR,FEV1/FVC and MVV) were measured by using a standard Pulmonary Function Test Procedure in normal males with different age groups (N=79). The positions were selected randomly to avoid the maturation effect. The Parameters were analysed by repeated measures of variance (ANOVA)., **Results:** The upright sitting position had significantly higher value when compared to other positions in all four age groups. Slumped sitting had lower values when compared to sitting., **Conclusion:** Therapists should be aware about the effect of gravity in various positions on forced expiratory maneuvers in order to achieve the good outcome.

Keywords: Positions, Pulmonary Function Tests, Airway Clearance, Forced Expiratory Techniques

INTRODUCTION

Most hospitalized patients often assume body positions such as supine lying, sitting, side lying, prone lying and slumped sitting. Patients routinely change their positions for comfort and to avoid the negative effects of these positions such as skin breakdown and contractures. In all these positions both internal and external forces also exert their influence on the pulmonary system. Hough [1] in 1984 highlighted an issue associated with the typically 'slumped sitting' position observed in most of the hospital wards, where patients tend to spend considerably long periods of time in this posture, which predictably limits their lung function.

The hospitalized patients are prone to develop respiratory complications especially if they are predisposed to secretion retention, such as following surgeries and chronic airflow limitation.[2] Adequate clearance of airway secretions is an essential component of the defense mechanism of the respiratory tract against infection.[3] Coughing and huffing are the expiratory maneuvers that use high expiratory pressures and flow rates to aid with the secretion clearance. These two forceful expiratory maneuvers are influenced by lung volumes, sensitivity of airway reflexes, lung mechanics, medications and the psychological aspect of the patient. Of these, lung mechanics and lung volumes are proved to be influenced by body positions [4].

Pulmonary function test is one of the most important tools which measures both the lung volumes and mechanics. Lung mechanics include movements of the thoracic cage, length tension relationship of respiratory muscles and elastic

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properties of the lung tissues [5]. It has been reported in several studies that in the upright posture the ribcage movements are more than that in the recumbent position.[6,7] The activity of the diaphragm is also affected by the body position.[8,9,10]

The lung mechanics test includes measurement of forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), peak expiratory flow rate (PEFR) and lung compliance. All these parameters can be used as alternate measures to evaluate the efficacy of a cough and huff especially PEFR, which is accepted as an important tool to measure the airway patency. FVC evaluated at the total lung capacity is the most performed test to determine lung mechanics. In particular FEV_1 is the best characteristic measure of respiratory function.[11] Maximal voluntary ventilation (MVV) usually measures the endurance of the respiratory muscles. All these parameters of lung mechanics are influenced by lung volumes and muscle length tension relationships which in turn are influenced by body position.[5] It is therefore, of clinically importance to study the effects of commonly assuming positions on pulmonary mechanics.

Apart from the positions, aging also affects the lung functions. Lung volumes, especially the dynamic measurement of lung function are seen to decrease with age. (FVC, FEV_1 and FEV_1/ FVC) [12,13] In 1852, John Hutchinson recorded the vital capacities of more than 4000 persons by using his water sealed spirometer.[14] From then onwards most of the studies record the PFT readings either in sitting or in standing position.[15,16,] But as of yet very few studies with minimal number of subjects[17,18] have been done in this regard.

Hence, it has been believed that there is a need to understand normal responses as a basis for understanding abnormal responses superimposed by pathology .The purpose of this study, therefore, was to improve the knowledge regarding the relationship between the body positions and pulmonary functions in different age groups, to find the appropriate position for performing FET, to minimise the deleterious effects of body positions and thus extend the existing body of knowledge pertaining normal relationship between commonly assuming body positions and supportive measures of forced expiratory maneuvers.

MATERIALS AND METHODS

This study was conducted on seventy nine normal male subjects with no evidence of respiratory disease or smoking habit between the age group 20 – 59 years. Ethical clearance has been obtained from the institutional review board. The study protocol was explained to each of the subjects and a written informed consent was obtained.

Subjects with history of cardiac ailments, recent systemic infections and with the history abdominal and thoracic surgeries were excluded. The subjects were divided into 4 groups according to their age. Group 1 consisted of subjects aged between 20- 29 years, Group 2 of subjects aged 30- 39 years, group3 consisted of subjects of age group 40 – 49 years and the Group 4 of subjects aged 50 – 59 years.

TEST PROTOCOL FOR PFT

The subject's age, height and weight were recorded. Following the explanation about the equipment and procedure, all the subjects were allowed a practice session before the commencement of the testing protocol. The procedure was monitored by the researcher, and adequate explanation and motivation was given to the subjects.

INSTRUCTIONS GIVEN TO THE SUBJECTS FOR PERFORMING PFT

They were instructed to place the mouthpiece in situ and to form a tight seal with their lips. For forced expiration tests, they were instructed to take two tidal breaths followed by one deep breath and forced expiration with maximal force. For the measurement of MVV, subjects were instructed to breathe as deep and as fast as possible for approximately fifteen seconds. All instructions were given by the same researcher throughout the procedure.

After the practice session, subjects were positioned as per a randomly derived sequence.

POSITIONS USED

1) Sitting on a chair with back rest with hips and knees flexed to right angle and arm relaxed on the thigh
2) Supine lying on a standard bed with one pillow under the head, limbs relaxed
3) Prone lying on a standard bed with a pillow under the pelvis to free the abdomen and the head turned to one side.
4) Slumped half lying (sitting) with the bed elevated at head end to an angle of 45 degrees, pillows behind the head & thorax and beneath the knees. Subjects were not instructed to sit up-right.

The subjects were then instructed to perform the PFT tests in the same positions as placed. The test was repeated for three trails with adequate interval between two. The trials were repeated if the variation was more than 10%. In some subjects 7 trails were done to get the reproducibility of the values. The subjects were then placed in the other positions and the same procedure was continued till respiratory functions in all the four positions were studied. A rest period of 5 minutes was ensured between two positions.

INSTRUMENTATION

MIR spirobank (The multi function spirometer) Italy was used for the measurement of PFT. The equipment can measure 26 parameters with an automatic test interpretation. It has a turbine flow sensor, which needs no calibration. It gives results in BTPS because it has its own temperature sensor. It has the flow range of about +16 L/S and maximum volume of 10lt. The flow accuracy of this instrument is +5% or 200ml/s. It can be operated by using 9VDC battery. This instrument has been certified by the American Thoracic Society (ATS)

A separate sterilized mouth piece was used for each subject.

All the data was collected according to the guidelines of American Thoracic Society.

RESULTS

The dependent variables were analyzed by using repeated measure analysis of variance (ANOVA) and posthoc analysis using SPSS (16 VERSION).

77 subjects participated in this study with a mean age of 38.07 ±10.45 years. They were divided into 4 groups according to their age. Group 1 included 20 subjects aged between 20-29 years with the mean age of 25+1.9years. The mean age for group two was 33.7 +2.8 years (n=20). The mean age for subjects in group 3 (n=20) was 43.15 ± 2.23 years while the mean age for subjects in group 4 (n=17) was 52.58 + 2.06 years. Two of the subjects were dropped since they were not able to perform the test.

Results of the study demonstrated that upright sitting has higher values for FVC followed by slumped position, supine and prone. Statistical analysis of the data within the groups showed that FVC in all the groups was significantly better in the upright sitting position as compared to the other positions. It was also noted that the FVC in the slumped position was significantly better than supine and prone positions in groups 2, 3 and 4 while in group 1 FVC in slumped position with a mean of 4.08+.42 ml did not show a significant difference when compared to supine. (4.03+.40)

Of all the positions upright sitting also recorded highest values for PEF, FEV1 and MVV in all the groups as compared to the other positions.

It was noted that the slumped position showed significantly better values for all the measured PFT parameters as compared to the prone positions.

Also, the slumped position was significantly better than supine only in some of the cases. Hence, analysis showed that slumped position did not always have an added benefit or significant beneficial effect as compared to the supine position.

In group 2, supine was seen to have significantly higher value than prone position in the measurements of PEF. (P<0.010).

Statistical analysis of data between the groups demonstrated that group 1 which consisted of the younger age group showed significantly higher values for FEV1 and FVC while group 2 showed highest values for PEF and MVV. A significant difference was noted between group 1 and group 4 in the comparison of all the PFT measurements evaluated in both these groups. Group 1 had better values than those of group 4. There was no significant difference between group 1 and group 2 and between group 2 and group 3 in the measurement values of FEV1. In prone lying, group 2 has also got significantly higher value than group 4 (P<0.01). Again in slumped sitting, there was a significant difference in the FEV1 values between group 1 and group 4, but not in other groups.

Also, there was a significant difference between group 2 and 4 (P<0.001) in the MVV values obtained in sitting, supine and prone positions. In slumped, both the first and second groups have achieved significantly higher MVV values than group 4 (P<0.005, P<0.04).

Except supine lying, in all other positions, there was a significant difference between group 2 and group 4 for the PEF measurements.

Thus it is demonstrated that positional variation and age affect the PFT measurements obtained even in normal subjects.

Table 1: Demographic data of the subjects in all the groups

GROUP	AGE±MSD	HEIGHT IN CM M±SD	WEIGHT IN KG M±SD
1	25±1.97	171.35±5.22	61.55±6.1±2
2	33.75±2.94	171.25±5.99	69.15±9.02
3	43.75±2.23	170.45±5.94	65.70±4.43
4	52.58±2.06	170.23±5.57	68.82±6.24

Table 2: Comparison of FEV1, FVC, PEF, FEV1/FVC & MVV between the positions for Group 1

VARIABLE	SITTING	SUPINE	PRONE	SLUMPED	P<
FEV1	3.65±.34	3.40±.49	3.34±.49	3.49±.39	.001
FVC	4.30±.43	4.03±.40	3.99±.45	4.08±.42	.001
PEF	9.26±1.35	8.39±1.05	8.36±1.52	8.63±1.32	.001
FEV1/FVC	85.21±6.07	83.24±4.90	83.74±4.97	85.56±6.23	.022
MVV	160+23.8	138+22.7	134.72+21.18	145.33+23.41	.001

Table 3: Comparison of FEV1, FVC, PEF, FEV1/FVC & MVV between the positions for Group 2

VARIABLE	SITTING	SUPINE	PRONE	SLUMPED	P<
FEV1	3.52+.38	3.28+.34	3.20+.33	3.31+.37	.001
FVC	4.11+.39	3.84+.45	3.72+.40	3.87+.47	.001
PEF	9.34+1.54	8.99+1.54	8.54+1.55	8.67+1.26	.001
FEV1/FVC	85.85+5.66	84.35+5.74	85.08+5.70	85.44+4.76	.679
MVV	163.97+24.42	145+17.81	137.77+24.01	146+26.21	.001

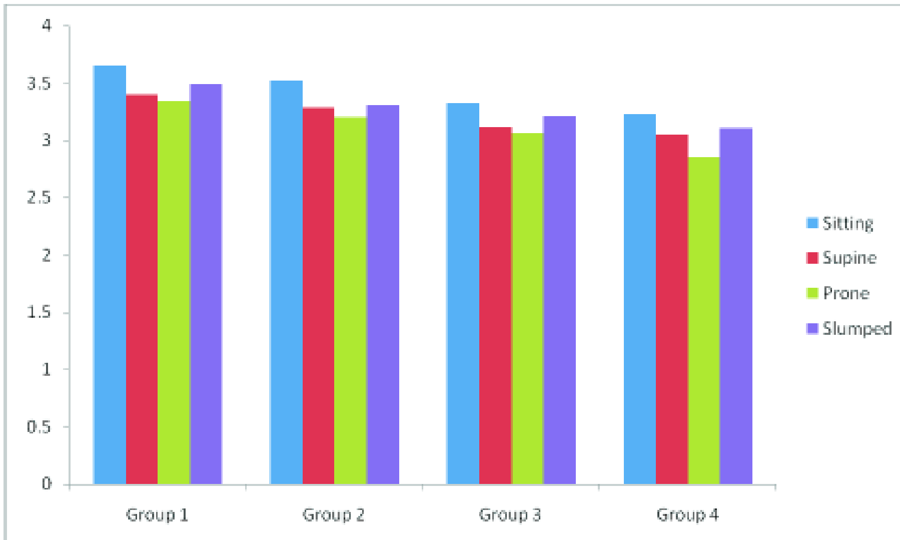
Table 4: Comparison of FEV1, FVC, PEF, FEV1/FVC & MVV between the positions for Group 3

VARIABLE	SITTING	SUPINE	PRONE	SLUMPED	P<
FEV1	3.32+30	3.11+.27	3.06+.27	3.21+.27	.001
FVC	4.10+43	3.81+.41	3.65+.42	3.93+.42	.001
PEF	8.57+.974	7.94+1.19	7.36+1.40	7.92+.90	.001
FEV1/FVC	84.59+5.73	81.23+4.66	83.81+6.07	82.16+.40	.189
MVV	144.83+19.55	132.39+17.10	125.70+12.4	135.26+25.90	.001

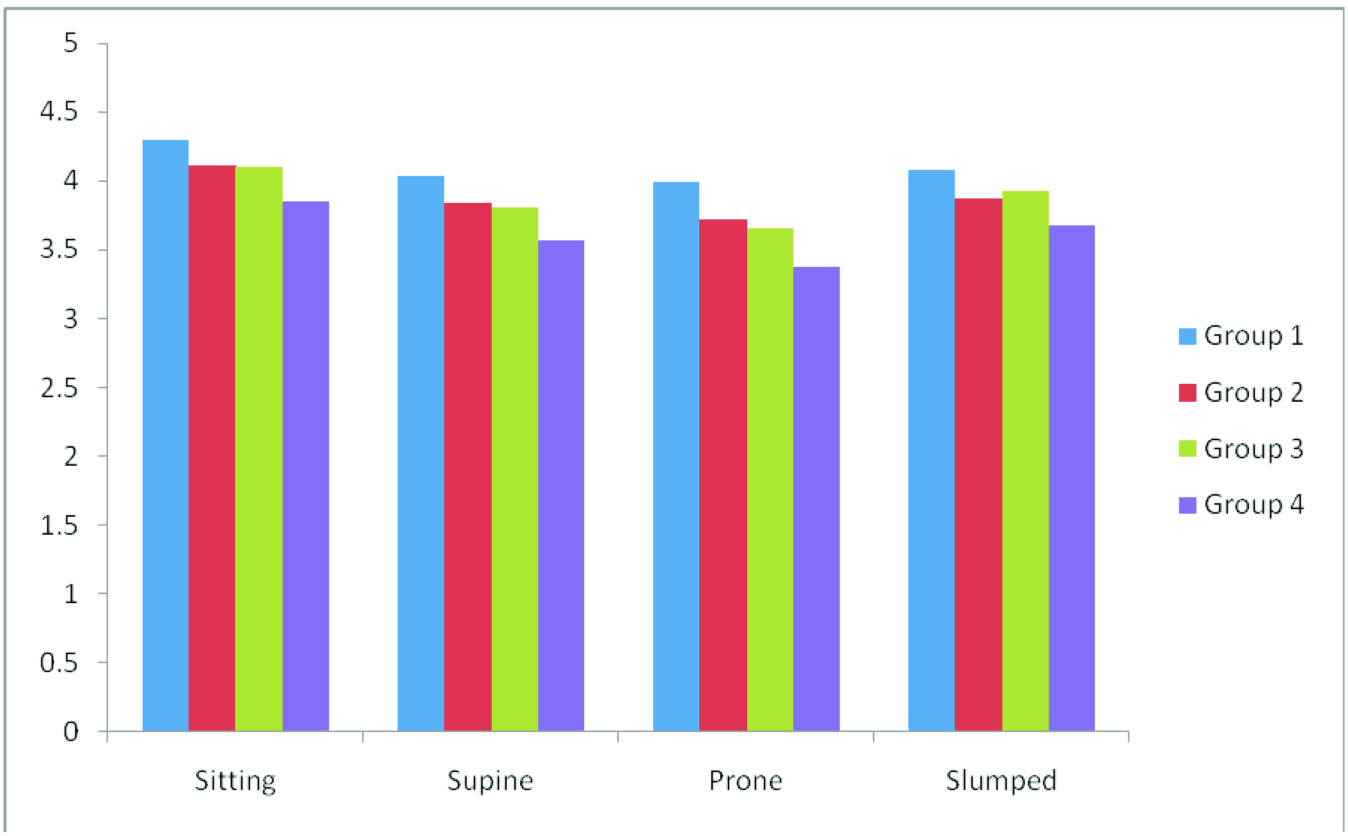
Table 5: Comparison of FEV1, FVC, PEF, FEV1/FVC & MVV between the positions for Group 4

VARIABLE	SITTING	SUPINE	PRONE	SLUMPED	P<
FEV1	3.23+.27	3.05+.20	2.85+.25	3.10+.19	.001
FVC	3.85+.26	3.57+.21	3.37+.34	3.68+.24	.001
PEF	8.00+.41	7.66+.45	7.21+.68	7.71+.44	.001
FEV1/FVC	83.87+6.09	85.51+4.2	84.57+1.75	84.59+4.86	.538
MVV	134.54+6.74	123.94+11.74	119.89+13.48	129.18+11.77	.001

Graph 1: Comparison of FEV1 Between the groups



Graph 2: Comparison of FVC between the groups



DISCUSSION

Results of this study showed that the upright sitting recorded the highest values for all forced expiratory maneuvers as compared to the other positions. According to Pride N.B. the forceful expiratory maneuvers (FEV1 & FVC) entirely depend up on the total lung capacity.

Lung volume increases in upright posture due to

1. Gravity – This pulls the abdominal contents downwards, to increase the vertical diameter of the thoracic cavity.[19]

2. The compressive force exerted by the weight of the heart and abdominal contents are less in upright sitting compare to recumbent positions [1].

3. The ribcage expansion is more in upright posture when compared to supine. This is due to increase in the deployment of Inspiratory muscles action directly on the ribcage and a decrease in abdominal compliance affected by a combination of passive gravitationally induced changes plus active tonic contraction of abdominal muscles.

Sitting has got more thoracic compliance when compared to supine because of the following reasons.

4. The gravity makes the ribcage more elliptical, this reduces the ribcage movements and there by thoracic compliance, and

5. In sitting position the diaphragm has to push the abdominal contents downwards, and this in turn reduces the thoracic compliance during deep inspiration [12].

The elastic recoiling force increases with increase in lung volume. In this study the subjects were asked to take deep inspiration. Before performing forced expiratory maneuvers. Due to this a large number of potential energy is stored in the chest wall structures. The increased descend of the diaphragm pushes the abdominal content downwards and stretch the abdominal muscles slightly. This increases the force production of the abdominal muscles. The action of the expiratory muscles also increases in the upright posture. The transverse abdominals acts more than oblique muscles, actively during normal ventilation. Due to the postural change the length-tension relationship of these abdominal muscles are altered. This may lead to less force production during expiratory maneuvers [20].

The respiratory resistance also increases in supine lying when compared to sitting. All these actions combined together produce the maximal forceful expiratory values in upright sitting.

Followed by sitting, slumped sitting got the second highest values. Compared to upright sitting, thoracic kyphosis increases slightly in the slumped position. This will reduce the chest wall compliance but not like supine. Anthonesen reported that hyperextension of the neck results in an increase in FEV1, secondary to elongation and stiffening of the trachea, thereby facilitating airflow. But in slumped sitting the neck goes into mild flexion compared to upright sitting [21]. Compared to supine slumped sitting has got significantly more value because reasons explained for the sitting position are also applicable to slumped sitting. Due to neck posture in the slumped positions, the scalene muscles which act during quite breathing may for a biomechanically disadvantageous position, leading to decreased thoracic expansion [22.]

Compared to all other positions, prone lying has got the lowest values because of the action of gravity. As compared to supine position diaphragmatic excursion is less in prone lying due to mechanical compression. Though the pillows have been provided under the pelvis to clear the abdomen, the pressure exerted by the gravity to the abdominal wall can't be neglected. Placement of pillows may increase diaphragm-abdominal compliance, but compressive force to the ribcage may reduce the thoracic compliance. Due to these reasons prone lying may have recorded lesser values. Similar results have been shown by Villike [23] et al in 2000.

Apart from forced expiratory parameters, the maximal voluntary ventilation (MVV) was also more in upright sitting compared to other positions. MVV entirely depends upon the strength of the respiratory muscles. In sitting position all the respiratory muscles are placed in a mechanically advantageous position. But in supine and prone due to the effect of gravity the length tension relationship of the diaphragm is altered. It has been mentioned earlier that in the upright position the motor recruitment of the respiratory muscles is more when compared to recumbent position. All these together increase the strength of the respiratory muscles in upright sitting.

INTER GROUP

These results address the effects of aging on the pulmonary system. All the variables significantly decreased among the groups as age advanced. This may be attributed to the increased rigidity of smooth muscles of the respiratory tract, decreased range of motion of the costochondral junction, increased kyphosis, decreased respiratory muscle strength, increased diaphragm – abdominal compliance, decreased chest wall compliance, reduced diaphragmatic force generation and increased closing volume. It has been proved that the closing volume has a direct effect on forced expiratory measures.

Closing volume is 10% of vital capacity in young healthy individual. It increases with age and is 40% of the vital capacity at the age of 65 years. This increase in closing volume is mainly due to the loss of airway patency [24]. Mark Estenne [12] et al, in 1985, found that the diaphragm-abdominal compliance increases due to aging. This is an important factor, which directly affects the lung mechanics. It has been well documented that the recumbent position affects the diaphragmatic force generation. Thus, the combined effects of positioning and aging significantly affect the pulmonary function.

Increased resistance to airflow occurs especially when breathing at the lower lung volumes. Airway resistance increases in older age, due to decrease in the number and thickness of elastic fibers of small airways. This leads to decrease in FVC, FEV1 and $FEF_{25\%}$.[25]

When comparing group 2 with group 3 and group 3 with group 4, there is no significant difference in most of the variables. This suggests that the aging effects occur in the respiratory system gradually. Group 2 has achieved the highest value for PEF and MVV. This may be due to the effect of body mass index.

MVV and PEF are entirely effort dependent, which can be easily affected by the body mass index. In this study group 2 has got higher BMI than group 1. Even though group 4 has more or less same BMI like group 4 due to aging MVV and PEF may be reduced in group 4 compared to group 2.

Studies have been done by Charbel Badr (2002), Vilke et al (2000) and Crossbie (1985) on the effects of various combination of positions on pulmonary functions, they concluded that the lung volumes and capacities in upright sitting has the highest values in all parameters (PEF, MEP, FEV1, and FVC), compared to recumbent positions including supine and prone positions. These results were similar to this study.

The significant change in the pulmonary function values due to change in position and age help us to disprove the null hypothesis.

FUTURE RESEARCH

Similar studies using more variables like airway resistance, lung compliance, maximal Inspiratory and expiratory pressures and closing volume in more positions should be carried out. Such studies will provide more knowledge and reliable information about the respiratory mechanics. Continuation of these kind of studies with different subject groups like abdominal and thoracic surgery, spinal cord injury and chronic obstructive pulmonary disease (COPD) would have provide important information regarding position selections, during forced expiratory techniques (FET). Finally, radiological investigation of mucociliary clearance in different positions could provide appropriate information about airway clearance.

RELEVANCE TO CLINICAL PRACTICE

The results of this study indicate that there was a significant change in pulmonary functions due to change in positions and aging, upright sitting position has an advantage over all other positions (slumped, supine and prone positions). While performing forced expiratory techniques, adopting upright sitting could increase the efficacy of technique when compared to other positions. This has to be considered strictly, especially with the old age group. While prescribing forced expiratory techniques, most of the hospitalized patients tend to adapt slumped sitting and supine position. Therapist should take utmost care to avoid these positions while performing forced expiratory techniques (coughing and huffing)

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Physiotherapy following cardiac surgery: A national survey

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ABSTRACT

Physiotherapy has been widely accepted as an integral part of post operative care following open heart surgeries. Preventing and correcting postoperative pulmonary complications are the main goals of postoperative physiotherapy. In the health care practice following a uniform protocol based on the available evidence is considered as one of the important tool in improving the quality of care. With this back ground this study was aimed to identify the variability in postoperative care at national level., **Methods:** The randomly identified centres which perform open heart surgeries were approached for this survey. The senior most therapists were interviewed through telephone by using a standardised questionnaire. The questionnaire consisted of various aspects of postoperative physiotherapy., **Results:** Out of 28 centres which were contacted, representatives of 25 centres participated in this interview. There was a marked difference in postoperative physiotherapy care among these centres. In all the centres Deep breathing was practised mandatorily but the recent techniques like Active Cycle of breathing techniques were underutilized. Phase II cardiac rehabilitation was followed only in two centres. This survey leads us to think of formulating a nationwide protocol for postoperative Physiotherapy.

Key words: Postoperative Pulmonary Complications, Physiotherapy, Open Heart Surgery.

INTRODUCTION

The disability caused due to cardio vascular disorders is increasing in India as also seen in many other parts of the world. More than 60,000 open heart surgeries are performed to reduce the morbidity and mortality, associated with cardiovascular disorders, throughout the country every year [1]. A high risk of pulmonary complications following major surgery is universally acknowledged, especially in the thoracic procedures. Postoperative pulmonary complications after cardiac surgeries are a major source of morbidity and mortality and increased length of hospital stay and resource utilization. The occurrence of post operative pulmonary complications following open heart surgeries may be of a multi factorial origin. The effect of general anaesthesia on the respiratory system, use of cardio pulmonary bypass and the presence of drains in addition to the post surgical pain lead to impaired pulmonary function [2, 3, 4]. Physiotherapy is recognised in the prevention and management of these postoperative pulmonary dysfunctions. Physiotherapists have, therefore, been accepted as important members of the cardio thoracic surgical team. Post operative physiotherapy – consisting of breathing exercises emphasizing inspiration, incentive spirometry, air way clearance techniques and early mobilization is administered with an aim to increase lung ventilation, prevention of chest infections and rehabilitation of the individual to the activities of daily living [5]. Though the scientific evidence regarding the efficacy of physiotherapy is limited, due to a dearth of good quality studies, it is practised in almost all the cardio thoracic surgery units worldwide. It has therefore, been suggested

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by experts that practicing a uniform protocol is needed to improve the quality of care.

Hence this study aimed to explore the various protocols used in different cardiothoracic units throughout the country, in order to find out the variability in postoperative physiotherapy care, which in turn determines effective patient recovery and health costs.

METHODOLOGY

An Interview method was used to survey the various cardiac surgery centres across the country. A detailed questionnaire was prepared related to postoperative physiotherapy care. A total of 44 centres spread across the nation were identified for the study, of which therapists from 28 centres were contacted and interviewed successfully through telephonic conversation. At the commencement of the interview, the purpose of the study was explained to the respondents, most of them being the in-charges of the physiotherapy services in their respective workplace. If the in-charges could not be contacted, the senior most therapists working in the Cardio Thoracic surgery unit was interviewed. After explaining the purpose of the study, the interview was conducted with the consent of the respondent. All the interviews were conducted by the same therapist to avoid any bias. Three of the respondents were not willing to participate in the survey due to their personal reasons.

All the answers were documented in the Proforma and clarifications were sought whereever necessary. The duration for each interview varied from 9 – 11 minutes. The total time taken for each of the interview was documented. In case a fixed protocol was being followed in the centre, a copy of the same has been requested.

DATA ANALYSIS

The data was analysed using the descriptive statistics and Chi square test, as appropriate.

RESULTS

The mean age of the respondents was 27years and 11 of them were having their post graduate degree in Cardio Pulmonary Physiotherapy. 52 % of the respondents were having only 1- 2 years of post qualification experience in the field of postoperative cardiac care, 24 % of therapists were having 3-4 years and while the remaining 24% had more than 5 years of experience. 40 % of the therapists were working in multi speciality hospitals, 40% in super speciality hospitals and only 20% of the respondents were from academic institutes. The number of cardiac surgeries performed in the hospitals ranged from 2 to 60 per week with a mean of 11.08 surgeries a week. The total number of physiotherapists working in the cardiac surgery unit varied from 1 to 12 with the mean of 3.36 therapists per unit. Of the 25 hospitals included in the study only 7 hospitals had 24 hour physiotherapy service. The preoperative admission in the hospitals ranged from 1 – 4 days. In 19 of these centres physiotherapists evaluated the patients preoperatively. 13 centres had a fixed hospital protocol for the management of the cardiac surgical patients.

Fig 1. Preoperative Physiotherapy Assessment:

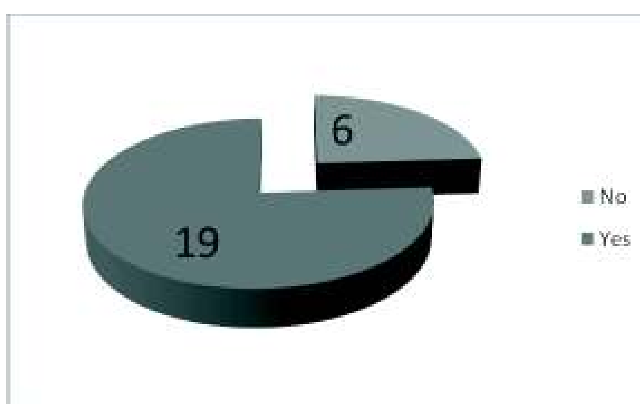


Fig.2 Components of Preoperative Physiotherapy Assessment

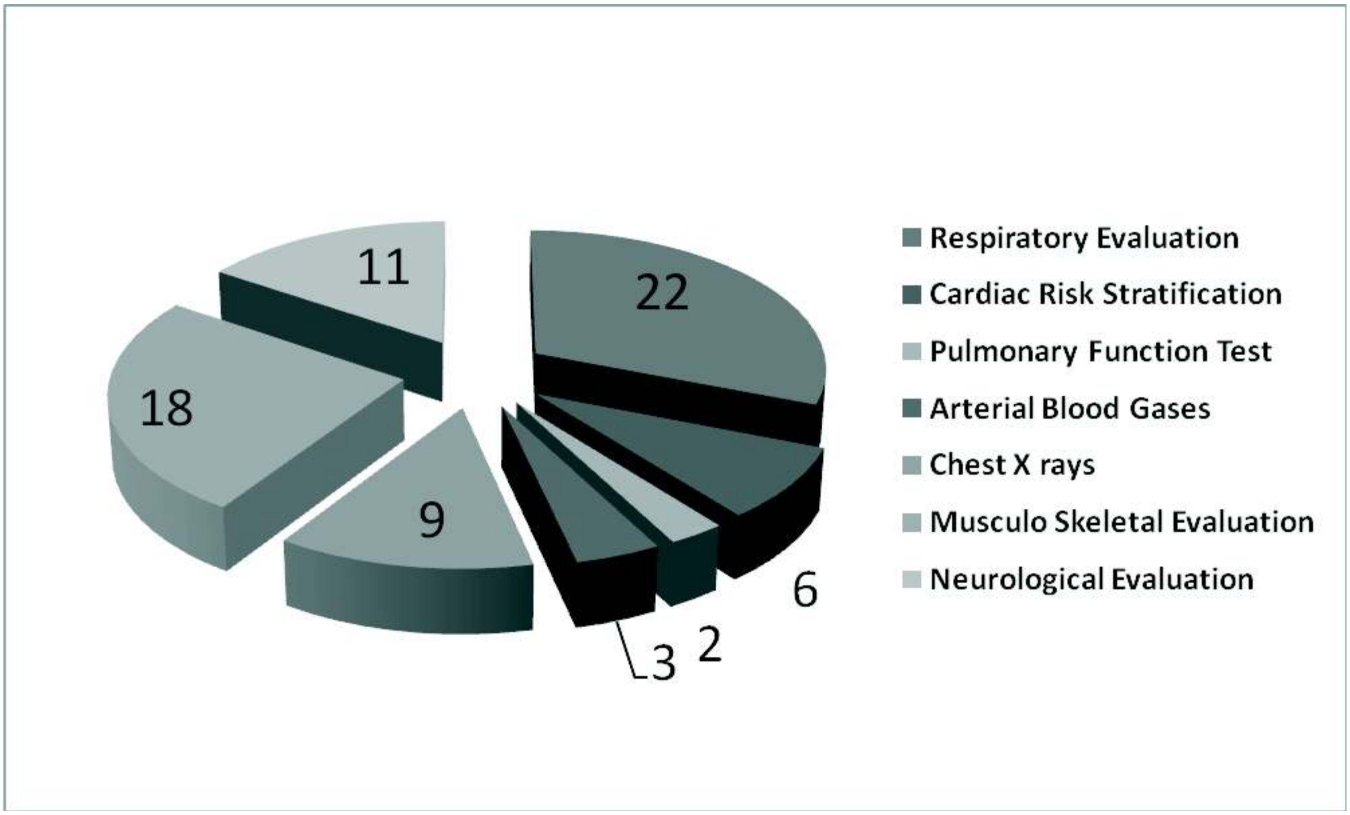


Fig 3. Protocol Followed

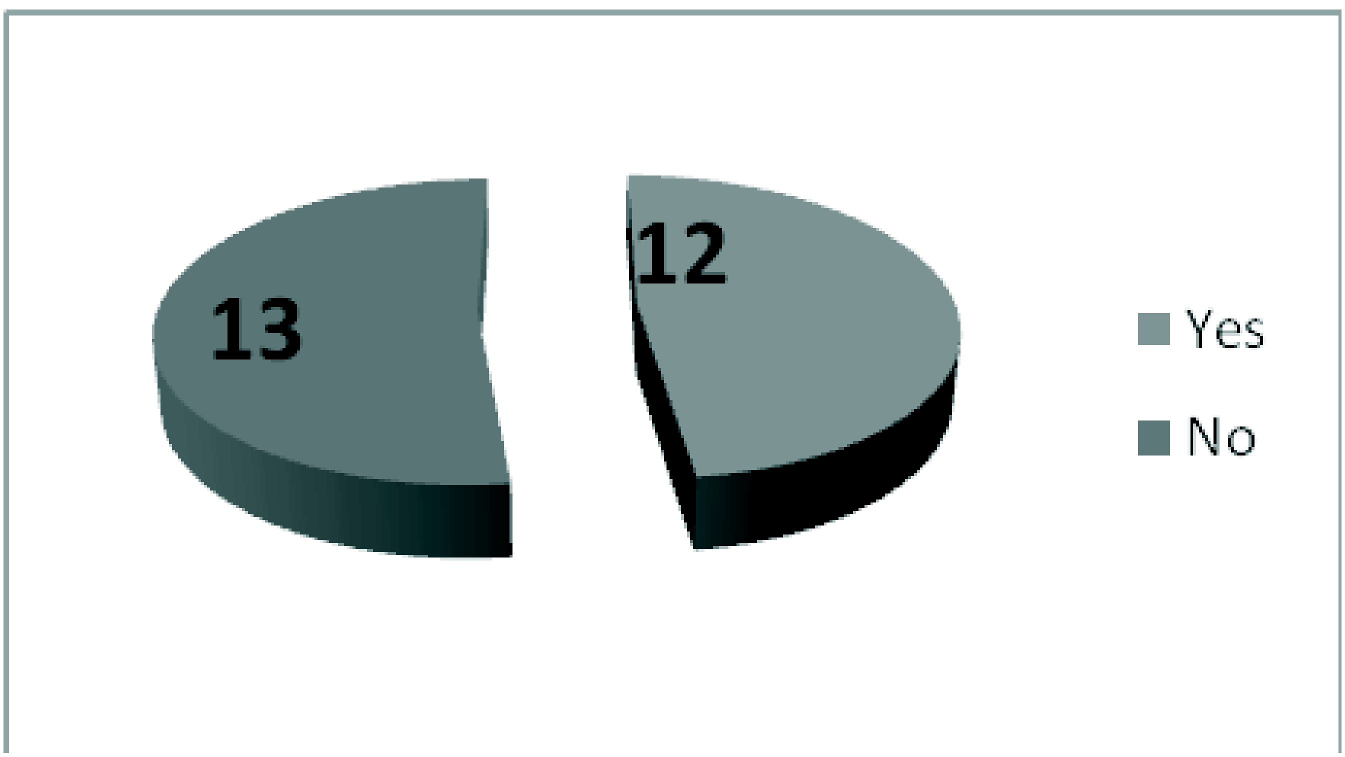


Fig. 4: Commencement of Physiotherapy

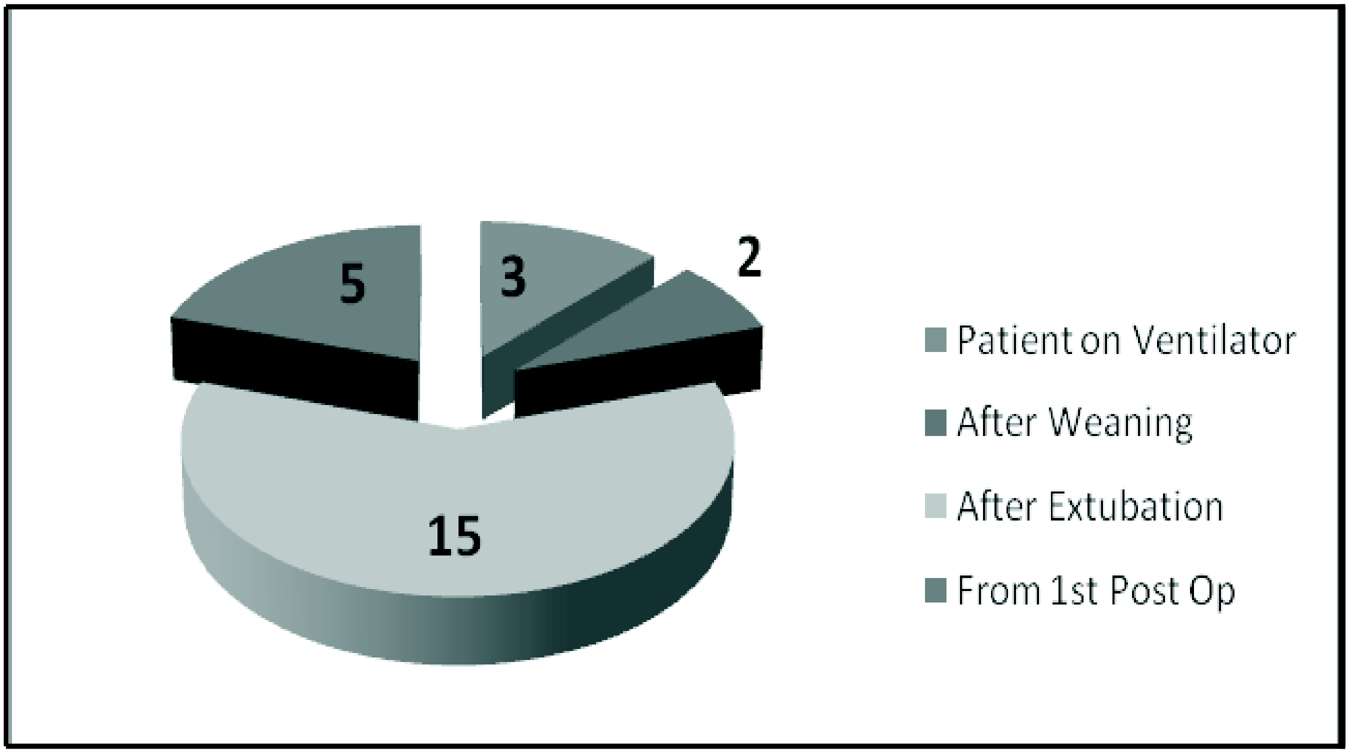


Fig. 5: Physiotherapy Techniques Used

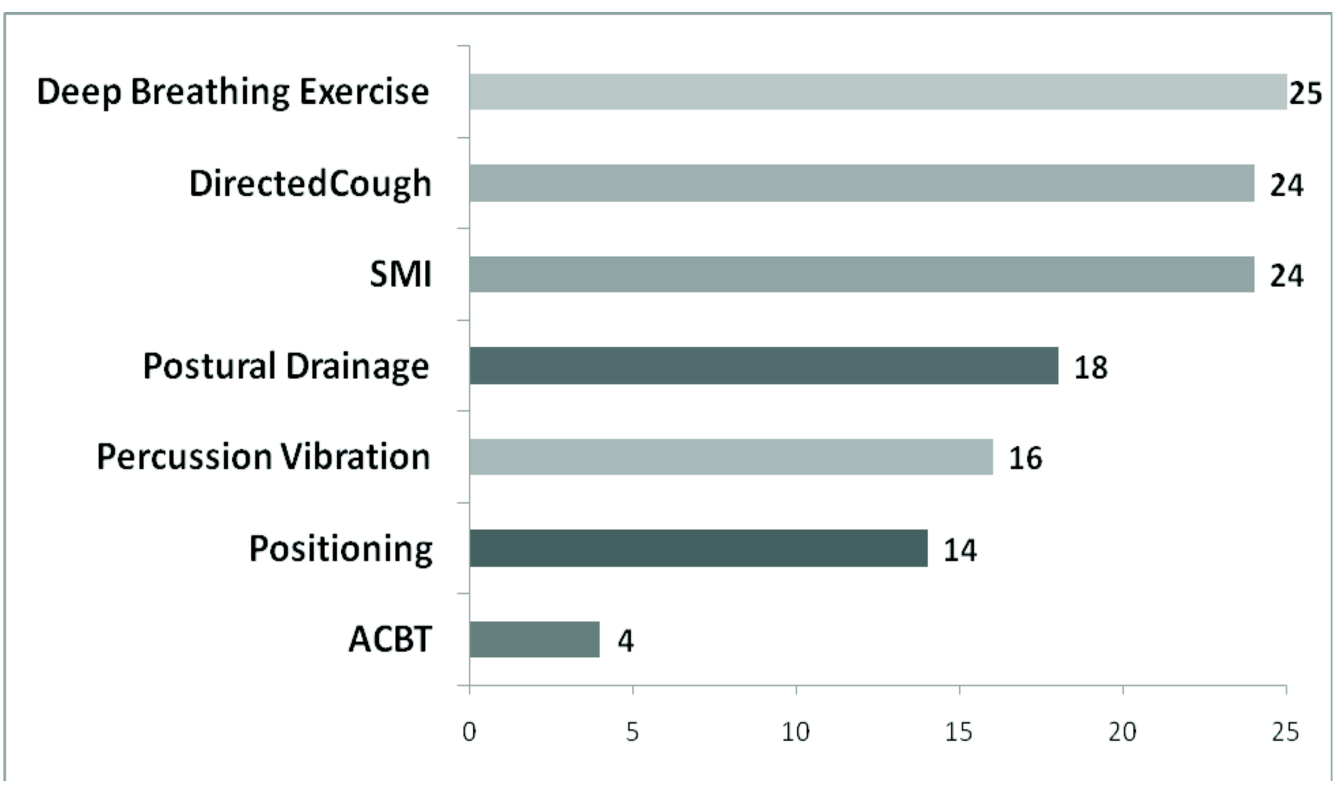


Fig. 6: Supervision of SMI

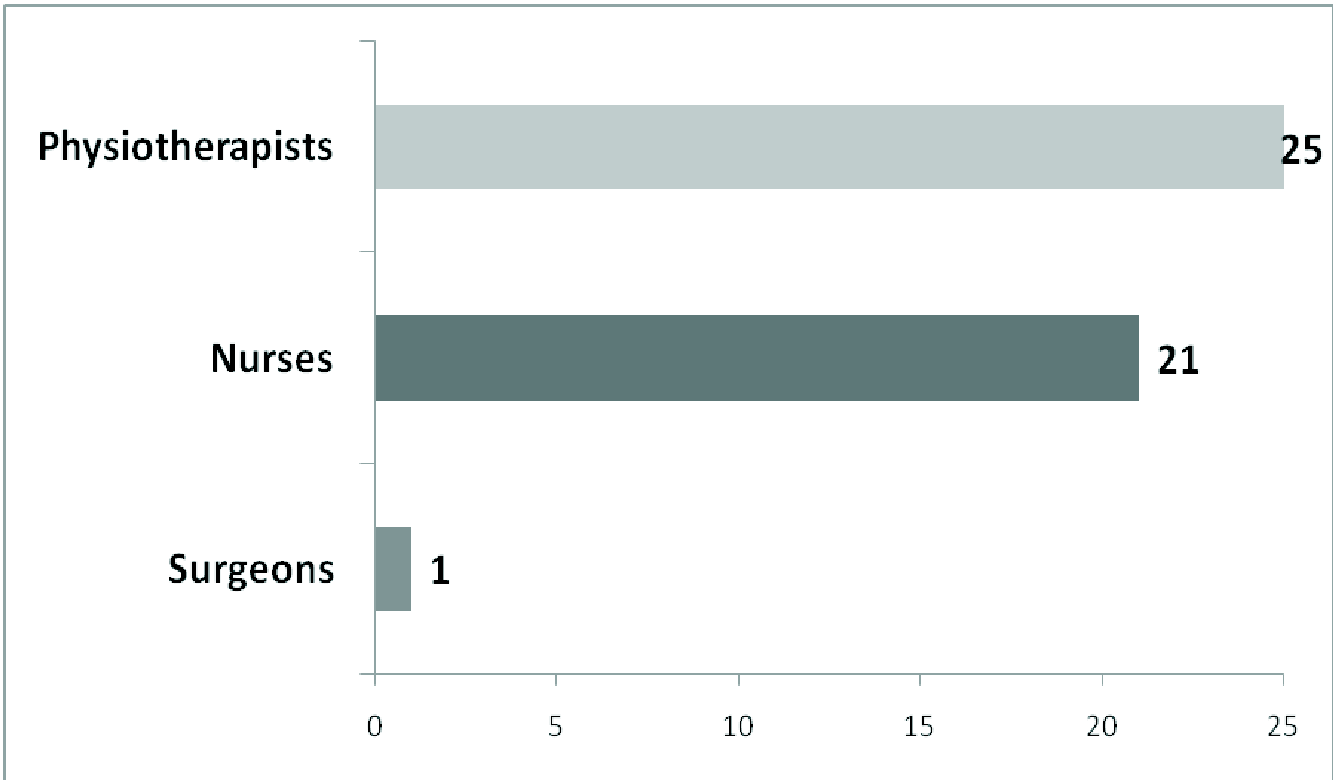


Fig. 7: Mobilisation

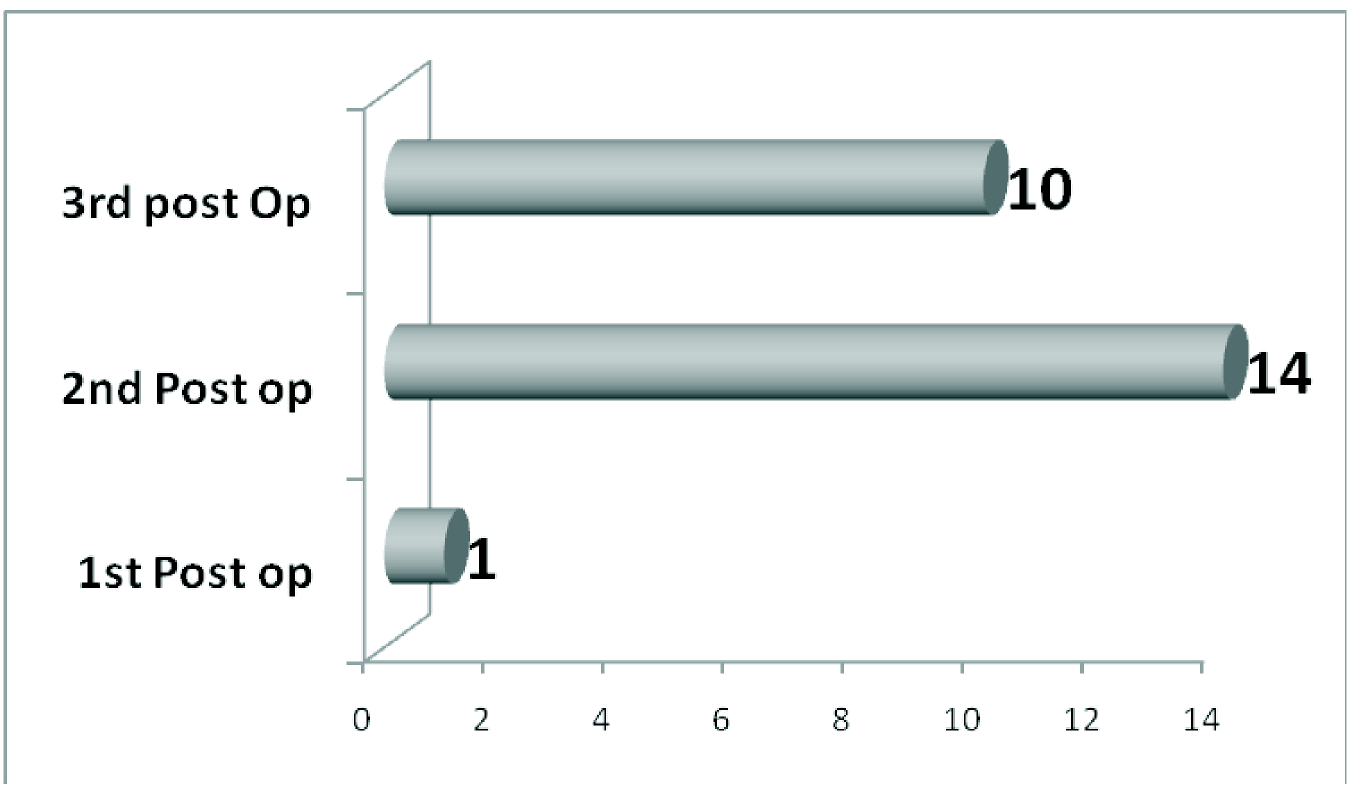


Fig. 8: Who decides about Mobilisation?

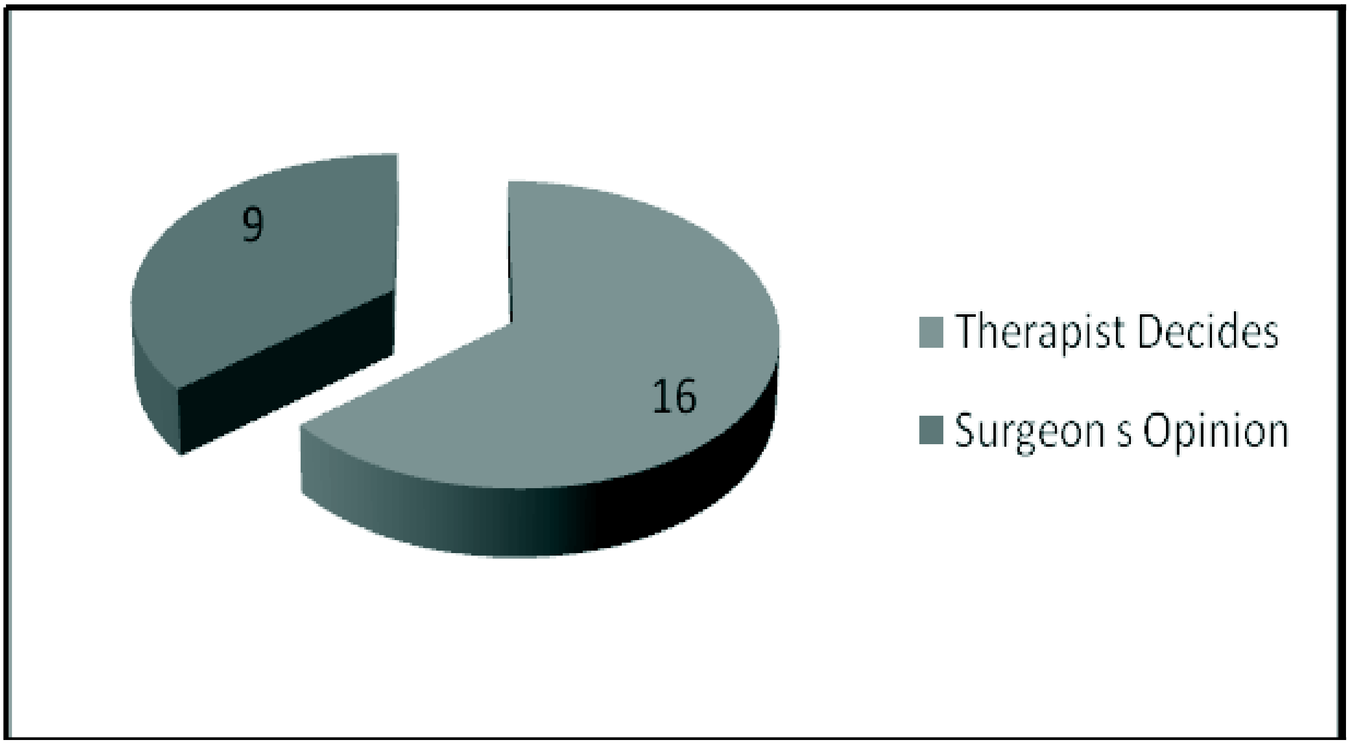


Fig 9: Frequency of Therapists' Visit

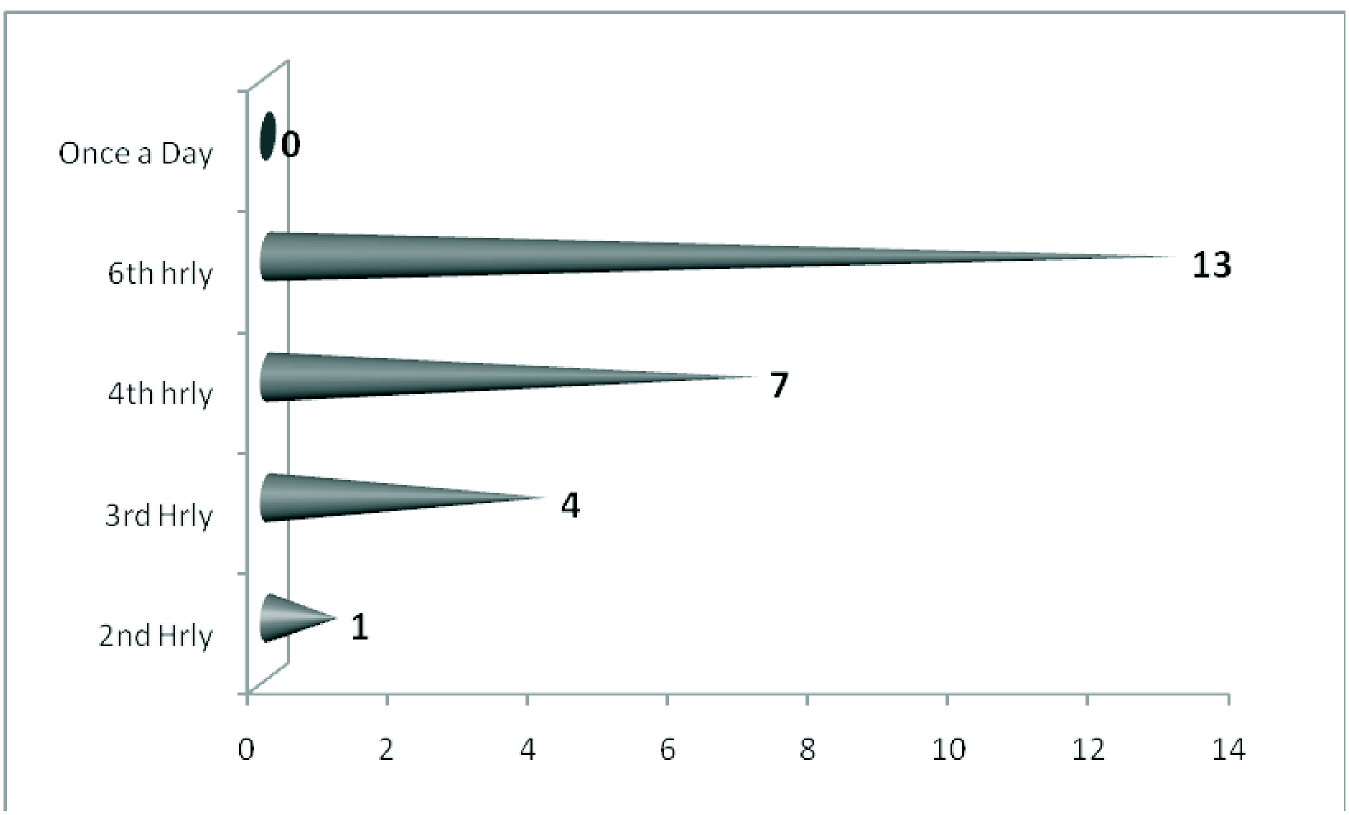


Fig 10: Advice on Discharge

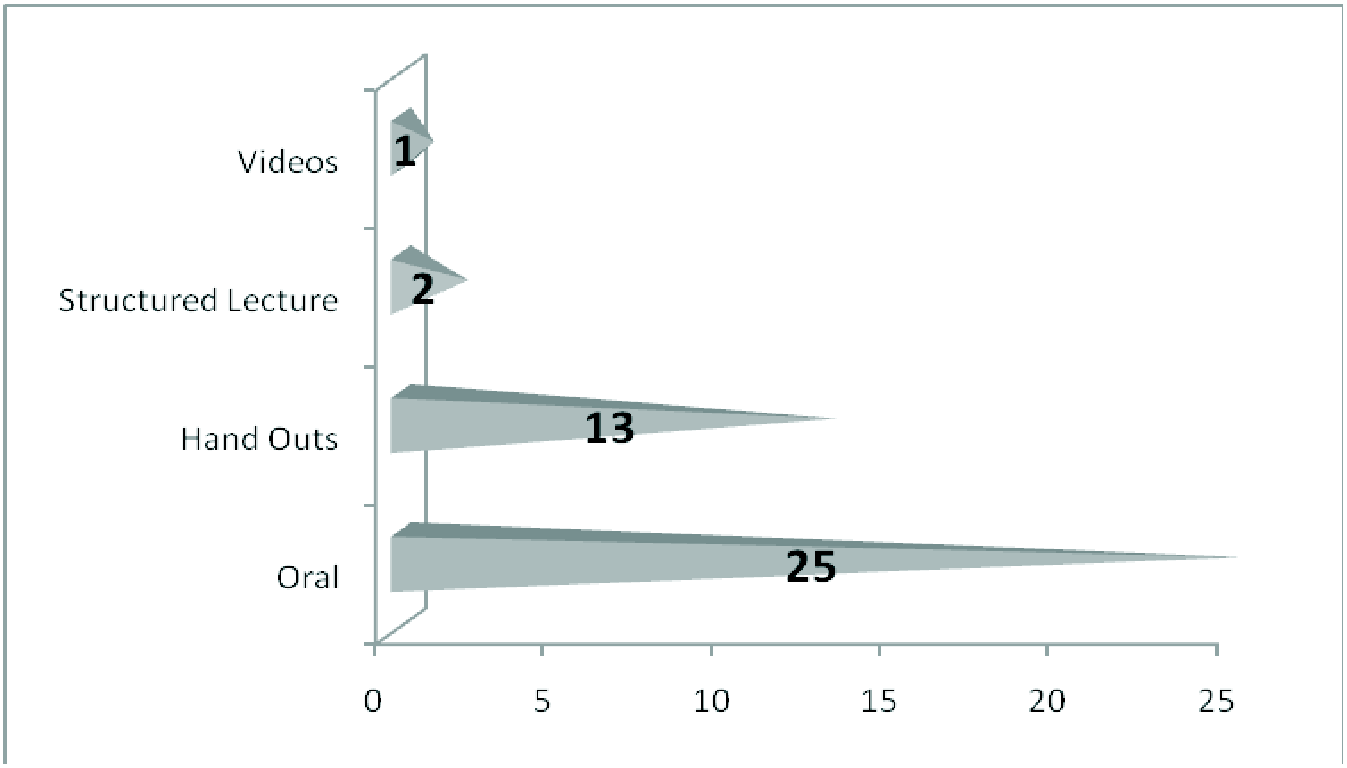
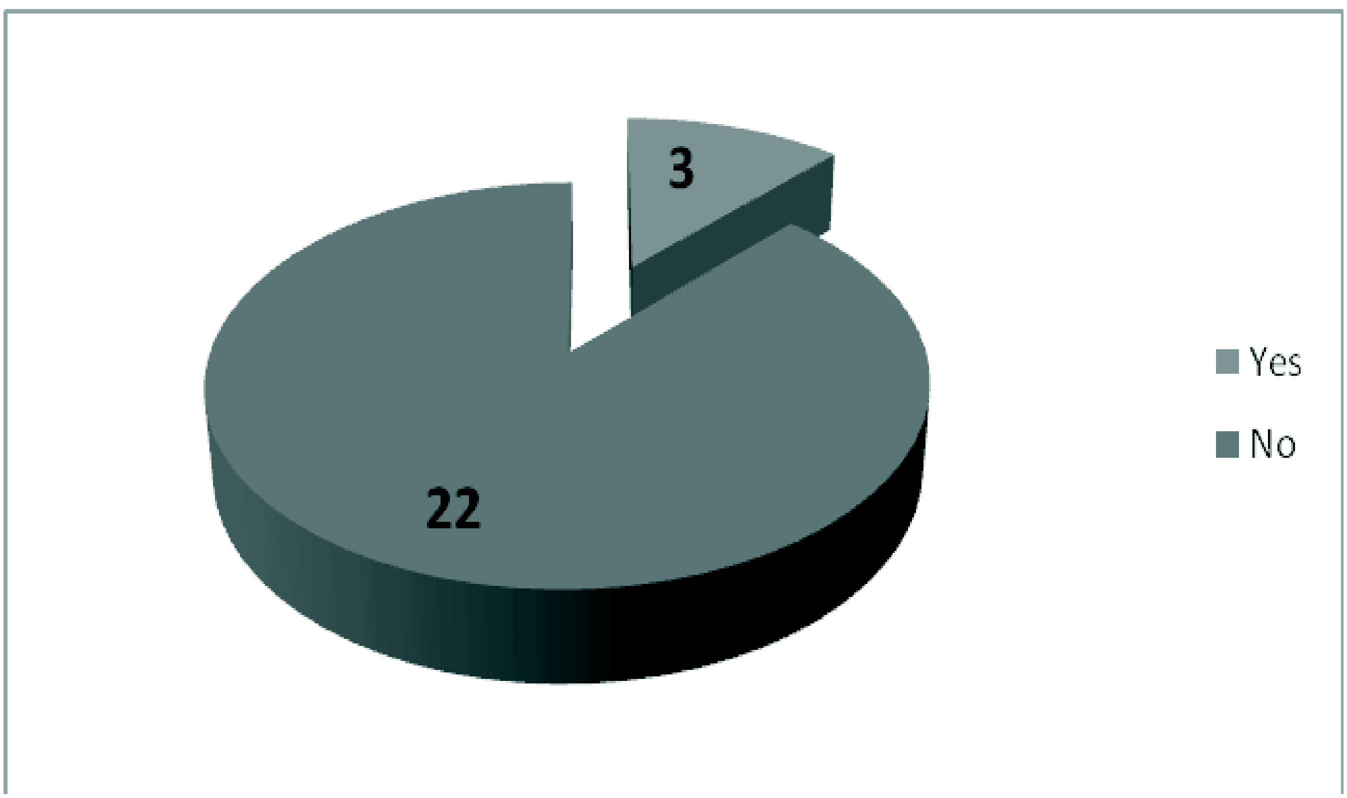


Fig. 11: Phase II Cardiac Rehabilitation



DISCUSSION

44 centres were identified for the study of which 25 centres were included. The included centres represented almost all the states of India.

In 76% of the centres, among the respondents, pre-operative physiotherapeutic assessment is carried out by the therapist. The remaining are not involved in pre-operative assessment probably due to lack of awareness which can be attributed to the therapists' qualification and hospital protocol. A similar study conducted in Australia in 1996 found that 94% of the respondents were involved in preoperative assessment [6]. Hence, the point to be focused is that in spite of the difference in the time period between the two studies and even though this study is conducted years later India still has a scope for improvement. This study could therefore be considered as a first step towards the same.

It is also noted that 52% of the physiotherapists are following a fixed protocol in managing the post operative patients while no two protocols are the same. This shows the need for a national wide standard protocol as mentioned by Prof B. Airan [1].

60% of the respondents reported that the commencement of physiotherapy is only after extubation. But we are not aware of the duration of mechanical ventilation in these centers. The previous survey conducted among the cardiothoracic units in Australian and Newzeland found that the average duration of mechanical ventilation following surgery was between 4-8 hours [6]. In the above survey 63% of the respondents used a specific respiratory management protocol even for the intubated patients, while according to our survey physiotherapy is being practiced in only 3 centres when the patient is on ventilatory support. 20% of the therapists started the management only from the first post-operative day.

There is a wide range of techniques incorporated in the physiotherapy protocols practiced by the respondents. Deep breathing exercises are a mandatory part of the postoperative cardiac physiotherapy in all the centres even though the evidence for deep breathing exercises is not well established. A study done by Brasher AP [7] found that the removal of deep breathing exercises from routine physiotherapy management does not produce any significant change in the incidence of pulmonary complications. Inspite of the controversy regarding the effect of deep breathing exercises in preventing the respiratory complications following cardiac surgery this technique is still widely practiced and accepted by the Physiotherapists all around the world [7, 8, 9]. The wide usage of deep breathing exercises may be attributed to the simplicity of the technique, traditional background and cost effectiveness [10].

The presence of surgical pain and drains may affect the sigh mechanism which in turn may produce postoperative pulmonary atelectasis. This is considered to be the physiological rationale behind deep breathing exercises and SMI. A narrative review with four RCTs and a systematic review, explored the evidence regarding the benefits of SMI is limited. But the physiological rationale behind this technique is widely accepted [11].

In 96% of the hospitals SMI and directed coughing is incorporated in their post operative treatment protocol. In most of the cases SMI was done by the patients under the supervision of the therapist while in 84% of the centers, nurses are also involved in supervising Incentive spirometry. As per the international standards SMI should be performed 5-10 times every awake hour to prevent pulmonary atelectasis. Hence, involving the critical care nurses in supervising Incentive spirometry could be beneficial.

Splinted coughing has been recommended as a gold standard technique to remove pulmonary secretions after abdominal or thoracic surgery. This has been endorsed by a study conducted by Fiore FJ et al [12]. Directed cough significantly increases the cough peak expiratory flow and cough expiratory volume. The method of holding the sternal incision firmly with the patient's palm during cough was not able to reduce the pain as documented in the above study. In most of the centres the same method is still being used.

In only 56% of the centres positioning is being considered even though it has been well established that frequent change in the position is mandatory to prevent pulmonary complications. The limited practise of positioning could be accredited to the presence of various lines and drains connected to the patient. But it is suggested that positioning can still be considered with at most care.

ACBT is incorporated in the physiotherapy protocol only in 4 of the centers which is minimal as compared to the Australian and New Zealand survey. This may be attributed to the lack of familiarity of the technique among the therapists and its less popular use in the past, though the physiological rationale stands strong.

In 40 % of the centers mobilization is deferred to in the 3rd postoperative day, though early mobilization is considered to be the gold standard technique in preventing pulmonary complications. Early mobilisation is universally accepted to be practiced from the first postoperative day in cardiac surgery unit, hence a need for practice of the same should be emphasised. In majority of the centers the early mobilization is based on the therapists' assessment.

In all the centers advice on discharge is given orally. Only in 52 % of the centers handouts were provided in the local language. This component has not been analyzed in the previous surveys. Handouts may be more feasible in training the patients for a home based protocol and the same to be followed by them without supervision.

Unfortunately it has been found that only three centres do undertake a phase II cardiac rehabilitation. The knowledge that Phase II cardiac rehabilitation plays an important role in improving the quality of life of the patients who have undergone cardiac surgeries has been well established decades before. Therefore the key point here is that Cardio Thoracic surgical units in India need to initiate cardiac rehabilitation programmes for the complete rehabilitation of the patients.

CONCLUSION

The results of this survey strongly stress the need for a nationwide uniform physiotherapeutic protocol in the management of the post- surgical cardiac population the components of which should be designed based on the recent research evidence.

ACKNOWLEDGEMENTS

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