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A Study to Find the Effect of Inspiratory Muscle Training in Patients with Upper Thoracic Spinal Cord Injuries in Improving the Pulmonary Function

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Abstract
Background: *Depending on these levels of lesions following spinal cord injury ventilatory dysfunction varies in severity from reduced cough effectiveness to total inability to breathe. Respiratory complications are the most prevalent source of morbidity and mortality after spinal cord injury. These complications occur as a result of reduction in both inspiratory and expiratory ability*
Objectives: *To improve ventilation and To improve the strength, endurance and coordination of respiratory muscles*
Materials and Methods: *In this study 25 patients with upper thoracic spinal cord injuries were selected and the pts treated with diaphragmatic breathing exercise' incentive spriometer, active cycle of breathing technique and inspiratory muscle training for a period of one month*
Results: *The statistical analysis by paired 't' test concluded that there was significant changes in the patients treated with the above techniques Based on the obtained results it can be concluded that the combined effect of incentive spriometry, diaphragmatic breathing exercises, and Active Cycle of Breathing technique is more effective in improving the pulmonary functions in upper thoracic spinal cord injuries.*
Conclusion: *In order to find the effect of inspiratory muscle training in upper thoracic spinal cord injuries. Diaphragmatic breathing exercises, incentive spirometry, Active Cycle of Breathing technique and weight training are more effective in this study.*

INTRODUCTION

A healthy respiratory system depends upon the integrated activity of many nerves and muscles to generate power to breathe. The respiratory system performs the critical functions of supplying oxygen to and removing carbon dioxide from the body. The higher centers play a major role in the regulation of respiration. Any injury to the cortex affects the voluntary regulation of respiration. Damage of descending motor tracts, anterior horn cells or nerve roots leads to an impaired capacity to contract the skeletal muscles at or below the level of lesion. Depending on these levels of lesions following spinal cord injury ventilatory

dysfunction varies in severity from reduced cough effectiveness to total inability to breathe.

Respiratory complications are the most prevalent source of morbidity and mortality after spinal cord injury. These complications occur as a result of reduction in both inspiratory and expiratory ability. These complications can be avoided with proper care. Respiratory care should be initiated soon after spinal cord injury and continued throughout acute and post acute rehabilitation. The process of weaning from ventilator is rapid if the respiratory program includes inspiratory muscle training. Skeletal muscles respond to training in well described ways which depend upon the characteristics of the training load. The extent of muscle adaptation depends upon the application of the principles of training.

Inspiratory resistive training represents the simple imposition of an additional workloads on the inspiratory muscle during breathing. Later this increased work load should increase both the strength and endurance of these muscles. Incentive spirometer provides immediate visual feedback regarding achievement of preset goals while they perform sustained maximal inspiratory manoeuvres. The visual input encourages the patient to continue to use the unit and to work toward increasing their maximal inspiratory effort. Peak flow meter is a good tool for assessing the lung function test.

The aim of this study is to evaluate the improvement in pulmonary function by giving inspiratory muscle training in upper thoracic spinal cord injuries. A spinal cord injury is among the most catastrophic injuries that a person can experience. The personal and societal effect of a significant spinal cord injury is profound because it confers lifelong disability on persons who are typically young adults. Fifty four percent of all between 16 and 30 years of age with 75% of injuries occurring in those less than 45 years old.

INCIDENCE

Motor vehicle accidents are the most common cause (47.7%) of spinal cord injury. Falls or falling objects (20.8%), sports (14.2%), acts of violence (14.6%). Remaining 14.6% of spinal cord injuries comes from variety of causes.

Most injuries of the vertebral column involve either a single level or a limited number of contiguous vertebrae. Multiple, non-contiguous, vertebral injuries are associated with injuries of the upper and middle thoracic spine .

NEED FOR STUDY

Respiratory complications are the most common in upper thoracic spinal cord injuries when compared to Lower thoracic spinal cord injuries. Chest physiotherapy plays an important role in reducing the complications. Despite of the important advances that have occurred in the prevention, diagnosis and treatment of respiratory complications, they continue to significantly affect the persons with spinal cord injury. So, additional studies of interventions should be aimed at reducing respiratory complications to decrease the morbidity and mortality associated with these injuries. Consequently none of the previous literatures have incorporated the following technique viz. diaphragmatic breathing exercise, Active Cycle of breathing Technique, incentive spirometry, inspiratory muscle training, in their study. So the intention of this study is to find the combined effects of all these techniques in order to improve the pulmonary function in upper thoracic spinal cord injuries.

OBJECTIVES

- To improve ventilation.
- To improve the strength, endurance and coordination of respiratory muscles.

MATERIALS AND METHODOLOGY

STUDY DESIGN: Pre test and post test experimental design.

SAMPLE SELECTION: Purposive sampling method

SAMPLE POPULATION: 25 patients with upper thoracic spinal cord injuries

INCLUSIVE CRITERIA

- Age with 25 to 40 years, both the genders are selected, T_1-T_5 region and
- No motor or sensory functions are preserved in the sacral segments S_4 to S_5 . When the patient is able to sit out of the bed with the help of brace.

EXCLUSIVE CRITERIA: COPD Conditions, Chest wall deformities, Hypertensive patients and Cardio vascular instability

TECHNIQUES USED

Techniques used in this are Diaphragmatic breathing exercises, Incentive spirometry. Active cycle of breathing and Inspiratory muscle training.

DIAPHRAGMATIC BREATHING EXER-CISE

- ❖ The patient should be in a relaxed and comfortable position.
- ❖ Therapist hand is placed on the rectus abdominals just below anterior costal margin.
- ❖ Patient is asked to breathe in slowly and deeply through the nose with relaxed shoulders and ask the patient to hold for 3-5 seconds.
- ❖ Then the patient is asked to slowly let out the air through the mouth using controlled expiration.
- ❖ Now the patient is asked to place his or her own hand below the anterior costal margin and asked to feel the movement.
- ❖ The patient is advised that the placed hand should rise during inspiration and fall during expiration.

Sessions - 3 sessions per day
Repetitions - 10 repetitions per session

INCENTIVE SPRIOMETER

- ❖ The patient should be in a relaxed and comfortable position.
- ❖ The patient is asked to take 3-4 slow easy breaths.
- ❖ Patient is asked to maximally exhale with the fourth breath.
- ❖ Incentive spirometer is placed in the mouth and patient is asked to maximally inhale through the spirometer and hold it for few seconds.

Sessions - 3 sessions per day
Repetitions - 10 repetitions per sessions

ACTIVE CYCLE OF BREATHING TECHNIQUE

The active cycle of breathing technique involves three phases repeated in cycles.

- ❖ Breathing control
- ❖ Thoracic expansion
- ❖ Forced expiratory technique (FET)

TECHNIQUE

- ❖ Breathing control.
- ❖ Diaphragmatic breathing at normal tidal volume.
- ❖ 3-4 thoracic expansion exercises.
- ❖ Deep inhalation with relaxed exhalation at vital capacity.
- ❖ Breathing control
- ❖ Forced expiratory technique
  - One to two huffs at mid to low lung volume
  - Abdominal muscle contraction to produce forced exhalation.
- ❖ Breathing control

TREATMENT WITH THE ACTIVE CYCLE OF BREATHING TECHNIQUE

BREATHING CONTROL

- ❖ The patient is instructed to breath in a relaxed manner using normal tidal volume.
- ❖ The upper chest and shoulders should remain relaxed and the lower chest and abdomen should be active. The phase of breathing control should last as long as the patient requires to relax and to prepare for the next phase 5 to 10 seconds.

THORACIC EXPANSION

- ❖ The patient is instructed to take in a deep breath to inspiratory reserve.
- ❖ Expiration is passive and relaxed.
- ❖ The care giver or the patient may place a hand over the area of the thorax being treated to further encourage increased chest wall movement.

FET

- ❖ This phase consist of huffing interspersed with breathing control. A huff is a rapid forced exhalation but not with maximal effort.

EFFECTIVE HUFFING

- ❖ The patient is asked to keep the mouth open, ('O' shaped to keep glottis open).
- ❖ The patient is asked to expire forcefully by contracting his abdominals.
- ❖ The patient must pause for breathing control after one or two huffs.

Sessions - 3 sessions perday

Repetitions - 5 repetitions per session

INSPIRATORY MUSCLE TRAINING

- ❖ Position of the patient-supine
- ➢ A small weight (Sandbag) is placed over the epigastric region[2, 22, 24, 25].
- ➢ The patient is asked to inspire through nose and expire through mouth and simultaneously try to raise the weight during inspiration.
- ➢ The weight is increased gradually when the patient can sustain diaphragmatic breathing pattern without the use of accessory muscles of inspiration for 15 minutes.

i. De Lorme and Watkins[13]

- ○ 10 lifts with ½ 10 R.M.
- ○ 10 lifts with ¾ 10 R.M.
- ○ 10 lifts with 10 R.M.
- ○ 30 lifts 4 times weekly
- ○ Progress 10 R.M. once weekly

Sessions - 2 sessions per day

DURATION OF THE STUDY

- A period of one month

DATA ANALYSIS

CHEST EXPANSION

LEVEL	AXILLARY		NIPPLE		XIPHISTERNUM	
Mean	Pre test	Post test	Pre test	Post test	Pre test	Post test
	1.5	2.11	1.9	2.59	2.31	3.17
't' value	7.06		10.8		13.2	
P value and significance	P< 0.05 and significant		P< 0.05 and significant		P<0.05 and significant.	

INCENTIVE SPIROMETRY AND PEAK FLOW METER

Mean	INCENTIVE SPIROMETRY		PEAK FLOW METER	
	Pre test	Post test	Pre test	Post test
	1.52	5.05	261.36	499.54
't' value	9.4		18.6	
P value and significance	P<0.5 and significant		P< 0.05 and significant	

MEASUREMENT TOOL: Chest expansion at Axillary level, Nipple level, Xiphisternal level ,Incentive spirometer, Peak flow meter

DATA ANALYSIS

CHEST EXPANSION

LEVEL	AXILLARY		NIPPLE		XIPHISTERNUM	
Mean	Pre test	Post test	Pre test	Post test	Pre test	Post test
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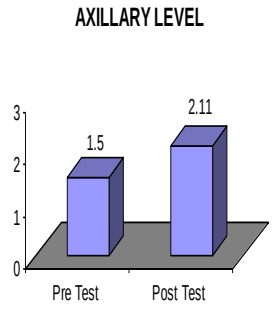
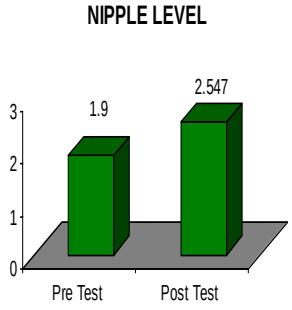
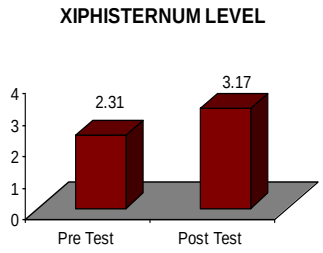
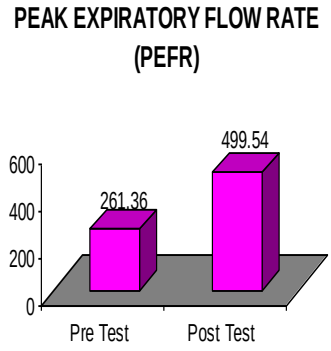
GRAPHICAL REPRESENTATION

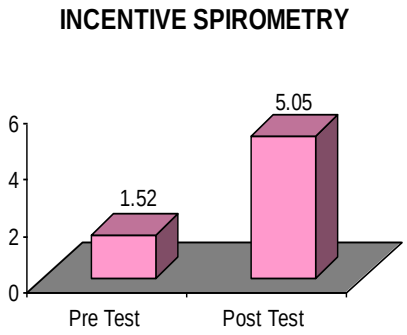
CHEST EXPANSION











RESULTS

CHEST EXPANSION

i) AXILLARY LEVEL

The calculated 't' value between the pretest and post test values by paired 't' test is 7.06. The table 't' value for 21 degrees of freedom at 5% level of significance is 2.08. As the calculated 't' value is greater than the table value, the alternate hypothesis is accepted.

ii) NIPPLE LEVEL

When the pre-test and post-test values of experiment group were analysed by paired 't' test, the calculated value is 10.8. The table 't' value at 21 degrees of freedom is 2.08. So the null hypothesis is rejected.

iii) XIPHISTERNUM LEVEL

The 't' value calculated between pretest and post test by paired 't' test was 13.2. For 21 degrees of freedom at 5% level of significance the table 't' value is 2.08. As the calculated 't' value is greater than table value, the null hypothesis is rejected.

iv) INCENTIVE SPIROMETRY

The 't' test value for experimental group is 9.4 and the critical value is 2.08, which states that there is significant effect of inspiratory muscle training in improving pulmonary functions by using incentive spirometry.

v) PEAK FLOW METER

The calculated 't' value between the pretest and post test values by paired 't' test is 18.6. The table 't' value for 21 degrees of freedom at 5% level of significance is 2.08 . As the calculated 't' value is

greater than the table value, alternate hypothesis is accepted.

DISCUSSION

Respiratory muscles must overcome principally resistive and elastic loads than inertial loads. They must contract regularly without prolonged rest for whole of our lives. Failure of the muscles to generate the required force results in respiratory failure.

Respiratory failure, pneumonia and atelectasis are the most common pulmonary complications which leads to death and morbidity in spinal cord injury patients. In order to decrease the morbidity and mortality due to respiratory complications, this study was conducted in 25 patients of upper thoracic spinal cord injuries, and were given a period of training of 30 days. Three patients are not able to continue their treatment. The patients are tested in both pre training and post training. The results were analyzed using paired 't' test. It was found that there is a increase in chest expansion levels.

Weight training:- it can be given by Inspiratory muscle training improves the muscle strength and there by improves pulmonary function. So the combined effect of incentive spirometry, Active Cycle of Breathing Technique, Diaphragmatic breathing exercises and weight training plays, a very important role in improving the pulmonary functions in upper thoracic spinal cord injuries.

SUMMARY AND CONCLUSION

Respiratory complications are the most common in upper thoracic spinal cord injuries when compared to Lower thoracic spinal cord injuries. Chest physiotherapy plays an important role in reducing the complications.

In order to find the effect of inspiratory muscle training in upper thoracic spinal cord injuries, this study was conducted with an experimental group consisting of 25 patients. They were treated with diaphragmatic breathing exercises, incentive spirometry, Active Cycle of Breathing technique and weight training.

The statistical analysis by paired 't' test concluded that there was significant changes in the patients treated with the above techniques Based on the obtained results it can be concluded that the combined effect of incentive spriometry, diaphragmatic breathing exercises, and Active Cycle of Breathing technique is more effective in improving the pulmonary functions in upper thoracic spinal cord injuries.

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