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DIFFERENT TYPES OF INSPIRATORY MUSCLE TRAINING PROVIDES BETTERMENT IN ALTERED PULMONARY FUNCTIONS IN UPPER THORACIC SPINAL CORD INJURIES

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ABSTRACT

Background: Respiratory problems are usual in upper thoracic spinal cord injuries when compared to Lower thoracic spinal cord injuries. Generally there are frequent respiratory complications in the individuals with spinal cord injuries. The complications of the respiratory system are severe and more prevalent source of morbidity and mortality after the spinal cord injury due to the inefficient breathing capacity including inspiratory and expiratory abilities. The present study represents the inspiratory muscle training especially in upper thoracic spinal cord injury patients to assess the improvement in the pulmonary functions.

Methods: Twenty five patients with the age between 25 -40 years with the upper spinal cord injuries were selected in the present study in order to assess the efficacy of the training. Several types of exercises were practiced including diaphragmatic breathing exercises, incentive spirometry, active cycle of breathing technique and weight training. COPD Conditions, Chest wall deformities, Hypertensive patients, Cardio vascular problems were excluded in the study.

Results: The results from the study showed that significant changes were found in the patients treated with all the above mentioned techniques. Axillary level, nipple level, Xiphisternum levels were analysed and the results found to be significant after the treatment. Incentive spirometry and peak flow meter observations were also found to be significant when compare to the pretreatment.

Conclusion: The present study conclude 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 than single method efficiency.

Keywords: Muscle training, spinal cord, pulmonary, injury, breathing exercise, Xiphisternum.

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INTRODUCTION

Respiration exchanges air in blood around the lungs, which is the core of the ventilation system. It is controlled by the respiratory muscles and neurological regulation [1]. A healthy respiratory system normally depends upon the combined activity of numerous nerves and muscles to generate power to breathe. The respiratory system also performs the critical functions of supplying oxygen to and removing carbon dioxide from the body[2]. 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[3]. Inability to breath mostly depends on the levels of lesions after spinal cord injury ventilator dysfunctions. The complications of the respiratory system are severe and more prevalent source of morbidity and mortality after the spinal cord injury due to the inefficient breathing capacity including inspiratory and expiratory abilities[4].

Respiratory care is one of the important factors which are to be initiated soon after spinal cord injury and continued throughout acute and post-acute rehabilitation[5]. The process of weaning from ventilator is rapid if the respiratory program includes inspiratory muscle training.

Inspiratory resistive training represents the simple imposition of additional workloads on the inspiratory muscle during breathing. Incentive spirometer provides immediate visual feedback regarding achievement of preset goals while they perform sustained maximal inspiratory maneuvers[6]. The visual input encourages the patient to continue to use the unit and to work toward increasing their maximal inspiratory effort.

The study is focused in evaluating the enhancement of pulmonary function through training of inspiratory muscle in spinal cord injury at upper thoracic level patients. Motor cycle accidents (47.7%) are the major cause for spinal cord injury, falling objects (20.8%), sports (14.2%), acts of violence (14.6%). Remaining 14.6% of spinal cord injuries come from variety of causes. Most injuries of the vertebral column involve either a single level or a limited number of contiguous vertebrae[7]. Multiple, non-contiguous, vertebral injuries are associated with injuries of the upper and middle thoracic spine. Laboratory studies have demonstrated that forces applied in different directions lead to distinct patterns of bony and ligamentous damages[8].

Among them, the most frequent complication is respiratory complication in persons with spinal cord injuries. It contributes in significant amount of associated morbidity, and economic burdens. Neurological deficit types, spinal levels and also the duration of injury are the main factors determining the degree of respiratory compromise[9]. The recent study shows with any spinal cord injury patient 50-67% are complicated with respiratory infections. The occurrence of pulmonary complication is 70% in patients with thoracic levels of injury 16% in patients with cervical levels of injury.

There are only 37% of patients with cervical or thoracic levels of injury complained with atelectasis. In 1993-1997 a recent study was conducted by Winslow C et al., in that out of 413 patients 49 patients had an episode of pneumonia[10].

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.

METHODS

STUDY DESIGN

Pre-test and post-test experimental design was chosen. Purposive sampling method was selected in this study. The sample population in this study was 25 patients aged between 25 to 40 years old both male and female with upper thoracic spinal cord injuries. The inclusive criteria includes the level is T1-T4 and complete type with No motor or sensory functions is preserved in the sacral segments S_4 to S_5. The duration is Phase II When the patient is able to sit out of the bed with the help of brace. The exclusive criteria are COPD Conditions, Chest wall deformities, Hypertensive patients, Cardio vascular problems.

Four different types of methods used in this study. They are

i) Diaphragmatic breathing exercises
ii) Incentive spirometry.
iii) Active cycle of breathing.
iv) Inspiratory muscle training.

DIAPHRAGMATIC BREATHING EXERCISE

The patient should be in a relaxed and comfortable position. Therapist hand is placed on the upper abdomen just below the sternum. Patient is asked to take breathe in through nose with slowly and deeply with relaxed shoulders and ask the patient to hold for 3-5 seconds. Then the patient is asked to breathe out slowly through the mouth. Now ask the patient to place his or her own hand on the upper abdomen just below the sternum and asked to feel the movement. The patient is advised that the placed hand should synchronize with movement of abdomen.

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

INCENTIVE SPIROMETER

The patient is 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. Place the incentive spirometer in mouth and ask the patient to maximally inhale through the spirometer and hold it for few seconds (Figure:1).

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

ACTIVE CYCLE OF BREATHING TECHNIQUE

This technique involves three phases repeated in cycles. Controlled breathing, thoracic expansion exercise and

forced expiratory technique (FET), 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.

TREATMENT

ACTIVE CYCLE OF BREATHING TECHNIQUE CONTROLLED BREATHING

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 was 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 was asked to keep the mouth open, ('O' shaped to keep glottis open). The patient was asked to expire forcefully by contracting his abdominals.

The patient must pause for breathing control after one or two huffs.

Sessions - 3 sessions per day
Repetitions - 5 repetitions per session

INSPIRATORY MUSCLE TRAINING

Position of the patient-supine

i) A small weight (Sandbag) is placed over the epigastric region (Fig.2a).

ii) The patient is asked to inspire through nose and expire through mouth and simultaneously try to raise the weight during inspiration (Fig.2b, 2c).

iii) The weight is increased gradually with the patient can withhold the diaphragmatic breathing pattern without using the accessory muscles of inspiration for 15 minutes.

iv) De Lorme and Watkins[11]

- ❖ 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

A period of one month is taken for this study.

INCENTIVE SPIROMETRY

Figure 1: Breathing with incentive spirometer

Figure 2 (b) : Inspiratory muscle training (inspire through nose)

Figure 2 (c) : Inspiratory Muscle Training (expiration through mouth)

Figure: 2 (a) Inspriratory muscle training, (Sandbag) is placed over the epigastric region

MEASUREMENT TOOL

1. INCH TAPE-CHEST EXPANSION

Axillary level

Nipple level

Xiphisternal level

2. INCENTIVE SPIROMETER

3. PEAK FLOW METER

Data analysis: The analysis of the data in the current study done by two related paired t –test between the variables

RESULTS

The results of chest expansion and incentive spirometry and peak flow meter have been shown in the table 1.0 and 1.1 respectively.

Chest Expansion

i) Axillary level

The calculated 't' value between the pretest and posttest 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' 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 was rejected. The results are formulated in table 1.0

iii) Xiphisternum level

The't' value calculated between pretest and posttest 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' value is greater than table value, the null hypothesis is rejected. The results are formulated in table 1.0

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. The results are formulated in table 1.1

v) Peak flow meter

The calculated 't' value between the pretest and posttest 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. The results are formulated in table 1.1

Table 1.0: 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.	

Table 1.1: 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	

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 forces results in respiratory failure.

Pneumonia, respiratory failure and atelectasis are the very common pulmonary complications which lead to mortality and morbidity following spinal cord injuries [12, 13]. 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 were tested in both pre training and post training and were found that there is an increase in chest expansion at axillary level, nipple level, and xiphisternum levels. This increase is due to the diaphragmatic breathing exercises. It also improves ventilation and increases the effectiveness of the cough mechanism[14]. It was found to improve the strength, endurance and co-ordination of respiratory muscles and also improve the chest and thoracic spine mobility. It was found to promote relaxation and improves overall functional capacity. Incentive Spirometry provides visual feedback and increases the volume of air inspired and is used to prevent the alveolar collapse [15]. It also strengthens the weak inspiratory muscle. Active Cycle of breathing technique helps to maintain stability of oxygen saturation. It also helps to avoid prolonged retention of secretions even in patients who produce little sputum. The cost of using this technique for the long term is minimal. It helps to manage airway clearance independently. Inspiratory muscle training improves the muscle strength and there by improves pulmonary function. 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.

CONCLUSION

Complications of respiratory system are the very common complication in upper level thoracic spinal cord injuries when compared to Lower level thoracic spinal cord injuries. Chest physiotherapy plays a vital 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 concluded that there were 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 spirometry, diaphragmatic breathing exercises, and Active Cycle of Breathing techniques are more effective in improving the pulmonary functions in upper thoracic spinal cord injuries.

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