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Effects of Respiratory Proprioceptive Neuromuscular Facilitation on Respiratory Parameters in Craniotomy Patients: A Quasi-Experimental Study

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ABSTRACT

Background: A craniotomy is a surgical technique in which the brain and surrounding tissues are momentarily exposed by creating an incision in the skull bone. This reduces the risk of brain herniation and aids in decreasing intracranial pressure. Numerous post-operative respiratory problems, including elevated respiratory rate, decreased chest expansion, tidal volume, and vital capacity, can arise from craniotomies. Respiratory Proprioceptive Neuromuscular Facilitation (PNF) is used as a facilitator stimulus to elicit reflux respiratory movement responses that seem to change the depth and rate of breathing. The goal of the current study is to determine how respiratory proprioceptive neuromuscular facilitation, when combined with standard physiotherapy, affects individuals who have had craniotomies.
Materials and Methodology: A Quasi-Experimental study was carried out on 20 participants with craniotomy surgery according to the inclusive and exclusive criteria. Examination of the vitals, Rancho Los Amigos (RLA) stage and chest expansion was done before and after the application of the Respiratory Proprioceptive Neuromuscular Facilitation (PNF). The intervention was implemented for 14 days along with conventional physical therapy. The collected data was analysed through student's paired t-test.
Results: The Statistical Package for Social Sciences, Version 24.0 (SPSS 24.0) was used to analyse the data. According to the analysed data 2nd and 4th Intercoastal Spaces have shown significant difference according to the paired t-test with a p-value <0.001. The Rancho Los Amigos report less significant changes with a p-value of 0.002.
Conclusion: This study concludes that Respiratory Proprioceptive Neuromuscular Facilitation (PNF) techniques demonstrated highly significant improvement in chest expansion and less significant in Rancho Los Amigos (RLA) Stages in craniotomy patients.

Keywords: Craniotomy, Respiratory PNF, Intercostal Stretch, Posterior Basal Lift, Rehabilitation, Respiratory Physiotherapy.

INTRODUCTION

An intracranial operation is carried out during a craniotomy, a surgical procedure in which an opening is made into the skull bone temporarily to expose the brain and the surrounding tissues.[1] In this surgical procedure, a portion of the skull is taken out to create a surgical window which

provides direct access to the brain. More space is created for the brain edema by opening the dura mater, the membrane that covers the brain, which releases the enlarged brain tissue from the confines of the inflexible skull. As a result, this lowers intracranial pressure and lessens the possibility of brain herniation, which subsequently raises the patient's chances of surviving and produces better neurological results.[2,3]

Anesthesia inductions during craniotomy reduces thoracic ventilatory excursion which takes place due to progressive failure of the intercostal muscles. In addition to this, there is reduction in functional residual capacity, expiratory reserve volume, total lung capacity, and lung compliance.[4] Furthermore, the reduction in the tidal volume and increase in the respiratory rate is observed.[5] Intraoperative tachycardia and hypertension are independent predictors for poor outcomes and had increased post-operative mortality and morbidity prolonging the hospital stay. Intraoperative tachycardia was discovered as a distinct risk factor for post operative respiratory complications development.[6] Post-operative nausea/vomiting could be associated with electrolyte and fluid imbalances, increased intracranial pressure, and pulmonary aspiration as a result of hypoactive airway reflexes during the recovery phase.[7]

Physiotherapy management in craniotomy patients following Traumatic brain injury include Muscle tone management, strengthening, retraining functional motor tasks, promotion of physical activities, balance and co-ordination training, gait training, bowel and bladder management and respiratory management. Respiratory management include Breathing Exercises, Manually Assisted Cough Technique, Inspiratory muscle training and Respiratory Proprioceptive Neuromuscular Facilitation. [8,9]

Proprioceptive neuromuscular facilitation is a technique in which muscle passively stretches and contracts alternatively. The method works on nerve receptors of muscles to extend through its length.[10] Respiratory Proprioceptive Neuromuscular Facilitation (PNF) is used as a facilitator stimulus to elicit reflux respiratory movement responses. It improves hemodynamic and compliance characteristics by changing the depth and rate of breathing. PNF methods involve the application of proprioceptive and tactile stimuli externally, which result in reflexive respiratory movement responses that seem to change the depth and rate of breathing.[11]

An intercostal stretch is carried out by exerting pressure on the upper border of a rib to stretch the intercostal muscle in downward direction. The stretch is maintained while the patient breathes. It can be performed unilaterally or bilaterally. The region beneath and surrounding the stretch has a progressive rise in respiratory movements in response to this stimulus. Applying this technique to regions with reduced mobility seems to help restore respiratory movement patterns.[12]

While performing posterior basal lift, the patient is in a supine position, and the hands are placed beneath their ribs posteriorly and gently lifted upwards. In addition to maintaining pressure and stretch posteriorly, the lift also maintains a stretch anteriorly. In case of a lean patient, this could be done bilaterally simultaneously. If this isn't feasible or essential, it can be applied unilaterally. It is possible to observe and feel the ribs expanding more laterally and posteriorly as the lift stretch is maintained. Moreover, increased epigastric motions frequently become apparent.[12]

Muscle strength can be increased with proprioceptive neuromuscular facilitation (PNF). It gives the respiratory muscles proprioceptive feedback, which triggers reflex respiratory movement responses and enhances rate and depth of breathing. Stretch reflex works to aid with the repeated contractions and the initiation of inhalation utilized to increase the volume inspired.[13]

Craniotomy may result into various post operative respiratory complications such as increased respiratory rate, reduced chest

expansion, tidal volume and vital capacity. As anaesthesia depresses the respiratory centre during any surgery therefore respiratory monitoring and care becomes vital in post operative period. To address this critical need, the present study aims to investigate the impact of Respiratory proprioceptive neuromuscular facilitation with traditional physiotherapy in craniotomy patients. The primary objective is to assess the effect of this intervention on key parameters, including vital signs, Rancho Los Amigos (RLA) stage, and chest expansion.

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MATERIALS & METHODS

Participants: This study included 20 individuals, both male and female, who had craniotomy surgery. The inclusion and exclusion criteria were followed in the screening and selection of participants. This study included participants who had undergone craniotomy surgery and were between the ages of 22 and 60. The study eliminated participants with unstable vital signs, spinal deformity, recent myocardial infarction, chest pain, and GCS < 9.

Procedure: An approval from ethical committee DYPCPT/ISEC/81/22023 was acquired. 20 individuals were chosen based on inclusion and exclusion criteria. Consent from the participant's family members was acquired for this study. Data was extracted from Dr. D. Y. Patil Hospital and Research Centre, Pimpri, Pune. Written informed consent was given by each participant who opted to take part in the research. Prior to the application of respiratory proprioceptive neuromuscular facilitation, baseline outcomes were assessed. The 14-day application of respiratory PNF along with traditional physical therapy was carried out. Vitals, RLA, and chest expansion measurements taken after the intervention were documented. Comprehensive documentation and data analysis comparing the significant changes that occurred before and after the intervention was done.

IMAGE 1: INTERCOSTAL STRETCH

IMAGE 2: POSTERIOR BASAL LIFT

An intercostal stretch is carried out by exerting pressure on the upper border of a rib to stretch the intercostal muscle in downward direction. The stretch is maintained while the participant breathes. It

can be performed unilaterally or bilaterally. [15]

Posterior basal lift is performed while the participant is in a supine position, and the hands are placed beneath their ribs posteriorly and gently lifted upwards. [15]

Outcome measures: The outcome measures include Monitoring Vital Signs (Heart Rate, Blood Pressure, SpO2, Respiratory Rate), assessing Chest Expansion, and evaluating the Rancho Los Amigos Scale (RLA) Stage.

RESULT

The Statistical Package for Social Sciences, Version 24.0 (SPSS 24.0), was used to analyse the data of 20 participants to evaluate the mean, standard deviation, standard error mean, and to determine the p value. The student's paired t-test was used for the within group analysis.

Paired Samples Statistics					
		Mean	Std. Deviation	Std. Error Mean	P Value
HR	Pre	85.8	12.9	2.9	0.148
	Post	82.6	8.6	1.9	
Systolic BP	Pre	121.9	6.9	1.5	0.098
	Post	120.0	5.8	1.3	
Diastolic BP	Pre	83.9	10.2	2.3	0.186
	Post	82.4	8.0	1.8	
SpO_2	Pre	97.3	1.8	0.4	0.012
	Post	98.1	0.8	0.2	
Respiratory rate	Pre	19.4	2.3	0.5	0.169
	Post	18.7	1.7	0.4	
RLA scale	Pre	6.0	1.9	0.4	0.002
	Post	6.5	1.7	0.4	
CE 2nd ICS	Pre	2.1	0.9	0.2	<0.001
	Post	2.9	0.9	0.2	
CE 4th ICS	Pre	2.4	0.7	0.2	<0.001
	Post	2.9	0.9	0.2	
CE xiphoid process	Pre	2.2	0.7	0.2	0.005
	Post	2.5	0.8	0.2	

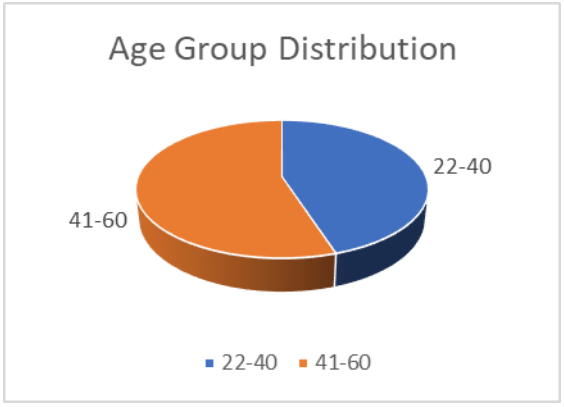

Figure 1: Age Group Distribution of Participants

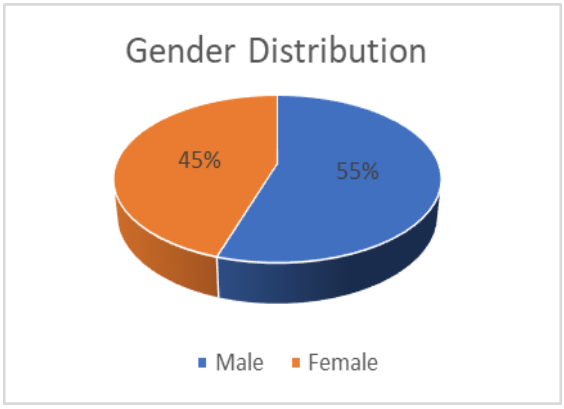

Figure 2: Gender Distribution of Participants

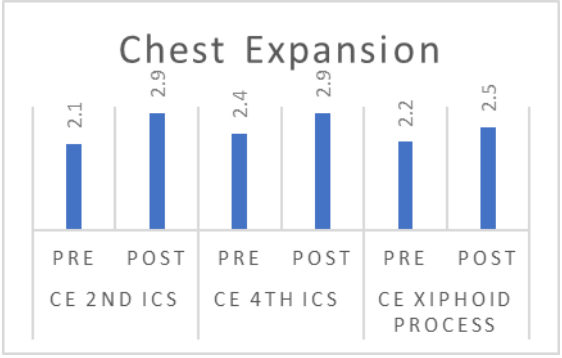

Figure 3: Comparison of Chest Expansion

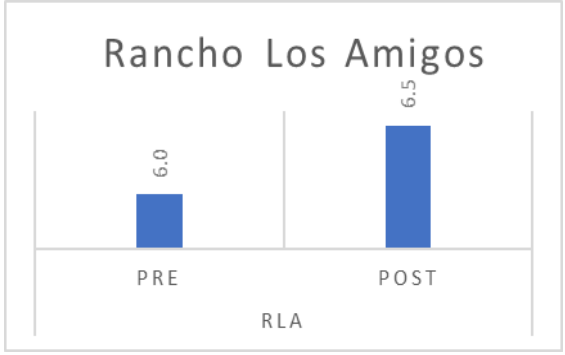

Figure 4: Comparison of Rancho Los Amigos

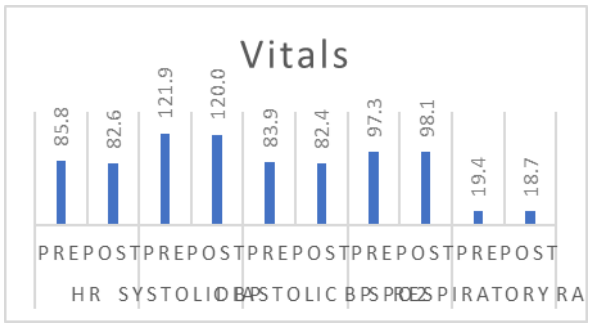

Figure 5: Vitals Pre and Post Treatment

Figure 1: The findings show that the patients mean age, ranging from 22 to 60, is 41. The research population's age distribution was designed to include 45% of patients between the ages of 22 and 40 and around 55% of patients between the ages of 41 and 60. These data show that age groups over 40 encounter a greater number of craniotomies performed.

Figure 2: A descriptive and schematic representation of gender wise distribution among the study population. As per the collected data the proportion of males were higher than females.

Figure 3: Demonstrates the chest expansion at various levels. 2nd and 4th Intercoastal Spaces have shown significant difference according to the paired t-test with a p-value <0.001. The chest expansion at xiphoid process reports lesser difference with a p-value of 0.005.

Figure 4: Represents comparison of Rancho Los Amigos (RLA) Stage in Craniotomy Patients pre and post application of the intercoastal Stretch and Posterior Basal Lift. The p-value obtained was 0.002 which tend to be of less statistical significance.

Figure 5: Depicts comparison of the vitals. The p-value calculated through paired t-test indicates non- significant changes between the pre and post vitals.

DISCUSSION

This study aimed to evaluate the effect of Respiratory Proprioceptive Neuromuscular Facilitation on respiratory parameters in patients who underwent craniotomy surgery. Physiological parameters such as vitals, RLA, and chest expansion were evaluated to understand the effects of the intervention. The results of the intervention have shown an increase in chest expansion. Although the analysis does not show significant changes in vitals. Limitations of the study, including sample size and time period involved, should be acknowledged. Selected individuals were based on inclusion criteria.

The objectives of the study were to find the effects of Respiratory Proprioceptive Neuromuscular Facilitation in craniotomy patients pre and post intervention while assessing Chest expansion and Rancho Los Amigos. In this study 20 participants were included after screening inclusive and exclusive criteria. There was significant increase in chest expansion and RLA stage thus our first alternative hypothesis was supported. The significant results were obtained through paired t-test. By comparing the pre and post outcome measures significant increase in chest expansion and RLA stages.

The stretch reflex facilitates repeated contractions as well as the inhalation of an increased volume during inspiration. The primary respiratory muscles receive proprioceptive stimulation from chest PNF, which improves chest wall movement. The inhibition of the rigid muscles of the chest wall may be obtained through autogenic inhibition, allowing the chest wall to become more compliant. The mobility of the chest wall is also enhanced through relaxation of the muscles.[13]

Intercostal stretch: The corresponding muscle is stretched to increase the respiratory excursion in the area under the stretch, which widens the intercostal space.

Muscle contraction that occurs after muscle spindle activation is enhanced by reflex neuronal activity.[14]

Posterior Basal Lift: This allows the ribs to extend in a "bucket and pump handle" manner. Reflex inspiratory activity is produced on the thorax by excitatory skin fields. It is thought that the inspiratory motor neurons were larger than those for expiratory neurons, indicating that tactile stimulus can induce inspiration. These areas may be recruited by direct cutaneous stimulation. This method may result in the activation of the muscle spindle. A larger tidal volume is facilitated by an increase in the thoracic and abdominal excursion. The mechanism of this technique is explained by segmental proprioceptive regulation of respiration. Phrenic motor neurons may be under reflex control when proprioceptors in the lower intercostal and spinal muscles are stimulated.[14]

Post-craniotomy chest expansion reduces as the chest wall's mobility and lung compliance diminish. Intercostal stretching promotes chest expansion, which will increase the lung's intra-thoracic volume. The electrical release of the muscle spindle during a passive stretch could be the cause of the change in breathing characteristics. The thorax may have been stretched as a result of intercostal stretching activating the stretch receptor in the chest wall, which may have resulted in a neurological connection between the medulla and efferent nerve cells. The benefit of using the PNF approach is that it lowers RR by reducing work of breathing and enhancing lung compliance.[15]

According to this study, Intercoastal Stretch and Posterior Basal Lift improves chest expansion. Level of consciousness which is assessed by Rancho Los Amigos Scale in Craniotomy Patients.

CONCLUSION

This study concludes that Respiratory Proprioceptive Neuromuscular Facilitation (PNF) techniques demonstrated highly significant improvement in chest expansion and less significant in Rancho Los Amigos (RLA) Stages in craniotomy patients. The respiratory PNF technique has proven to be quite effective for patients receiving inpatient craniotomy rehabilitation. Healthcare professionals should consider integrating Respiratory PNF into post-operative care to enhance rehabilitation and improve patient outcomes.

Declaration by Authors

Ethical Approval: Approved

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