International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Immediate Effect of Thoracic Thrust on Diaphragmatic Excursion in Subjects with Forward Head Posture - A Pre-Test and Post-Test Experimental Design

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Abstract: ***Background and Objectives: Forward head posture (FHP) is a postural dysfunction caused by anterior translation of the head leading to an increase in craniovertebral angle caused by a narrowed lower chest and expanded upper chest which limits the diaphragmatic excursion. FHP occurs as a compensatory mechanism to improve respiratory functions or to change the thorax morphologically (i. e., kyphotic posture). FHP mechanical effects on the diaphragm and chest wall result in diminished thoracic compliance and impaired diaphragmatic excursion. Thoracic spine manipulation releases chest wall restriction the mechanical changes in the lungs were reversed via a hysteresis-like pathway. Thus, any abnormality that affects the muscle of respiration or rib biomechanics will have an effect on the optimal functioning of the lungs. Methodology: 40 subjects with forward head posture aged between 20-40years were selected. A single group pre-test and post-test experimental study design was used to examine thoracic spine thrust manipulation effects on chest expansion and lung function in healthy subjects. Ethical approval was granted by Manipal Hospitals private limited, Yeshwanthpur, Bangalore, Karnataka, India. Subjects with forward head posture was assessed and diaphragmatic excursion was measured before and after thoracic thrust. Differences between pre and post thrust was assessed and statistical tool was used for the statistical analysis. Results: The result shows that there is a significant difference between pre-thrust and post-thrust with p<0.000. As the sig. (2-tailed) value is 0.00 which is less than 0.05, the result is interpreted as significant. Hence, the null hypothesis is rejected. Conclusion: The present study concludes there was significant immediate difference in diaphragmatic excursion between pre and post thoracic thrust. Hence, this study concludes that thoracic thrust can improve diaphragmatic excursion in subject with forward head posture.***

Keywords: Thoracic spinal manipulation, thoracic thrust, diaphragmatic excursion, forward head posture

1. Introduction

Forward head posture (FHP) is a postural dysfunction caused due to anterior translation of head leading to increase in craniovertebral angle [1]. This could be caused by narrowed lower chest and expanded upper chest which limits the diaphragmatic excursion. [2], or a biomechanical disturbance in thoracic cage with compromised lower ribs movements during respiration. [3]. FHP occurs as a compensatory mechanism to improve the respiratory functions [4], or to change the thorax morphologically (i. e., kyphotic posture) [5]. In normal breathing, the diaphragmatic contraction forces the stomach downward and forward, and the contraction of external intercostal muscles pull the ribs in upward and forward direction. Due to forward head posture, the diaphragm compressed and compromised in its function. This inhibits the action of the diaphragm muscle. FHP mechanical effects on diaphragm and chest wall result in diminished thoracic compliance and impaired diaphragmatic excursion. Due to the restricted rib and diaphragmatic mobility caused by these structural changes in the thoracic and abdominal regions, the respiratory system's dynamics are altered and its compliance is decreased, which results in mechanical impairment of the respiratory muscle. The main respiratory

muscle, the diaphragm, contributes up to 70% of resting ventilation. [6] The diaphragmatic excursion has a positive correlation with respiratory function [7].

The craniovertebral angle (CV angle) measurement is a convenient and easy clinical method for the cervical posture assessment. "Markus Bader (MB) ruler software" assists to measure angles and distances on the computer screen. The MB ruler protractor is almost transparent; hence, it can be easily used on the computer screen. Many studies in physiotherapy have used this software for postural assessment with the photographic method, as MB ruler demonstrates high intra-rater and inter-rater reliabilities. [8]

Diaphragmatic excursion is the movement of the thoracic diaphragm during breathing. Normal diaphragmatic excursion should be 3–5 cm, but can be increased in well-conditioned persons to 7–8 cm. This measures the contraction of the diaphragm. It is performed by asking the patient to exhale and hold it. [9] Effect of diaphragmatic stretching techniques; these techniques work by relaxing the diaphragm in its resting condition and enhancing its ability to contract and relax, which increases the pressure gradient between the thorax and abdomen. Stretching results in an activation of the muscle spindle, which boosts sensory afferent stimulation, boosts neuromotor response, and ultimately increases muscular tension and viscoelasticity while reducing muscle stiffness. [10]

The Guide to Physical Therapist Practice "mobilization/ manipulation" as "skilled passive movements to joints and related soft tissue that are applied at varying speeds and amplitudes including small-amplitude/ high therapeutic movements" and produced popping or crack sound characterized by cavitations in the thoracic spine with the aim of restoration of joint mobility. [11] Thoracic spine manipulation (TSM) is defined as a high-velocity low amplitude movement or "thrust" directed of the thoracic spine on circumference measurements of chest expansion and lung function in healthy subjects. [12] The release of chest wall restriction the mechanical changes in the lungs were reversed via a hysteresis like pathway. Thus, any abnormality that affects the muscle of respiration or rib biomechanics will have an effect on the optimal functioning of the lungs and respiratory system as a whole. [13]

In this study, a simple and inexpensive technique for measurement is to use a tape measure. This manoeuvre, during maximal inspiration and expiration the circumference around the thorax is measured at specific measurement were evaluated at two sites corresponding to the middle chest wall (4th Intercostals Space) and lower chest wall (Xiphoid Process). The purpose of this study was to determine the immediate effect of thoracic spine thrust manipulation on diaphragmatic excursion in subjects with forward head posture.

2. Materials and Methodology

A single group pre-test and post-test experimental study design was used to examine thoracic spine thrust manipulation effects on chest expansion and lung function in healthy subjects. Ethical approval was granted by Manipal Hospitals private limited, Yeshwanthpur, Bangalore, Karnataka, India.

Subjects: The medically healthy 40 male participants aged 20 – 40 years meeting the research criteria were accepted into the study from 07 July 2023. Exclusion criteria were a previous history of rib fractures, dislocations, sprains of costochondral, costosternal, and interchondral joints. Spinal deformity, kyphoscoliosis. spine pain, taking pain medications, any serious spinal pathology, surgery, infections, rheumatic disorders, acute fractures, osteoporosis, ankylosing spondylitis, tumours, history of cancer or metastatic disease of the thoracic spine. Previous history of myocardial infarction, pregnancy, and uncooperative participants. Smokers were excluded from the study. Before starting the session pre- intervention baseline assessment reading was taken and recorded as pre-test data. Pre-intervention baseline assessment on chest expansion at the 4th intercostal space and the xiphoid process was taken by outcome measure inch tape in centimetres (cm). [14]

Method: The posture of subjects was assessed and measured in supine, sitting and standing position. Subjects was asked to breathe normally, keeping full body relaxed, head and neck in the normal anatomical position. The degree of forward head posture was measured, and noted. Pre thrust diaphragmatic excursion was measured in centimetres using inch tape. Then, Subject was advised to be relax and take deep breathing. Thoracic thrust was given in supine position and Post Thrust Diaphragmatic excursion was measured and noted. The statical differences was noted from pre and post thrust data and Statistical tool was applied for statistical analysis.

Figure: Measuring Diaphragmatic Excursion & Thoracic Thrust

3. Data Analysis and Interpretation

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-thrust	2.2875	40	.54968	.08691
	Post-thrust	4.1575	40	1.28799	.20365

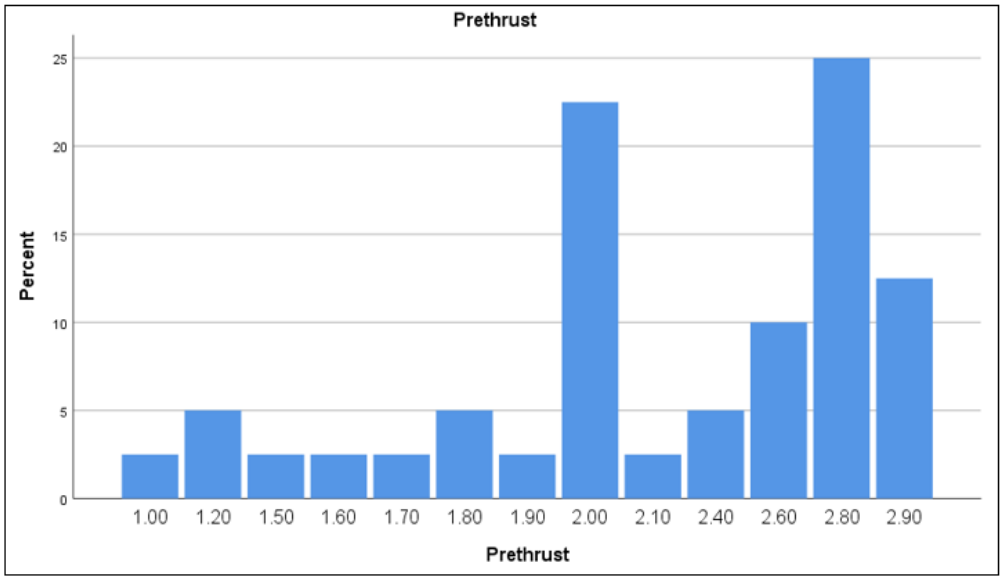
Frequency and Percentage:

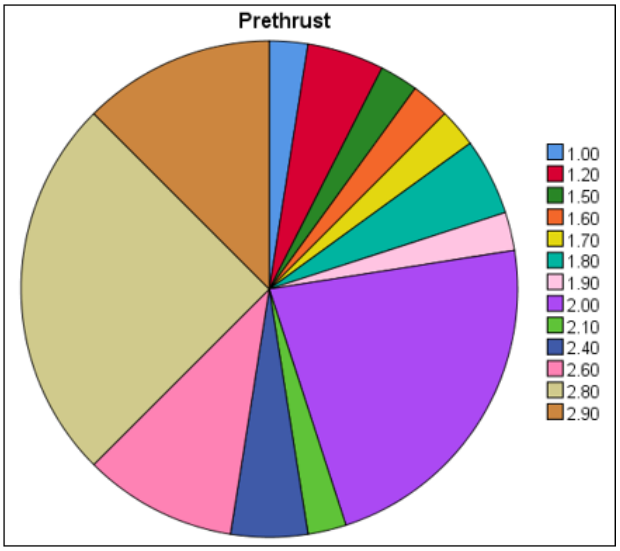
Prethrust					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	1	2.5	2.5	2.5
	1.20	2	5.0	5.0	7.5
	1.50	1	2.5	2.5	10.0
	1.60	1	2.5	2.5	12.5
	1.70	1	2.5	2.5	15.0
	1.80	2	5.0	5.0	20.0
	1.90	1	2.5	2.5	22.5
	2.00	9	22.5	22.5	45.0
	2.10	1	2.5	2.5	47.5
	2.40	2	5.0	5.0	52.5
	2.60	4	10.0	10.0	62.5
	2.80	10	25.0	25.0	87.5
	2.90	5	12.5	12.5	100.0
	Total	40	100.0	100.0	

Postthrust					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.50	1	2.5	2.5	2.5
	2.00	3	7.5	7.5	10.0
	2.40	1	2.5	2.5	12.5
	2.80	2	5.0	5.0	17.5
	3.00	1	2.5	2.5	20.0
	3.20	1	2.5	2.5	22.5
	3.40	2	5.0	5.0	27.5
	3.50	3	7.5	7.5	35.0
	3.60	2	5.0	5.0	40.0
	3.80	1	2.5	2.5	42.5
	4.00	3	7.5	7.5	50.0
	4.20	3	7.5	7.5	57.5
	4.40	1	2.5	2.5	60.0
	4.50	1	2.5	2.5	62.5
	4.80	2	5.0	5.0	67.5
	5.00	3	7.5	7.5	75.0
	5.20	1	2.5	2.5	77.5
	5.60	1	2.5	2.5	80.0
	5.80	3	7.5	7.5	87.5
	6.00	5	12.5	12.5	100.0
	Total	40	100.0	100.0	

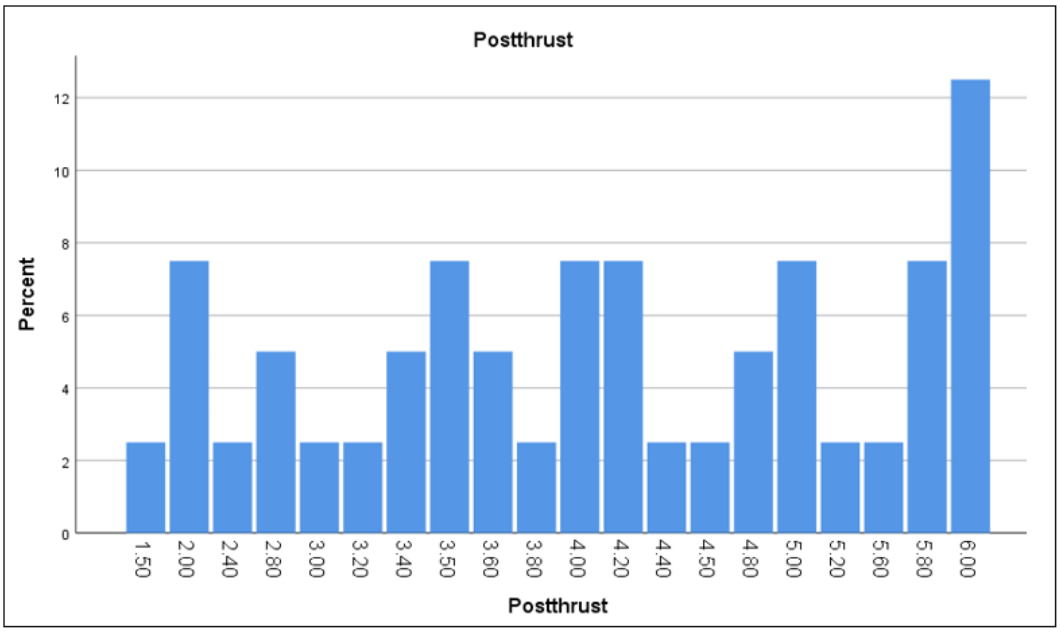
Graphical representation:

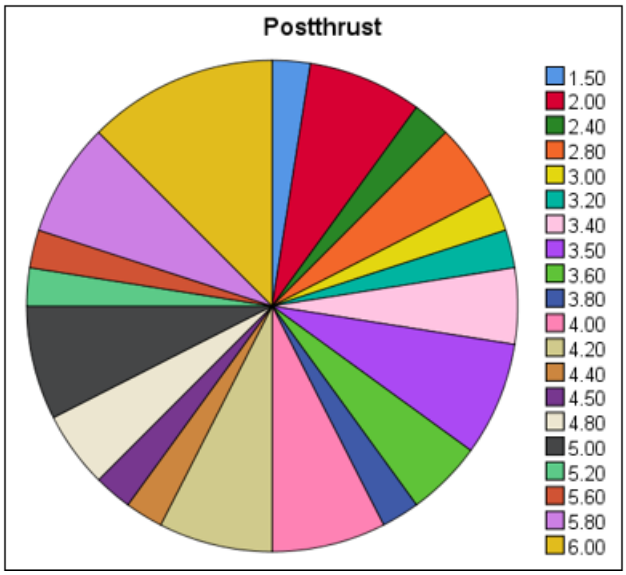
(Pre-thrust)





(Post thrust)





Null hypothesis (H_0): There is no significant difference between pre-thrust and post-thrust.

4. Discussion

There were several studies which concluded that pulmonary function improves after thoracic thrust. The aim of this study was to examine the immediate effect of thoracic thrust on diaphragmatic excursion in subject with forward head posture. We noticed a noticeable increase in diaphragmatic excursion immediately after thoracic post thrust ($p<0.00$). In addition, we found significant improvement in Forward head posture, compared to the pre thrust posture of head of the subjects.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Prethrust – Postthrust	- 1.87000	.89305	.14120	- 2.15561	- 1.58439	- 13.243	39	.000

The sig. (2-tailed) value is 0.00, which is less than 0.05, so the result is interpreted as significant. Hence, the null hypothesis is rejected. The result shows that there is a significant difference between pre-thrust and post-thrust.

A study done by Biplab Maji at al. to see the immediate effect of thoracic spine thrust manipulation on chest expansion and lung function in healthy subjects was found to influence chest expansion significantly and also improved spirometry measures of lung function. [14] Our study also supports a study done by Kaji Nakamaru et al. to see the immediate effects of thoracic spine self-mobilization in patients with mechanical neck pain was showed increases in active cervical flexion and extension ROM of the neck. [15] In our study, the diaphragmatic excursion has improved from 0.4cm to 3.7cm immediately after the thoracic thrust depending upon the subjects' built, degree of forward of the head, and physical activities. There is a relationship between the ideal length and tension in the diaphragm muscle and the diaphragmatic excursion. Even though we didn't assess each variable in this study, we found the reason behind the improvement in the diaphragmatic excursion is due to thrust to the thoracic part may interfere the tension in the diaphragm and thereby increasing the length of muscle, which has led to the increased in diaphragmatic excursion and also the vital capacity of the lung. One more reason there is the stimulation of higher center via spinal level during the thrust and the signal from higher center to the chest muscle to relax from the contracted position. During the Thoracic thrust, subjects need to take deep breathing followed by deep expiration, which has significant effect in the lung volume and capacity. In our study, both diaphragmatic excursion and forward head posture improved with post thoracic thrust, but we didn't find any significant improvement in the normal respiration. This might be due to the recoil of the muscle length and residual volume.

5. Limitation and Future Scope of our Study

Our study has several limitations. Firstly, as we evaluated immediate effect, we were not taken follow-up data. Hence, it is not sure to have the long-term effect after the thoracic thrust. This need to be addressed in the future study and research. Also, our study has age group limitation and gender limitation, so this study can't be the data and reference for the generalised population. Our study didn't have control group, so reason is not very clear for the increased diaphragmatic excursion and future study is needed to evaluate the exact Patho-mechanism by having control group.

6. Conclusion

In this study we found that there was significant immediate difference in diaphragmatic excursion between pre and post thoracic thrust. Also, there was significant improvement in forward head posture. Hence, this study concluded that thoracic thrust can improve diaphragmatic excursion in subject with forward head posture.

Author Disclosures
There was no external funding in the preparation of this manuscript.

Author certifies that he, or a member of his immediate family, has no commercial association (i. e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Compliance with Ethical Standards

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the Manipal Hospital Private Limited,

Yeshwanthpur research committee and with declaration and its later amendments or comparable ethical standards.

Data Availability: The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

Conflicts of Interest

The author certifies that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript and publication of this paper.

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