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Effects of Scapular Stabilization Exercise and Abdominal Muscle Strengthening Exercise On Pain, Craniovertebral Angle and Lumbar Lordotic Angle in Patients with Forward Head Posture Along with Low Back Pain

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Abstract

BACKGROUND: Forward head posture (FHP) occurs when there is an anterior translation of the head, deviating from normal alignment. It is characterized by increased flexion in the lower cervical and upper thoracic spine. Changes in cervical hyperlordosis and thoracic hyperkyphosis can trigger a chain reaction, leading to lumbar hyperlordosis. There is a correlation between forward head posture and low back pain. The present study will focus on the curative aspects of forward head posture as well as low back pain.

AIM: The aim of the study is to find out the effects of scapular stabilization exercise and abdominal muscle strengthening exercise to measure the pain, craniovertebral angle and lumbar lordotic angle in patients with forward head posture along with low back pain.

METHODOLOGY: A one year pre-test and post-test experimental study at K.G. Physiotherapy and Rehabilitation Centre and K.G Hospital, Coimbatore, involved 30 participants aged 25-45 years with forward head posture along with low back pain. Group A underwent scapular stabilization exercise along with pectoralis muscle stretching and Group B underwent abdominal strengthening exercise along with pectoralis muscle stretching for three days a week for six weeks, with treatment sessions of 45 minutes. Pain intensity, craniovertebral angle and lumbar lordotic angle were assessed pre and post intervention using a visual analogue scale, photogrammetry, flexicurve ruler. Respectively statistical analysis included paired and unpaired t-tests.

RESULTS: Both groups showed significant improvements in pain intensity, craniovertebral angle and lumbar lordotic angle from pre to post intervention. Unpaired t- test analysis demonstrated significant between group differences ($p<0.05$) for all post-test measures: pain intensity ($t = 4.04$), craniovertebral angle ($t = 2.99$) and lumbar lordotic angle ($t = 3.58$). Participants in Group B shows greater improvements than Group A.

CONCLUSION: The study concludes that abdominal muscle strengthening exercise combined with pectoralis muscle stretching has marked therapeutic effects than the scapular stabilization exercise combined with pectoralis muscle stretching.

Key Words: Forward head posture, Scapular stabilization exercise, Abdominal muscle strengthening exercise, Pectoralis muscles stretching, Pain, Craniovertebral angle, Lumbar lordotic angle.

1. Introduction

Forward head posture (FHP) occurs when there is an anterior translation of the head, deviating from normal alignment [1]. It is characterized by increased flexion in the lower cervical and upper thoracic spine. This condition is commonly associated with the shortening of muscles such as the sternocleidomastoid, posterior cervical extensors, upper trapezius, and levator scapulae [5, 8]. In the modern era, the extended use of computers and mobile phones has significantly contributed to anterior weight bearing of the cervical spine. This shift alters the biomechanical stress on the spine, resulting in various neck-related musculoskeletal disorders [2].

Studies have shown that approximately 37% of individual's exhibit anterior head translation, with a higher prevalence among women (58%) compared to men (42%) [1, 38]. Teenagers are estimated to use handheld devices for five to seven hours daily, raising concerns about the effects of prolonged screen time on cervical spine strain. Forward head posture is linked to muscular imbalances, discomfort, fatigue, and limited cervical spine mobility. Notably, who flex their neck by at least 20° for more than 70% of the time are at increased risk of developing neck pain [4].

Maintaining the position of various body joint segments in relation to one another at a specific moment is known as posture. When the line of gravity passes through all of the joint axes and the body segments are vertically aligned, this is known as ideal posture. This line of gravity passes slightly in front of the transverse axis in the case of the head and behind the vertebrae in the case of the cervical. Correct posture, which can be greatly influenced by both internal and external factors, is therefore defined as maintaining a position that places the least amount of stress on each joint. Extrinsic factors include things like using a laptop or mobile device, and intrinsic factors include things like ligaments, muscles, and other soft tissues [1].

One common malalignment associated with FHP is rounded shoulders, which occur when the head fails to align with the body's vertical axis [6]. This posture is also linked to changes in scapular and spinal kinematics, increasing the activity of neck and shoulder stabilizer muscles [7]. These postural alterations contribute to the development of upper cross syndrome, a condition with a prevalence ranging from 11% to 60% across different populations and age groups [1, 9].

Changes in cervical hyperlordosis and thoracic hyperkyphosis can trigger a chain reaction, leading to lumbar hyperlordosis. This phenomenon illustrates the body's compensatory mechanisms to maintain a horizontal eye gaze and preserve the line of gravity within the base of support [9, 10]. These compensations require neuromuscular coordination adjustments and often result in postural repositioning, increased thoracic kyphosis leads to shortening of the anterior longitudinal ligament and upper abdominal muscles [11].

The abdominal muscles maintaining trunk stability. It when weakened, trunk stability declines, increasing the risk of low back pain. An unbalanced trunk with weakened abdominal muscles results in

abnormal posture [1]. If the head is positioned too far forward, the pelvis may tilt anteriorly in an effort to maintain the body's center of gravity [13, 2].

Scapular stabilization exercises are designed to engage the shoulder muscles to maintain the scapula in a neutral position on the thoracic cage [14]. These exercises use the muscles surrounding the shoulder joint which connects the upper limb to the trunk to position the scapula between the second and seventh ribs, the ideal neutral point on the chest wall [14, 12, 8].

The abdominal sprinter pattern is a technique that strengthens muscles responsible for body stabilization. It incorporates synchronized arm and leg movements along with abdominal muscle engagement to stabilize the trunk. This movement effectively activates key muscles such as the external oblique, rectus abdominis, and internal oblique [15, 16].

Strong abdominal muscles are essential for individuals prone to back pain or spinal instability. These muscles help broaden the intervertebral foramen, thereby reducing the pressure placed on the facet joints due to hyperlordosis and supporting optimal postural control [15, 17]. While traditional exercises like sit-ups and curl-ups are commonly used to strengthen the abdominal muscles, they may also increase the risk of lower back injuries if not performed with proper technique or spinal support [15].

The sit-up test is easy to perform. And is simple enough to administer in a fair amount of time to large groups. There are several different versions of the test. For instance, some organizations employ a sit-up test with the hands of the participants were folded across the chest. People cup their hands behind their ears in other situations. A 30-second SU test could lead to significantly while the SU lasting 60 or 120 seconds could rely more on the anaerobic lactic system, Oxidative system in contrast to a test with a shorter duration [50].

The Visual Analogue Scale (VAS) is a widely accepted, simple, and effective tool for quantifying pain intensity in both clinical and research settings [30]. It consists of a 10 cm horizontal line anchored with descriptors such as "no pain" and "worst imaginable pain." Patients are asked to mark their current pain level along the line, providing a numerical score based on the distance from the "no pain" anchor [31]. The Visual Analogue Scale has demonstrated strong validity and reliability in musculoskeletal conditions, including low back pain, where pain is often a dominant symptom interfering with function [32].

The craniovertebral angle is measured by drawing a line from the tragus of the ear to the spinous process of the seventh cervical vertebra (C7), relative to the horizontal line [22]. This angle indicates the head's position in relation to the cervical spine. A smaller angle reflects a more forward head posture, while a larger craniovertebral angle suggests the head is more aligned with the vertical plumb line, indicating a more upright posture [21, 23].

The flexicurve is a plastic-covered, flexible metal ruler that can be moulded to the back of an individual to replicate the shape of their spine [25]. It is positioned along the spine's midline contour between two marked points and then transferred onto paper using a pencil to trace the spinal curvature [24]. The flexicurve ruler provides a portable, affordable, and non-invasive method for assessing spinal curvature, making it suitable for use in both clinical settings and general populations [26].

2. Methodology

STUDY DESIGN -Pre-test and Post-test Experimental study design.

STUDY SETTING -The study was conducted at the Outpatient Department of Physiotherapy, KG College and KG Hospital, Coimbatore.

STUDY SAMPLING -Convenient sampling method.

STUDY DURATION -The study was conducted for a period of 1 year

2.1. TREATMENT DURATION -Each participants received treatment for 3 sessions per week for 6 weeks of Intervention.

2.2. SELECTION CRITERIA

INCLUSION CRITERIA

- Forward head posture with low back pain for a symptoms lasting longer than 1 months, Above 5 hours of screen time in a day, Less than 50˚ of CVA angle, Forward head posture Horizontal distance more than 5 cm patients, Age: 35±10 years, Pain score – VAS <6, Grade level of 1-2 in the 7 stage sit-up test.

EXCLUSION CRITERIA

- Scoliosis, All type of tumours, Cardiac pulmonary disorder, Spinal canal stenosis, Osteoporosis, Degenerative disorder, Neurological dysfunction, Recent spinal, upper limb and lower limb fractures, Recent spinal and lumbosacral surgery, Dislocation, Pregnancy, Recent trauma, Class 2 and 3 Obesity, Visual or auditory problems.

2.3. VARIABLES

INDEPENDENT VARIABLES

- Scapular stabilization exercise.
- Abdominal muscle strengthening exercise.
- Pectoralis muscles stretching.

DEPENDENT VARIABLES

- Pain, Craniovertebral angle, Lumbar lordotic angle

2.4. OUTCOME MEASURES

- Pain intensity: Visual Analogue Scale
- Craniovertebral angle: Photogrammetry
- Lumbar lordotic angle: Flexicurve ruler

2.5. MATERIALS

- Dumbbell, Thera band, Photogrammetry device, Flexicurve ruler, White sheet, Marker/ pen.

2.6. PROCEDURE

30 participants with Forward head posture were selected based on the selection Criteria and divided into 2 groups. Visual analogue scale, Craniovertebral angle and Lumbar lordotic angle measurements will be obtained on the 1st day before the treatment and at the end of 6th week.

- Group A–Scapular stabilization exercise with Pectoralis muscle stretching
- Group B–Abdominal muscle strengthening exercise with Pectoralis muscle stretching

2.6.1. BASELINE ASSESSMENT

On Day 1, the following baseline measurements were recorded for all participants:

- Abdominal muscle endurance – measured using the sit-ups test.
- Pain Intensity – measured using the Visual Analogue Scale (VAS).
- Forward Head Posture – assessed by measuring the Craniovertebral Angle (CVA) using lateral photogrammetry.
- Lumbar lordotic curve - assessed by measuring the Lumbar lordotic Angle (CVA) using flexicurve ruler.

2.6.2. SCAPULAR STABILIZATION EXERCISE

The subject in group A received scapular stabilization exercise with Pectoralis muscle stretching.

- The first exercise was for the subject to make a 90° and 120° shoulder abduction in prone position, followed by a thumb pointing up.
- The second exercise was a shoulder horizontal abduction dumbbell exercise with the elbow flexion at 90° in the prone position to strengthen the subject's trapezius, rhomboids and rotator cuff muscles.
- The third exercise was elbow and shoulder extensions using a dumbbell in the prone position to strengthen the subject's lower trapezius and rotator cuff muscles.
- The fourth exercise a side lying posture was taken to improve the cooperation and muscle strength of the participant's trapezius muscle. The dumbbell exercise was then carried out by elbow extension and shoulder flexion.

- The fifth exercise used dumbbell in a side lying position for elbow flexion to 90° and shoulder external rotation and the infraspinatus and teres minor of the subject's rotator cuff muscles.
- The sixth exercise was to hold an elastic band around the back in a standing position to the subject's scapular stabilization, extend the upper arm forward with the elbow extension, and then hold that position for two seconds and release the force slowly.
- The seventh exercise placed a ball between the wall and the scapular in a standing position with an elastic band to improve the balance and posture of the subject's shoulder muscles.

Each exercise was performed for 15 repetitions, with a total treatment duration of 30 minutes. 2-minute rest period was given after each set of exercises.

2.6.3. ABDOMINAL MUSCLE STRENGTHENING EXERCISE

The subject in group B received abdominal muscle strengthening exercise with pectoralis muscle stretching.

- **Sprinter pattern exercise**

The participants lay on their backs with their knees bent at a 45◦ angle and their arms resting beside them on the floor. Upon receiving a given signal, they raised their heads off the mat and simultaneously performed a series of coordinated arm and leg movements: flexing, adducting, and externally rotating one arm, while extending and internally rotating the corresponding leg. Conversely, they extended, abducted, and internally rotated the other arm while flexing, adducting, and externally rotating the opposing leg.

- **Crunch exercise**

The participants lay on their backs with their knees bent at a 45◦ angle and placed their hands behind their heads. When given the start signal, they lifted their heads and shoulders, elevating the inferior angle of the scapular from the mat.

- **Side bridges**

The participants was instructed to be on side lying position with knee extended, the supporting shoulder superior to the respective elbow, the other arm held in akimbo, and the supporting forearm flat on the mat, participant raised their hip until a straight line is reached from the knee up to the shoulder and they continuously raised and lowered their hips at a moderate velocity for both sides.

Each exercise was performed for 15 repetitions, with a total treatment duration of 30 minutes. 3-minute rest period was given after each set of exercises.

2.6.4. PECTORALIS MUSCLE STRETCHING

Position:

- Participant stands or sits upright.
- Shoulder abducted to 90˚and elbow flexed to 90˚.
- Forearm placed against a doorway or wall corner.

Procedure:

- Gently rotate the torso away from the fixed arm until a stretch is felt in the chest region.

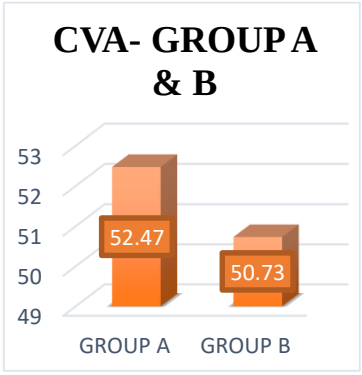
- Maintain neutral cervical spine alignment during the stretch.
- Holding each stretch for 30 seconds followed by a 1-minute relaxation period. The procedure was repeated 10 times.
- Total 15 minutes for treatment duration.

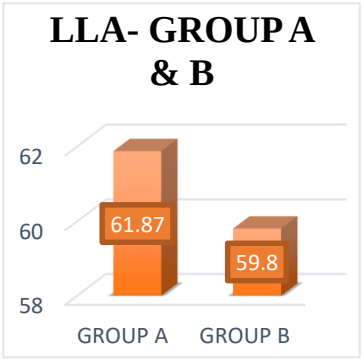
3. Result.

Both the groups shown significant differences in the pre-test and post- test values. The calculated 't' value of visual analogue scale for pain intensity in Group A was 10.46 and the 't' value for the Group B was 17.35.

There was a significant difference shown between the Groups. Subject in Group B shown superior mean difference in visual analogue scale for pain intensity than Group A. The calculated 't' value for the post test variables of both groups was 4.04.

Both the groups shown significant differences in the pre-test and post- test values. The calculated 't' value of craniovertebral angle in Group A was 11.75 and the 't' value for the Group B was 16.14.





There was a significant difference shown between the Groups. Subject in Group A shown superior mean difference in craniovertebral angle than Group B. The calculated 't' value for the post test variables of both groups is 2.99.

Both the groups shown significant differences in the pre-test and post- test values. The calculated 't' value of lumbar lordotic angle in Group A was 11.37 and the't' value for the Group B was 15.32.

There was a significant difference shown between the Groups. Subject in Group B shown superior mean difference in lumbar lordotic angle than Group A. The calculated 't' value for the post test variables of both groups is 3.58.

4. Discussion

The aim of the study is to show the effects of scapular stabilization exercise versus abdominal strengthening exercise on pain, craniovertebral angle and lumbar lordotic angle in forward head posture along with low back pain patients.

Forward head posture and abdominal muscles are directly connected through the myofascial chains, with the spiral line serving as the primary link between the neck and abdominal muscles. When the body remains in an improper position for prolonged periods, certain muscles stay in a lengthened (stretched) position, while others remain in a shortened (contracted) position. Muscle knots in the contracted muscles and weakness in the elongated muscles may result from this ongoing imbalance [38].

The alignment of the entire spine depends critically on the cervical spine. When the head shifts forward from the body's vertical pivot, the muscles of the head, neck, and shoulders experience increased strain, resulting in abnormal afferent input [13]. This improper positioning alters the normal spinal alignment and disrupts the natural curves of the spine, causing exaggerated extension at the upper cervical spine, flexion at the lower cervical spine, and kyphosis of the upper thoracic vertebrae. These changes are a direct consequence of the altered head position in relation to the line of gravity [38] [8].

The sternocleidomastoid, levator scapulae, and scalene muscles shorten with forward head posture, while the anterior scalene, longus colli, and longus capitis muscles become weaker [9] [5]. Thoracic hyperkyphosis contributes to tightness in the upper trapezius and weakness in the middle and lower trapezius, serratus anterior, rhomboids, and infraspinatus muscles [9] [14]. The rhomboid, trapezius, and serratus anterior muscles are major shoulder stabilizers; when these muscles are affected, scapular protraction and anterior rotation of the shoulder occur, leading to scapular dyskinesia [6] [7].

Pectoralis muscle stretching will reduce the shoulder protraction and lengthening the pectoralis muscles and maintaining the scapula in a normal position to prevent the rounded shoulder. Because anterior rotation of the shoulder results in shortening of the pectoralis muscles [9]. Additionally, in anterior shoulder dysfunction, the humerus is influenced by its position in the glenoid cavity, causing the arm to move forward and rotate internally. This leads to weakness and strain of the shoulder's external rotator muscles and shortening of the internal rotator muscles, contributing to a rounded shoulder posture [9] [14].

Thoracic kyphosis often causes abnormal trunk flexion, which affects both the chest and abdominal muscles, resulting in weakening of the external and internal oblique muscles as well as the transverse abdominis [41] [42]. In this abnormal flexed posture, the biomechanics of the abdominal and paraspinal muscles become impaired due to changes in their angles of pull and load distribution. This leads to altered motor control and decreased endurance of these muscles [1] [40].

Scapular stabilization exercises increase the exertion of the serratus anterior and lower trapezius muscles, which drop compensatory muscle movements brought on by abnormal posture. This approach effectively improves the musculature around the neck by stabilizing the scapula [44].

Increased activation of the serratus anterior also decreases the over activation of the upper trapezius, thereby promoting effective scapular elevation. Overall, these changes contribute appreciatively to the correction of abnormal postures, similar as counter-rotational movements [7]. As a result, scapular stabilization exercises may be a useful way to help people with forward head posture, which constantly causes compensatory muscle exertion and structural deformation of the neck. By addressing dysfunctions in the neck and scapular regions, these exercises lead to salutary structural and functional changes. The dropped exertion of the upper trapezius and increased exertion of the serratus anterior through motor control training result in advanced head posture. Accordingly, in this study, after training, the serratus anterior and upper trapezius muscles were more controlled in individualities with forward head posture,

and the performing scapular or thoracoscapular positioning shifted from an abnormal state toward a more optimal alignment [8, 14].

Abdominal muscle strengthening exercises are a standard physiotherapy treatment for managing lumbar hyperlordotic curvature and postural instability. These exercises actively contribute to reducing pain and improving the function of the lumbar vertebrae [42]. The abdominal muscles play a crucial role in core stability and lumbar biomechanics, and dysfunction in these muscles has been linked to low back pain. Strengthening exercises target key abdominal muscles, including the transverse abdominis, internal oblique, and external oblique, which are essential for providing stability to the thoracic and lumbar regions. Weakness in the transverse abdominis, in particular, can lead to an increased lumbar lordotic curve, potentially resulting in low back pain. Therefore, abdominal strengthening exercises are effective in enhancing core muscle activity and improving overall spinal stability [43].

Many postural reflexes originate or are located in the head and neck region. Therefore, individuals with forward head posture may experience impaired repositioning sense and disrupted neurological regulation of static upright posture. The neuromotor response of the lower body and pelvic girdle to head position and visual stimuli is controlled by the pelvo-ocular reflex. When the head is positioned too far forward, the pelvis tilts anteriorly to help balance the center of gravity and this leads to increase lumbar lordotic angle [13].

The fact that techniques of scapular stabilization exercise along with pectoralis muscle stretching and abdominal muscle strengthening along with pectoralis muscle stretching could increase the craniovertebral and lumbar lordotic angle may be because the spiral line was connected through the neck to the abdominal region.

According to the results of this research, scapular stabilization exercise and abdominal muscle strengthening exercise were applied to participants with forward head posture, resulted in increase in craniovertebral angle and reduced lumbar lordotic angle.

From the above results scapular stabilization exercise along with pectoralis muscle stretching was more beneficial than abdominal muscle strengthening exercise along with pectoralis muscle stretching on increasing craniovertebral angle. On the other hand abdominal muscle strengthening exercise along with pectoralis muscle stretching shows more significant improvement than scapular stabilization exercise along with pectoralis muscle stretching on pain and lumbar lordotic angle.

5. Conclusion

This study concluded that there is a significant improvement in both groups in terms of pain intensity. Group B is more significant than Group A. In terms of craniovertebral angle, there is significant improvement in both groups. Group A is more significant than Group B. In lumbar lordotic angle, there is significant improvement in both groups. Group B is more significant than Group A.

There will be beneficial effects to the participants treated with abdominal muscle strengthening exercise combined with pectoralis muscle stretching than scapular stabilization exercise combined with pectoralis muscle stretching.

6. Limitations

- The intervention period was restricted to 6 weeks, no follow up to assess long term retention of postural improvements.
- In this study, BMI was not classified.
- This study cannot account for such as patients involved in other interventions.
- This study did not specify separate classifications for male and female participants.
- The results were applicable to participants belonging to age group of 25-45 years only.

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