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Effectiveness of Blackburn Exercise with Thoracic Extension Exercises Versus Thoracic Extension Exercise on Postural Hyper Kyphosis and Scapula Position in Young Asymptomatic Individuals - A Comparative Study

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ABSTRACT

BACKGROUND: The spine is composed of two types of curvature: kyphosis and lordosis. Postural hyper kyphosis is the most common posture abnormality and can happen at any age. Causes are idiopathic, sedentary lifestyle, impairments, and aging. Abnormal posture has a detrimental effect on articular and muscular structures as it leads to muscular weakness and degenerative changes. It affects the muscular tension around the neck and shoulder; as it shifts the neck forward (muscle tightness) and the shoulder moves more internally, leading the upper back scapular muscle lengthening. This study uses a flexi-curve ruler to measure postural hyper kyphosis and lateral scapula slide test (LSST) to measure scapula distance. The Blackburn protocol is often used for shoulder and scapular impairments; in this study, the protocol is used to manage postural hyper kyphosis as it targets the same muscle groups that are in an altered state.

OBJECTIVE: To compare the effect of Blackburn exercise along with thoracic extension exercise versus thoracic extension exercise on postural hyper kyphosis and scapula position in young asymptomatic individuals.

METHODS: A comparative study included 70 samples, age between 18 and 28, divided into 2 groups. The degree of kyphosis was measured using a flexi curve ruler (fcr), and scapula distance was measured using a lateral scapula slide test (lsst) at three positions. Intervention was given for six weeks.

RESULTS: After 6 weeks of data analysis, Group A's p-value for kyphosis angle is 0.5 and lateral scapula slide test at 0 degree is 0.735, at 45 degree is 0.1992, and at 90 degree is 0.536, showing significant improvement over another group.

Conclusion: Blackburn exercises, along with thoracic extension exercises, were found to be effective in reducing the angle of kyphosis in the young population.

Keywords: Hyper kyphosis, Flexi curve Ruler, LSST, Blackburn protocol.

INTRODUCTION

The spine represents lateral S-shaped curvature and is an important component in the human body.(1)Normal alignment of the spine is contributed by structural, muscular, and articular function.(1)Lack of any one component contributing to normal alignment of the spine will lead to musculoskeletal abnormalities, which result in altered movement patterns and a lack of normal range of motion and function.(1)Kyphosis is the primary curvature of the spine; excessive curvature of the thoracic spine is one of the most common postural abnormalities, and it

can occur at any age.[2]According to Morris (1992), the prevalence of hyper kyphosis was stated at 38% in 20–50 years; in 1993, Culter reported 35% in the 20–64 age group. [2] The normal value of thoracic kyphosis is 20–40 degrees; more than 45 degrees is hyper kyphosis. [3] Also, postural hyper kyphosis harms structural and functional components, affecting functional performance and normal posture. It results in poor posture and weakened muscles and ligaments of the spine. Thoracic hyper kyphosis could have a detrimental effect on quality of life while performing daily activities, and other factors such as protruding head position, slouched sitting, an ill-fitting desk, and overloaded bag packs will contribute to thoracic hyper kyphosis. Sustaining this faulty posture can increase the risk of compression fractures of the vertebral column. A high concentration of biomechanical stress leads to osteoporosis of the spine. [3] In contrast, excessive kyphosis associated with forward neck position results in extension of the neck due to muscular imbalance in neck extensors and deep neck flexors. In hyper kyphosis, altered alignment of spinal curvature will affect the shoulder joint and increase tension in shoulder muscles, resulting in a round shoulder (i.e., internal rotation of the shoulder). [4] The glenohumeral rotator cuff, responsible for the shoulder stability and mobility, altered alignment of the spine, will impact the position of the scapula, causing scapular malalignment and shoulder pathology with increased kyphosis. [4] The normal alignment of the scapular borders is about 2.5–3 inches parallel to the spine and flat against the thorax from T2–T7 at an angle of 5 degrees from the frontal plane. There are several ways to measure thoracic kyphosis, and the most common of all is lateral radiological investigation of the spine. Radiological investigations are expensive and potentially hazardous. [1,5] There are various non-invasive techniques to assess thoracic kyphosis, of which the flexi curve ruler is one, as it is cost-effective and simple to carry without possessing the negative impact of radiation and is mostly used. With postural hyper kyphosis, there will be an alteration of scapula position, which is assessed by the lateral scapular slide test. [6] Varieties of interventions have been carried out to treat this postural abnormality, such as passive and active mobility exercises, stretching exercises, strengthening exercises, manual therapy, etc. In many studies, thoracic extension exercise, along with other interventions, has been proven to be effective in treating postural hyper kyphosis. On the other side, Black burn exercises have been popular in treating shoulder girdle pathologies, rotator cuff tears, and scapular muscular imbalance and weakness. Despite its popularity, Blackburn exercise was not taken into consideration in treating scapular muscle imbalance and weakness due to postural thoracic hyper kyphosis. This study will evaluate and compare both groups effectiveness on primary and secondary outcome measures and conclude the effects of Blackburn exercise along with thoracic extension exercise on scapular alignment and thoracic kyphosis angle, as well as the effect of thoracic extension exercise on the same outcome measures.

MATERIALS & METHODS

Clearance from the institutional ethical committee was obtained. Written informed consent was obtained from the participants. Demographic data like name, age, sex, and contact number were taken. Subjects were divided into two groups (A and B) with the help of a simple randomization method. Group A (the experimental group) received Blackburn exercises along with thoracic extension exercises; Group B (the control group) received thoracic extension exercises. Participants were assessed before and after 6 weeks. Both interventions were given for 6 weeks, 3 sessions per week, for a total of 18 sessions. Each group was instructed to perform routine exercises three times a day with 10 reps of each exercise. Exercises were progressed according to patient comfort. In case of any discomfort or injury during the

exercises, the exercise was not progressed for the same treatment session. Any confounding factors during this time were noted telephonically. During the COVID-19 pandemic, special precautions laid down as per the central and state governments rules were strictly followed. Surfaces used to carry out the protocol were disinfected both, before and after treatment. Safety measures were always taken by the therapist and patient during the entire duration of the session.

Inclusion Criteria:

1. Male and female.
2. Age 18-28 years.
3. Kyphosis angle more than 45 degrees

Exclusion Criteria:

1. Subjects involved in any other exercise regime like Dance Therapy, Yoga, Strength and Functional training.
2. Fixed spinal deformities like structural thoracic kyphosis, cervical and lumbar scoliosis.
3. Fractures of vertebra, compression fracture, vertebral end plate fracture.
4. Osteoporotic or any systematic diseases.
5. Pathogical conditions of cervical, thoracic, lumbar spine.
6. Any space occupying lesion over spinal level.
7. Any shoulder pathology like frozen shoulder, impingement syndrome, fracture of shoulder girdle joint and fracture of clavicle

Measuring Tools*:*

Primary outcome measures:

1) Flexi curve ruler:

1. The subject was instructed to stand up straight and as tall as possible. Each subject stood barefoot with the back uncovered. During the procedure, the subjects were instructed to remain standing with the knees straight, feet parallel, and shoulders and elbows at 90° of flexion. This position was adopted in order to avoid the humerus appearing in front of the spinal column.
2. Keeping the subject in the same posture, the flexi curve was placed over the spinous process.
3. Line contour shape of the spinal length, and the ruler was placed gently on the back to mold the curvature. While molding the C7, T12, L1, and L5 spinal segments were located and marked using the metric scale incorporated in the instrument.
4. After molding the contour of the spine, the flexi curve was removed, and the internal edge (the side of the flexi curve in contact with the skin) was traced on to the chart paper, representing the thoracic and lumbar curvature in the sagittal plane with the spinal processes identified. In this study, the kyphosis angle formula is used to measure postural hyper kyphosis.
5. Formula for Kyphosis Angle: Kyphosis Angle $\theta = 4 \arctan [(2\ TW)/TL]$

Secondary Outcome Measures:

1) Lateral scapula slide test

a) Distance is measured from spine of scapula T2 or T3 to inferior angel of scapula at T12
b) Tested in 3 position - hands hanging at side
c) (Hands over waist)- 45degree abduction
d) 90degree abduction with medial rotation

INTERVENTION

Group A training programme

Warm up exercises (5-10mins)

Cool down exercises (5-10 mins)

Blackburn Exercises

A: Prone Horizontal Abduction (Neutral):
Lie on the table, face down, with arms hanging straight down to the floor and palms facing down. Raise arms out to the side, parallel to the floor. Hold for 2 seconds and lower slowly.

(Figure A)

B: Prone Horizontal Abduction (Full ER): Lie on the table, face down, with arms hanging straight to the floor, and thumbs rotated up (hitch-hiker position). Raise arms out to the side with slightly in front of shoulder, parallel to the floor. Hold for 2 seconds and lower slowly.

(Figure B)

C: Prone Horizontal Scaption (Neutral): Lie on the table, face down, with arms hanging straight down to the floor and palms facing down. Raise your arms to the side but slightly forward by about 30degree compared to horizontal abduction. Hold for 2 seconds and lower slowly.

(Figure C)

D: Horizontal Scaption (Full ER): Lie on the table, face down, with arms hanging straight to the floor, and thumbs rotated up (hitch-hiker position). Raise your arms to the side but slightly forward by about 30degree compared to horizontal abduction. Hold for 2 seconds and lower slowly.

(Figure D)

E: Prone Horizontal External Rotation: Lie on the table, face down, with arms abducted horizontal to side and elbows bent 90degree, thumb pointing upward. Rotate arms externally so that forearms come parallel to ground. Hold for 2 seconds and lower slowly.

(Figure E)

F: Prone Horizontal Extension: Lie on the table, face down, with arms hanging straight down to the floor and palms facing upward. Raise your arms to the horizontal parallel the thorax. Hold for 2 seconds and lower slowly

(Figure F)

Protocol started with warm up then proceeded with Blackburn exercises which were prescribed for 10 repetitions and hold for 2-3 seconds and thoracic extension exercises, concluding the session with cool down.

Thoracic extension exercise:

G. Cat thoracic extension

Subjects are instructed to maintain a four-point kneeling position on a yoga mat (hands and knees touching the ground). Subjects arched their back in a sequential movement from the cervical spine to the lumbar spine. This exercise recovers ROM in the spine, especially the lumbar spine. (10 reps x 1 set)

Group B (Thoracic extension exercises)

Warm up exercises (5-10mins)

Cool down exercises (5-10 mins)

A. Prone lying on bolster with trunk lift in neutral

Subjects are asked to attain prone position over bolster neck extended, with arms at the side of the body and toes supporting on the floor and subjects are asked to extend the both arms simultaneously. (10 reps x 1 set)

(Figure A)

B. Wall push up

Subjects are asked to attain standing facing towards wall with shoulder abduction at 90 degree and with elbow flexion and subject is

asked to perform wall push up by extending and flexing his arms (10 reps x 1 set)

(Figure B)

C. Unilateral overhead shoulder flexion on bolster

Subjects are instructed attain supine lying position over bolster with slight knee flexion, simultaneously subject has to perform complete active shoulder flexion unilaterally. The exercises done bilaterally (10 reps x 1 set).

(Figure C)

D. Side lying thoracic extension and rotation

Subjects are instructed to attain side lying position with bilateral knee flexion. Then ask the subject to flex shoulder at 90 degree and then attaining that posture, subject must turn towards the contralateral side (10reps x 1 set)

(Figure D)

E. Thoracic spine extension ROM

Subjects are instructed to maintain the position taught in the first exercise. Subjects joined their hands behind their heads with their elbows maximally outstretched forward. While maintaining stability of the lumbar spine, the thoracic spine was maximally extended, and then restored to its original position. (10 reps x 1 set)

(Figure E)

F. Quadripod Thoracic spine rotation ROM

Subjects are instructed to maintain a four-point kneeling position on a yoga mat (hands and knees touching the ground). Subjects placed one hand on their head with their elbow maximally outstretched laterally. Then performs lateral rotation of the thoracic spine through its maximum range. The exercises done bilaterally. (10 reps x 1 set)

(Figure F)

G. Cat thoracic extension

Subjects are instructed to maintain a four-point kneeling position on a yoga mat (hands and knees touching the ground). Subjects arched their back in a sequential movement from the cervical spine to the lumbar spine. This exercise recovers ROM in the spine, especially the lumbar spine. (10 reps x 1 set)

(Figure G)

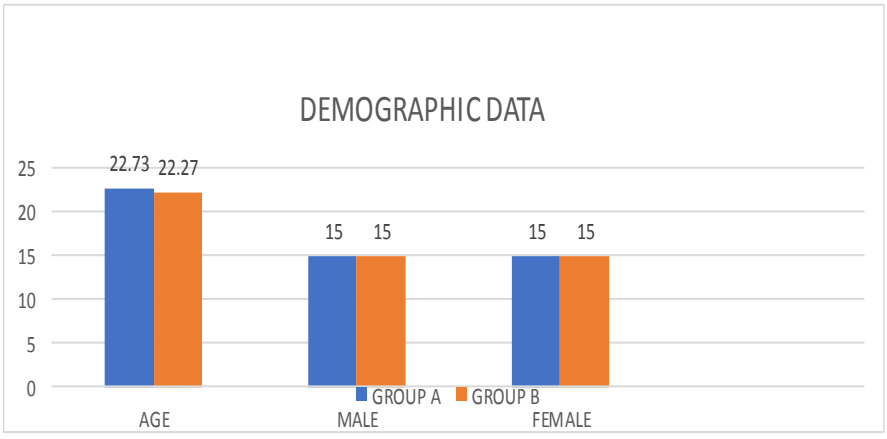
STATISTICAL ANALYSIS

Descriptive statistics were performed for all baseline characteristics, like age and gender. The data was checked for normalcy. The level of significance of <0.05 was considered statistically significant with a 95% confidence interval. The study data was statistically analysed using Graph Pad Instat v. 3.1. For all analyses, statistical tests were two-tailed, and the threshold of the p value considered significant was set at < 0.05. Seventy participants were recruited and received 18 treatment sessions within the 6-week treatment period. No adverse effects were reported during the sessions. Paired t tests were used to analyse the pre-post difference within the groups, whereas unpaired t tests were used to analyse the significance of the difference between the groups, and the p value, mean, and mean of the difference were calculated. Results from the statistical analysis were tabulated and presented in graphical formats for better understanding and easier interpretation.

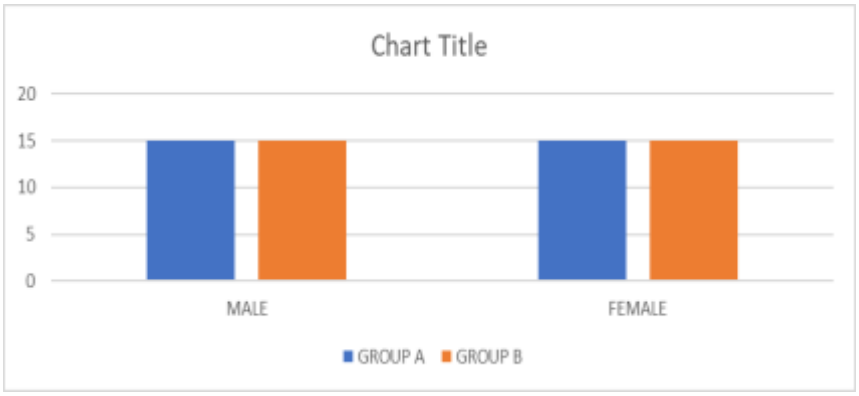
RESULT

Descriptive statistics of Age distribution, it was performed using Mann Whitney Test. The two tailed P value is 0.75 considered non-significant suggesting that data was normally distributed in both groups.

Graph 1: AGE DISTRIBUTION



Graph 2: GENDER



Comparison within the group A and B

Paired t-test is carried out to test significance for pre-post observations. From above table we can observe that, P-Value for Group A and Group B is less than 0.05. Hence, we can conclude that, effect observed in Group A and Group B is significant

Table 3: GROUP A FLEXICURVE KYPHOSIS ANGLE

GROUP A	
PRE	46.93±1.51
POST	43.92±2.21
P VALUE	0.0001

Graph 3: GROUP A FLEXICURVE KYPHOSIS ANGLE

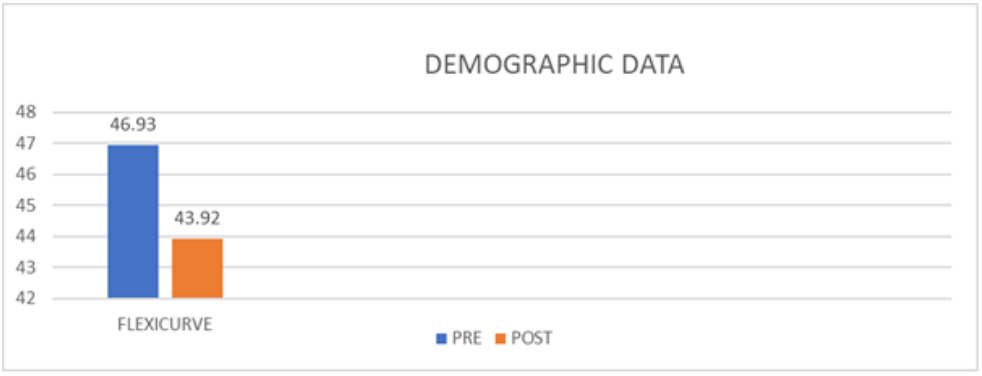


Table 4: GROUP A LATERAL SCAPULA SLIDE TEST

LSST	0 DEGREE	45 DEGREE	90 DEGREE
PRE	9.233	10.09	10.92
POST	8.79	9.663	10.62
P VALUE	0.0001	0.0001	0.0001

Graph 4- GROUP A LATERAL SCAPULA SLIDE TEST

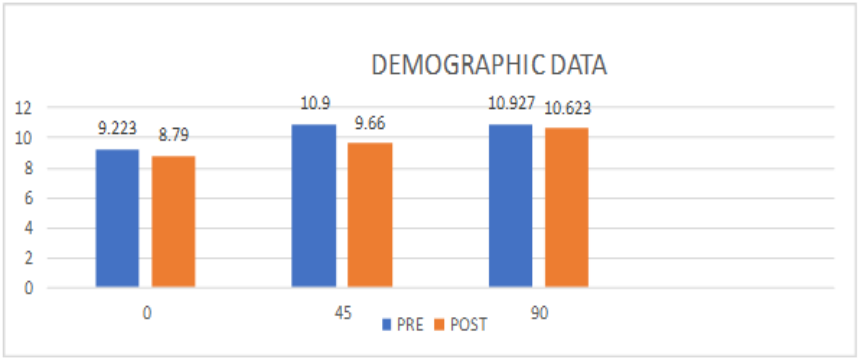


Table 5- GROUP B FLEXICURVE KYPHOSIS ANGLE

GROUP B	
PRE	46.72±1.72
POST	45.79±1.27
P VALUE	0.0001

Graph 5- GROUP B FLEXICURVE KYPHOSIS ANGLE

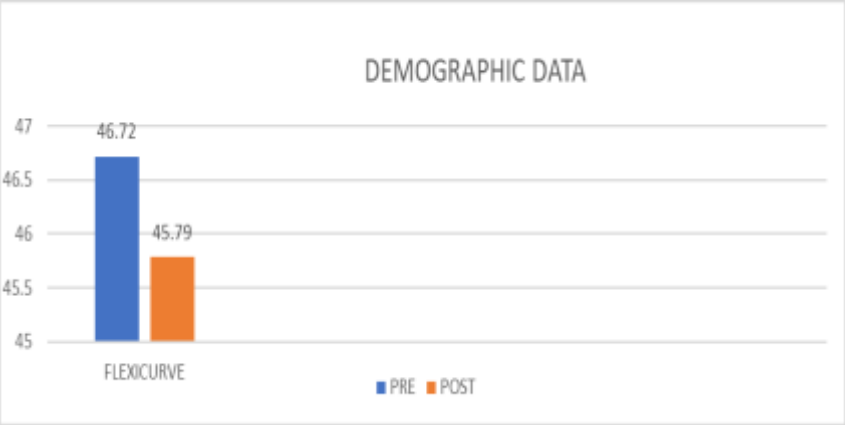
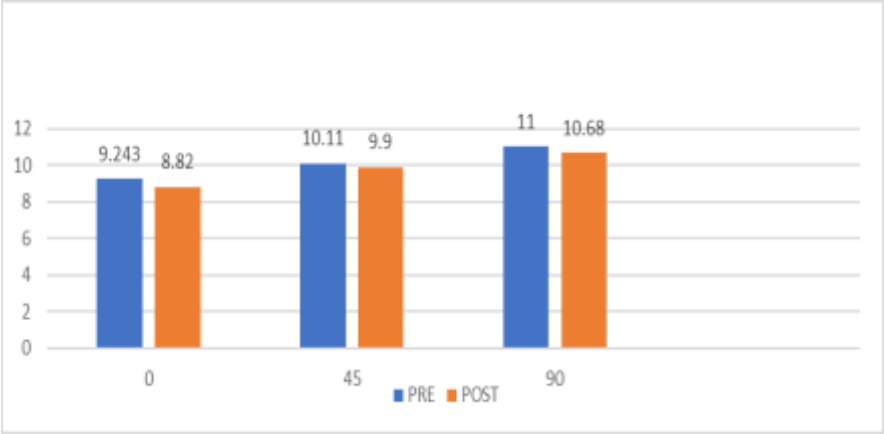


Table 6- GROUP B LATERAL SCAPULA SLIDE TEST

LSST	0 DEGREE	45 DEGREE	90 DEGREE
PRE	9.243±0.62	10.11±0.55	11.00±0.51
POST	8.82±0.72	9.90±0.60	10.68±0.51
P VALUE	0.0001	0.0001	0.0001

Graph 6- GROUP B LATERAL SCAPULA SLIDE TEST



Comparison between Group A and Group B - Unpaired t-test is carried out for comparison between Group A and Group B.

Table-GROUP A AND B COMPARISON FLEXICURVE

	GROUP A	GROUP B
PRE	46.937	46.72±1.72
POST	43.92±2.21	45.79±1.27
P VALUE	0.5889	

Graph 7- GROUP A AND B COMPARISON FLEXICURVE

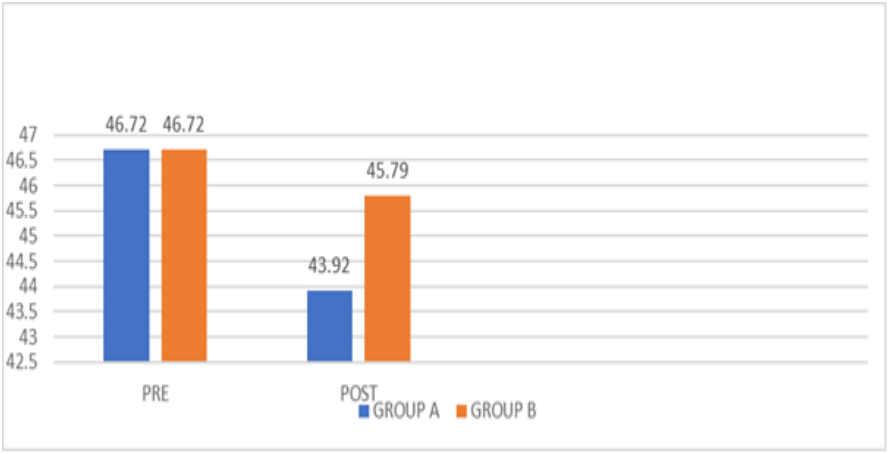
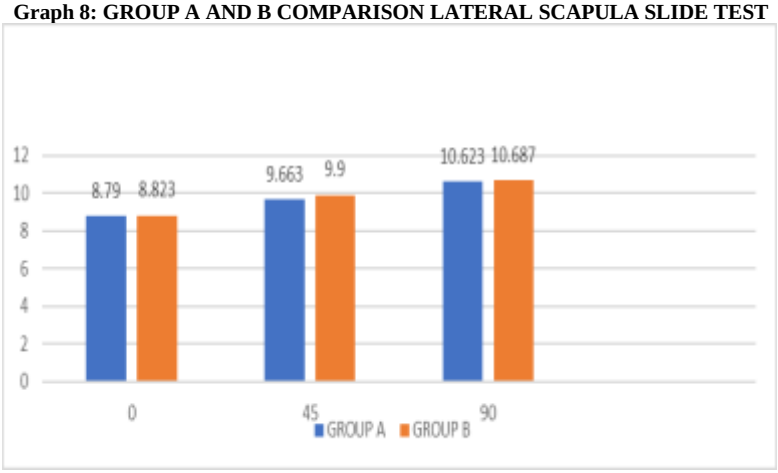


Table 8: GROUP A AND B COMPARISON LATERAL SCAPULA SLIDE TEST

LSST	0 DEGREE	45 DEGREE	90 DEGREE
GROUP A	8.790	9.663	10.623
GROUP B	8.823	9.900	10.687
P value	0.8735	0.1992	0.5367

Graph 8: GROUP A AND B COMPARISON LATERAL SCAPULA SLIDE TEST



DISCUSSION

This clinical trial investigated the effect of Blackburn exercises along with thoracic extension exercises for postural hyper kyphosis and scapula position in asymptomatic individuals

Over all 60subjects were recruited. Age and gender were matched for both groups. It is important to note that all participants were divided into two groups and exercises were prescribed according to the groups that is Blackburn exercises along with thoracic extension for group A and thoracic extension exercise for group B. There was a decrease in 4 degrees observed in the kyphosis angle of the experimental group compared to the control group which indicated that the corrective program had a significant effect on the reduction of kyphosis angle. The results of this study were also supported by findings of Katzman (2017), Jang (2015), Feng (2018) and Yelfani (2015) who reported a significant decrease in the kyphosis angle after the implementation of the exercise program along with Zabiholah Tarasi (2019). Kamali et al. evaluated 18 -30-year-old patients with kyphosis over 45 degrees of kyphosis and found reduction in thoracic kyphosis along with improvement in back extensor strength significantly greater in both the exercise and manual therapy groups ($p < 0.001$) which was reflected in this study

as well. Another study showed a decrease in thoracic kyphosis angle after 8 weeks of corrective exercises in water and on land comprising a set of stretching and strengthening exercises in kyphotic students. That study also used a flex curve ruler to measure the angle of kyphosis (Azizi et al, 2012). The results in this trial implies that Blackburn exercises along with thoracic extension exercises is beneficial for treating postural hyper kyphosis and scapula position in the young asymptomatic subjects. Significant improvement in primary outcome measures (Kyphosis angle) and secondary outcome measure (Lateral scapula slide test) occurred in both groups which was evident after the intervention with p value 0.5889for kyphosis angle and for LSST the p value at 0 degree is 0.735, at 45 degree is 0.1992 and at 90 degree 0.536The group receiving a combination of Blackburn exercises along with thoracic extension exercise showed significantly greater improvements in Kyphosis Angel and Scapula position compared with a group receiving thoracic extension exercises. Blackburn group was statistically and clinically significant. Some earlier studies stated that thoracic spine posture affects the scapular alignment and kinematics during shoulder elevation· [(18),] with hyper kyphosis which leads to the forward and downward rotation of scapula, acromion depression in relation with change in direction of glenoid fossa resulting in less active posterior scapula tilt and shoulder abduction compared with erect posture. (Kenichi Otoshi,2014). [(19)] Blackburn exercise group improved in all outcome measures. A mechanism of extension of the spine and position of scapula post intervention is via positive effect on the scapula alignment as the repositioning of shoulder lead to decrease in kyphotic posture, there's change in the scapular alignment with a change in scapular muscle length stating a significant change in our study

Alteration in length of scapula muscle can impact the shoulder joint and acromion clavicular joint resulting subacromial issue with blackburn exercises there's retraction of scapula and approximation of medial border of scapula to the spine, relative extension of thoracic spine leading to backward and posterior tilt of scapula in relation to thorax by training the weak scapular muscle stated by Kenichi Otoshi, (2014) [(19)] and supported by this study

Thoracic kyphosis is directly corelated with narrow subacromial space. Blackburn exercises restores the correct alignment of thoracic spine and with correct alignment affects scapular positioning and also alleviate the muscular imbalance (Won-gyuYoo2018) [(6)]. Batumans et. al reported that 10 weeks exercise regime in middle aged woman can decrease the kyphosis angle and increase lung function. Another reason for kyphosis reduction and scapula position as seen in experimental group suggests that Blackburn exercise can reduce the tension in shoulder muscle including pectoralis major, subclavius and pectoralis minor causes internal rotation of shoulder i.e rounding of shoulder, improvement can also be due improving shoulder strength by improving joint position awareness[(23)].In contrast effectiveness of thoracic extension was not as significant when compared with experimental group as these exercises did not focus on shoulder or scapular muscle, these muscles are responsible for stability and they tend to go in weakness, with abducted scapula trapezius and rhombidus tends to go in weakness and the anterior muscle develops tightness, so the posterior muscle has to be strengthened and anterior muscle has to be stretched and these exercises were found to increases the length of anterior chest muscles and approximate the back muscles and central area of the body hence, reducing the amount of abnormality by coordinating agonist and antagonist muscles by Zabilo 2019[(1,2)].Our study was also supported by Liebenson et. al who stated that thoracic extension reduces kyphosis angle and improves strength, and thoracic extension exercises are also reduce pain disability and

improved range of shoulder (Haider 2018)[21]. In the training program, strengthening was attempted for thoracic extensors as these exercises maintains spine and permit the body to keep the orientation of spine during static and dynamic loading. Another reason supporting the improvement with thoracic extension exercises in both groups could also be due to expansion of the ribs and elevation of scapula, believing that increasing the gap between intercostal will increase thoracic space and provides effective muscle length studied by Won-gyuYoo in 2017[6].

CONCLUSION

The results of this study showed that 6 weeks of Blackburn exercise along with thoracic extension exercises was found to be effective in reducing the angle of kyphosis and scapula position in young asymptomatic people. It is suggested that researchers consider this selected corrective program as a new method and upgrade of former corrective exercises.

Declaration by Authors

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