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Correlation between core stability and scapulohumeral rhythm in badminton player-An observational study

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Abstract
Background: During functional activity core stability helps in maintaining balance of forces to and from extremities. The co-ordinated movement of the scapula and humerus help in proximal to distal activation of kinetic chain. Overhead motion in badmintion player requires coordinated movement from feet to hand, which is activated by core muscle. Hence, the present study is planned for correlation of the core stability and scapulohumeral rhythm in badminton player.
Objective: The purpose of the study was to correlate the core stability and scapulohumeral rhythm in badminton player.
Methodology: The study includes 40 badminton players were randomly included in the study. Demographic Data (name, age, gender) was noted. Core stability and strength testing was performed to assess the core stability. Inclinometer was used to assess scapulohumeral rhythm. Participants under went through lateral scapular slide test, Functional throwing performance index, close kinetic chain upper extremity test and scapular muscle strength testing.
Result: The correlation was analyzed by Karl Pearson's correlation coefficient test. The result showed a positive correlation between core stability and scapulohumeral rhythm in outcome measure core stability and strength testing, scapulohumeral rhythm, lateral scapular slide test, Functional throwing performance index, close kinetic chain upper extremity test and scapular muscle strength testing. The level of significance was set as $p<0.05$.
Conclusion: The result showed that there was correlation between core stability and scapulohumeral rhythm.

Keywords: Core stability, scapulohumeral rhythm, Badminton.

Introduction

The musculoskeletal core of the body consists of hip, pelvis, spine and proximal lower limb and abdominal structures. The muscles of the spine and pelvis are core musculature provide stability to the spine and muscle. The core muscles generate energy and transfer that to the small body parts from large body parts during various sports activities. Apart from the generation of energy and stabilizing the hip, pelvis, spine and the proximal lower limb core muscles also involved in almost all extremity activities such as running, throwing, kicking [1].

"Core stability" has been defined as the ability to control trunk position and motion for the purpose of optimal production, transfer, and control of forces to and from the terminal segments during functional activities [1].

The scapula plays a vital role in the shoulder function. The co-ordinated movements of the scapula and humerus together provide efficiency for shoulder functioning [2, 3]. It is a stable socket for the normal ball and socket kinematics. It protracts and retracts in follow through movement, elevates with arm abduction, provides a stable base of support to the origin for the shoulder muscles. It acts as an important connection for the proximal to distal activation, to the kinetic chains of overhead activity [4]. The role of the scapula in shoulder function is the ability to coordinate motion between scapula and humerus or scapula-humeral rhythm. It may have a clinical implication for overhead athletes or shoulder pathologies [3].

Any alterations to the mechanism of the scapulohumeral rhythm will adversely cause shoulder pathologies like glenohumeral impingement or rotator cuff tear. Variations in the scapular position and control can lead to disruption of the stability and function of the scapular stabilizing muscles [2].

There is a high risk of injury for overhead athletes playing tennis or volleyball while serving or smashing respectively, due to high loads and forces [5]. Shoulder pain in the overhead athlete may result from fractures, nerve related pathology, overuse, articular, muscular or tendon injuries. In sports such as baseball, softball, water polo, tennis, racquetball and volleyball; the overhead throwing motion requires the coordinated movements from the feet to the hands in a single kinetic chain1. Athletes who routinely assume the overhead arm position i.e. maximal external rotation of the humerus with shoulder abduction and elevation are vulnerable to internal impingement from micro-instability of the glenohumeral joint, overuse or fatigue of the shoulder girdle muscles [6].

Alteration of scapular dynamic control is present in as many as 67% to 100 % of athletes with shoulder injuries [7]. The most common sites of pathomechanics include the shoulder, scapula, legs, and core. In a closed kinetic chain, alteration in one area creates changes throughout the entire system this is known as the catch-up phenomenon. In this, the changes in the interactive moments alter the forces in the distal segments these increased forces place extra stress on the distal segments, which often result in the sensation of pain or actual anatomical injury [8].

Overhead motions require well-controlled and synchronized coordination of the shoulder musculature [9]. This precise neuromuscular control can be trained through proprioceptive neuromuscular facilitation (PNF). The efficacy of this type of training is generally well accepted, although there is a broad spectrum of variations in the application of this technique [10]. Swanik suggested that plyometric activities may facilitate neural adaptations that enhance proprioception, kinesthesia, and muscle performance characteristics. It also was hypothesized that significant neuromuscular benefits may be attained if these techniques are implemented at an early stage in shoulder rehabilitation [11]. Some authors also have stated that muscle fatigue can lead to scapular dyskinesis and subsequent outlet impingement. Scapular muscle training for endurance in the scapular stabilizers becomes crucial and can be achieved with exercises [12].

Along with training muscular endurance, proprioception, and neuromuscular control, kinetic chain training should be advanced throughout the rehabilitation program. Proximal muscle strength, including the core and hip musculature, are essential for both generation and absorption of forces during the throwing motion. Both the core and hip musculature can be trained with single leg exercises, including a single leg squat. The throwing athlete also must have enough flexibility in the planting leg to allow for proper throwing biomechanics. If there is a ROM restriction in the lower extremity, then that deficit must be compensated for elsewhere along the kinetic chain. This compensation may occur at the shoulder joint complex, potentially resulting in shoulder dysfunction, pain, and injury [13].

Clinical identification of scapular dyskinesis is difficult and relies primarily on visual observation Kibler *et al*. Described the most well-known classification technique was subsequently modified to include weighted exercises, videotaping for further review by investigators, inclinometer, and tape measurements [7].

In badminton player scapulohumeral rhythm plays an important role during serving and smashing movement. The co-ordination of movement of the scapula and humerus leads to fulfilling the shoulder function. Any alteration of the mechanism of scapula and humerus results in shoulder pathologies. Overhead forceful motion forceful motion requires coordinated movement from the feet to the hands in a single kinetic chain, it has been demonstrated that the activation of the kinetic chain musculature starts from the external oblique's, which is a core muscle and later proceeds to the arm.

Therefore, in this study, the aim was to correlate the core stability and scapulohumeral rhythm in badminton player.

Materials and Methods Used

Materials Used

- Consent form
- Data collection sheet

Apparatus and Equipment

- Digital inclinometer
- Goniometer
- Measuring tape
- Ball
- Mat
- Hand Held dynamometer

Methodology

Ethical clearance was obtained from the Institutional Ethical Committee of KLEU Institute of Physiotherapy, Belgaum. Participants were recruited according to the fulfillment of the inclusion and exclusion criteria respectively. A written informed consent was given to all the participants before the commencement of the study. The participants were from the JNMC badminton court Indoor Stadium,-Belgavi. Demographic characteristics of the participant, including their age, gender, age of onset of playing and years of playing were noted. The inclusion criteria were asymptomatic badminton player, 18-25 year of age both male and female who were willing to participate. The participant were excluded if there was any history of recent trauma to the upper limb which is affected shoulder function, symptom related to the shoulder, scapular winging due to any neurological involvement and shoulder or cervical pathology.

Outcome Mesures

Core strength and stability test:

Stage 1

- Warm up 10 minutes
- The participant using the mat to support their elbows and arms, assumes the start position
- Once the participant correct position the assistant starts the stopwatch
- The athlete is to hold this position for 60 seconds

Stage 2

- The participant lifts their right arm off the ground and extends it out in front of them parallel with the ground
- The participant is to hold this position for 15 seconds

Stage 3

- The participants returns to the start position, lifts the left arm off the ground and extend it out in front of them parallel with the ground
- The participant is to hold this position for 15 seconds

Stage 4

- The participant returns to the start position, lifts the right leg off the ground and extends it out behind them parallel with the ground
- The participant is to hold this position for 15 seconds

Stage 5

- The participant returns to the start position, lifts the left leg off the ground and extends it out behind them parallel with the ground
- The participant is to hold this position for 15 seconds

Stage 6

- The participant returns to the start position, lifts the left leg and right arm off the ground and extends it out behind them parallel with the ground
- The participant is to hold this position for 15 seconds

Stage 7

- The participant returns to the start position, lifts the right leg and left arm off the ground and extends it out behind them para1llel with the ground
- The participant is to hold this position for 15 seconds

Stage 8

- The participant returns to the start position
- The participant is to hold this position for30 seconds

Stage 9

End of the test

Scapulhumeral rhythm

Scapulohumeral rhythm will be analyzed from digital inclinometer. The Participant stands with shoulder width apart and arms at the sides. The digital inclinometer will be placed along the lateral border of the upper arm at midshaft. When instructed participant raises their arm slowly and the scapular position is measured at 5 angles of humeral elevation (rest, 30°, 60°, 90°, 120°). Scapular upward rotation is recorded. Then, with the help of goniometer glenohumeral elevation in scapular plane is measured[3].

Scapular muscle test

1. Lower trapezius

The Lower Trapezius muscle test is performed with the resistance force from the Hand Held dynamometer being applied to the spine of the scapula midway between the acromial process and the root of the spine. The force on the scapula is applied in the superior and lateral direction parallel to the long axis of the humerus, which was at 140 degrees of elevation. The scapular motion for this test was scapular adduction and depression.

2. Serratus anterior

The elbow was placed in 90 degrees of flexion, and resistance is applied to the ulna at the olecranon process along the long axis of the humerus. This application of resistance is modified for the Serratus Anterior muscle test because,

3. Middle Trapezius

The Middle Trapezius muscle test is performed. The Hand Held dynamometer resistance force was applied to the spine of the scapula midway between the acromial process and the root of the spine. The force is applied in the lateral direction parallel to the long axis of the humerus, which was placed in 90 degrees of abduction. Scapular retraction was the scapular motion for the MT muscle test.

4. Upper trapezius

The Upper Trapezius muscle test is performed. The Hand Held dynamometer is placed over the superior scapula. Force was applied directly downward (inferior) through the Hand Held dynamometer in the direction of scapular depression. Scapular elevation was the scapular motion for the UT muscle test [10].

Lateral scapular slide test

In this test patient sits or stands with the arm resting at the side and examiner measure the distance from the base of the spine of the scapula to the spinous process of T2 or T3, from the inferior angle of the scapula to the spinous process of T7-T9, or from T2 to the superior angle of the scapula. The patient is then tested holding two other positions: 45° abduction in which hands on waist and thumbs posteriorly on the back and 90°abduction and medial rotation of the arm. The distance measured should not vary more than 1 to 1.5 cm11.

Functional Throwing performance Test

Participants performed a 5 minute warm up running on a treadmill. The participant was made to stand 15 feet from a 1foot by 1 foot square target 4 feet high on the wall from the floor. The participant was instructed to throw a 21cms rubber ball within the target square as many times as possible within a 30second time period. The participant threw with a natural overhand throwing motion using their dominant arm. The participant threw the ball under control as fast and accurately as possible catching the thrown ball's rebound.3 maximal 30 second tests were performed, throwing the ball as many times as possible. A one minute rest period was allowed between each test. An accurate throw was one that lands within the target square, not on the line. The total number of throws as well as the total number of accurate throws produced that percentage score. The average percentage score from the three trials was calculated 12.

Close kinematics chain upper extremity Test

Subjects assume the push up position with one hand on each marker which are placed 91 cm apart. When examiner say 'go' then the subject move there one hand to touch the other and return to starting position and does the same with other hand, repeat the motions for 15 seconds. The examiner counts the number of touches or crossover made in the allotted time. The test repeated three times and average score is the result.

Statistical analysis: Statistical Package of Social Sciences (SPSS) version 21 was used for statistical analysis. Correlation of core stability, scapulohumeral rhythm, scapular muscle strength were done using Karl Pearson's Correlation Coefficient. Correlation between core stability, scapulohumeral rhythm and scapular muscle strength was assessed using Probability values of less than 0.05 were considered statistically significant.

Results

Table 1: Distribution of male and female.

Gender	Total no.	%
Male	21	52.50
Female	19	47.50

Table 2: Distribution of participants age and BMI

Age	BMI
Mean± SD	Mean ± SD
20.80± 1.83	22.75± 3.40

Table 3: Correlation between Core strength and Scupulohumeral rhythm scores by Karl Pearson's correlation coefficient method

Variables	Correlation between Core strength		
	r-value	t-value	p-value
Scupulo humeral rhythm	0.1615	1.0089	0.3194

The correlation coefficient (r value) between core stability and scapulohumeral rhythm is 0.1615 and probabiility (p value =<0.05) 0.3194 which was not significant but shows positive coorelation.

Table 4: Correlation between Core strength and scapular ms strength i.e. UT, LT, MT and SA scores by Karl Pearson's correlation coefficient method

Variables	Correlation between Core strength		
	r-value	t-value	p-value
UT	0.0802	0.4958	0.6229
LT	0.2931	1.8896	0.0665
MT	0.2978	1.9229	0.0620
SA	0.4009	2.6977	0.0104*

Table 5: Correlation between Core strength and CKCUET scores by Karl Pearson's correlation coefficient method

Variables	Correlation between Core strength		
	r-value	t-value	p-value
CKCUET scores	0.6217	4.8928	0.0001*

Table 6: Correlation between Core strength and FTPI scores by Karl Pearson's correlation coefficient method

Variables	Correlation between Core strength		
	r-value	t-value	p-value
FTPI scores	0.4706	3.2874	0.0022*

Table 7: Correlation between Core strength and Lateral scupalar slide test scores by Karl Pearson's correlation coefficient method

Variables	Correlation between Core strength		
	r-value	t-value	p-value
At rest	0.0802	0.4958	0.6229
45° abd	0.2931	1.8896	0.0665
90° abd	0.2978	1.9229	0.0620

Discussion

The aim of the present study was correlate the core stability with sacpulohumeral rhythm in badminton player. The present study showed correlation between core stability and scapulohumeral rhythm with regard to various parameters assessed in the values of core stability and strength testing, scapular upward rotation with digital inclinometer, lateral scapular slide test, functional throwing performance index and close kinemetic chain upper extremity test.

The present study states that core stability is related to scapulohumeral rhythm which is clinically reliable. Ahmed Radwan, Jennifer Francis *et al* conducted study on Sixty-one Division III overhead athletes in which 28 males and 33 females were recruited to participate in this study. Several overhead sports were represented in the sample which include six football players, seven swimmers, three water polo players, thirty one lacrosse players, one baseball player, six softball players, six field throwing athletes, and six basketball players. There were 48 healthy participants and 14 participants with shoulder dysfunction. Subjects were classified as having shoulder dysfunction if they had history of noncontact shoulder injury and scored less than 80 on the Kerlan-Jone Orthopaedics Clinic (KJOC) questionnaire. Subject were randomly assigned to start at one of the core measures stations as follows; Single-Leg Stance Balance Test (SLBT), Double Straight Leg Lowering Test (DLL), Sorensen Test, and Modified Side Plank Test. The results of this study demonstrated that collegiate overhead athletes with shoulder dysfunction had less balance compared to healthy athletes. Additionally, poor performance of these athletes in some of the core stability measures was correlated to the extent of their shoulder dysfunction [13].

Lust KR, Sandrey MA *et al* determined the extent to which throwing accuracy, core stability, and proprioception improved after completion of a 6-week training program that included open kinetic chain (OKC), closed kinetic chain (CKC), and/or core-stability exercises. 19 healthy baseball athletes with a control group of 15.Two 6-week programs including OKC, CKC, and core-stabilization exercises that were progressed each week. Main outcome measure was Functional throwing-performance index, closed kinetic chain upper extremity stability test, back-extensor test, 45 degrees abdominal-fatigue test, and right- and left-side bridging test. There was no significant difference between groups. An increase was evident in all pre-test-to-post test results, with improvement ranging from 1.36% to 140%. Both of the 6-week training programs can be used to increase throwing accuracy, core stability, and proprioception in baseball[14]. This study showed a correlation of core stability with functional throwing performance test and also with close kinetic chain upper extremity test. Corrie J Odom Andrea B Taylor *et al* performed a study with 46 subjects including both men and women ranging in age from 18 to 65 years were recruited. One group consisted of 20 subjects being treated for shoulder impairments, and one group consisted of 26 subjects without shoulder impairments. Two measurements in each test position were obtained bilaterally. From the bilateral measurements, we derived the difference measurement [15].

The present study also reflects relationship of core stability and scapular muscle strength. In this study we had examined upper trapezius, lower trapezius, middle trapezius and serratus anterior muscles strength

Conclusion

The present study concludes that core stability is related to scapulohumeral rhythm and if core stability is less then scapulohumeral rhythm is also disturbed. Additionally if there is poor core stability then it can also affect the scapular muscle strength. Such results may support the use of core stability training in badminton player or overhead athletes to maintain their scapulohumeral rhythm.

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