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Relationship between core stability and shoulder function in shoulder impingement Syndrome in athletes

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The objective was to investigate the relationship between core stability and the closed chain shoulder function in athletes with shoulder impingement syndrome. Shoulder impingement syndrome is the most common disorder of the shoulder. Postural, kinematic, and muscle changes have all been demonstrated to directly or indirectly alter the subacromial space dimension. Any physical condition that alters components of the kinetic chain, especially one that affects the core will alter more distal segments and may cause shoulder dysfunction. Core training is a mainstay in many athletic development training programs despite little evidence to prove its direct contribution to athletic performance. Twenty seven male athletes were tested. The transversus abdominis activation capacity by the pressure biofeedback unit and trunk flexion and horizontal back extension endurance times were recorded, in addition to the upper quarter Y balance test (UQYBT) scores. Pearson correlations were used to determine relationships between core stability and athletic performance. The core stability tests were not significantly related to the closed kinetic chain shoulder function. Core is comprised of synergistic parts working together, the current study supports the notion that some tests of core stability is unlikely to capture all aspects of the core that might be related to measures of shoulder function.

Keywords: core stability; shoulder impingement syndrome; back endurance; pressure biofeedback; UQYBT

INTRODUCTION

The kinetic chain, in which the upper extremity operates, depends on the core and lower extremities for power generation and support (Sciascia et al., 2012). There is a little evidence regarding direct contribution of core training to athletic performance, however it is a basic portion in development of most athletic training programs (Reed et al., 2012). The ailments of the racquet or throwing arm has now been extensively studied. The throwing act requires a coordinated motion progressing from the toes to the fingertips. The sequence of these events has been described theoretically as a kinetic chain (Kibler et al., 2006). Therefore this kinetic chain concept is the reason for the necessity of observing the whole body mechanism during rehabilitation of the injured shoulder. For effective kinetic chain work, sequential muscle activity is required so that the generated energy in the lower body can be transmitted to the upper body (Hirashima et al., 2002). Any physical condition that alters the kinetic chain components, especially condition that affects the so called core (back, trunk, and proximal parts of the lower limbs), will alter more distal segments and may lead to development of a dysfunctional shoulder (Bedi, 2011). Shoulder impingement syndrome (SIS) is the commonest shoulder disorder, resulting in functional loss and disability (Ardic et al., 2006). SIS can be defined as encroachment of the subacromial soft tissues underneath the acromial arch as the arm is elevated, especially in overhead positions (Desmeules et al., 2004). Pain and loss of function are cardinal symptoms associated with Shoulder impingement (Clausen et al., 2017). Patients with SIS have substantial deficits in ROM additional to high levels of shoulder pain and low self-reported shoulder function (Witten et al., 2018). The etiology of SIS is multifactorial as anatomic, biomechanical, and psychosocial factors are likely involved (Desmeules et al., 2004). Postural, kinematic, and muscle changes have all been demonstrated to directly or indirectly alter the subacromial space dimension (Michener et al., 2003). Two systems aid in stabilizing the spine and coordinated movement of the spine, the local muscle system and the global muscle system. The local system (deep layer) contains short muscles to control intersegmental mobility responding to postural and changes of extrinsic load. The slow twitch muscles of the transverse abdominis, multifidi, internal oblique, transversospinalis, and pelvic floor muscles. The global system are long muscles with large lever arms generate high torque and gross movements, includes rectus abdominis, erector spinae muscles, quadratus lumborum, and external oblique (McGill, 2001). Previous studies revealed that activities of limb muscles during motion may be affected by the effort exerted by muscles stabilizing the trunk (Cynn et al., 2006; Park et al., 2010). The inadequate contribution of those stabilizing muscles exhibit a challenge in preserving axioskeletal alignment and postural stability during motion of the limb, which change the pattern of recruitment for movement accomplishment and consequently produces an undesirable substitute pattern of movement (Kibler et al., 2006). Core muscle exercise and lower body training permit smooth movement of the arm around the body, provide shoulder stability during pitching, and are important for natural pitch of the elbow and hand. If there is weakness of the lower body muscles and little endurance, or the muscular control is inefficient, the athletes cannot pitch normally. So making of a good player depends on the lower body strength (Park and Lee, 2015). If the spine and its associated musculature have inadequate mobility and strength, there is potential for energy dissipation, loss of throwing control, and altered biomechanics of shoulder. Trunk connects between shoulder and lower extremity and responsible for ground reaction force transferring into the upper extremities as well as producing additional force that contribute to the throwing movement (Young et al., 1996). A systematic review supported the findings of Okada (2011) and colleagues who utilized McGill's (2001) trunk muscles endurance tests to evaluate core stability to define relations with performance in the functional movement screen and measures of sport performance as they found weak to moderate correlations of core stability and functional movement screens and measures of core stability are not strong performance predictors on either physical performance test. They concluded that current assessment of core stability do not substantiate the significance of core stability on functional movement (Reed et al., 2012). Hodges and Richardson (1997) found that the transverse abdominis muscle fibers were the first fibers to fire, as persons free of low back pain flex their shoulders.

MATERIALS AND METHODS

Twenty seven overhead male athletes diagnosed as shoulder impingement syndrome were interviewed. Participants that had at least 3 out of the following 6 criteria were included in the study, these criteria are: Positive "Neer's sign", Positive "Hawkins sign", Pain with active shoulder elevation in the scapular plane, history of pain in the C5-6 dermatome, tenderness of the rotator cuff tendons or Pain with resisted isometric abduction (Lukasiewicz et al., 1999). Patients were excluded if they had shoulder instability (sulcus sign, apprehension sign or history of shoulder dislocation), current symptoms related to cervical spine, a history of acromio-clavicular pain, Diabetic patients, low back pain or previous abdominal surgery.

Procedures.

All volunteered players were informed by the purpose of the study and the testing procedures were fully explained and all relevant questions were answered. Then, if the individual agreed on participating in the current study, he signed on informed consent. A brief learning session about the nature of the study, the purpose of study and the tests to be done were provided to each participant. Patients' demographic data (name, age, address, weight, height & body mass index) were recorded. Core stability was assessed by modified Biering-Sorensen test, trunk flexor endurance test, the pressure biofeedback unit, while closed kinetic function of the shoulder was assessed by the upper quarter Y balance test (UQYBT).

Figure 1. pressure biofeedback unit (PBU)

1.1. The trunk extensor endurance test

Hold time was recorded in seconds while the subjects held a horizontal back extension from a prone lying position with the upper body from anterior superior iliac spines was out of the treatment plinth and the lower body was secured to the treatment plinth by straps.

Figure 2. Trunk extensor endurance test

The trunk flexor endurance test

Hold time was recorded in seconds while the subjects held a 60 degree trunk flexion from a hook lying position with lower limbs secured to the treatment plinth.

Transversus abdominis activation capacity by PBU

The pressure biofeedback unit (inflated to 70 mmHg) was placed under the prone lying subject's abdomen between navel and anterior superior iliac spine.The subject learned to perform abdominal draw in maneuver then readings were taken at rest and after 10 seconds of contraction. Average pressure reduction between rest and contraction of three trials was calculated (de Oliveira et al., 2018).

Upper Quarter Y Balance Test (UQYBT):

While in a push up position, subject tried to reach by the affected hand toward medial, superolateral and inferolateral directions named in relation to the other hand. Sum of the three reach distances divided by three time upper limb length (measured from C7 to tip of ring finger) for normalization (Westrick et al., 2012).

Statistical Analysis

Pearson's correlation was used for assessing relationships between core stability measures (trunk extension and flexion endurance times and transverse abdominis activation capacity) and upper quarter Y balance test scores. Alpha level for significance was set at α=0.05. Correlations Strength was determined using the Pearson's Correlation Coefficient.

RESULTS

Twenty seven male athletes participated in the current study (Table 1). Trunk extension and flexion endurance times, transverse abdominis activation capacity and upper quarter Y balance test scores was recorded. Correlation coefficient of Pearson was used to determine the relationship between core stability measures (trunk extension endurance time, trunk flexion endurance time, Tranversus Abdominis activation capacity) in relation to upper quarter Y balance test. SPSS software for windows, version 23 (SPSS, Inc., Chicago, IL) was used for the statistical significance. There was no significant relation between trunk extension endurance times and UQYBT scores (p=0.655). There was no significant relation between trunk flexion endurance time and UQYBT scores (p=0.266). Also, There was no significant relation between tranversus abdominis activation capacity and UQYBT scores (p=0.101) as illustrated in a Table (2).

Table 2. Characteristics of subjects participated in the study

Demographic variables	Minimum	Maximum	Mean	Std. Deviation
Age	20.00	34.00	26.18	4.35
Weight	65.00	91.00	75.29	6.43
Height	165.00	182.00	174.14	5.11
BMI	22.34	28.71	24.81	1.64

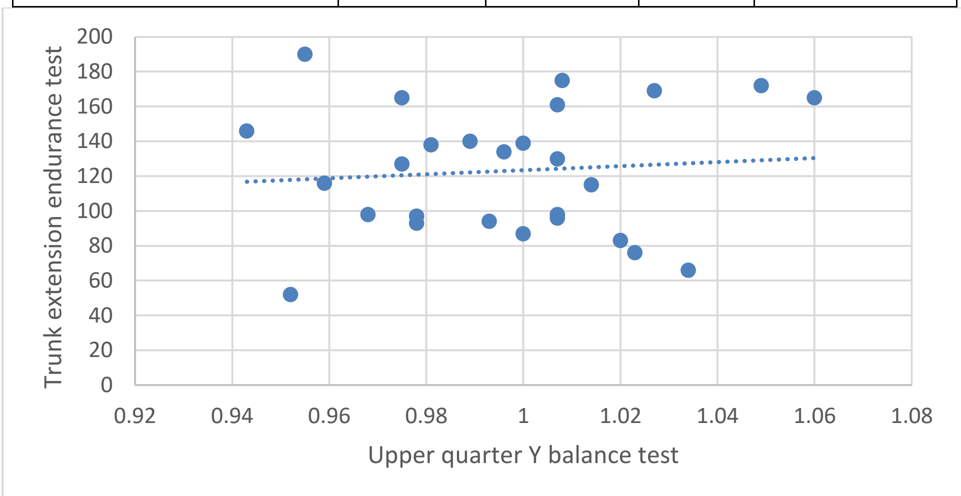

Figure 3. Scatter plot for the bivariate correlation between Upper quarter y balance test and Trunk extension endurance test.

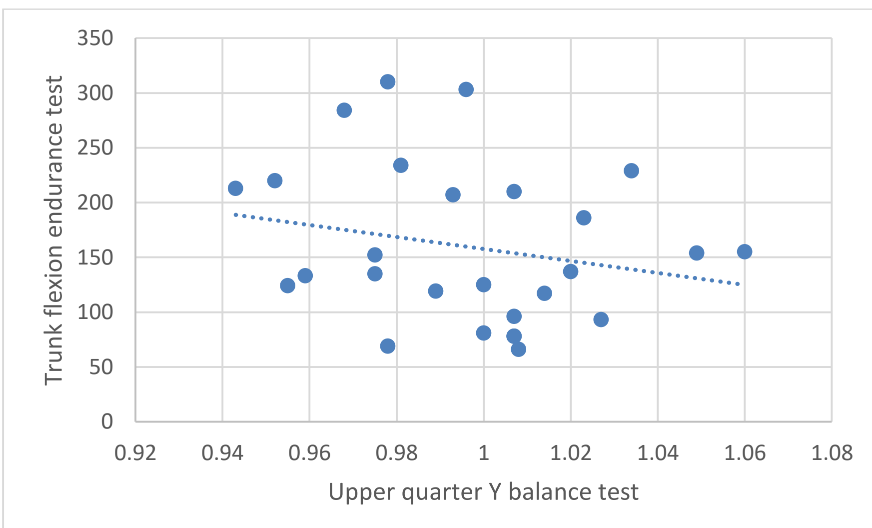

Figure 4. Scatter plot for the bivariate correlation between Upper quarter y balance test and Trunk flexion endurance test

Table 3. Descriptive statistics for core stability measures and shoulder function

Variable	Mean	Std. Deviation	Range	Pearson's Correlation Coefficient	P value
UQYBT	0.99	0.02	0.943-1.06	----	----
TEET	123.03	37.24	52-190	**0.09**	**0.655**
TFET	159.55	71.73	66-310	**-0.222**	**0.266**

TrA. Act. Cap	174.14	5.11	4.3-9.7	**-0.322**	**0.101**

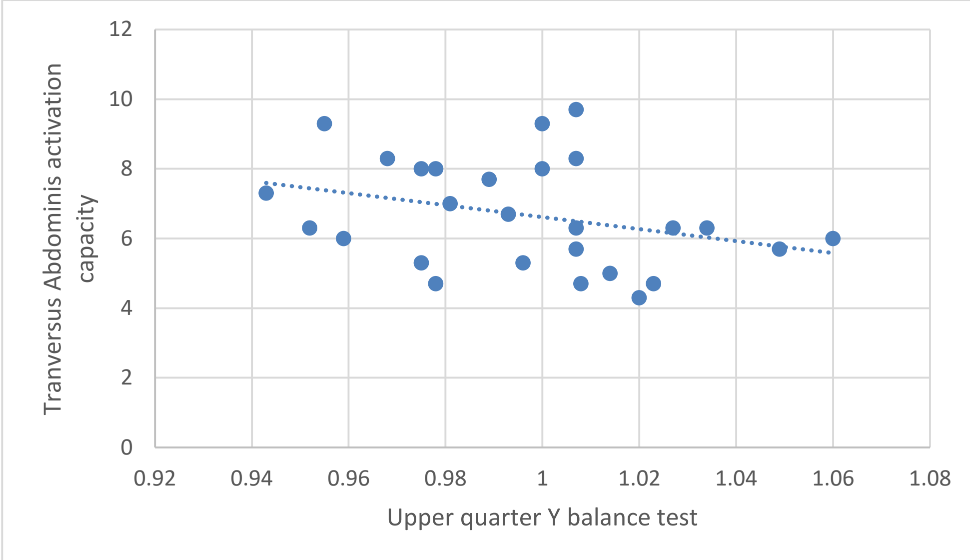

Figure 5. Scatter plot for the bivariate correlation between Upper quarter y balance test and Tranversus Abdominis activation capacity.

DISCUSSION

This study was conducted to examine the relationship between three measures of core stability and the shoulder closed kinetic function in overhead athletes with shoulder impingement syndrome. In the current study there was no significant relation between the endurance measures (holding time) for trunk extensor and flexor endurance and the scores of upper quarter Y balance test. Also, there was no significant relation between tranversus abdominis activation capacity measured by pressure biofeedback and upper quarter Y balance test scores among male overhead athletes. Participants had shoulder impingement syndrome due to mechanical causes (stage II Neer's classification). The inclusion criteria in this study were similar to those used in (Lukasiewicz et al., 1999, Cools et al., 2005 and Sarhan et al., 2009) which made our results consistent and complementary to their previous works. The results of the current study came with agreement with Radwan et al., (2014) who reported no significant difference between control group and shoulder dysfunction group in hold times in horizontal trunk extension as well as the pressure biofeedback readings during double leg lowering. The current study findings agree with previous studies that identified no significant difference for core stability values among swimmers with and without overuse shoulder injuries. Also, the injured group scored higher compared to the uninjured group on two endurance tests (one minute sit-up test and side bridge test) (Rolle, 2006). Endo and Sakamoto (2014) found no statistically significant difference in core stability between healthy adolescent baseball players and shoulder or elbow pain group. Leetun et al., (2004) found that core endurance times between injured and uninjured athletes are similar. Core stability is dependent on motor control and muscular capacity of the lumbo-pelvic-hip complex. Decreased perception of rapid body core displacements during sport-specific tasks may interfere with the generation of sufficient corrective responses of the core muscles (Nabil, 2017). Cholewicki et al., (2000) suggested that during high speed events, the injured athletes may be not able to generate enough force or resist the external forces. Previous studies clarified that core stability is considered an important issue for maintaining dynamic stability of joint throughout the kinetic chain (Akuthota and Nadler, 2004 and Zazulak et al., 2008). The injury-related neural effect on activation of muscles can occur in either a proximal-to-distal or distal-to-proximal pattern. Trunk muscles weakness may reduce the ability of the athletes to stabilize the trunk against the large external forces experienced by these segments during athletic maneuvers especially the anterior abdominal muscles. Hazar et al., (2014) found that UQYBT performance was significantly different between subjects with shoulder impingement syndrome and healthy controls. This difference existed in the medial and inferolateral direction (P<0.05) (P<0.05) respectively, there was a better performance in the healthy controls. On the other hand difference in superolateral performance was not significant. So it was suggested that subjects with shoulder impingement syndrome have worse performance of the UQYBT in the inferolateral and medial directions than healthy controls. In the current study, the sum of the 3 reach directions was calculated for a total excursion score which was normalized for limb length by dividing it by 3 times the upper limb length. Thus, using the medial and inferolateral directions distances of the UQYBT may represent more defects in shoulder function and may show correlation with one of the measures of core stability.

LIMITATIONS

The primary limitation of this study was the relatively small sample size of participants with shoulder impingement syndrome and the absence of dynamic multi-planar testing procedures. Also a limitation of this study was the absence of motor control and power assessments. The results of this study made many questions for further studies. For example, future studies may use measures that assess another core muscles function as the multifidi muscle function.

CONCLUSION

Core stability measures are not related in this study to closed kinetic function of the shoulder. Other measures as muscle capacity and motor control should be evaluated in the future.

CONFLICT OF INTEREST

The present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

All authors contributed equally in all parts of this study.

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