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Correlation between shoulder performance and scapular muscle strength among college students

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ABSTRACT

Shoulder girdle motion is complex and involves a synchronous movement of the scapula and humerus. The scapula serves as the platform for humeral motion. Shoulder injuries are common in the course of the student population. A decrease in shoulder strength plays an important role in the decrease in scapular muscle strength. The hand does not function as an independent factor, but it also depends on the proximal joint stability. Therefore the focus of the study is to correlate shoulder performance and scapular muscle strength among college students. 55 college students with the age group of 18-25 years, both male and female were analyzed. Shoulder performance was assessed by using Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) and scapular muscle strength was assessed by using push-pull dynamometer. Statistical analysis was done by using Karl Pearson's correlation coefficient test with p<0.05. There was a statistically significant correlation between shoulder performance and scapular muscle strength among college students.

Keywords— *Shoulder performance, Scapular muscle strength, Closed Kinetic Chain Upper Extremity Stability Test, College students*

1. INTRODUCTION

Shoulder girdle motion is complex and involves the synchronous movement of the scapula and humerus. The scapula serves as the platform for humeral motion [1]. Functional use of upper extremity is required for the individual to perform a wide variety of occupations necessary for day to day life [2]. The hand does not perform independently and is reliant on the integrity of the shoulder and elbow complexes to allow the appropriate positioning to complete the task [3].

The scapular muscles should be dynamically positioned to the glenoid so that efficient glenohumeral movement can occur. When weakness or dysfunction of the scapular musculature is present, normal scapular positioning and mechanics may become altered. When the scapula fails to perform its stabilization role, shoulder complex function is inefficient, which can result not only in decreased neuromuscular performance but also may predispose the individual to injury to the glenohumeral joint [4] [5].

Functions of scapular motion are to orient glenoid fossa for optimal contact with the manoeuvring arm and to provide a stable base for the controlled motions between the humeral head and glenoid fossa4. The scapula, along with its associated muscles performs the mobility and stability functions very well. That means all activities of upper extremity require controlled scapular mobility and stability. This controlled scapular mobility and stability is obtained by muscles attached to the scapula [6] [7].

Position and control of the scapula on the thorax play a critical role in the normal function of the shoulder. Scapular motions on the thorax align the glenoid fossa with the humeral head maximizing joint congruency and providing a stable base for humeral motion8. So whenever there is scapular muscle weakness which will ultimately lead to the weakness of the muscles around the shoulder joint too. Eventually, the strength of shoulder girdle muscles, as well as scapular muscles, are maintaining the appropriate scapular location [9] [10] [11].

Scapular stability is very much important for the normal shoulder function and to maintain the scapula in normal alignment [12]. Hence shoulder strength is an essential component contributing to whole upper extremity performance [13] [14]. Entire upper extremity strength is very important for doing daily activities [13].

Shoulder pain is frequently reported in individuals who use their arms in a repetitive manner during work or recreational activities14, 15 and 16. Studies have been done on athletic population and on diseased population rather than on college students.

The athletic population is well trained and the shoulder injury becomes very less among them. As the studies are showing that shoulder injuries are common throughout the student population [17] [18].

Due to the lack of studies on the relation between shoulder performance and scapular muscle strength among college students, there is a need to find out the relationship between shoulder performance and scapular muscle strength among college students.

When scapular muscle strength increases the shoulder performance will be better. For any kind of activities involving the upper extremity, scapular muscle strength might be increasing. So understanding the relationship among them can help to increase the whole upper extremity performance in their day to day activities and also design detailed effective exercise programme among college students.

2. MATERIALS AND METHOD

This cross-sectional study was conducted among college students in Dakshina Kannada Mangalore. A total population of 55 samples was collected according to the sample size calculation from the previous article (Tucci HT et al.) Using the formula n= $\frac{Z\alpha^2\sigma^2}{d^2}$ with an age group between 18-25years including both the genders. Students having any medical or musculoskeletal trauma of Upper Extremity (UE), past history of neurological involvement of UE, psychological illness and past surgical history of UE were excluded. Students who are trained athletes were also excluded from this study. Ethical clearance was obtained from the Institutional Ethical Committee. Subjects fulfilling the inclusion and exclusion criteria were enrolled for the study. Prior to the beginning of testing, the purpose and procedures of the study was explained to all participants and provided written informed consent. Shoulder performance was assessed by using closed kinetic Chain Upper Extremity Stability Test (CKCUEST) and scapular muscle strength was assessed by push pull dynamometer.

2.1 Scapular muscle strength was checked by using push pull dynamometer by the following procedure

Testing of the Middle Trapezius (MT): Participants were positioned in prone with their shoulder in 90 degrees of abduction and lateral rotation. The scapula was positioned in adduction. The examiner provided manual fixation just inferior to the contralateral scapula to prevent trunk rotation during testing. Participants were asked to maintain their arm position as the examiner applied a downward force with the dynamometer over the distal third of the radial forearm until the participants' maximal effort was overcome [19].

Testing of the Lower Trapezius (LT): Participants were positioned prone with a towel roll under their forehead. The extremity being tested was positioned diagonally overhead, in line with the muscle fibres and the scapula was passively positioned in an adducted and depressed position. All participants were able to attain the start position of the test. The examiner provided manual fixation just inferior to the contralateral scapula. Participants were asked to maintain the arm position. The examiner provided pressure with the dynamometer in a downward direction over the distal third of the radial forearm until the participants 'maximal effort was overcome [19].

Testing of the Serratus Anterior (SA): Participants were seated in a standard chair with their feet flat on the floor and back supported by the backrest. Their arm was positioned with scapular abduction and the shoulder flexed to 125 degrees. Participants were asked to maintain the upper extremity position as the examiner provided a downward force with the dynamometer just proximal to the elbow. The strength measurement was collected at the point the break occurred during the test [19].

2.2 Closed kinetic chain upper extremity stability test by the following procedure

2 strips of athletic tape are placed parallel to each other (36 inches apart) on the floor and the procedure was explained and demonstrated to the subjects. The starting position for the test is with one hand on each piece of tape while assuming a push-up position. The subjects were instructed that from the starting position they are to use one hand to reach across their body and touch the piece of tape lying under the opposite hand. After touching the tape, the hand is returned to the original starting position. The subject then performs the same movement with the other hand. Touches are counted as every time the hand reaches across the subject's body and touches the tape in the total time of 15 seconds. Three trials were taken and the average of all the three touches was calculated [20]. Shoulder Performance was calculated by following, the formula:

Performance=68%weight*average no. of lines touched/15.

3. RESULT

Data were analyzed by the statistical program for social science (SPSS). Karl Pearson's correlation coefficient was used to check the correlation between shoulder performance, and scapular muscles strength among college students. The level of significance is less than 0.05.

Table 1: Descriptive statistics

	N	Minimum	Maximum	Mean
SP	55	12.00	23.00	17.0091
UTRT	55	1.80	12.00	4.7182
UTLT	55	1.50	11.90	4.4145
LTRT	55	1.50	13.50	3.9964
LTLT	55	1.50	13.50	3.4073
SART	55	1.30	23.00	9.0455
SALT	55	3.00	20.00	8.5527
Valid N (listwise)	55			

The table1 shows the descriptive statistics of the Shoulder performance (SP) and Scapular muscle strength of upper trapezius right and left (SMSUPRT and SMSUTLT), lower trapezius right and left (SMSLTRT and SMSLTLT) and serratus anterior right and left (SMSSART and SMSSALT)

Table 2: Correlation values

	r	P
SP-SMSUTRT	0.863	0.000
SP-SMSUTLT	0.828	0.000
SP-SMSLTRT	0.816	0.000
SP-SMSLTLT	0.734	0.000
SP-SMSSART	0.868	0.001
SP-SMSSALT	0.820	0.001

Table 2 shows the correlation values among Shoulder Performance (SP), Scapular muscle strength of upper trapezius right and left (SMSUPRT and SMSUTLT), lower trapezius right and left (SMSLTRT and SMSLTLT) and serratus anterior right and left (SMSSART and SMSSALT)

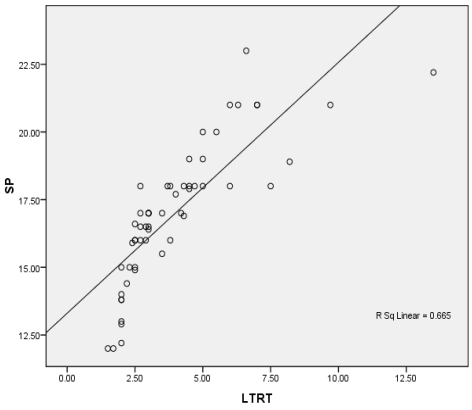

Fig. 1

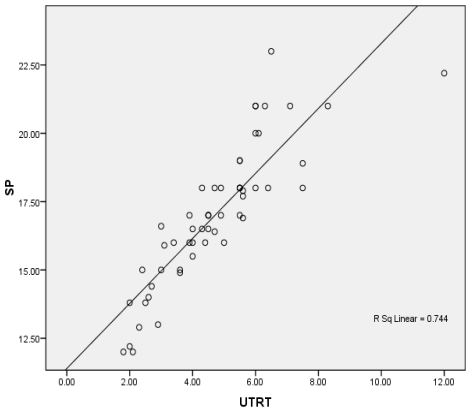

Fig. 2

The above scatter diagram shows that there is strong positive correlation among shoulder performance and scapular muscle strength of upper trapezius right and lower trapezius right.

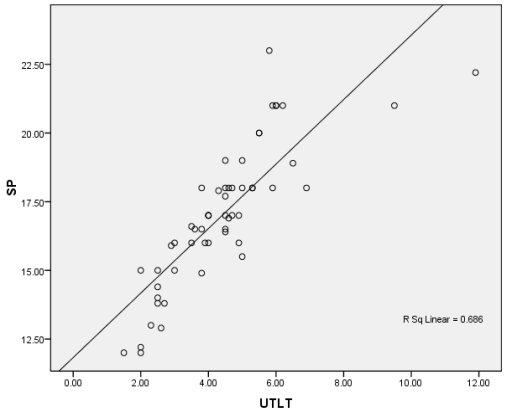

Fig. 3

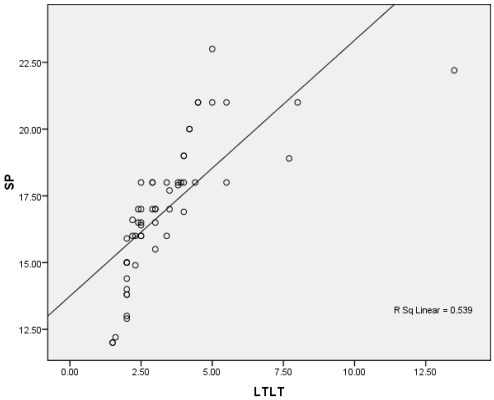

Fig. 4

The above scatter diagram shows that there is a significant strong positive correlation between shoulder performance and scapular muscle strength of upper trapezius left and lower trapezius left.

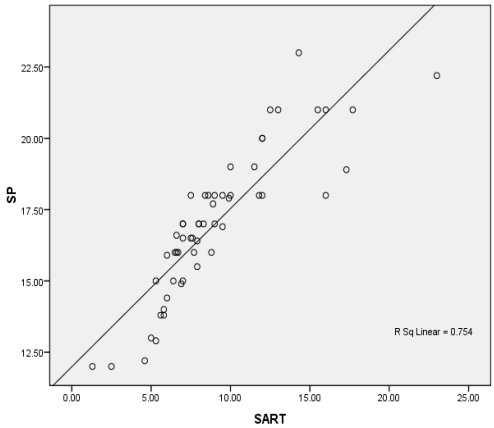

Fig. 5

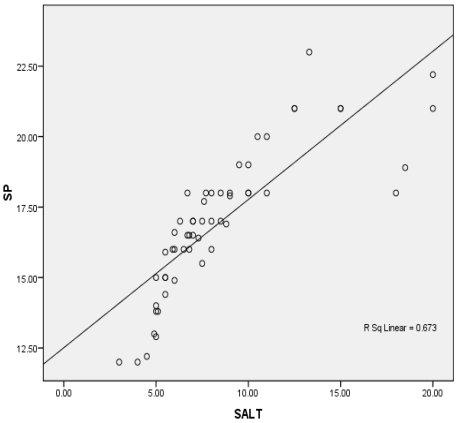

Fig. 6

The above scatter diagram shows that there is a strong positive correlation between shoulder performance and scapular muscle strength of serratus anterior right and left

4. DISCUSSION

In the human body, the role of the scapula is important and the scapula has a significant effect on shoulder movements because it is directly connected to the humerus [21]. The function of the human hand is required to perform various kinds of skilled movements in daily activities. Shoulder girdle motion is complex and involves the synchronous movement of the scapula and humerus. As the movement occurs, the accepted pattern of motion at the shoulder is as follows; the scapula upwardly rotates, posteriorly tilts and externally rotates [22] [23].

Position and control of the scapula on the thorax play an important role in the normal function of the shoulder. Scapular motions on the thorax can align the glenoid fossa with the humeral head maximizing joint congruency and providing a stable base for humeral motion [24]. Alterations in normal motion of the shoulder have been associated with shoulder pathologies such as shoulder impingement [25] [26]. When there is weakness or dysfunction of the scapular musculature, the normal scapular positioning and mechanics of the shoulder may become altered [27] [28].

Studies revealed that shoulder pain is one of the most common complaints and disabling of the musculoskeletal system in the general population. It has an estimated prevalence of 15 - 25% in patients that seek orthopedic and physiotherapy facilities. The literature reported that scapular mobility changes occur in 68% to 100% of individuals with a shoulder injury.

Pimentel et al. conducted a study among university handball players, which aimed to determine the prevalence of shoulder pain, they analyzed male and female handball team players, who were untrained student-athletes aged between 17 and 30 years [29]. From the previous studies it can be further concluded that in the age group between 17-36 years, the pain was irrespectively associated with the degenerative process of the glenohumeral joints [30].

According to the results of this study revealed the ranges of shoulder performance and scapular muscle strength among the age group of 18-25 years. The present study sought to identify the correlation between shoulder performance and scapular muscles strength and found that there is a strong positive correlation among them. The mean level of shoulder performance and scapular muscles strength is based on CKCUEST and Push-pull dynamometer and the r values are 0.863, 0.828, 0.816, 0.734, 0.868 and 0.820.

According to the objective, the shoulder performance was calculated by using a standard closed kinetic chain upper extremity stability test (CKCUEST) which includes 3 trials of a number of touches made in 15 seconds. The mean of the number of touches was calculated and then the shoulder performance was calculated by using the formula: Shoulder Performance=68% of body weight*number of touches/15 seconds. Scapular muscle strength is being calculated by the use of push-pull dynamometer. This had included 3 trials for each muscle group and the mean of which is calculated and that was taken as the average value.

Sathya P et al. showed an increase in shoulder performance with the increase in the age group. The probable reason could be, sport specific training with regular, repeated throwing motions while bowling and throwing the ball causes an increase of shoulder strength [31].

Bassey EJ and Kim YH have mentioned that the positioning of the scapula in the ideal position improves upper extremity function. The muscle activation of the scapula and the shoulder girdle muscles also increased after active scapular protraction. These results show that positioning the scapula in the ideal position can improve the muscle activation of the shoulder girdle muscles [32].

Cho et al. also studied how positioning the scapula in an ideal position through passive protraction affected the function of the upper extremity and ADL of chronic stroke patients. Here results showed that the upper extremity function and ADL of the group that had scapular setting improved more than those of the group that did not receive scapular setting. Hence, when the scapula is in its ideal position or when the stability of the scapula is secured, the shoulder function eventually improves and works better [33].

Huang T S et al. argued that alterations in scapular positioning can have an effect on shoulder function. Furthermore, scapular positioning is hypothesized to bear a direct relationship to scapular stability and the generation of muscular forces, because coordinated muscle patterns are believed to be requisite for normal GH joint function and muscle force production.

Cools AM and Huang TS showed that there is an association between scapular dysfunction and shoulder pain, specifically in the overhead athlete, however, there is no consensus regarding the cause-consequence relationship between both clinical entities. Some studies revealed no causative relationship between scapular dysfunction and shoulder pain, whereas others clearly identified scapular dyskinesis as a possible risk factor for chronic shoulder pain in a population of overhead athletes [34] [35] [36].

In summary, shoulder performance and scapular muscle strength are important factors which are equally important for the betterment of the upper extremity function. Individuals with reduced shoulder performance, their assessment of scapular muscles can be useful to plan a treatment program, which includes scapular muscle training. Scapular muscle strengthening might be helpful in order to improve their overall shoulder performance.

Scapular muscles and their strength are responsible for a better shoulder function, which ultimately lead to a good upper extremity performance. This study can be further conducted in different age groups, among patients with shoulder dysfunction and also who requires more upper extremity activities among sports people. The limitation of the present study is the age group, more males

were included than the females and the extent of their upper extremity use was not taken into consideration. This indicated that a good shoulder performance is a factor which can improve scapular muscle strength. It also shows that for a synchronised performance of scapular muscles and shoulder joint, which is necessary for the betterment of upper extremity performance.

5. CONCLUSION

Present study concluded that there is a strong positive correlation between shoulder performance and scapular muscle strength among college students. It is obvious that the GH joint and scapula cannot function independently. The function of the scapula and surrounding musculature is vital to the normal function of the GH joint. Increase in scapular muscle strength will lead to an increase in shoulder performance. For any activities involving the upper extremity, scapular muscle strength play a major role and both can be used for overhead activities like bowling, throwing etc. An effective exercise program will improve the strength and function of the muscles that control the position of the scapula. Altogether shoulder performance and scapular muscle strength are connected to each other. This individual should give equal importance and design a detailed effective exercise programme in their day to day life on improvement for better shoulder performance and scapular muscle strength.

- **Conflict of interest**: There are no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.
- **Ethics approval:** Ethical clearance was obtained from the Institutional Ethical Committee. All participants gave written informed consent before data collection began.
- **Source of support**: NIL

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