ORIGINAL ARTICLE

THE RELATIONSHIP BETWEEN SHOULDER GIRDLE MUSCLE LENGTH AND HAND DOMINANCE IN ATHLETES

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ABSTRACT: BACKGROUND: Muscular imbalance due to tightness or weakness of the muscles of the upper limbs reduces joint range of motion, changes biomechanical patterns, decreases the efficiency of force production, and increases the chance of injuries to the musculoskeletal system in athletes. This study was pursued as there is paucity of literature understanding the relationship between hand dominance and shoulder girdle muscle length in athletes. **AIMS AND OBJECTIVES:** To evaluate if there is any relationship between hand dominance and shoulder girdle muscle length in athletes. **MATERIALS AND METHODS:** An Exploratory Study was done on 60 athletes between the age group of 18-25 years who were recruited from various sports clubs and organizations in Belgaum, Karnataka. Kendall's Muscle Length Testing techniques were used to measure the length of the shoulder girdle muscles. **RESULTS:** The results of the study demonstrated that there is significant difference of shoulder girdle muscle length in dominant and non-dominant hand. Athletes playing overhead sports showed tight lateral rotators of the dominant hand when compared to non-dominant hand. Those playing contact sports and athletics showed tight rhomboids of both dominant and non-dominant hand and tight lateral rotators of both hands. **CONCLUSION:** There exists a relationship between hand dominance and shoulder girdle muscle length in athletes.

KEYWORDS: Muscle length testing, muscle imbalance, contact sports, overhead sports, athletics.

INTRODUCTION: The muscles around the shoulder complex provide dynamic stability during its large range of mobility. Thus, the muscles surrounding the shoulder complex should be properly balanced for good flexibility and strength. A flexibility or strength deficit in the agonists must be compensated for by the antagonists. Any alteration in this, leads to dysfunction.[1,2] According to Philip McClure, et al, muscular imbalance due to tightness or weakness of the muscles of the upper limbs is very common in athletes.[3] Any load on the musculoskeletal system is classified as either tensile or compressive and repeated demands on the muscles can cause it to shorten and decrease joint range of motion.[2]

This leads to musculoskeletal adaptation or maladaptation of the muscles, changing biomechanical patterns, decreasing the efficiency of force production, and increasing the chance of injuries to the musculoskeletalsystem.[5] The maladaptations lead to muscular imbalances that lead to impairments and structural damage.[3]

Similar maladaptations occur in shoulder girdle muscles that could lead to subacromial impingement and other such shoulder injuries that could reduce the overall performance of the athlete due to the physical demands of the sport.[5] The anterior shoulder girdle muscle tension may affect the tension on the edge of the coracoacromial ligament, predisposing to tightness. Tightness of the pectoralis major creates an anterior force on the glenohumeral joint with a consequent decrease in stability. Tight pectoralis minor limits scapular upward rotation, external rotation and posterior tilt.[8]

Full range of scapulohumeral and scapular motion for normal overhead elevation of the arm in flexion or in abduction requires adequate length in the following muscles: Pectoralis Major, Pectoralis Minor, Latissimus Dorsi, Rhomboidus Major, Rhomboidus Minor, Teres Major, Rotator Cuff muscles.[6] According to Ramsi M, et al, the internal rotator and external rotator muscles of the shoulder play an important role in providing stability and mobility to the glenohumeral joint, especially in overhead athletes.[11]

Thus, it is very important to understand the condition of all these muscles as a pre-evaluation screening to prevent and detect injuries such as shoulder impingement syndrome.[7]

Full Range of motion across a joint is dependent on the joint range of motion and the muscle length. Muscle length refers to the ability of a muscle to lengthen allowing a joint or a series of joints to move through the available range of motion. Muscle length testing with the help of a universal goniometer or an inch tape, is a technique used to measure the muscle length.[10]

To our knowledge, there have been limited studies to understand the relationship between shoulder girdle muscle length and hand dominance, using muscle length testing techniques.

A study done by H. K. Wang and T. Cochrane, suggested that there is a difference of muscle strength and mobility in the dominant and non-dominant limbs and that dominance is one of the factors contributing to decreased range of motion.[4] Hence, it was hypothesized in the present study that there would be a difference of the shoulder girdle muscle length in the dominant and non-dominant hand. Consequently, the objective of the study was to compare the shoulder girdle muscle length of the dominant and non-dominant hand in athletes and understand if there exists a relationship between them.

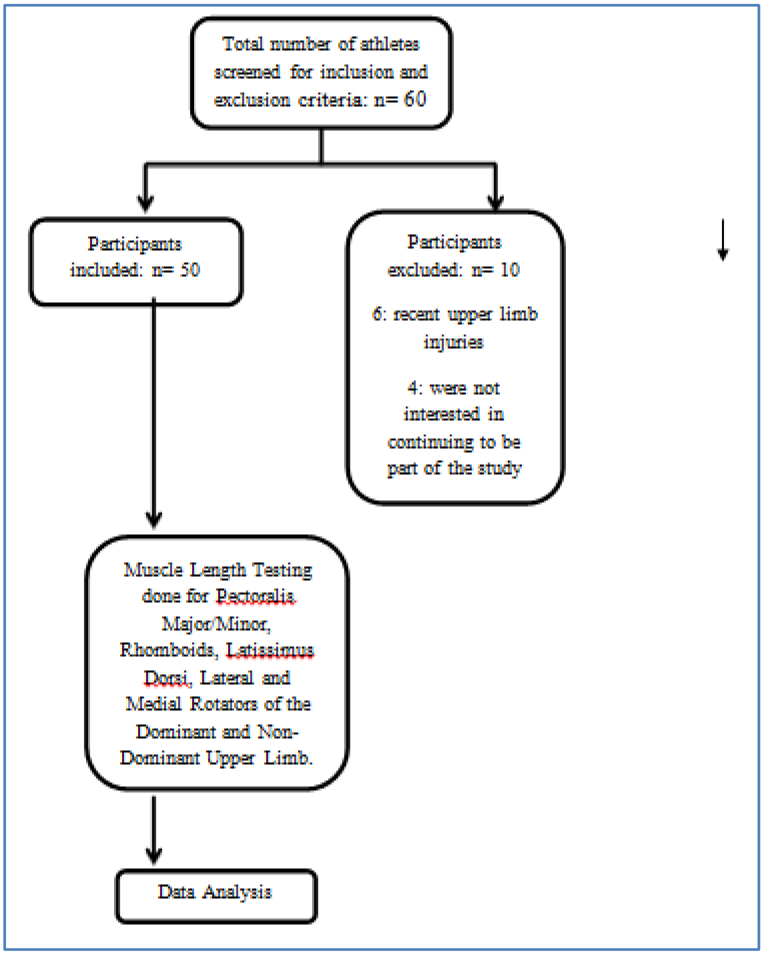
METHODS: We used a randomized design and enrolled 60 participants (using thumb rule) in our study, using convenience sampling. All the participants played at the university level. Six out of the 60 participants were excluded because of recent upper limb injuries and four participants backed out as they were not interested in continuing to be part of the study.

Inclusion Criteria: Participants playing any sport from the age group of 18-25 and participants who were willing to participate in the study.

Exclusion Criteria: Participants with any shoulder pathology or trauma from the past 6-12 months, participants who had undergone any physiotherapy treatment for shoulder or elbow pain from the past 6 months and participants with any medical illness or disabilities.

PROCEDURE: After obtaining the approval for the study from institutional ethical committee, all the participants who were willing to participate in the study were asked to sign an informed consent. Sixty participants were screened out of which ten were excluded due to previous shoulder injuries. Using Kendall's Muscle Length Testing Techniques,[6] the muscle length was assessed for the shoulder girdle muscles of both dominant and non-dominant hand. The muscles tested were, Pectoralis Major, Pectoralis Minor, Rhomboids, Teres Major, Rotator Cuff muscles.

Flowchart Depicting the Procedure:



Pectoralis Major: (shown in Figure 1, Appendix-2): The participant was asked to lie in supine with knees bent and low back flat on the table. The examiner placed the arm in a position of approximately 135 degrees abduction (in line with lower fibres), with elbow extended and shoulder in lateral rotation. Arm dropping to the table level with low back remaining flat on the table indicated normal length whereas if extended arm did not drop down to table level, it indicated shortness.

To test the clavicular part, participant's arm was horizontally abducted with elbow extended and shoulder in lateral rotation with the palm facing upward. Normal length showed full horizontal abduction with lateral rotation and arm flat on table without trunk rotation. If arm did not drop down to table level, it indicated shortness. In both these cases, limitation was in degrees using a goniometer.

If the arm dropped down beyond the table, it indicated excessive length and the limitation was measured in degrees using the universal goniometer.

Pectoralis Minor: The participant was in supine with arms at sides, elbows extended, palms upwards, knees bent and low back flat on the table. The examiner stood at the head of the table and observed the position of the shoulder girdle. The amount of tightness was measured by the extent to which the shoulder is raised from the table and by the amount of resistance to downward pressure on the shoulder.

Latissimus Dorsi, Rhomboid Major and Minor: (shown in Figure 2, Appendix-2): The participant was in supine with arms at the sides, elbows extended, knees bent and low back flat on the table. The examiner asked the participant to raise both his/her arms in flexion overhead, keeping arms close to the head and bringing arms down toward the table, maintain low back flat.

The ability to bring down the arms to the table level indicated normal length. Shortness was indicated by the inability to bring down the arms to the table level. Measurements were measured in degrees using the universal goniometer.

Medial Rotators: The participant was in supine with low back flat on table, arm at shoulder level with 90 degrees abduction, elbow at the edge of the table and flexed to 90 degrees and forearm perpendicular to the table. The examiner asked the participant to bring the forearms down to the table level parallel with the head. The participant was not allowed to arch the back up from the table.

Normal range indicated 90 degrees with forearm flat on the table while maintaining low back flat on the table.

Lateral Rotators: (shown in Figure 3, Appendix- 2): The position of the participant was same as that of medial rotators testing. The examiner then asked the participant to medially rotate the shoulder, bringing the forearms down towards the table while the examiner held the shoulder down to prevent substitution by the shoulder girdle. The participant was not allowed to forward thrust the shoulder girdle.

Normal range of motion will be 70 degrees with forearm at 20 degrees angle with table.

STATISTICAL ANALYSIS: The demographic data including the age, sex and the Body Mass Index (BMI) was analysed using mean and standard deviation. Analysis of the data was done using SPSS-12 Software. The variables in the data were analysed using χ^2 test.

RESULTS: The results of the present study showed no significant differences in relation to the demographic data (as shown in Table 1, Appendix-1). Nevertheless, the data analysis demonstrated significant results indicating that there is significant difference of shoulder girdle muscle length in dominant and non-dominant hand (as shown in Table 2, Appendix-1, Graph 1 and Graph 2, Appendix- 3). The participants played one of the three sports: overhead sports (basketball, volleyball, and racquet sports), contact sports (football and cricket) or athletics (track and field events). Athletes playing overhead sports showed tight lateral rotators of the dominant hand when compared to non-dominant hand (P value ≤0.0007). There was no significant difference in the length of latissimus dorsi, rhomboids and teres major (P value ≤0.841).There was also no significant difference in the length of pectorals (p= 0.924 to 1), medial rotators (p= 1) or the pectoralis minor (p= 0.160).

DISCUSSION: There have been several studies evaluating the muscle imbalances of the upper limbs in competitive swimmers and volleyball attackers[11,12,13] where they concluded that muscular balance of the shoulder girdle is essential to prevent injuries like shoulder pain and impingement.
To our knowledge, there has not been much research done measuring the muscle length of the shoulder girdle muscles using muscle length testing. The participants of the present study participated in either of three following categories of sports- Overhead Sports, Contact Sports, or Athletics. Out of the 50 participants, 25 played overhead sports (basketball, volleyball and racquet sports), 12 played contact sports (football and cricket) and 13 played athletics (track and field events). Participants who played overhead sports showed statistically significant tight lateral rotators of the dominant hand compared to that of the non-dominant hand. One of the reasons could be that most of the overhead sports involve overhead medial rotation during different activities of the game. A study done by H. K. Wang and T. Cochrane indicated similar results related to muscle imbalances, but this study was done exclusively on elite volleyball players and they measured the rotator muscles' strength and compared it with the dominant and non-dominant hand[4]. This is in contrast to the present study, where we have measured the length of the shoulder girdle muscles using muscle length testing and had taken all sport events into consideration.

In another study, Hassan Daneshmandi et al, assessed the ROM of shoulder in athletes and non-athletes and concluded that there was significant difference in the ROM of dominant and non-dominant hand in both the groups, particularly in external rotation.[5] This study had included handball, volleyball, football and non-athletes. The results of this study showed that by increasing age and years of tournament play, internal and external rotations of shoulder in all groups were reduced. The study also suggests that this could happen due to sport specific physiological adaptations that we have observed in our study. The present study demonstrated clinically significant tightness of the rhomboids, lateral rotators and pectoralis minor of the participants who played contact sports and athletics. This could be because of the protracted shoulders and the stooping forward posture that they develop due to vigorous running while focusing on the target and changing directions on the field. According to the biomechanical paradigm proposed by Shirley Sahrmann, repeated motions or sustained postures could lead to adaptations in muscle length, strength and stiffness.[10] This could also be explained by the neurological paradigm of Janda's Upper Cross Syndrome, where due to protracted shoulders there occurs tightening of Pectorals, leading to weakening of Rhomboids.[2] The present study did not show any significant differences in the length of the pectoralis major muscles.

LIMITATIONS AND FUTURE SCOPE OF THE STUDY: There are some limitations to be considered in this study. Firstly, the outcome measure considered was purely subjective and no objective quantification could be obtained with the help of it. Secondly, the sample size included was small.

CONCLUSION: It was found that there is a relationship between shoulder girdle muscle length and hand dominance in athletes. Muscle Length Testing can be used to understand this relationship. The muscle length was either shortened or lengthened depending on the dominance and the type of sport played.

CLINICAL IMPLICATIONS: Muscle Length Testing can be part of the regular screening that athletes undergo. This testing can rule out any imbalances in the muscle and prevent further injuries or detect them.

FUTURE SCOPE: The increase in length is probably dependent on the type of sport played. Hence, future studies can be performed with a larger sample size targeting specific sports to be able to have a more comprehensive understanding and also to see the effect on Pectoral muscles. The present study was done in athletes playing at the competitive level. Further research can be done, comparing the results with that of an elite group of players. Research can also be carried out in male and female players separately to make gender based comparisons.

Also, no research to date has been done exploring the reliability of muscle length testing of the upper extremity, as suggested by Nancy Berryman Reese, William D. Bandy. Further research can be pursued highlighting this fact to help clinicians with proper evaluation of upper extremity flexibility.

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APPENDIX- 1:

Table 1: Showing the Demographic data that was analysed using mean and standard deviation.

AGE	21.4 ± 2.27
BMI	22.6 ± 2.95
MALE: FEMALE (in %)	40:60
Table 1	

Table 2: Showing the values obtained for the muscles in the dominant and non- dominant hand: Pectoralis major (upper and lower fibres), Pectoralis minor, Latissimus dorsi/rhomboids/teres major, medial rotators and lateral rotators.

PECTORALIS MAJOR (UPPER/ LOWER FIBRES)			
	NORMAL	LENGTHENED	P VALUE
DOMINANT	38	12	0.202
NON-DOMINANT	43	7	
PECTORALIS MINOR			
	NORMAL	SHORTENED	P VALUE
DOMINANT	35	15	0.160
NON-DOMINANT	41	9	
LATISSIMUS DORSI/ RHOMBOIDS / TERES MAJOR			
	NORMAL	SHORTENED	P VALUE
DOMINANT	23	27	0.841
NON-DOMINANT	24	26	
MEDIAL ROTATORS			
	NORMAL	SHORTENED	P VALUE
DOMINANT	47	3	1
NON-DOMINANT	48	2	

LATERAL ROTATORS			
	NORMAL	SHORTENED	P VALUE
DOMINANT	6	44	0.0007
NON-DOMINANT	21	29	

Table 2

APPENDIX- 2:

Fig. 1: Measuring the length of Pectoralis Major (clavicular fibres)

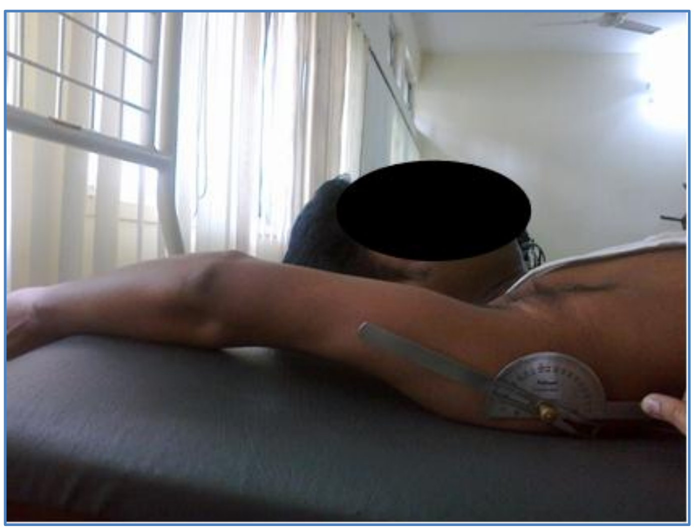


Fig. 2: Measuring the length of Rhomboids/ Latissimus dorsi

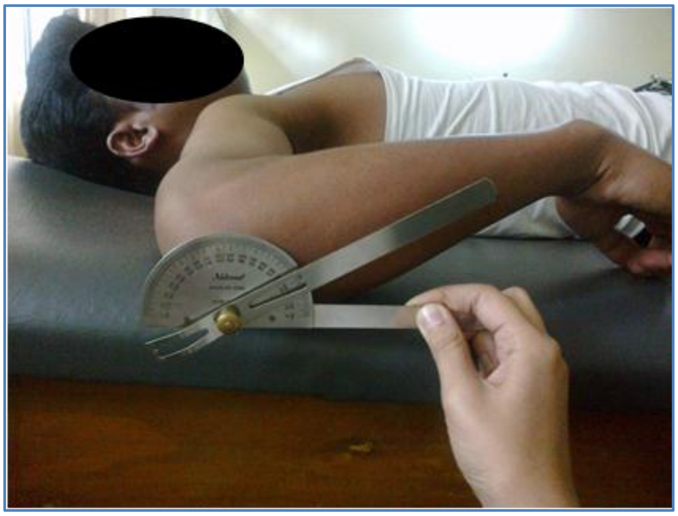
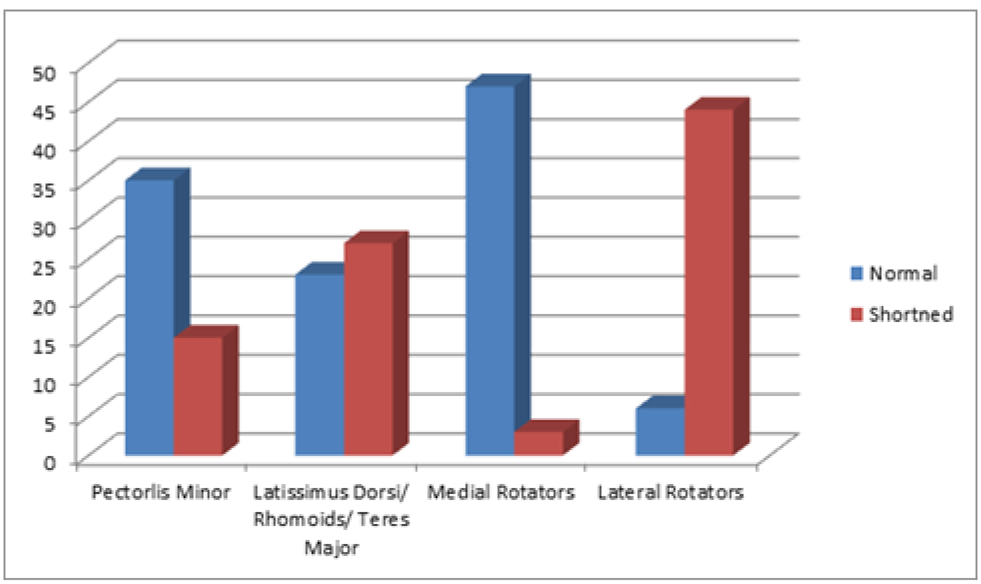
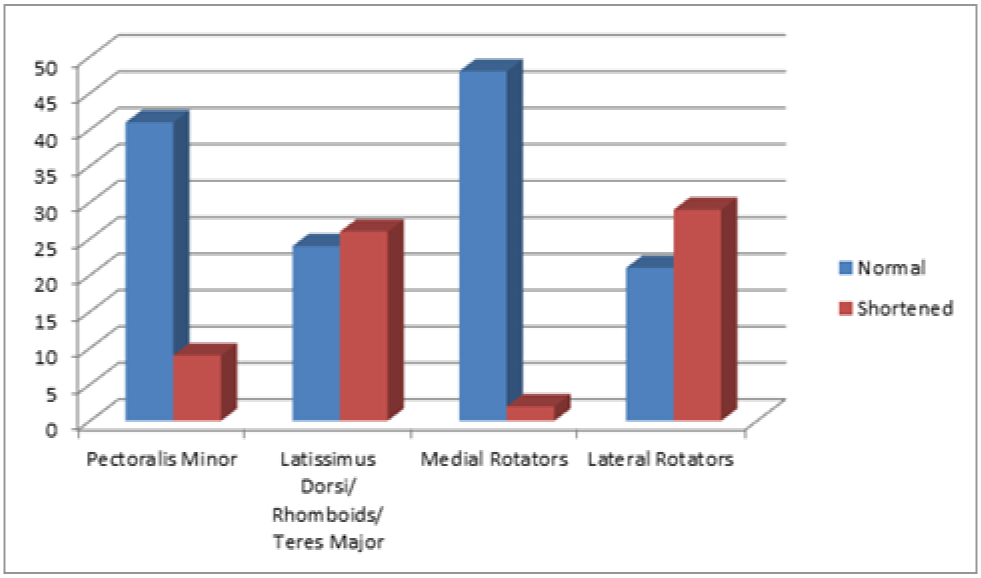


Fig. 3: Measuring the length of Lateral Rotators

APPENDIX- 3:



Graph 1: Representing the muscle length of the shoulder girdle muscles of the dominant hand (excluding Pectoralis Major)



Graph 2: Representing the muscle length of the shoulder girdle muscles of the non-dominant hand (excluding Pectoralis Major)

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