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[ORIGINAL ARTICLE]

Evaluation of Isometric shoulder rotator cuff strength variation among healthy individuals using isometric strength testing device- Cross sectional study.

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Background: The study is based on measuring the isometric strength of rotator cuff muscles in healthy individuals aged 40 years and above. As mechanical force generated by these muscles is easily measurable, the pathology of these muscles might be identified by assessment of the isometric strengths of these muscles. For assessing the isometric strength, we used an isometric strength testing device with an adjustable dynamometer shaft & one weight sensor, which determines the force generated by the respective muscle group in kilograms.
Method: It was an observational study with six months duration. A total of 50 healthy adult volunteers, 26 males & 24 females, were included; maximal isometric force is measured at standardized positions for supraspinatus and subscapularis in both dominant and non-dominant shoulders, using isometric strength testing devices.

Result: Isometric strength of the subscapularis muscle, when compared between the dominant and non-dominant sides, showed a significant difference. And the mean was(0.5479). The average isometric strength of the Supraspinatus muscle, when compared between both dominant & non-dominant sides, there was a significant difference. The mean was(0.2417), and the p-value was < 0.0001, showinga significant difference.

Conclusion: The study concludes that there is minimal isometric strength variation for the supraspinatus muscle, while a significant difference was found for the subscapularis muscle.

Keywords-

Rotator cuff muscles, isometric strength testing device, healthy individuals, shoulder injuries.

Introduction:

The rotator cuff is a group of four muscles and tendons surrounding the shoulder joint, providing strength and stability. The rotator cuff consists of the subscapularis, supraspinatus, infraspinatus, and teres minor. The rotator cuff has an essential role in the stability and function of the glenohumeral joint.[2] The rotator cuff provides a stabilizing effect on the shoulder because of Compression of the humeral head against the glenoid cavity. The rotator cuff performs multiple functions during shoulder exercises, including glenohumeral abduction, external rotation (ER), and internal rotation (IR). The rotator cuff also stabilizes the glenohumeral joint and controls humeral head translations. The infraspinatus and subscapularis have significant roles in scapular plane abduction (scaption), generating two to three times greater than the supraspinatus force. The subscapularis muscle (SCM) is the main medial rotator of the humerus and contributes to the anterior dynamic stability of the glenohumeral joint. However, the supraspinatus remains a more effective shoulder abductor because of its more effective moment arm. Both the deltoids and rotator cuff provide significant abduction torque, with an estimated contribution up to 35-65% by the middle deltoid, 30% by the subscapularis, 25% by the supraspinatus, 10% by the infraspinatus and 2% by the anterior deltoid.[6][4]

Muscular strength is one of the components of physical fitness. Muscular strength is defined as the total amount of force a muscle can produce and is usually measured by the maximum amount of force a muscle can produce in a single attempt.[8] Muscular

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strength is the ability to exert force on an external object or resistance and is a crucial determinant of physical function. It is a strong predictive factor of functional capacity. Greater muscular strength can enhance the ability to perform functional tasks.[11] Measurement of muscle strength has its importance in clinical practice and rehabilitation.[6] It is an essential clinical factor when planning a treatment protocol to measure the therapy's effect, and it can be a considerable factor while discharging a patient.[4] Decreased muscle strength is a significant area of focus during a treatment intervention in physiotherapy.[12]

Muscle strength can vary by a change in muscle length while performing a muscular contraction. In regards to muscular length, there are three types of muscle contractions. They are isometric contractions, concentric contractions, and eccentric contractions.[9] During an isometric contraction, there is no change in length. While performing the concentric contraction, the length of the muscle decreases, and while performing the eccentric contraction, the length of the muscle increases.[6][8] Isometric muscle testing is the most commonly used assessment method as it is simple to perform and reproduce.[1][2] Isometric measurement predicts functional capacity in older adults and patients who have experienced functional losses because of injury.[11] Device the isometric strength testing device has been designed and invented for the isometric quadriceps and hamstrings muscle strength. An adjustable dynamometer shaft is placed in front of the chair. One weight sensor is attached, determining the force the respective muscle groups generate in kilograms. The chair consists of a visual display at the top, through which the pressures applied over the resistance pad in the form of mechanical energy are converted into electrical signals and will be displayed in the digital display and are read and saved in the computer.

The chair has a solid frame, adjustable back support, and a firm seat base. Armrests by the sides for manual fixation. The wrist or resistance pad over the armrest is adjustable and can be slid horizontally and vertically. Four stabilization belts are attached to the chair via hooks to avoid trick movements and achieve contraction of the targeted muscle group.

Method:

This is a cross sectional study with a study duration of 6 months. A total 50 no of Participants were recruited at the Department of Physiotherapy and Orthopaedics using the purposive sampling method Dr. Vikhe Patil Memorial Hospital, Ahmednagar. The study material included was an isometric strength testing device. Normal healthy individuals with age group of 40 to 60 years. Individuals with intact rotator cuff were included in the study. Individuals without any cardiovascular or neurological disorders. Individuals with recent injuries around the shoulder were excluded, and individuals with any orthopedic surgery related to the upper extremity were excluded from the study.

Procedure:

Institutional committee approval was obtained before the study's commencement after explaining the research's purpose and importance to the participants. After the verbal agreement of the participants, informed consent in English/Marathi was obtained. Participants were screened according to inclusion and exclusion criteria. Primary demographic information such as name, age, gender, and occupation were documented. The study procedure was explained to all the participants, and instructions were given to participants, such as"lift your hand as much as you can" to measure the isometric strength of the rotator cuff. I will encourage you and instruct you when to start and when to stop. As I say, "START," You need to perform the maximum contraction and hold it for 5 seconds. As I say, "STOP," reduce your power to the starting position and release the pressure over the resistance pad. Three trials were conducted for each rotator cuff muscle with a 1-minute break between the three trials of each muscle group and a 3-minute interval between measurements of muscle groups.

Isometric strength testing:

Supraspinatus muscle testing:-

Isometric strength test of supraspinatus muscle. This maneuver assesses the strength and integrity of the supraspinatus tendon. The patientstood beside the chair with the armabducted to 45 degrees. The patient was asked to apply pressure against the resistance pad in the direction of abduction movement.

Fig. 1: Supraspinatus muscle testing

Subscapularis muscle testing:-

This maneuver assesses the strength and integrity of the supraspinatus tendon.The lift-off test was performed by placing the back of the hand at the L3 level when the subscapularis was in its maximum contraction amplitude.

Fig. 2 : Subscapularis muscle testing

Subscapularis muscle testing:-

This maneuver assesses the strength and integrity of the supraspinatus tendon.The lift-off test was performed by placing the back of the hand at the L3 level when the subscapularis was in its maximum contraction amplitude.

Result:

The data were analyzed in an Excel sheet. An InStat version 3 was used to calculate the mean, standard deviation, and p values. The unpaired "t" test was used to compare the strength of both the dominant and non-dominant sides.

Table1: Baseline details of participants

Sr No	Gender	No. of Participants	Muscle	Side
1	Male	26	Supraspinatus	Dominant
2	Female	24	Subscapularis	Non-dominant

Table 2 : Isometric supraspinatus muscle strength of both dominant and non-dominant sides in males& females, respectively.

Sr No.	Supraspinatus Muscle	Mean Value	SD value	P value	Result
1	Dominant side	2.906	0.6926	0.0919	Considered not quite significant
2	Nondominant side	2.664	0.5880		

The above table depicts the mean value of supraspinatus muscle strength among healthy male & female participants. The mean isometric strength in both dominant and non-dominant sides was found to be 2.906 for the dominant side, and for the non-dominant side it was 2.664. The p-value was 0.0919, suggesting no difference in the isometric strength of both dominant and non-dominant sides.

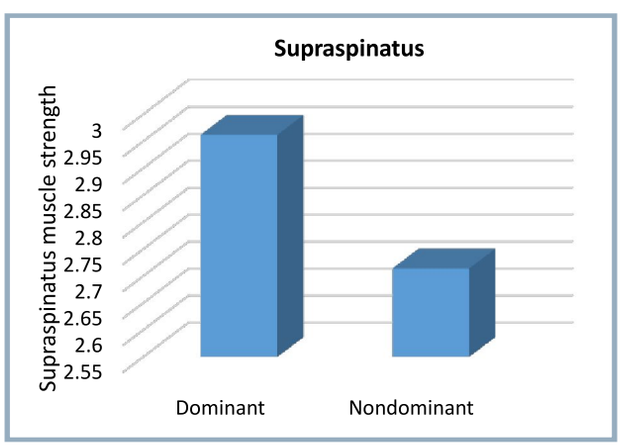


Fig1: Shows isometric strength of the supraspinatus muscle

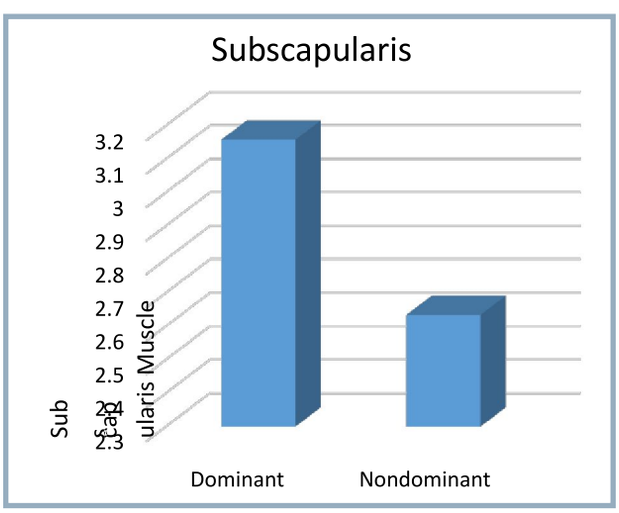
This is a graphical representation of the isometric strength variation of the supraspinatus muscle between the dominant and non-dominant sides.

Table 2 - shows the isometric subscapularis muscle strength of both dominant and non-dominant sides in males & females, respectively.

Sr No.	Subscapularis Muscle	Mean Value	SD value	P value	Result
1	Dominant	3.1854	0.7426	<0.0001	Considered Extremely Significant
2	Non-dominant	2.6375	0.5077		

The above table depicts the mean value of the isometric strength of the subscapularis muscle among healthy individuals. The mean isometric strength of the dominant side was found to be 3.1854 and 2.6375 for the non-dominant side. The p-value is<0.0001, suggesting a significant strength difference between the dominant and non-dominant sides.

Fig 2: shows the isometric strength of the subscapularis muscle.



This is a graphical representation of normal isometric strength variation of the subscapularis muscle in both the dominant and non-dominant sides.

Discussion:

A previous study used a portable dynamometer to measure isometric muscle force, which is known to be precise and efficient.15Therefore, they employed one method that would have determined the normal values of isometric force generated by the rotator cuff muscles. They chose to measure the isometric forces in positions of the arm that do not provoke subacromial impingement,12, i.e., in 45° of abduction and 30° of forward flexion for supraspinatus muscle evaluation, without reaching 90° of abduction in the scapular plane. In this position, a maximal effort of the supraspinatus is generated, according to electrophysiological analysis.7 Also, secondary discomfort of subacromial irritation as a result of narrowing the subacromial space at 90° of shoulder abduction is eliminated. The latter is of special importance, as in further studies in patients with subacromial narrowing, a comparison with the present normal values will be considered.

Supraspinatus activity is similar between 'empty can' and 'full can' exercises, although the 'full can' results in less risk of subacromial impingement. Infraspinatus and subscapularis activity have generally been reported to be higher in the 'full can' than the 'empty can.' In contrast, posterior deltoid activity has been reported tobe higher in the 'empty can' than the 'full can.'[2] In his study, MacKinnon14 built a device for isometric muscle strength analysis of the upper right limb in different positions using a load cell. The study included eight subjects (five men and three women) aged 20-43. However, information on participating subjects, such as occupational and physical activity and general health, was not provided. The average strength values (N) found by this author vary according to the subject's position during testing. For example, in the sitting position, the averages for efforts in the sagittal plane (flexion) ranged between 75 and 204 N. When the subjects were tested standing, the averages ranged from 99 to 241 N. In this study, there was no statistical difference between the strengths produced by muscle contraction of the dominant limb compared to those produced by the non-dominant limb.

In this study, we determined a basis for the future development of muscle testing for diagnosing disabilities in rotator cuff muscles. Recognizing the normal values of isometric strength of the rotator cuff muscles will enable the identification of abnormal patterns of muscle isometric strength in patients with shoulder rotator cuff pathology in future studies. Recognition of these patterns might provide a reliable tool for developing an effective strength testing method for diagnosing disorders in the rotator cuff.

Conclusion:

Oncomparison of the isometric strength generated by rotator muscles such as supraspinatus and subscapularis muscles of shoulder joint between the

Dominant and non-dominant upper limb among healthy individuals. The normative data we found for isometric supraspinatus and subscapularis muscle strength shows minimal strength variations of supraspinatus muscle on the dominant and non-dominant sides. In contrast, there is a significant strength variation in both sides' isometric strength of the subscapularis muscle. No statistical difference was observed by comparing the strength values of all isometric strength tests.

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