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Correlation between grip strength and scapular muscle

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ABSTRACT

The human hand is designed to perform various kinds of skilled movements in the daily activities. Such activities are termed as 'Prehension Activities'. Grip strength has been used to assess general strength in order to determine work capacity, to determine the extent of injury and disease processes and progress of rehabilitation. To perform distal movements it is important to have proximal joint stability. The hand being the distal component, a good grip might require adequate shoulder stability which will be dependent upon its musculature. Hence this study was conducted to find out if there exists a correlation between these two. Aim: To find out if there is a correlation between grip strength and scapular muscles Methodology: Grip strength assessment was done using dynamometer and scapular muscle strength was assessed using Micro-FET. Results: Pearson's correlation coefficient was calculated for the correlation between grip strength and scapular muscle strength Conclusion: There is the statistically significant correlation between grip strength and scapular muscle strength

Keywords: *Grip Strength, Hand dynamometer, Micro FET, Scapular muscle strength*

1. INTRODUCTION

The human hand is designed to perform various kinds of skilled movements in the daily activities. Such activities are termed as 'Prehension Activities'. Prehension activities of hand involve the grasping or taking hold of an object between any two surfaces of hands; the thumb participates in almost all prehension tasks. These activities can be categorized as either power grip (full hand prehension) or precision handling (finger-thumb prehension). Power grip is a forceful act which leads to flexion at all finger joints. When a thumb is used, it acts as a stabilizer to the object held between the fingers. Power grip has 4 sub-types: Cylindrical grip, Spherical grip, Hook grip, Lateral prehension. Precision handling is a skillful placement of an object between fingers and thumb. Precision handling has 3 sub-types: pad-to-pad, tip-to-tip, and tip-to-pad. Thumb is generally abducted and rotated from the palm. The fingers in a power grip usually function in concert to clamp on and hold an object into the palm. The degree of Finger flexion changes as per the size, shape, and weight of an object.

The most 'functional' type of grip within the 4 types of power grip is 'Cylindrical Grip'. It almost involves exclusive use of flexors to carry the fingers around and maintain a grasp on the object. The function in the fingers is performed largely by FDP (Flexor Digitorum Profundus) muscle especially in the dynamic closing of the fingers. In the static phase when the more powerful grip is required, the FDS (Flexor Digitorum Superficialis) assists. Along with FDP and FDS muscles, considerable interosseous muscle activity is also required. The interossei function primarily as MP (Metacarpophalangeal) joint flexors and abductors/adductors. The thumb usually comes around the object, then flexes and adducts to make a grip. The FPL and thenar muscles are also required. The activity of thenar muscles will change with a width of the web space and with the more pressure or resistance. The cylindrical grip is typically performed with the wrist in neutral /extension and slight ulnar deviation.

The hand being the distal component, a good grip might require adequate shoulder stability which will be dependent upon its musculature

Grip strength is correlated with upper extremity function and proximal stability provided by shoulder girdle. Grip strength has been used to assess general strength for determining work capacity, the extent of injury and disease processes and progress of rehabilitation. In short, grip strength is a parameter to assess the function of the upper extremity. In case of cervical region pathologies, it is very common to have a weak grip and/or weak scapular muscles. Several studies have shown a positive correlation between hand gripping activity and rotator cuff muscle activity. (1-3) Kwasniewski (4) compared bilateral rotator cuff strength in patients with a unilateral hand or wrist disorder using a hand-held dynamometer and reported a statistically significant decrease in elevated external rotation strength. Kwasniewski (4) stated that it was unclear whether there is a causal relationship. Similarly, Budoff (5) found an increased prevalence of rotator cuff weakness of the limb with an associated hand or wrist disorder. Alterations in muscle activity patterns have been seen in the presence of shoulder dysfunction (6-8). The activity of some shoulder muscles

increasing or decreasing when gripping is added to shoulder movements[1](2,9) Alterations in muscle activity where there is pain is considered to reduce load within the painful region to protect from further pain and/or injury(9) and gripping may result in a redistribution of force in the rotator cuff muscles(10) Because co-activation of the proximal and distal arm muscles has been shown to occur during gripping(11) it is feasible that assessment of grip will give an indication of the activity of the rotator cuff. This is especially likely in the light of the findings of Antony and Kei (9) who noted that infraspinatus activity increased when gripping was added to shoulder motion.

The ultimate functions of scapular motion are to orient glenoid fossa for optimal contact with the maneuvering arm and to provide a stable base for the controlled motions between the humeral head and glenoid fossa. The scapula, with its associated muscles and linkages, performs these mobility and stability functions very well. That means all activities of hands (prehension activities) require controlled scapular mobility and stability. This controlled scapular mobility and stability is obtained by muscles attached to the scapula.

Scapular stability is important for normal shoulder function and to maintain the scapula in normal alignment. The resting position of the arm creates a downward rotation, abduction and forward tipping moment on the scapula. The downward rotation is balanced by the dynamic support of upper trapezius and serratus anterior. The forward tipping and abduction are balanced by rhomboids and middle and lower trapezius. With active arm motion, the trapezius muscles with serratus anterior upwardly rotate the scapula whenever arm abducts or flexes and the serratus anterior protracts the scapula on the thorax to align scapula during arm flexion and hand activities. A faulty scapular posture is associated with decrease flexibility in the pectoralis minor, levator scapulae and scalene muscles and weakness in the serratus anterior and trapezius muscles. The main stabilizers are the serratus anterior, rhomboid major and minor, levator scapulae, and trapezii. The glenohumeral "protectors" include the muscles of the rotator cuff: the supraspinatus, infraspinatus, teres minor, and subscapularis. These muscle groups function through synergistic co-contraction to anchor the scapula and guide movement specifically, the muscles of the scapula function as follows:

Shoulder being extremely proximal and grip being the distal-most component is important. Even though they are not directly connected to each other it will be of clinical importance to study their correlation so as to design an effective treatment programme. There are not many studies which highlight the importance of these two components in relation to each other.

Hence this study was conducted to find out if there is any correlation between grip strength and shoulder girdle muscle strength

2. METHODOLOGY

This study was a cross-sectional analytical study which included 100 healthy young adults in the age group of 18-25 years of age group. Individuals with a history of shoulder girdle injury or pain or any type of dysfunction or hand dysfunction were excluded. Individuals who regularly undertake a structured exercise program were also excluded to maintain homogeneity' Hydraulic Hand Dynamometer was used to assess grip strength and MicroFET3 was used to assess scapular muscle strength.

Method/Procedure

Subjects were selected based on inclusion criteria. The written consent from the participants was obtained. The Study procedure was explained to subjects. The maximal isometric handgrip strength was assessed using hydraulic hand-held dynamometer by following the standardized testing procedure, of both- dominant and non-dominant hand. The maximal isometric strength of scapular muscles- Serratus anterior, Lower and Middle trapezius, and Rhomboids was assessed using MicroFET3 (12), on both dominant and non-dominant side. Each measurement was taken 3 times and best of those 3 values was chosen. Participants were constantly verbally encouraged to develop maximal isometric strength. The strength of each muscle was correlated with the corresponding value of grip strength using calculated Pearson's coefficient of correlation and P value.

3. GRAPHS AND RESULT

Graph I

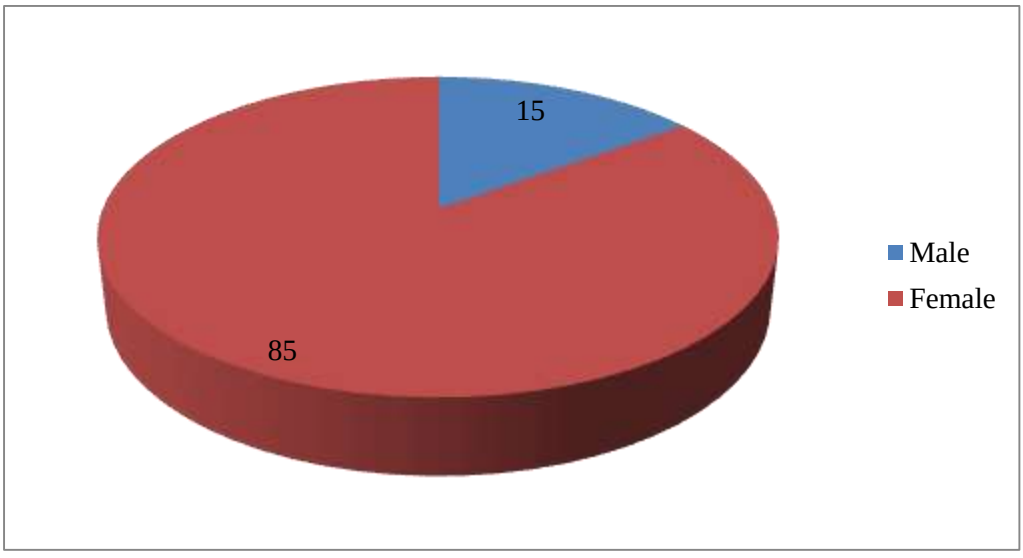

Fig. 1: Gender wise Distribution of the subjects (85% females and 15%males)

Graph II

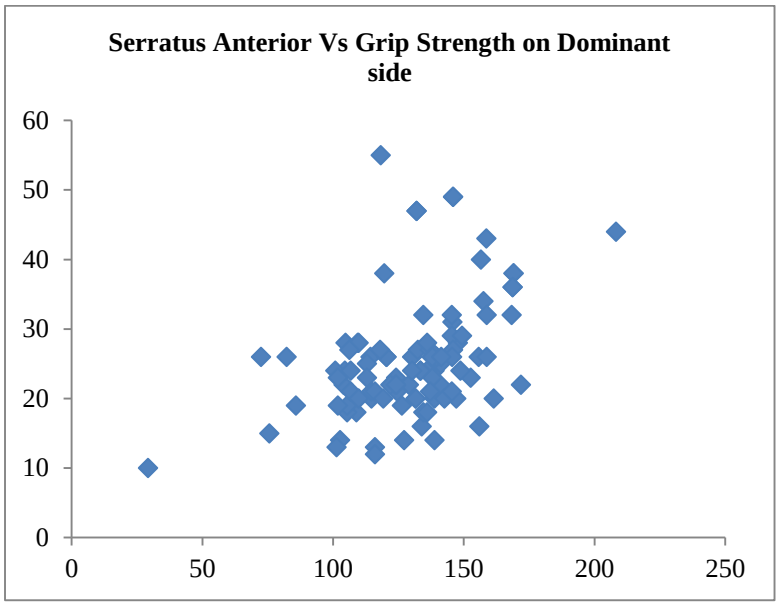

Fig 2: Shows an extremely significant correlation between grip strength and serratus anterior (dominant side) with r=0.441041 and P<0.0001**

Graph III

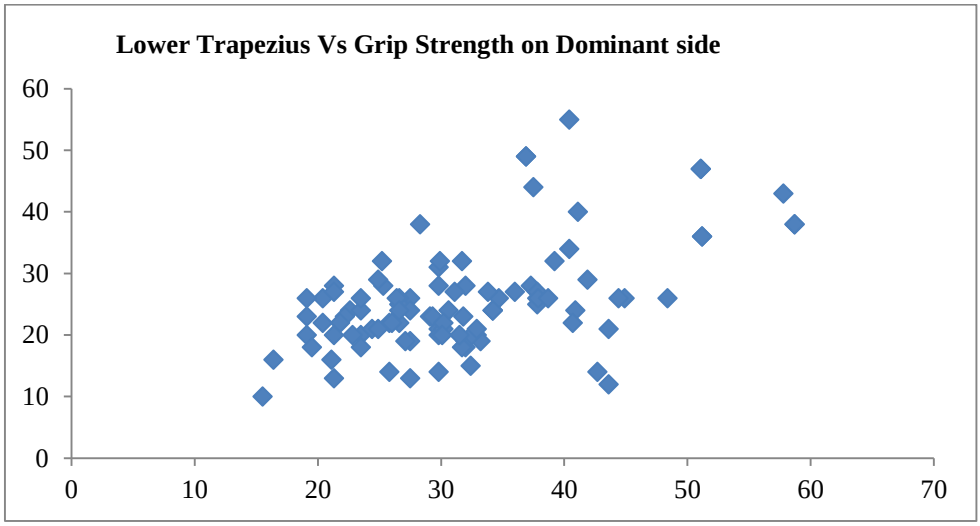

Fig. 3: Shows an extremely significant correlation between grip strength and Lower trapezius (dominant side) with r=0.536062and P<0.0001**

Graph IV

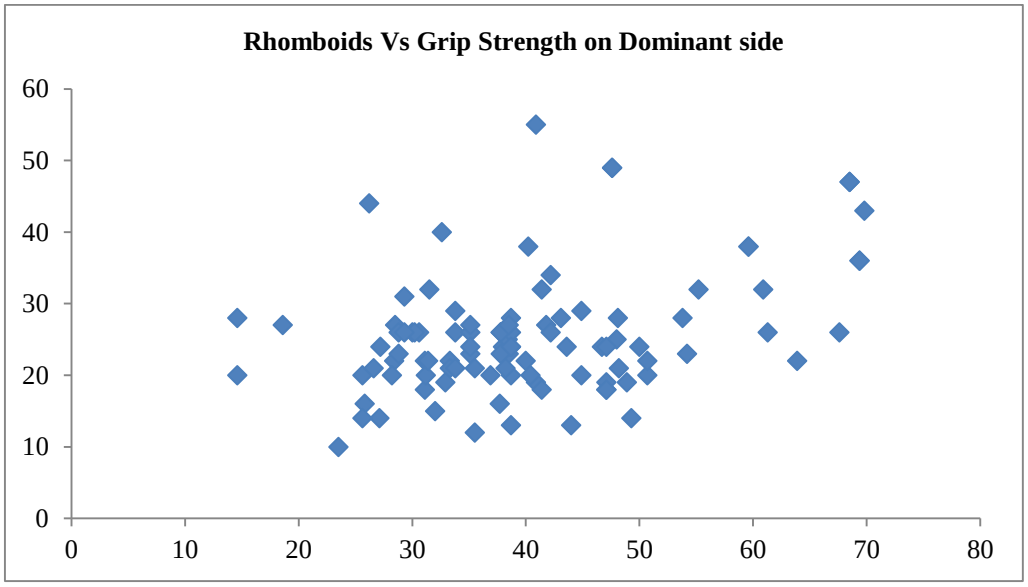

Fig. 4: Shows an extremely significant correlation between grip strength and Rhomboids (dominant side) with r=0.389323and P<0.0001**

Graph V

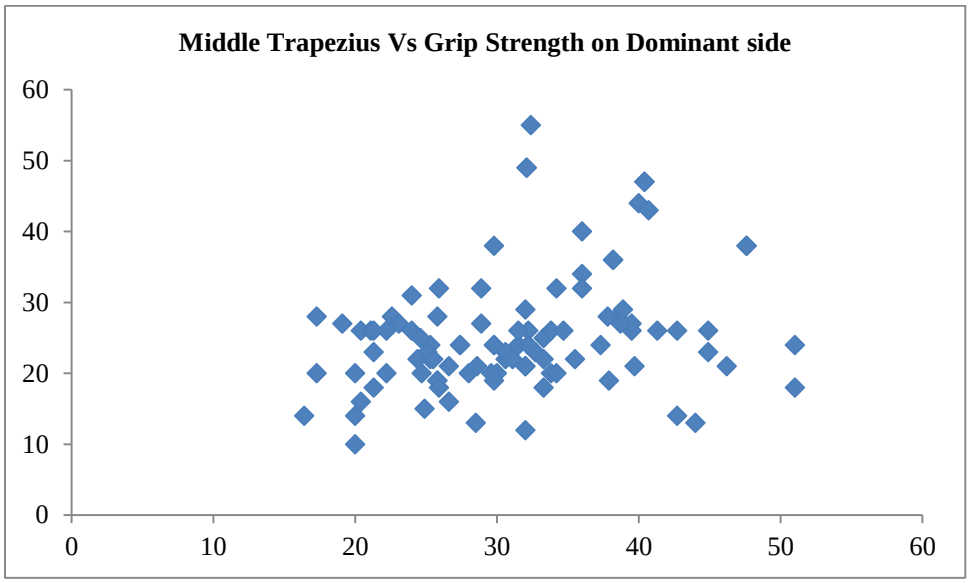

Fig. 5: Shows an extremely significant correlation between grip strength and Middle trapezius (dominant side) with r=0.295828and P<0.0001**

Graph VI

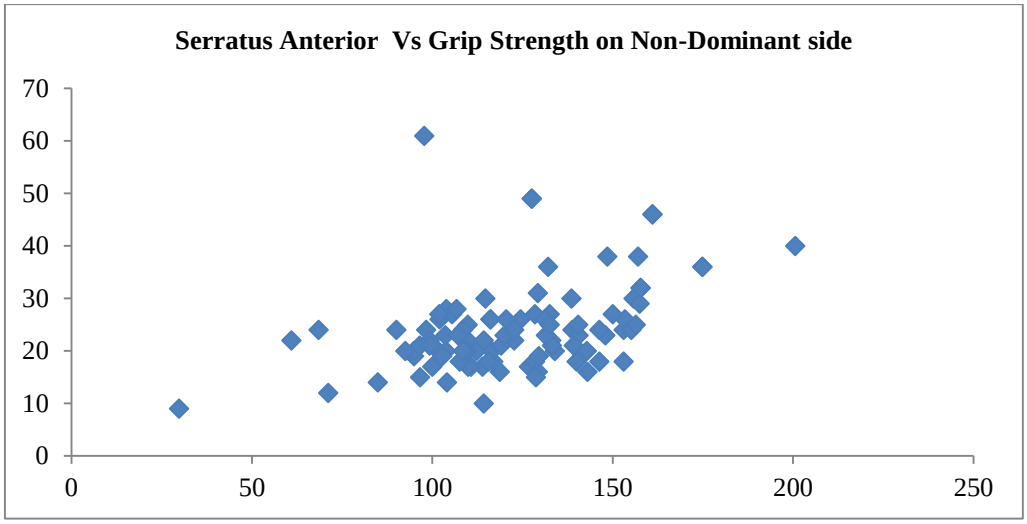

Fig. 6: Shows an extremely significant correlation between grip strength and Serratus anterior (Non-dominant side) with r=0.428051and P<0.0001**

Graph VII

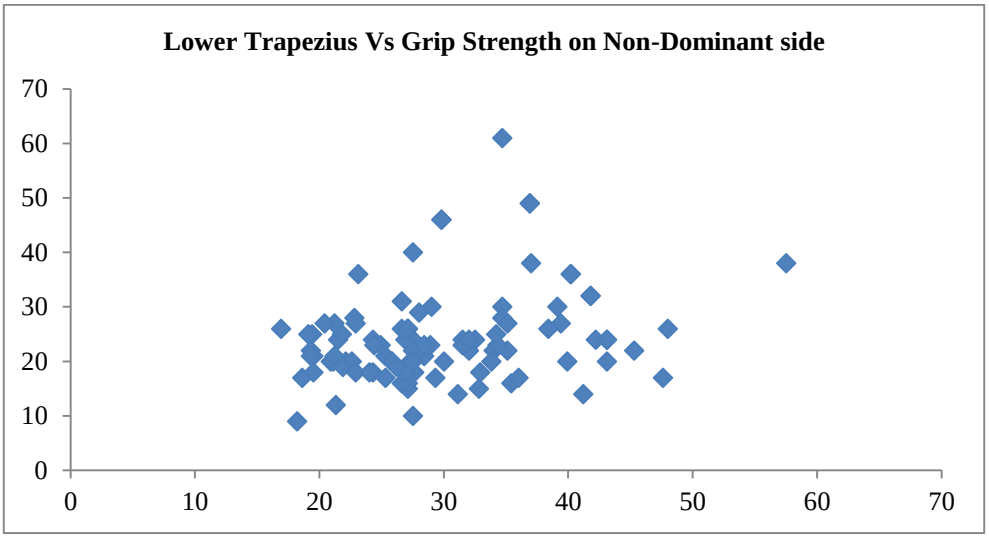

Fig. 7: Shows an extremely significant correlation between grip strength and Lower trapezius (Non-dominant side) with r=0.283705and P<0.0001**

Graph VIII

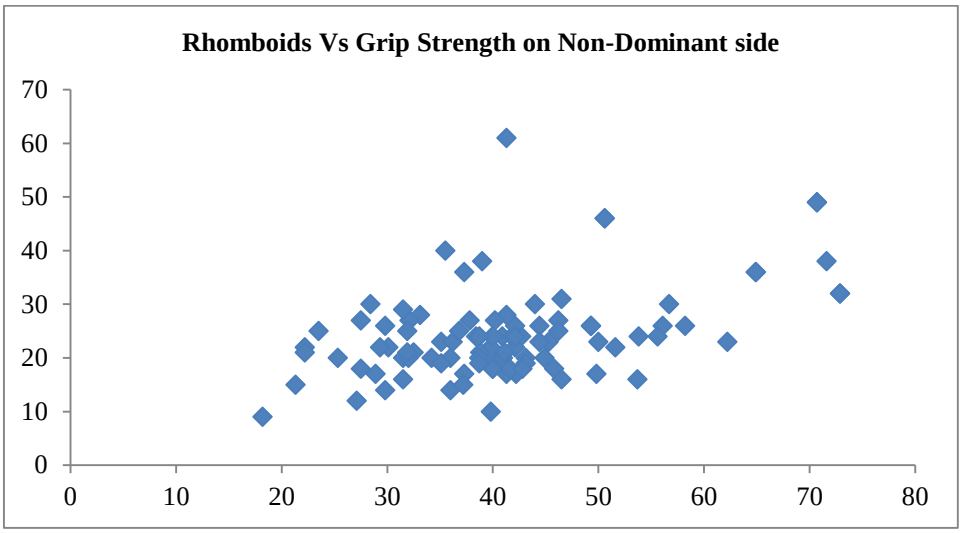

Fig. 8: Shows an extremely significant correlation between grip strength and Rhomboids (Non-dominant side) with r=0. 0.472931and P<0.0001**

Graph IX

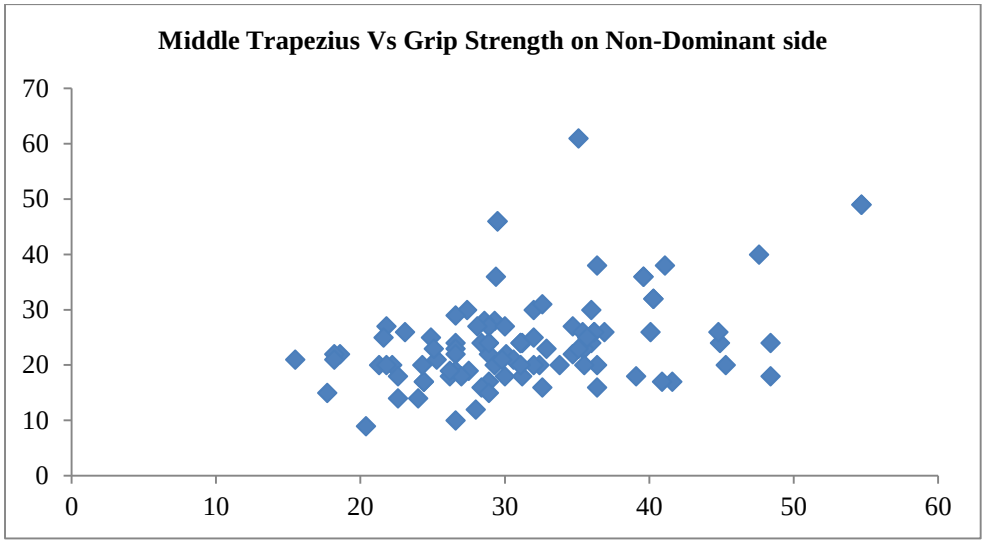

Fig. 9: shows an extremely significant correlation between grip strength and Middle trapezius (Non-dominant side) with r=0.428013and P<0.0001**

4. DISCUSSION

This study was conducted to find out the correlation between the scapular muscles strength and the grip strength of the same side. Grip strength is used to assess the overall functional capacity of the upper extremity. Since hand functions (prehension activities) are the most essential part of the upper extremity function in our day-to-day life. Thus in upper extremity rehabilitation, grip strength is used as one of the parameters to check the progress or effectiveness of the training.

According to statistical analysis, the results suggest that there is a statistically significant correlation between each muscle strength and grip strength.

There are several factors, which are responsible for good (normal) hand functions. The intrinsic muscles of hand along with the thenar and hypothenar muscles are not the only muscles responsible for proper functioning of hand. The proximal muscles like flexors and extensors of wrist and fingers as well as the proximal joints- Elbow (Humero-ulnar and Humero-radial), all 3 Radio-ulnar joints and all joints of shoulder girdle i.e. Gleno-humeral, Acromio-clavicular, Scapulo-thoracic, and Sterno-clavicular are responsible for hand functions.

Based on the result of previous studies, the appropriate position of the scapula is essential for optimal grip strength. (13) The optimum position of the scapula is maintained by the muscles attached. Thus, these muscles and their strength are ultimately responsible for hand functions. That means, there might be a correlation between scapular muscles' strength and grip strength.

The Trapezius muscles, Rhomboids, and Serratus anterior muscle control the stability and mobility of the scapula. Thus these muscles were assessed in this study to find out the correlation of their strength with grip strength. The most important functions of the upper extremity for independent and smooth activities of daily living are the functions of the hand. A representative function of

the hand is to hold something. The strength of the fingers when holding something is known as grip strength and it is an important index in the evaluation of the motor function of the hand (14). Since grip strength is strongly positively correlated with muscular strength (15), grip strength can be used to evaluate changes in muscular strength effectively and economically. Grip strength has been used in a lot of studies because of its simple measurement (16,17) Grip strength is not simply the force generated by the fingers and wrist joint, it is also intimately connected with the muscular strength of forearm, and the brachial and shoulder joints18. In connection with this, Park19 mentioned that reaching movement was more efficient after passive pre-positioning of the scapula, and noted that hand function is influenced by the alignment of the scapula.

The results of the previous study show that there was an increase in grip strength of 13.14% after active scapular protraction, from 20.39 kg before contraction to 23.07 kg after contraction. This demonstrates that positioning of the scapula in the ideal position improves upper extremity function. The muscle activation of the muscles surrounding the scapula and upper extremity muscles also increased after active scapular protraction. The muscle activation of the serratus anterior muscle, trapezius and flexor carpi ulnaris. These results show that positioning the scapula in the ideal position can improve the muscle activation of the upper extremity muscles (20,21).

Cho (22) 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. Her results show 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, upper extremity function has improved the function of the upper extremity works better when the stability of the scapula is secured. Our One more study conducted with grip strength measurement with scapula in protracted position showed that when the scapula was placed in an ideal position through active scapular protraction, the muscle activations of the muscles surrounding the shoulder joint were increased, demonstrating the effectiveness of scapular protraction at improving the function of the upper extremity.

These previous studies support the result of this study where grip strength and shoulder girdle muscles show a highly significant correlation. The limitation of this study was that more females were included in this study and extent of their upper extremity use was not taken into consideration. As per the result this study, a good scapular muscles' strength is essential for the powerful grip. Thus, individuals who require powerful grip for their occupation strengthening of scapular muscles might improve their efficiency also for individuals with reduced grip strength; assessment of scapular muscle strength can be useful to plan a treatment program, which includes scapular muscle training. Scapular muscle strengthening might be helpful in order to improve their grip strength. This study can be further conducted in different age groups, in patients with shoulder girdle dysfunctions, in individuals who require more upper extremity functions in their sports activities

5. CONCLUSION

Based on the result of this study, it is concluded that there is a correlation between grip strength and scapular muscle strength.

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