

Hand Grip Strength as a Clinical Proxy for Shoulder Function in Rotator Cuff Rehabilitation

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ABSTRACT:**Background**

Shoulder discomfort affects 16% to 21% of the population, second only to low back pain among musculoskeletal problems. Disabilities and functional limitations are most often caused by rotator cuff injuries, which affect more people than any other shoulder problem. Mechanical stress, tendon degeneration, and neuromuscular dysfunction are all factors in the condition's genesis, which causes changes in glenohumeral biomechanics and a decrease in the function of the upper limbs.

Objective

Finding out if hand grip strength (HGS) can stand in for shoulder function in clinical situations was the main goal of the research. This is achieved by delving into the correlation between HGS and shoulder rotator cuff strength.

Methods:

Fifty people diagnosed with RC tendinopathy participated in a cross-sectional research. Analogue pain scales and dynamometry were used to measure LRS, HGS, and pain overall. Regression and Pearson correlation analysis were performed.

Results:

From HGS to LRS, there were significant positive associations ($r = 0.351-0.850$, $p < 0.05$). The pain-LRS relationship was strongly inverse ($r = -0.697$ to -0.847 , $p < 0.001$).

Conclusion

It seems that hand grip strength may be used as a proxy measure for shoulder function, namely how well the rotator cuff is working. However, further clinical studies in pathological populations are required to confirm its diagnostic and prognostic utility in musculoskeletal practice..

Keywords: population, degeneration, tendinopathy.

Introduction

With a prevalence ranging from 16% to 21%, generalized shoulder discomfort is the second most frequent musculoskeletal complaint, second only to low back pain. Disability benefits for musculoskeletal illnesses constitute more than 20% of overall disability benefits, posing a significant societal and financial burden. numbers between one and ten In primary care settings, consultations for musculoskeletal issues involving the shoulder complex—which consists of the glenohumeral (GH), clavicular (CL), and scapulothoracic (ST) joints—rank third most often. This situation is

characterized by a high incidence of rotator cuff tendinopathy (RCT).^{55, 53} Medical professionals often use the phrases tendinitis, bursitis, tendinosis, and subacromial impingement syndrome to describe these conditions. [1, 10]

Shoulder rotator cuff pain is clinically represented by a "painful arc" that is most apparent with the arm lifted and rotated externally, and it often occurs between 60° and 120° of abduction. 15 Since this illness severely limits shoulder movement and function, it would significantly impact your quality of life and your capacity to do

daily duties. scene (3,66) Although there are other variables that contribute to its development and progression, including as genetic susceptibility, biochemical alterations, neurophysiological sensitivity, and adaptations in the central nervous system, the main culprit has long been recognized as mechanical stress of the rotator cuff.(7,40)

The glenohumeral joint is the most movable joint in humans, according to biomechanical study. This is because of its unusual design, where the glenoid fossa only covers about one-third of the humeral head. It. A complex set of static and dynamic stabilizers is required to preserve joint congruency since this structural arrangement naturally prioritizes mobility over stability. There is a complex web of muscles, ligaments, and osseous structures that make up the shoulder. The scapula is pivotal in controlling movement and transmitting force, and it also provides many attachment points for muscles.¹⁷ and ¹⁹ The surrounding muscles provide dynamic stability, while the capsuloligamentous tissues, especially the glenohumeral ligaments, give static stability. nine, eleven, twelve)

The subscapularis, supraspinatus, infraspinatus, and teres minor muscles make up the rotator cuff, which plays a crucial role in stabilizing the GH joint. The humeral head remains centered inside the glenoid fossa during movement thanks to a force-coupling system that begins on the scapula and inserts on the humerus.^{14.1}, the infraspinatus and teres minor aid with posterior stability and external rotation, ^{15.5}, the supraspinatus starts abduction, and ^{16.6}, the subscapularis provides anterior support and posterior internal rotation. When these muscles work in tandem with the deltoid, it keeps the joint mechanics stable and prevents the humeral head from translating too much.^{fifty-two}, The stability of the shoulder is determined by the balance of opposing force pairs. In order to limit the humeral head's range of motion, the rotator cuff must oppose the deltoid's superior translational force. Problems with neuromuscular control, tendon degeneration, or weak muscles may disrupt the normal kinematics of the joint, which can lead to subacromial impingement and structural damage. Scapular

dyskinesia exacerbates this discord by reducing the subacromial space and altering the scapulohumeral rhythm. Those three digits... Causes of rotator cuff tears include aging, tendon overuse, vascular compromise, recurrent mechanical impingement, and other conditions; they may occur in persons with or without symptoms. Acromial morphology is another extrinsic element.(87-8, 25-21)

Distal performance measurements may provide light on the state of the upper limb due to the strong relationship between the arms and shoulders. One common, easy, and objective way to measure upper-body strength is hand grip strength (HGS). Crafted by coordinating the flexor and extensor muscles of the fingers and wrist, it is fundamental for everyday tasks and athletic achievement. range from 26 to 38 Grip performance, which is not limited to the distal domain, requires the proximal stability of the shoulder girdle, mostly via rotator cuff activation. (10, 28) Because the upper limb kinetic chain is so interdependent, a decrease in distal force output might indicate a problem farther up the chain.

More and more evidence is emerging from studies that corroborate the link between powerful grip strength and efficient shoulder muscle function. Positive correlations have been demonstrated between isometric HGS and isokinetic strength of shoulder stabilizing muscles, suggesting that grip strength may reflect proximal force-generating capacity and neuromuscular efficiency .(35,43) Furthermore, studies have shown strong associations between HGS and rotator cuff strength across multiple shoulder positions, reinforcing its potential role as a functional indicator of shoulder performance .(32, 54) This relationship is biomechanically supported by the requirement of proximal stability for efficient distal force transmission along kinetic and myofascial chains.

Hand-held dynamometry (HHD) provides a valid, reliable, and practical method for quantifying muscle strength in both clinical and research settings. It is more cost-effective and accessible than isokinetic dynamometry while maintaining

acceptable reliability across different populations and testing conditions .(16, 36)

HHD has also demonstrated good validity for assessing both isometric and eccentric rotator cuff strength, and standardized protocols improve measurement reliability and reproducibility.(6, 45)

There is a lack of data from clinical populations with shoulder disease, and the majority of research that have looked at the correlation between hand grip strength and shoulder function have been done on healthy people, despite the increasing body of evidence. Furthermore, there is still a lack of clarity on how well HGS can be used as a clinical proxy for rotator cuff function.(71, 13)

This research sets out to answer the question, "Is hand grip strength a clinical proxy for shoulder function? If so, how does it relate to the strength of the muscles that stabilize the shoulder?" by looking at the correlation between the two. By establishing this connection, a non-invasive, easy-to-use tool for monitoring shoulder function and aiding in rehabilitation decision-making in clinical and sports medicine settings might become available to physicians.

Subjects and Methods

Study Design

In order to learn more about how rotator cuff tendinopathy (RCT) affects shoulder function, researchers performed a cross-sectional study that looked at hand grip strength (HGS). The physical therapy faculty of Beni Suef University in Egypt's Ethical Committee for Scientific Research gave its stamp of approval (FPTBSUREC/0412/15426).

Participants

Fifty people having a history of RCT were a part of the research. They were in their sixteen to forties. Orthopedists sent patients to the outpatient clinics at Deraya University and Al Eman General Hospital, where the participants were enrolled. Magnetic resonance imaging (MRI) or musculoskeletal ultrasonography (US) confirmed the diagnosis of RCT.

Sample Size Justification:

Consistency with other research that investigated comparable results in individuals with rotator cuff tendinopathy, practical considerations, and the availability of competent volunteers dictated the sample size.

Eligibility Criteria

Inclusion Criteria

People were considered for participation if they fulfilled the following requirements:

- Shoulder discomfort has been present for at least three months and has been felt most acutely on the outside of the affected shoulder, especially when the affected person is active and elevating their arm or leg
- Two positive impingement tests are required among these: Tests for neuralgia include the Jobe, Neer, and Hawkins-Kennedy batteries. If you feel discomfort when you touch the tendon insertion at the bigger tuberosity, it might be a sign of tendinitis.

Exclusion Criteria

No one could take part in the study if they had the following conditions:

- A full rotator cuff tear
- Issues with the neck's radicles
- Shoulder, acromioclavicular, or osteoarthritis-related operations inflamed capsular tissue
- After three months of subacromial injections of corticosteroids
- A background of complicated fractures in the shoulder
- An acromion that is hooked
- Problems with compartments
- Peripheral neuropathy
- Problems with the hands, wrists, or elbows
- Past injuries to the tendons that bend or straighten the fingers or wrist

Instrumentation

- **Handheld Dynamometer (HHD):** For the purpose of gauging the shoulder's lateral rotator strength, this Lafayette device (Model 01163) is used.
- **Hydraulic Hand Grip Dynamometer (HGD):** Makes use of the JAMAR 5030J1 HGS measuring device.

- **Digital Goniometer/Inclinometer:** Designed for use for measuring elbow and shoulder angles.
- **Visual Analog Scale (VAS):** A tool for measuring the degree of discomfort experienced by test subjects.

Measurement Procedures

All measures were taken from individuals who had anterolateral shoulder discomfort for at least three months.

Joint Positioning

Abduction, external rotation (ER), and elbow flexion angles were measured using a computerized goniometer, which has shown high reproducibility for shoulder measurements among raters. Everyone used a chair designed to support the back in order to minimize the amount of time their trunks had to bend over. A neutral wrist and a mid-prone forearm were used to place the testing arm. After the therapist gently placed the limb in the desired posture, the participant took an active role in replicating and maintaining it.

Assessment of Shoulder Lateral Rotator Strength (LRS)

Three different postures were used to test shoulder LRS using a portable dynamometer:

1. Neutral position
2. 90° shoulder abduction
3. 90° shoulder abduction with 90° external rotation

Those taking part were told to sit with their forearms neutral and elbows bent at a 90-degree angle. To maintain uniform resistance, the dynamometer was wall-stabilized while in the neutral and abducted-external rotational positions. The dynamometer was held in place and resistance was applied using a strap system while the subject was in the 90° abduction position.

On the dorsal forearm, the dynamometer was placed about 2 cm from the ulnar styloid process. In each position, participants rested for one minute between sets of three maximum isometric

contractions. We recorded the average value for analysis.

Assessment of Hand Grip Strength (HGS)

We repeated our prior testing of HGS in all three shoulder positions using a hydraulic hand grip dynamometer. A neutral forearm position, wrists in a functional position, and elbows bent to 90 degrees were the instructions given to the participants while they sat.

The participants were instructed to maintain a firm grip for a duration of five seconds. There was a one-minute pause in the middle of each of the three testing sessions for each position. The three experiments were averaged for the study.

Pain Assessment

We tested the patient in three different shoulder postures and used a Visual Analog Scale (VAS) to measure the intensity of their pain.

Statistical Analysis

We used the right statistical tools to conduct all of our studies. Mean $\pm$ standard deviation (SD) was used to provide descriptive statistics for all variables, which were used to characterize the research sample and guarantee data consistency.

The exact nature and direction of the link between shoulder lateral rotator strength (LRS), hand grip strength (HGS), and pain severity as evaluated by the Visual Analogue Scale (VAS) were determined by researchers using Pearson's correlation coefficient (r). We considered a p-value less than 0.05 to be statistically significant.

RESULTS

Finding out how RCT, LRS, and HGS relate to one another while the shoulders are in various postures was the driving force for this research. Fifty patients with RCT were enrolled in this study; the gender breakdown was as follows: half male and half female. They ranged in age from twenty-five to forty-five. We measured the angles of neutral, abduction (90 degrees), and rectal angle (90 degrees) for both LRS and HGS. An evaluation of pain was conducted using a visual analog scale (VAS) during the measurement procedures in all

three shoulder positions. We evaluated the strength of the association between HGS and shoulder LRS using the Pearson correlation coefficient in this research. We also looked at the connection between shoulder LRS and discomfort in different shoulder positions.

Descriptive statistics

Shoulder lateral rotator strength (LRS)

All three of the examined sites had different mean LRS values. In both the neutral position (5.81 ± 1.69 kg) and the 90° abduction position (5.84 ± 1.91 kg), the results were greatest. In contrast, the 90° abduction with external rotation position showed a significant decrease (3.56 ± 1.31 kg).

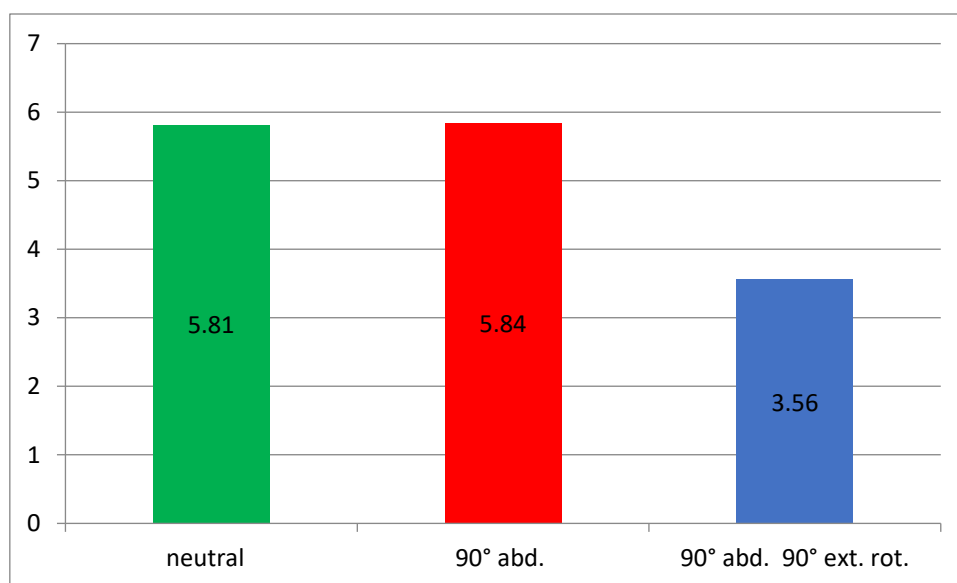


Fig. (1): Mean and $\pm$ SD of LRS across the three positions.

Hand grip strength (HGS)

HGS showed slight variation across positions. The mean value was 24.77 ± 8.37 kg in the neutral

position and 23.18 ± 8.93 kg at 90° abduction. The highest mean HGS value was observed at 90° abduction with external rotation (26.07 ± 9.64 kg).

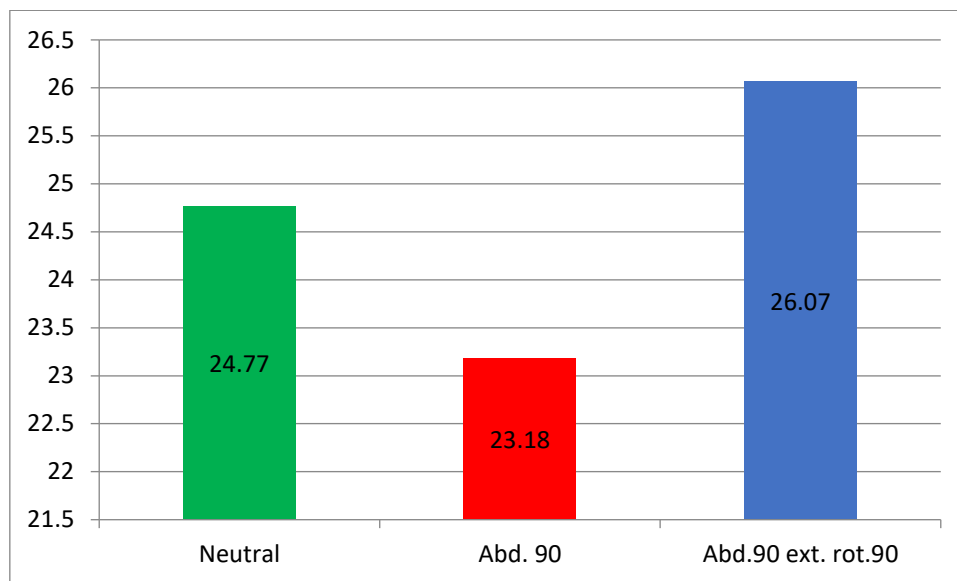


Fig. (2): Mean and $\pm$ SD of HGS across the three positions

Pain intensity (VAS)

Pain levels differed according to shoulder position. The lowest pain scores were reported in the neutral

position (2.47 ± 1.74), while the highest values were observed at 90° abduction (4.35 ± 1.68). Pain slightly decreased in the 90° abduction with external rotation position (3.50 ± 1.36).

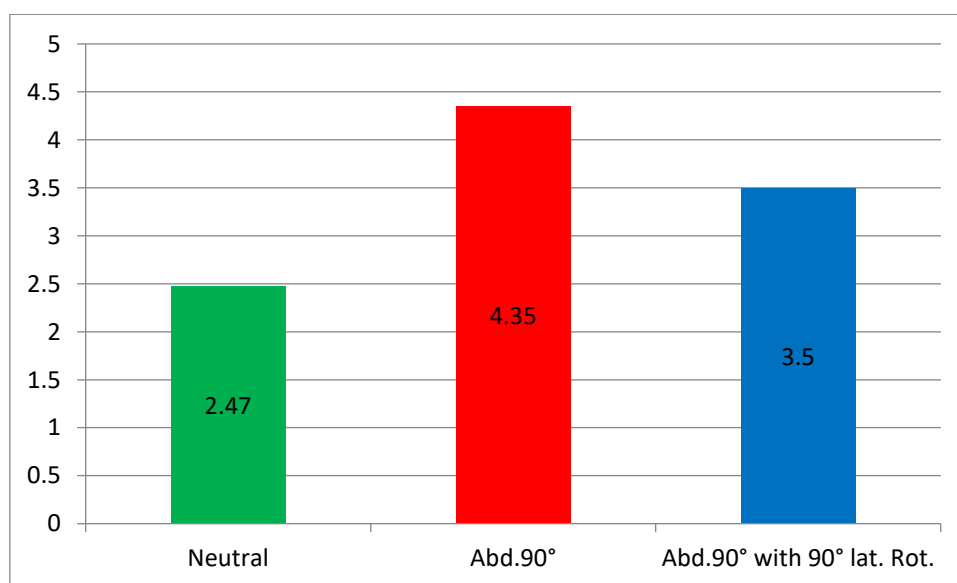


Fig. (3): Mean and $\pm$ SD of VAS across the three positions.

Correlation Analysis

Correlation between Shoulder LRS and HGS

Test subjects' lateral rotator strength (LRS) and hand grip strength (HGS) were shown to be positively correlated with one another, regardless

of the testing position, according to Pearson correlation analysis.

- At rest, there was a weakly positive correlation ($r = 0.351$, $p = 0.012$).

	HGS	p- value	Significance
	R		
LRS	0.351	.012	S

Table (1): correlation between shoulder LRS and HGS in RCT patients in neutral position

r: correlation coefficient p- value: probability value S: significant

- A significant positive connection was seen in 90° shoulder abduction ($r = 0.850$, $p < 0.001$).

	HGS	p- value	Significance
	R		
LRS	0.850	.0001	S

Table (2): correlation between shoulder LRS and HGS in RCT patients in 90° abduction

- There was a strong positive correlation ($r = 0.820$, $p < 0.001$) between 90° abduction and 90° external rotation.

	HGS	p- value	Significance
	R		
LRS	0.820	.0001	S

Table (3): correlation between shoulder LRS and HGS in RCT patients in 90° abduction with 90° ER

Correlation between Shoulder LRS and Pain (VAS)

No matter the location, a statistically significant inverse correlation was found between VAS pain ratings and shoulder LRPs.

- During the neutral posture, there was a significant negative association ($r = -0.847$, $p < 0.001$).

	VAS	p- value	Significance
	r		
LRS	- 0.847	.0001	S

Table (4): correlation between shoulder LRS and VAS in RCT patients in neutral position

- A significant inverse relationship was discovered in 90° shoulder abduction ($r = -0.771$, $p < 0.001$).

	VAS	p- value	Significance
	r		
LRS	- 0.771	.0001	S

Table (5): correlation between shoulder LRS and VAS in RCT patients in 90° abduction

- The results showed a moderate-to-strong negative association ($r = -0.697$, $p < 0.001$) in 90° abduction with 90° external rotation.

	VAS	p- value	Significance
	R		
LRS	- 0.697	.0001	S

Table (6): correlation between shoulder LRS and VAS in RCT patients in 90° abduction with 90° ER

The results indicate that:

The analysis of data revealed the following findings:

- Assuming a neutral posture with the shoulders abducted 90 degrees (ER), patients with rotator cuff tendinitis (RCT) show a favorable connection between horizontal grip strength (HGS) and range of motion (LRS) of the left shoulder.
- For individuals with a neutral spine, shoulders abducted at 90 degrees, or both, there is an inverse relationship between shoulder LRS and discomfort.

Discussion

The purpose of this research was to compare lateral rotator strength (LRS), hand grip strength (HGS), and RCT symptoms in various shoulder postures. There was a strong negative association with pain and a positive correlation with positional LRS and HGS, lending credence to the idea of proximal-distal interdependence in the upper limb.

Notably, the research discovered that there was a notable increase in the strength of the link between LRS and HGS in three different positions: neutral ($r = 0.351$), 90° abduction ($r = 0.850$), and 90° abduction with external rotation ($r = 0.820$). When biomechanical demands are raised, the role of the rotator cuff muscles in producing distal forces becomes more apparent, as stated above. When Horsley et al. (32) assessed the grip and shoulder rotator strength of healthy persons in a number of different ways, they came to the same conclusions.

Newer research lends even more credence to this connection. The fact that Manske et al. [44] found a strong correlation between grip strength and symptoms of rotator cuff injuries implies that grip strength might be an indicator of how well the muscles in the shoulder work. The results of Turabi et al. [63] corroborate the idea that stability in the shoulder affects the mobility of the upper limbs, as they showed that those with unstable shoulders also had stronger grips and better rotator cuff function.

One possible explanation for the substantial connections shown at higher levels of this research is the kinetic chain hypothesis, which considers the need of proximal stability for effective distal movement and force production. Recent clinical investigations have shown promising results in predicting the functional outcomes of the shoulder based on hand grip strength, lending credence to this idea. Liu et al. [41] found that a patient's pre-operative grip strength is a good clinical proxy signal for predicting the shoulder's function after surgery.

Curiously, HGS had the greatest mean value, even though LRS values were lower in the 90° abduction with external rotation posture. Enhanced central drive or the activation of auxiliary muscles to sustain grip performance could be the result of compensating neuromuscular processes. Recent comprehensive evaluations on patterns of muscle activation and synchronization of the upper limbs have also addressed similar neuromuscular changes [5,6].

In terms of discomfort, the current research showed that LRS was significantly correlated negatively with pain in all postures ($r = -0.847$ to -0.697). Previous research has shown that pain causes arthrogenic muscle inhibition, which in turn reduces muscular activation and strength. This idea is consistent with our findings. A thorough analysis by Hegedus et al. [30] shown that pain affects the performance and functional outcomes of the shoulder muscles. The robust correlation between alleviating pain and enhancing strength and function in rotator cuff illnesses was highlighted in a meta-analysis by Naunton J. et al. [47].

Specifically for rotator cuff-stressing activities, our findings lend credence to the notion that HGS is a valid non-invasive proxy evaluation of shoulder function in clinical contexts. Additionally, the strong influence of pain on shoulder strength highlights the importance of integrating pain management strategies into rehabilitation programs.

CONCLUSION

In randomized controlled trials, measuring HGS is a dependable way to track how well the shoulder's lateral rotators are working. Additionally, it might be helpful for monitoring muscle atrophy particularly in cases when RC contraction is limited due to surgery. Since shoulder pain impacts LRS, it is important to take LRS into account while managing patients with RCT.

RECOMMENDATIONS

1. A similar study should be undertaken for

patients who underwent RC repair.

2. Further researches on other pathological shoulder conditions are needed

to confirm whether a similar relationship exists.

3. Another research is recommended to compare between HGS and other

RC muscles

4. A similar study should be undertaken to large number of patients

providing better statistical analysis of data.

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