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Relationship between rotator cuff and hand grip strength in shoulder tendinopathy

Ahmad Mohamad Fawzy*[1], Khaled Elsayed Ayad[2], Nadia Abdelazem Fayaz[3] and Mohamad Mohamad Bahi Elden Elshafie[4]

[1]Department of Physiotherapy for Orthopedics, Faculty of Physiotherapy, Deraya University, El Minya, **Egypt**
[2]Faculty of Physiotherapy, Deraya University, El Minya, **Egypt**
3Department of Physical Therapy for Musculoskeletal Disorders and its Surgeries, Faculty of Physical Therapy, Cairo University, Giza, **Egypt.**
[4]Department of Orthopedics, Faculty of Medicine, Minya University, El Minya, **Egypt**

***Correspondence:** ahmed.fawzy@deraya.edu.eg **Received 19-12-2019, Revised: 12-01-2020, Accepted: 15-01-2020 e-Published: 23-01-2020**

Shoulder pain as a result of rotator cuff pathology is one of the most common musculoskeletal complaints presenting within primary care. Assessment of handgrip strength (HGS) has been proposed as an indicator of rotator cuff function. The main objective of the study was to investigate whether there is a relationship between shoulder lateral rotators strength (LRS) and (HGS) in patients with rotator cuff tendinopathy (RCT). Fifty patients with RCT, age ranged from 20 to 40 years participated in this study. They were referred from orthopaedic physician and their diagnosis was confirmed with magnetic resonance imaging or Sonography. Shoulder LRS (measured with hand held dynamometer) and HGS (measured with hand grip dynamometer) were measured with the arm in three different positions: neutral position, 90° shoulder abduction and 90° shoulder abduction with 90° external rotation (ER). statistics showed a strong positive correlation between shoulder LRS and HGS in 90° shoulder abduction and 90° shoulder abduction with 90° ER and a weak positive correlation in neutral position (r = 0.850, r = 0.820, r = 0.351 respectively). Assessment of HGS when shoulder is abducted 90° can be reliably used to monitor the function of the lateral rotators of the shoulder in patients with RCT.

Keywords: rotator cuff, hand grip strength and shoulder tendinopathy

INTRODUCTION

Shoulder pain is second only to low back pain which affects about 16% to 21% of the population (Dinnes et al. 2003). In addition, about one-fifth of all musculoskeletal disability expenses are for patients with shoulder injuries (Blume et al. 2015).

Disorders of shoulder complex including clavicular, scapulothoracic, and glenohumeral (GH) articulations, are suggested to be the third most common cause of musculoskeletal consultation in primary care with the most common shoulder diagnosis being rotator cuff tendinopathy (RCT) (Picavet and Schouten, 2003, Rizzo et al. 2017). It is often described using many different terms such as subacromial impingement syndrome (SIS), bursitis, tendonitis or tendinosis (Bateman and Adams, 2014).

During shoulder elevation and external rotation (ER), medical diagnosis of pain and loss of shoulder movement and function is generally seen. Although a number of factors, including; genetic, biochemical, patho-anatomical and sensory-motor cortex changes, have the potential to contribute to rotator cuff (RC) related shoulder pain, excessive and excessive tissue loading appears to have a major impact (Lewis, 2016).

Furthermore, shoulder pain associated with RCT and loss of normal function and shoulder

joint flexibility clearly disrupt the patient's functional condition. These disorders can significantly reduce patients' quality of life and their participation in everyday life activities (Wnuk et al. 2017).

Rotator cuff tendinopathy is particularly prevalent in employees and can cause workplace absenteeism and loss of productivity leading to major societal economic costs with increased health care demands, decreased work performance, prolonged absence of illness, and early retirement or job losses (Baldwin and Butler, 2006, Palmer et al. 2012).

Hand-held dynamometer (HHD) is used less commonly than manual muscle test (MMT), but as an objective measure of muscle strength, it has the ability to solve some of the latter's limitations. HHD can detect minor deteriorations or improvements during or following resistive strength training (Pfister et al. 2018).

Interestingly, Cools et al. (2014) tested the reliability of using HHD, which is a more objective strength assessment tool than MMT, aiming to assess GH rotation strength in multiple patients and specific shoulder positions, and recorded good to excellent reliability regardless of patient or shoulder position.

Hand grip strength (HGS) depends entirely on finger and wrist flexor and extensor synergistic coordination. This is an important element in the proper execution of everyday activities as well as in particular sporting movements (Kobesova et al.2015).

Hand muscle function, especially gripping, is an important kinesiological part of many activities related to work and sport that can contribute to upper limb disorders. GH joint stability maintained by RC muscles is an important requirement of hand grip activity (Alizadehkhaiyat et al.2011).

Hand grip strength assessment is only accurate when standardized methods and calibrated equipment are used, even when there are specific dynamometer assessors or brands (Bandyopadhyay 2008). HHD was used to measure muscle strength, particularly muscles strong enough to exert strength against gravity and tolerate resistance (Shah et al. 2012).

It has been shown that the hand grip dynamometer (HGD) is accurate, reliable and easy to use for HGS measurement (Mathiowetz et al. 1984, 1985). Compared to other conventional isokinetic dynamometers, they are inexpensive and a moderate correlation between the two has been reported (Mandalidi and O'Brien, 2010).

It was concluded that in healthy subjects there is a positive relationship between HGS isometric strength and isokinetic moment produced by external shoulder rotators and abductors and elbow flexors. It has been suggested that isometric HGS can be used to monitor isokinetic strength of some muscle groups that contribute to shoulder joint stability including lateral rotators (Mandalidi and O'Brien, 2010).

MATERIALS AND METHODS

This study was conducted at the faculty of Physiotherapy, Deraya University, Egypt. Fifty male and female patients with RCT participated in this study. Their ages ranged from 20 to 40 years. LRS and HGS were measured from neutral position, 90° abduction and 90° abduction with 90° ER.

Patients were excluded if they had a history of complete RC tendon rupture, substantial radiating neck pain, previous surgery of the affected shoulder, osteoarthritis in the acromioclavicular joint, adhesive capsulitis, subacromial corticosteroid injection within the past three months, previous fractures in the shoulder complex or shoulder surgery on the affected side, hooked acromion, compartment syndrome, carpal tunnel syndrome, fracture of hand, wrist or elbow and previous injury of flexor or extensor tendons involves muscles that flex or extend fingers or wrist.

All patients had at least two out of three of the following impingement tests positive: Neer (Neer, 1972), Hawkins-Kennedy (Hawkins and Kennedy, 1980) and Jobe (Jobe and Moynes, 1982) tests. Measurements were taken in patients with typical history of pain for at least 3 months in the anterolateral region of the shoulder.

Isometric strength of shoulder lateral rotator muscles was measured using a HHD (LAFAYETTE 01163) with the arm in three different positions: neutral, 90° abduction and 90° abduction with 90° ER positions from sitting. In the neutral and 90° abduction with 90° ER positions, the dynamometer was placed against a wall for stability and to give resistance to counter the maximal contraction (fig. 1 A, B). In the 90° abduction position, a strap was adjusted to patients' shoulder height and used as an aid to place the dynamometer inside and resist the maximal contraction that was in upward direction (fig. 1 C). The HHD was placed 2 cm proximal of the styloid process of ulna on the dorsal forearm (Cools et al. 2014, Horsley et al. 2016).

(A) (B) (C)

Figure 1: Assessment of shoulder LRS with the arm in three different positions: (A) neutral, (B) 90° abduction with 90° ER, and (C) 90° abduction.

(A) (B) (C)

Figure 2 :Assessment of HGS with the arm in three different positions: (A) neutral, (B) 90° abduction, and (C) 90° abduction with 90° ER.

Hand grip strength was assessed using HHD (JAMAR-5030J1). All patients completed 5-second maximal contractions with the arm in three different positions: neutral, 90° abduction, and 90° abduction with 90° ER. The wrist was in neutral position, forearm in mid position and the elbow at 90° flexion in all positions. Patient was sitting on a chair with back support without arm rest to prevent trunk rotation and help maintain arm position (fig. 2 A, B and C). Each patient was tested three times in each arm position. An average of these three scores was calculated. There was a rest time of 1 minute to ensure sufficient recovery after each contraction (Horsley et al. 2016).

Statistical analysis

Pearson correlation coefficient was used to measure the strength of association between shoulder LRS and HGS. Baseline data statistics showed a strong positive correlation between shoulder LRS and HGS in 90° shoulder abduction and 90° shoulder abduction with 90° ER and a weak positive correlation in neutral position ($r = 0.850$, $r = 0.820$, $r = 0.351$ respectively).

RESULTS

The correlation between shoulder LRS and HGS in patients with RCT, regarding the results in neutral position, the mean ±SD for LRS was 5.81±1.69 kg and for HGS was 24.77±8.37 kg ($r = 0.351$) (fig. 3).

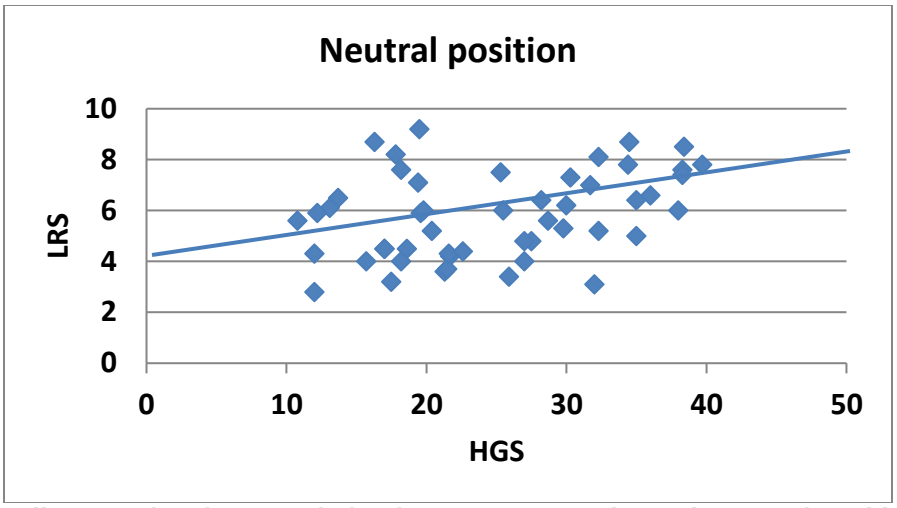

Fig. 3: Scatter diagram showing correlation between LRS and HGS in neutral position (r = 0.351)

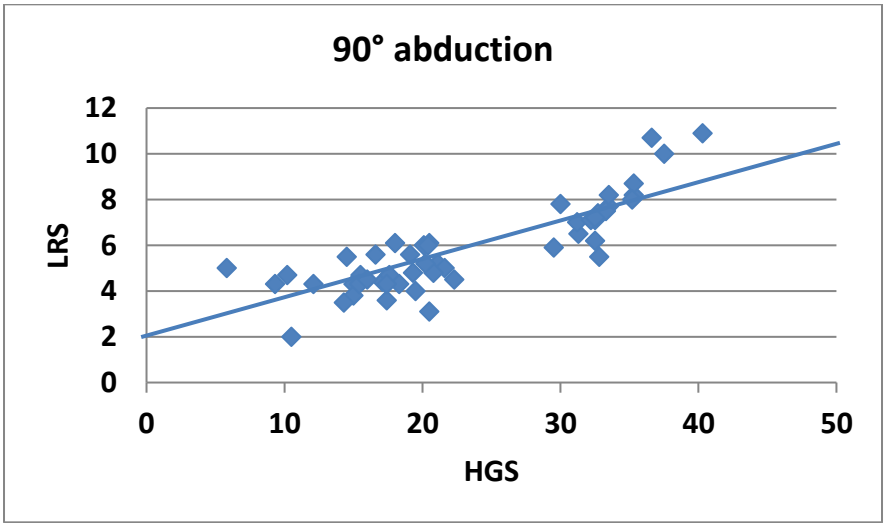

Fig. 4: Scatter diagram showing correlation between LRS and HGS in 90° abduction (r = 0.850).

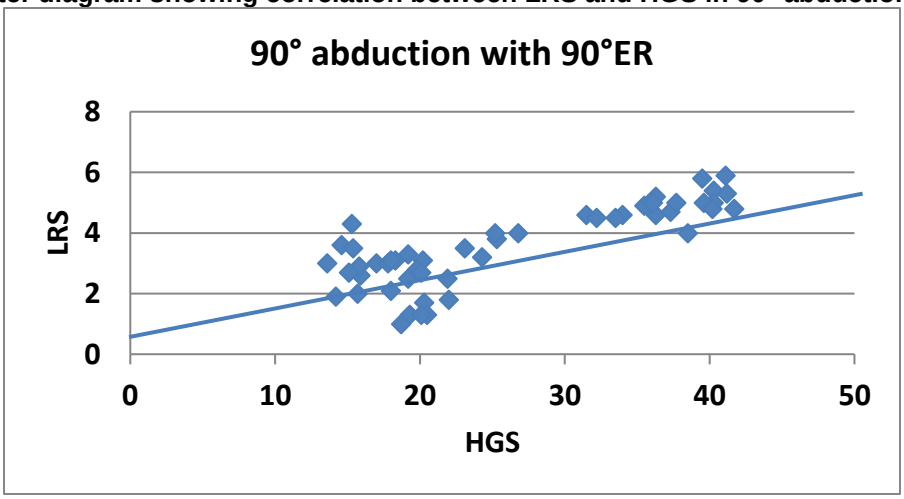

Fig 5: Scatter diagram showing correlation between LRS and HGS in 90° abduction with 90° ER (r = 0.820)

Table 1: Correlation between shoulder LRS and HGS in patients with RCT.

	neutral position	90° shoulder abduction	90° shoulder abduction with 90° ER
Correlation between LRS & HGS	0.351	0.850	0.820

In 90° shoulder abduction, the mean ±SD for LRS was 5.84±1.91 and for HGS was 23.18±8.93 kg (*r* = 0.850) (fig. 4). In 90° shoulder abduction with 90° ER, the mean ±SD for LRS was 3.56±1.31 kg and for HGS was 26.07±9.64 kg (*r* = 0.820) (fig. 5). There was a strong positive correlation between shoulder LRS and HGS in 90° shoulder abduction and 90° shoulder abduction with 90° ER and a weak positive correlation in neutral position (r = 0.850, r = 0.820, r = 0.351 respectively) (table 1).

DISCUSSION

Although RC muscle weakness is commonly associated with RCT, shoulder rotator strength measures are not examined in depth in these patients, external rotator weakness is associated with an increased likelihood of serious shoulder problems and related injury that may require surgical intervention (Decleve and Cools 2016).

Hand grip strength measurement can be used particularly among older people as an indicator of muscle function and physical health. It has been used in different disciplines, including research in gerontology and epidemiology (Ramlagan et al., 2014).

Regarding the results of the current study, there was a strong positive correlation between shoulder LRS and HGS with the shoulder in 90° abduction and 90° abduction with 90° ER. These results could be attributed to the weakness of shoulder rotators as the proximal stabilizers affect HGS, which depends not only on synergistic coordination between finger and wrist flexors and extensors, but also on proximal stabilization as many studies have emphasized the critical influence of elbow or shoulder position or movement on the strength of the hand muscles (Kobesova et al., 2015).

Horsley et al. (2016) examined the relationship between HGS and shoulder LRS in a number of different shoulder positions with the intention of exploring whether there was such a relationship and whether HGS could be used as a functional assessment method for the posterior cuff. The study group consisted of twenty-seven young, physically active participants (19 males, 8 females) with no shoulder history, upper limb or neck injury. The average age (SD) was 19.8 (5.7) years (range 18 to 23 years). There was a strong correlation between GS and LRS for both left and right hands in 90 ° abduction and 90 ° abduction with 90 ° ER, indicating that HGS assessment could be used as a selection method for RC recruitment.

In another study, the effect of hand grip (closed-handed grip (CHG) versus open-handed grip (OHG)) on four shoulder girdle muscle activation including lateral rotators during ER strengthening exercises performed against elastic resistance. The results showed a significant higher activation in the state of CHG and significantly higher rates of muscle activation of the shoulder girdle muscles including lateral rotators occurred during CHG versus OHG elastic-resisted ER. This results may be effectively useful in determining HGS in different shoulder conditions for exercise prescriptions (Hoogenboom et al. 2019).

Antony and Keir (2010) noted that when gripping was added to shoulder movement, infraspinatus (IS) activity increased. Because it has been shown that co-activation of the proximal and distal arm muscles occurs during gripping (possibly as a result of the grip motor control command resulting in activity in the proximal shoulder muscles), it is feasible that HGS assessment will provide an indication of the RC activity.

Regarding the results of the current study, there was a weak positive correlation between shoulder LRS and HGS with the shoulder in neutral position. These findings could be attributed to that the IS activity at 90 ° elevation is higher (55 percent) than IS activity at 0 ° for humeral head control during shoulder elevation due to the fact that IS is a rear rotator cuff muscle preventing anterior translation of the humeral head (Lin et al., 2015)

Dir et al. (2019) reported a weak correlation between HGS and RC power in RC dysfunction. The purpose of this study was to prospectively examine the relationship between the percent loss of hand grip and shoulder strength (LRS and abductor strength) and RC tear dysfunction in

those with proven RC tears (affected compared to unaffected).

CONCLUSION

Assessment of HGS when shoulder is abducted 90° can be reliably used to monitor the function of the lateral rotators of the shoulder in patients with RCT. It may also prove a useful tool when contraction of the RC is restricted as a result of surgery and in the monitoring of muscle weakness.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

AMF developed the idea and performed the measurement procedure. KEA scientific writing. NAF reviewed the statistical design and manuscript. AMF and KEA conducted the statistical analysis and wrote the result and discussion sections. MMB diagnosed and referred patients. All authors read and approved the final version.

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