



Research Paper

Relationship Between Pain, Muscle Strength, Function, and Quality of Life in Overhead Players With Chronic Internal Shoulder Impingement



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ABSTRACT

Background and Objectives: This study aims to determine the relationship between pain, muscle strength, function, and quality of life (QoL) in overhead players with chronic shoulder internal impingement syndrome.

Methods: Forty-seven overhead players consisting of 15 men, 32 and women (mean age 32.45±7.2) with chronic shoulder internal impingement were enrolled. The pain was measured by a visual analogue scale (VAS). Disabilities of the arm, shoulder, and hand (DASH) and shoulder pain and disability index (SPADI) questionnaires were used to measure pain and function, and a short form (SF)-36 questionnaire to measure QoL. Muscle strengths were evaluated in both hands with a hand-held dynamometer and players were asked to hold the maximal voluntary isometric contraction (MVIC) in the middle range for 3 s and rest for 30 s between each test and each contraction was repeated three times on both affected and healthy side and the average of contractions was considered for each side.

Results: The study showed a significant relationship between pain, the strength of shoulder muscle groups (-0.354), function (-0.935), and QoL (-0.861) in overhead throwers with chronic shoulder internal impingement syndrome and the strength of internal rotators of the affected shoulder decreased more than others. (P<0.05)

Conclusions: This correlational study showed a significant relationship between pain and strength of shoulder muscles and function and QoL in overhead throwers with this syndrome.

Keywords: Pain, Strength, Function, Shoulder internal impingement syndrome



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↑ *What is “already known” in this topic:*

Shoulder pain has the third rank among other pains. Shoulder impingement syndrome is the most common disease of shoulder complaints among individuals.

The mechanism of impingement syndrome as an entrapment between the greater tuberosity and glenoid labrum during shoulder abduction and lateral rotation in the interval between supraspinatus and infraspinatus tendons.

→ *What this article adds:*

Studies have only mentioned the relationship between this syndrome and the range of motion, and either the effect of pain on the strength of the shoulder muscles has been investigated, or the improvement of the range of motion of rotation into the shoulder; as well as the ratio of the strength of the internal and external rotator muscles have been investigated. The innovative aspect of this study is the multi-faceted examination of the relationship between pain, shoulder muscle strength, performance and quality of life of throwing athletes.

Introduction

Shoulder pain has the third rank among other pains. Shoulder impingement syndrome is the most common disease of shoulder complaints among individuals. It is classified into three subsets, internal, subacromial, and subcoracoid impingement [1, 2].

These patients state pain during elevating the arm or lying on the painful shoulder [3]. The prevalence of this syndrome is estimated at about 44%–65% of all shoulder pain disorders [4]. This syndrome is one of the most common injuries happening in overhead throwers due to normal physiological contact between the postero-superior glenoid and the greater tuberosity in repetitive hyperabduction and external rotation positions. This physiological contact can be symptomatic when repeated overhead motions result in partial articular-sided posterosuperior rotator cuff tears and lesions of the posterosuperior glenoid labrum, therefore, posterosuperior rotator cuff and labrum will be “pinched” in the space of greater tuberosity and the glenoid rim. This syndrome is multifactorial, such as shoulder physiological remodeling, contracture of the posterior capsule, and scapular dyskinesis. These factors cause shoulder pathologies like glenohumeral internal rotation deficit (GIRD), humeral hyper angulation, and superior labral anterior to posterior (SLAP) tears [5].

Jobe [6] and Walch et al. [7, 8] assert the mechanism of impingement syndrome as an entrapment between the greater tuberosity and glenoid labrum during shoulder abduction and lateral rotation in the interval between supraspinatus and infraspinatus tendons. Walch et al sug-

gested that anterior glenohumeral (GH) laxity has an important role in this syndrome in overhead throwers [7].

This syndrome causes pain in the posterior of the shoulder and happens in the throwers usually during cocking phase of throwing or pitching in the GH joint, whether in excessive external rotation and horizontal abduction or in abduction and shoulder flexion. Other associated pathologies with this syndrome are labrum injury, rotator cuff tear; mostly infraspinatus muscle, greater tuberosity injury, Inferior glenohumeral ligament injury, GIRD, and scapular dyskinesis [9, 10].

According to Jobe’s categorization of the internal impingement syndrome into three stages regarding to patient’s symptoms and presentations, patients in the early stage complain of shoulder stiffness and required to warm-up longer but have no problem with activity daily livings [6]. During the intermediate stage, patients reported pain in the posterior side of the shoulder during the late phase of cocking and have no pain during activities of daily livings (ADLs). During the advanced stage, the patient’s symptoms are like an intermediate stage, but will not get better with rest and rehabilitation [11].

Materials and Methods

This is a correlation study that was conducted at a hospital in Tehran during the summer of 2023. Forty-seven participants (32 males, 15 females) overhead players (volleyball, basketball, badminton, bodybuilding, powerlifting, and swimming) with chronic shoulder internal impingement syndrome participated in this study. Players were tested by shoulder fellowship (orthopedic surgeon) and PhD in physiotherapy. Players entered by

checking the inclusion and exclusion criteria and filling out the consent forms. Then, the pain was measured by a visual analogue scale (VAS). Muscle strength was measured by a handheld dynamometer (Imada design) with the ability to measure tensional strengths and a pressure capacity of 500 N, and a precision of 0.1 N (Figure 1).

Inclusion criteria

The inclusion criteria included 15 to 45-year-old male and female overhead throwers (elite, semi-professional, amateur) with chronic shoulder internal impingement [11, 12], players with no cortisone injection in the last 3 months [11], complaining reduction in ball speed, endurance and ball control during throwing [11, 12], and having the ability to read and write in Persian.

Exclusion criteria

The exclusion criteria included players with a history of neck, shoulder, elbow, and hand pain and injuries in the last 3 months, instability or dislocation of GH joint, undergoing neck and shoulder, elbow, and wrist surgeries last year, and player's unwillingness to participate in this research [12].

Questionnaires

Disabilities of the arm, shoulder, and hand (DASH)

Persian form of DASH questionnaire was used to determine symptoms and degree of disability of musculoskeletal disorders of upper limbs. The severity of symp-

toms, pain, weakness and arm stiffness, function, work, and exercise were discussed. It was completed by players [13]. The scores were converted to percentages by computer program.

Shoulder pain and disability index (SPADI)

Persian form of SPADI questionnaire was used to measure shoulder pain and disability, disability, pain in different situations, and the ability of a person to perform ADL are discussed. It was completed by the players [14]. The scores were converted to percentages by computer program.

Short form (SF)-36

We used the Persian short form (SF)-36 with eight subgroups. Physical and mental aspects were discussed, which examines the pain, health status and its impact on ADL and social activities [15, 16]. The scores were converted to percentages by computer program.

Handheld dynamometer

It was used to measure the isometric strength of all shoulder muscles on both healthy and affected sides in Newton and players were asked to hold the maximal voluntary isometric contraction (MVIC) in the middle range for 3 s and rest 30 s between tests and contractions were asked for 3 times on both sides and the average of the contractions was calculated [17] (Figure 1).



Figure 1. Imada hand held dynamometer



Figure 2. Strength assessment of shoulder muscle groups

A) Shoulder flexors assessment with hand-held dynamometer, B) Shoulder extensors assessment with hand-held dynamometer, C) Shoulder internal rotators assessment with hand-held dynamometer, D) Shoulder abductors assessment with hand-held dynamometer, E) shoulder external rotators assessment with hand-held dynamometer

Muscle tests MVIC

Shoulder flexors (anterior deltoid, biceps, coracobrachialis)

For MVIC of shoulder flexors, players lay in a supine position with shoulder 90° flexion, elbow extension, and the palm faced to the lower limb. It was placed exactly proximal to the styloid process of the ulna at the level of the extensors. Players were asked to apply force to the dynamometer for 3 s in the direction of shoulder flexion, and after each contraction, they rested for 30 s, we considered the average contractions of both shoulder sides [18] (Figure 2).

Shoulder extensors (latissimus dorsi, teres major, posterior deltoid)

For MVIC of shoulder extensors, players lay in a supine position with shoulder 90° flexion, and elbow was completely extended and the palm was facing to the lower limb. The dynamometer was placed proximal to the styloid process of the ulna at the level of the flexors. Players were asked to apply force to the dynamometer similar to previous measurements [18] (Figure 2).

Shoulder internal rotators (subscapularis, pectoralis major, teres major, latissimus dorsi)

For MVIC of shoulder internal rotators, players lay in a supine position with the shoulder in 90° flexion, elbow was 90° flexed, and forearm in a neutral position. The

dynamometer was placed exactly proximal to the styloid process of the ulna at the level of flexors. Players were asked to apply force to the dynamometer similar to previous measurements [18] (Figure 2).

Shoulder abductors (supraspinatus, middle deltoid)

For MVIC of shoulder abductors, players lay in a supine position with the shoulder in 90° abduction, elbow fully extended, palm facing the lower limb. The dynamometer was placed proximal to the styloid process of the ulna at the level of extensors. Players were asked to apply force to the dynamometer similar to previous measurements [18] (Figure 2).

Shoulder external rotators (infraspinatus, teres minor)

For MVIC of shoulder external rotators, players lay in a supine position with the shoulder in 90° flexion, and elbow was 90° flexed, and forearm in a neutral position. The handheld dynamometer was placed exactly proximal to the styloid process of the ulna and at the level of the extensors. The players were asked to apply force to the dynamometer similar to previous measurements [18, 19] (Figure 2).

Data analysis

All statistical analyses were performed by SPSS software, version 26. The significance level for all tests was

set at a value of 0.05. The differences in the means and proportions were evaluated using t-test. Descriptive statistics included the mean and dispersion of the data, and analytical statistics included the Kolmogorov-Smirnov method to determine the normal distribution of the data. In the case of normal distribution of data, two-by-two correlation was measured with Pearson correlation.

Results

Table 1 shows the demographic data of the overhead thrower players.

According to Tables 2 and 3, the pain had a moderate negative relation with the isometric strength of all muscle groups. The relationship between pain and the DASH score (function) and disability part of the SPADI and SF-36 was significant. Duration of the syndrome had no relationship with other parameters.

The strength of shoulder muscle groups on both sides showed that the MVIC of the healthy side is more than affected side and the strength of the internal rotators of the affected shoulder significantly decreased more than others. The MVIC of flexors of the healthy side was higher than the MVIC of other muscle groups.

The strength of all muscles had a high positive relation with other muscle groups. Also, it had a moderate positive relationship with quality of life (QoL), but a moder-

Table 1. Patient demographics (n=47)

Variables		No./Mean±SD
Age		32.45±7.2
Gender	Male	15
	Female	32
Weight (kg)		78.66±14.5
Hight (cm)		175.57±9.1
BMI (kg/m ²)		25.34±3.1
Pain (VAS)		6.17±1.9
Duration (m)		9.21±2.2
Level of activity	Amateur	34
	Semi-professional	5
	Professional	8
Dominant hand	Right	36
	Left	11

ate negative relationship with the DASH questionnaire (function) and a low negative relation with SPADI questionnaire (pain and disability).

The DASH questionnaire had a high positive relationship with the SPADI questionnaire and its relationship with QoL was negative and high.

Also, the results of the SPADI questionnaire had a high negative relationship with QoL. It showed that the MVIC of male players was higher than female players.

However, no significant difference was observed between men and women to compare the disability.

Based on the t-test, the MVIC of the flexors was higher than the MVIC of other muscles in the healthy side. However, the MVIC of abductors was lower than the MVIC of other muscle groups on the healthy side. Also, in the affected hand, the MVIC of the extensors was higher than MVIC of other muscle groups but the MVIC of the abductors was lower than MVIC of other muscles.

Table 2. Correlation between pain, muscle strengths, function, and QoL

	Pain	Duration	Stregh Flex Affected	Stregh Ext Affected	Stregh Abd Affected	Stregh Int Rot Affected
Pain	1	0.117*	-0.430*	-0.268*	-0.377*	-0.344*
Duration	0.117*	1	-0.083*	-0.018*	-0.113*	-0.141*
Strength flex affected	0.430*	-0.083*	1	0.834	0.916	0.801
Strength ext affected	-0.268*	-0.018*	0.834*	1	0.874	0.942
Strength abd affected	-0.377*	-0.113*	0.916	0.874	1	0.874
Strength Int rot affected	-0.344*	-0.141*	0.801	0.942	0.874	1
Strength ext rot affected	-0.351*	-0.152*	0.815	0.876	0.873	0.923

	Strength Ext Rot Affected	DASH	SPADI Pain	SPADI Disability	SF36 Physical	SF36 Mental
Pain	-0.351*	0.897	0.946	0.935	-0.869	-0.820*
Duration	-0.152*	0.068*	0.070*	0.057*	-0.176*	-0.170*
Strength flex affected	0.815	-0.500	-0.396*	-0.475*	0.421*	0.422*
Stregh ext affected	0.876	-0.373*	-0.255*	-0.359*	0.278*	0.329*
Strength abd affected	0.873	-0.440*	0.342*	-0.422*	0.397*	0.402*
Strength int rot affected	0.923	-0.403*	-0.284*	-0.380*	0.305*	0.345*
Strength ext rot affected	1	-0.395*	0.324*	-0.403*	0.338*	0.397*

*Statistically significant difference

Abbreviations: SPADI: Shoulder pain, and disability index; SF-36: Short form-36; DASH: Disabilities of the arm, shoulder, and hand.

Table 3. Correlation between pain, function and QoL

	DASH	SPADI Pain	SPADI Disability	SF36 Physical	SF36 Mental
DASH	1	0.894*	0.913*	-0.897*	-0.847*
SPADI pain	0.894*	1	0.953*	-0.889*	-0.864*
SPADI disability	0.913*	0.953*	1	-0.888*	-0.853*
SF36 physical	-0.897*	-0.889*	-0.888*	1	0.926*
SF36 mental	-0.847*	-0.864*	-0.853*	0.926*	1

*Statistically significant difference.

Abbreviations: SPADI: Shoulder pain and disability index; SF-36: Short form-36; DASH: Disabilities of the arm, shoulder, and hand.

According to the average results of the DASH (function) questionnaire, the rate of decrease in function and disability between female players was higher than male players and the average results of the SPADI questionnaire demonstrated more pain and disability in men than in women. The results of the SF-36 questionnaire showed that the quality of both the physical and mental life of women is higher than that of men.

Discussion

In the past research, the relationship was two-by-two (the amount of pain with strength or pain with the amount of decreased range of motion, especially the decrease in the range of internal rotation) was investigated. However, in this focal research, several factors that were affected after this injury were investigated. Also, previous studies focused on other shoulder syndromes, such as subacromial syndrome.

Players' function showed a very high and significant indirect relation with pain intensity. Also, the decrease in shoulder flexor muscle strength had the most relationship with the decrease in the function of players, and the decrease in the strength of shoulder extensor muscles had the least relation with the decrease of function in players. Also, it had a significant direct relationship with players' QoL (physical and mental).

Pain is an unpleasant sensory and emotional experience, associated with tissue damage or tissue destruction [20]. It usually protects a person by preventing them from doing activities that may damage the tissue. The crucial concept is that pain is not a sign of tissue damage, but shows the brain's belief that a particular tissue needs protection. The mechanisms of pain are divided into three categories of nociceptive, peripheral neuropathic, and central sensitivity. In this research, the pain

of players with this syndrome was central sensitization and biopsychosocial [21].

According to this syndrome, increased response of nociceptors in the central nervous system to normal or subthreshold afferent input leads to hypersensitivity to stimuli. A pathophysiological process in which the central nervous system undergoes changes that alter the processing of pain and other sensory stimuli. This kind of pain often does not respond to medications [21].

Effect of pain on muscle strength

Muscle strength is the maximum force that muscles can generate at a determined speed. This ability of skeletal muscle to generate force is important for functional stability and mobility.

The relationship between pain and normal motor response is justified by pain adaptation theory.

This theory suggests facilitated and inhibited motor responses depending on their relationship to the painful area, partially combining the vicious cycle theory and the inhibition theory. It means agonist's muscles show decreased activity, while antagonist's muscles show increased muscle activity [22]. Lund et al. suggested that through a mechanism, nociceptive input converges on group II interneurons and leads to a decrease in muscle strength [23].

Disability refers to difficulty in performing tasks or activities of ADL. The patient cannot take care of him/herself. Shoulder pain in athletes caused a decrease in their muscle strength and disability and their participation in sport [24].

Function refers to the person's ability to do tasks and activities at home, at work, in the community, and during recreational activities independently.

The international classification of functioning, disability and health (ICF) model, suggests a framework of function, disability, and health to help us for describing and organizing patient's information about the function. It divides health-related information into two parts. First one contains function and disability, which is divided into two subsets, functions and structure of the body, activities and participations and activity limitations.

The second part includes factors that are divided into two components: environmental factors, and personal factors [25].

A person's level of function is a combination of dynamic interaction between his/her health conditions, environmental factors, and personal factors.

According to the international classification of functioning, disability and health (ICF) model, activity limitations take place whenever a person or player has difficulty performing activities or is unable to accomplish tasks or daily activities. Participation limitations are difficulties that a person may have in engaging in life situations [25].

The effect of QoL

Controlling pain plays a crucial role in QoL. Pain has a destructive influence on every aspect of a player's life with this syndrome and it causes anxiety and emotional problems for athletes, negatively affects their general well-being, and caused problems for abilities related to family, society, and work. Therefore, it had negative impacts on their physical and mental QoL [26].

In a study by Sahinoglu et al. [27] all patients with unilateral rotator cuff injuries received a physical therapy program for 6 weeks. Finally, a weak relationship was observed between changes in the range of motion of abduction and the SPADI score. Also, a relationship was observed between changes in external rotation strength and the score of the SPADI questionnaire.

Almeida et al. [26] studied on patients with subacromial impingement syndrome. They reported that the strength of the muscles between the healthy and affected side is significantly different in all movements. Also, a significant indirect relationship between shoulder pain and function and isometric muscle strength of shoulder

flexion and internal rotation and a significant direct relationship with the level of fear of movement.

Celik et al. [28] investigated the relationship between pain and upper, middle, lower trapezius, serratus anterior, supraspinatus, anterior deltoid muscle strengths bilaterally in patients with subacromial impingement syndrome. The strength of the middle trapezius, serratus anterior, supraspinatus, and anterior deltoid of the affected side was lower than the healthy side. A significant relationship was observed between pain and weakness of the middle trapezius, serratus anterior, and supraspinatus.

Gutierrez et al. [29] examined the relationship between shoulder pain and QoL, physical activities, and social activities in spinal cord injury patients. It showed a significant relationship between pain and QoL and physical activities but no relationship between pain and social activities was found.

This correlation study shows that in overhead players with this syndrome, to return to sports, pain must first be reduced. Then, special exercises should be done for strengthening shoulder muscles, particularly internal rotators, and enhancing function and QoL of the players and their activity and participation should be considered and prevention of returning to sports until the above conditions are met.

Conclusion

Players with this syndrome showed a negative relationship between pain and muscle strength of the symptomatic shoulder. A high negative relationship between pain and function and QoL was considerable. A positive relationship between muscle groups' strength of the affected shoulder and function and QoL was palpable. Reduction in all muscle strengths of the affected shoulder in comparison with the asymptomatic side was observed. Therefore, a significant relationship was observed between pain, muscle strength, function, and QoL in overhead players with this syndrome.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by [Iran University of Medical Sciences](#) (Code: IR.IUMS.REC.1401.340).

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The paper is extracted from master's thesis of SeyedehPardis Emadi, approved by Department of Physiotherapy, School of Rehabilitation, [Iran University of Medical Sciences](#).

Authors' contributions

Conceptualization and supervision: Soheil Mansour; Methodology: SeyedehPardis Emadi; Writing the original draft; SeyedehPardis Emadi and Reza Salehi; Investigation, review and editing: All authors.

Conflict of interest

The authors declared no conflict of interest.

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مقاله پژوهشی



رابطه بین درد، قدرت عضلانی، عملکرد و کیفیت زندگی در بازیکنان بالای سر با برخورد مزمن داخلی شانه

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چکیده

مقدمه: هدف از این مطالعه، تعیین ارتباط بین درد و قدرت و عملکرد عضلات ناحیه شانه و کیفیت زندگی در ورزشکاران پرتابگر بالای سر حرفه ای، نیمه حرفه ای، آماتور مبتلا به سندرم مزمن گیرافتادگی داخلی شانه است.

مواد و روش ها: پرتابی (والیبال، بسکتبال، بدمینتون، بدنسازی، وزنه برداری و شنا) آماتور، نیمه حرفه ای و حرفه ای مرد و زن ۱۵ تا ۴۵ سال با تشخیص سندرم مزمن گیرافتادگی داخلی شانه توسط متخصص ارتوپدی به مرکز فیزیوتراپی ارجاع داده شدند و میزان درد با VAS سنجیده شد و پرسشنامه های DASH و SPADI برای بررسی درد و عملکرد تکمیل شد. از داینامومتر دستی برای سنجش میزان قدرت ایزومتریک همه گروه های عضلات شانه با انقباض ارادی ایزومتریک هر گروه عضلانی بصورت MVIC در هر دو سمت مبتلا و سمت سالم برحسب نیوتن استفاده شد و از بازیکنان خواسته شد که انقباض ارادی ایزومتریک هر گروه عضلانی را بصورت MVIC در دامنه میانی به مدت ۳ ثانیه نگه دارند و بین انجام هر تست ۳۰ ثانیه استراحت کنند. و هر انقباض سه بار هم در سمت مبتلا و هم در سمت سالم تکرار شد و برای هر سمت، میانگین این سه انقباض لحاظ شد. پرسشنامه SF-36 برای بررسی کیفیت زندگی تکمیل شد.

یافته ها: گروه های عضلانی شانه، عملکرد و کیفیت زندگی در ورزشکاران پرتابی مبتلا به سندرم گیرافتادگی مزمن داخلی شانه وجود دارد ($P < 0.05$) و قدرت عضلات چرخاننده داخلی شانه در سمت مبتلا بیشتر از سایر گروه های عضلانی شانه کاهش یافت.

نتیجه گیری: براساس تحقیق انجام شده، بین شدت درد، میزان قدرت عضلات شانه، عملکرد و کیفیت زندگی در ورزشکاران پرتابی مبتلا به سندرم گیرافتادگی مزمن داخلی شانه ارتباط وجود دارد.

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کلیدواژه ها:

درد، قدرت، عملکرد،
کیفیت زندگی، سندرم
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