ISSN: 2149-2018

Applied Medical Research, 2021
VOL 8, NO. 1, PAGE 1 – 3
DOI: doi.org/10.47363/AMR/2021(8)188

RESEARCH ARTICLE

Open Access

Shoulder Differences between Volleyball Players and Non-Overhead Athletes

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ABSTRACT

Introduction: in any sporting activity, there are functional adaptations specific to each sport. In volleyball, one of the most important functional adaptations is the shoulder's articular complex. Thus it is extremely important to determine, assess and to take them into consideration by the physioherapist in order to prevent any injury.

Objective: determine if there are any recurring functional adaptations due to overuse of the shoulder in volleyball players, compared with players of non-"overhead" sports.

Methodology: analysis of video footage of passive movement amplitude of the internal and external rotation, and horizontal adduction of the shoulder using the Kinovea program.

Results: After analyzing all the collected data, a difference in horizontal adduction was verified between the two groups under testing. There was no evidence of any difference in internal and external rotation.

Conclusion: regarding the functional adaptations of the shoulder, specifically in terms of horizontal adduction, there are significant differences between a volleyball player and a non-volleyball player. This adaptation in particular corresponds to a shortening of the posterior capsule, which is responsible for many shoulder related pathologies.

ARTICLE HISTORY

Received Feb 22, 2021
Accepted Feb 26, 2021
Published Feb 27, 2021

KEYWORDS

Volleyball, Functional Adaptations, Shoulder Injury

Introduction

In volleyball, due to the number of training sessions, intensity and also duration of the game, injuries are frequent. The type and incidence of injuries varies according to field position, however, injuries due to overuse are the most frequent. Among the injuries in volleyball, those in the shoulder joint complex (SJC) are the most frequent, with about 15 to 20% of professional volleyball players suffering from shoulder pain due to rotator cuff injury [1]. SJC injuries in overhead athletes are often attributed to adaptations in strength and flexibility that can lead to biomechanical changes, in particular at glenohumeral internal rotation deficit (GIRD) and also an imbalance of strength in the rotator cuff muscles. Consequently, subjects present different movement strategies during the technique to be performed, increasing the risk of overload injuries in the SJC [2]. Over the years of practice, as described in the literature, there seems to be a reduction in the GIRD, a total reduction in range of motion and a decrease in the strength of the external rotators, these factors are the main points for an increase in the risk of injury to the shoulder of overhead athletes.

Regarding the increase in humeral torsion, it can cause a change in the range of motion resulting in shoulder external rotation increase and a decrease in the internal rotation [3]. In sports where ballistic shoulder rotation is used, athletes may experience a shortening of the posterior shoulder capsule, and this is implicated in several SJC problems [4]. As mentioned earlier, these factors increase the risk of shoulder injury in athletes from overhead sports. The aim of this study was to understand the differences in the shoulder joint complex between volleyball players and subjects who do not practice overhead sports. These adaptations once present can induce injury, thus, the physiotherapist having this information, will be able to intervene avoiding the appearance of injuries through specific prevention programs.

Methods

Sample

The sample consisted of 23 female volleyball players, with the participation of Leixões Sport Club, Castêlo da Maia Ginásio Clube and Porto Volei and 23 female non-athletes, aged between 18 and 35 years. The non-athlete subjects were evaluated at the Pedagogical Physiotherapy Clinic of Universidade Fernando Pessoa.

As exclusion criteria we defined athletes / subjects with previous

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shoulder injuries, diagnosed with shoulder pathology, shoulder surgery, who had developed pain symptoms referred in the last 7 days prior to data collection, with medication dosage (NSAIDs, muscle relaxants), metabolic, cardiac, epilepsy, cardiorespiratory and neurological pathologies. Regarding the inclusion criteria, we define all female volleyball players, as well as non-athletes, who are available to participate in the study and without injuries.

Ethics

This study was initially submitted for approval by the Ethics Council of Universidade Fernando Pessoa. All participants signed an Informed Consent statement, after clarifying all the intended interventions throughout the study, they were given the possibility to refuse participation in the study at any time, without causing any personal loss. At the end of the investigation, the relevant data was transmitted to the participants for possible benefits.

Procedures

All athletes filled out a sample characterization questionnaire with variables such as: age, weight, height, pathologies, injuries, medication, among others.

Reflective markers were placed in all subjects at the glenohumeral center of rotation of the glenohumeral, olecranon, epitrochlea, epicondyle, styloid apophysis of the radius, styloid apophysis of the ulna and acromion. These same markers consisted of polystyrene balls lined with reflective material that were fixed to the skin with double-sided adhesive tape. All athletes were evaluated before physical activity.

Shoulder Range-of-Motion

All participants were subjected to the passive internal and external glenohumeral rotation range of motion evaluation of the dominant upper limb. All of them were placed in the supine position, on a table with the shoulder at 90º of abduction, and the elbow at 90º of flexion, this without the support of the table [5]. The amplitudes were filmed, using a Nikon D90 and later processed on a computer using the Kinovea software.

Shoulder Posterior Capsule Tightness

Flexibility of the posterior shoulder capsule was also assessed. For this, horizontal glenohumeral adduction was requested, in order to perceive the posterior capsule tightness. This movement was performed with the subject at the supine position, with the examiner at the head of the couch towards the subject's head, the upper limb was at 90º shoulder flexion and abduction and 90º elbow flexion. The examiner applied a force to stabilize the scapula, while the other hand was placed on the proximal area of the forearm performing the passive horizontal adduction [4].

Statistical Analysis

Statistical Package for the Social Sciences (SPSS) v.22 (IBM) was used to process statistical data. After analyzing the normality and homogeneous character of the sample (Shapiro-Wilk), it was concluded that all variables had a normal distribution except age. A descriptive analysis was performed, and then analytical statistics were performed. The following statistical tests were used: T test for two independent samples for variables that had a normal distribution. We considered a value of $p < 0.05$ as statistically significant and presented 95% confidence intervals.

Results

For this study, a sample composed of two groups consisting of 23 elements each, a group with volleyball athletes and another group with non-athletes, was selected. The sample's descriptive data will be presented in Table 1.

Table 1: Biometric Characteristics

	Athletes	Non-Athletes	p-value
Age* (Years)	21,00; 18 - 35	22,00; 20 - 25	p<0.005
Height **(m)	1,76±0,06	1,64±0,07	p>0.05
Wheight** (kg)	66,43±9,81	60,96±9,99	p>0.05

* median; mín - máx ** $\bar{X}$ ±DP

After comparative analysis of the two groups, athletes and non-athletes, it was concluded that there are statistically significant differences only in the age variable (Shapiro-Wilk test: $p < 0.005$).

Table 2: Internal, external and horizontal adduction range of motion

Degrees (º)	Athletes	Non-Athletes	p-value
Internal rotation	65,07±2,79	71,10±2,20	p>0.05
External Rotation	106,70±2,24	101,51±2,97	p>0.05
Horizontal Adduction	107,19±2,47	113,69±1,53	p<0.05*

After comparative analysis of the two groups, it is concluded that there are no significant differences in the variables under study.

Moving on to the analysis of the variables of interest, no statistically significant differences were found for internal rotation ($p > 0.05$; CI = [- 1.14; 13.19]) and external rotation $p > 0.05$; CI = [- 12.69; 2.31]). For horizontal adduction, statistically significant differences were observed, $p < 0.05$, CI = [0.64; 12.35].

Discussion

The aim of this study was to understand differences in shoulder joint complex between volleyball players and subjects who do not practice overhead sports.

We only found statistically significant differences in horizontal adduction, when the two groups were compared. We found that the results obtained go against what is described in the literature, in other “overhead” modalities. Thus, in a study with high competition swimmers and athletes who practice non-overhead sports, the authors also did not find statistically significant differences for internal and external rotation, however, they found differences for horizontal adduction, $p < 0.001$; 95% CI = [2.92; 7.33] [6]. However, in another study in female handball athletes, the authors obtained different results [7]. Thus, although they did not test the horizontal adduction, they did it for internal and external rotation. They divided the total number of athletes by three groups, with shoulder pain, with previous pain on the

shoulder and without pain, and compared the dominant with the non-dominant limb. Authors found differences concerning rotations, an increase in external rotation and a decrease in internal rotation between the dominant and non-dominant shoulders. There were no differences in the total range of motion between the three groups of athletes.

However, it should be noted that in the present study, athletes evaluated were asymptomatic, which is a significant difference when compared to the study by Myklebust, Bahr and Steffen [7]. Wilk, Macrina and Arrigo, on the other hand, tested the internal and external rotation and horizontal adduction of the dominant upper and non-dominant members of baseball players, to find if possible, differences between them [8]. The results were as follows: greater range of motion of the external rotation, in the internal rotation with stabilization of the scapula, the dominant limb had less range of motion. In the total range of motion of both shoulders, they found no clinically relevant differences. Regarding horizontal adduction, it was lower in the dominant shoulder when compared to the non-dominant shoulder. In the same study, authors reported that there was a weak relationship between horizontal adduction and internal rotation of the shoulder. These results, which coincide with the present study, can be explained by the fact that there may be a retraction of the posterior shoulder capsule that does not allow a full range of motion [9].

The fact that there are no differences for internal or external rotation may be due to the fact that there is a translation of the humeral head, due to the shortening of the posterior capsule [10]. Thus, in our case, the control group was composed entirely of students, which may be a factor promoting postural changes such as anterior and internal rotation of the shoulders as well as anteriorization of the head [6]. These adaptations happen due to factors of the student's daily life, such as: use of computer, non-ergonomic college desks, use of backpack [6]. It is important to note, however, that this assessment was not carried out and is therefore only a hypothesis. Another hypothesis of not having found significant differences between the external and internal rotation, is due to the fact that these movements were performed with stabilization of the scapula, distancing from the practice of sports [2]. This stabilization of the scapula allows an extension of the posterior articular capsule of the shoulder, thus facilitating the internal rotation movement, however, it increases the risk of rupture of the rotator cuff [10]. It was expected that this rotation would have less amplitude when comparing both samples [2]. Athletes who practice overhead sports tend to have postural changes caused by sports. These postural changes can therefore alter the subjects internal rotation. Athletes will be able to adopt a posture that increases the internal rotation of the humerus, which means that this movement is already limited, thus increasing the external rotation so that it is possible to maintain a wide range of movement [11, 12]. Another possible cause for not having found differences in internal rotation and external rotation, is related to the humeral retroversion angle. Myers, comparing the dominant and non-dominant shoulder of overhead athletes with a control group of non-athletes, found that the athletes shoulder presented a greater humeral retroversion in the dominant limb [9]. Even if the humerus retroversion angle has not been evaluated, we can see that total bone maturation may not have occurred yet, and this hypothesis is credible to justify the absence of differences in rotations. However, according to Yamamoto, it is possible that the excessive forces around the proximal humerus during growth, affect the growth of the humerus, inducing for this reason morphofunctional adaptations [13]. Although there are differences in age, this being a non-continuous variable, the median of the group of non-athletes is 22 and the group of athletes is 21. According to Macedo and Magee, in Caucasian women aged between 18 and 59 years, there are effects of a decrease in joint amplitude caused by age, except in the external rotation movement, which tends to decrease with age [14].

It is important to note that although there are no statistically significant differences between the rotations between the group of non-athletes and the group of athletes, both have different values than the standard value of 90º. The internal rotation is lower, with the group of athletes having an average of 65.07º and the group of non-athletes having an average of 71.1º. External rotation is greater, with the group of athletes showing a range of 106.7º and the group of non-athletes pointing to 101.51º.

There are differences between the female and male gender, one of them in the anatomy of the humeral head. The differences are in the height and width of the humeral head, which is always higher in men than in women [15]. Syed et al conducted a study on the possible differences between characteristics of the humerus in relation to height and weight [15]. There is a relationship between the individual's weight and height with the size and height of the humeral head. These changes can cause instability of the shoulder, which in turn can increase the risk of injury to the rotator cuff, as it is also a stabilizer of the humeral head [16].

It seems important to mention some of the limitations of this study, namely the fact that the sample is representative for women, does not allow extrapolating conclusions for male volleyball players. The reason why the sample is entirely female was due to pragmatic issues, namely the student having contact with coaches and clubs of female practitioners of the sport. The fact that there is a difference between ages can be justified by the fact that the control group came only from a university population. It is also important to note that our sample was small (n = 46) and that although we found statistically significant differences in one of the functional adaptation variables, we might not have enough sample size to demonstrate statistically significant differences in the two variables. Given that there is little literature in this population, it was not possible to calculate the sample size to demonstrate those differences.

The results obtained in this study are important with regard to the role of the physiotherapist, as it contributes to the evidence of the occurrence of these functional adaptations in these athletes. Thus, it is in prevention that the physiotherapist will have a fundamental role in monitoring these athletes.

Conclusions

With the present study it can be concluded that there are differences concerning functional adaptations in relation to the volleyball and non-overhead athlete's shoulders, in the study sample. Notably in the horizontal adduction, statistically significant differences were found. This represents a shortening

of the posterior capsule that is implicated in several shoulder pathologies.

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