ASSESSMENT OF DEFICIT IN MEDIAL ROTATION AND POSTERIOR SHORTENING OF THE SHOULDER IN PROFESSIONAL BASKETBALL PLAYERS

LOCOMOTOR APPARATUS IN EXERCISE AND SPORTS

ORIGINAL ARTICLE

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ABSTRACT

Throwing is distinguished as one of the main gestures that involve the shoulder joint. Athletes who practice throwing over the head are more prone to develop lesions in the shoulder and can provide significant increase in lateral rotation (LR) and decreased medial rotation (MR). The deficit of MR is called GIRD (Glenohumeral Internal Rotation Deficit). The objective of this study was to verify the existence of changes in mobility of the glenohumeral joint in basketball professional athletes and if there is a correlation between range of motion (ROM) of MR and shoulder posterior shortening. Method: 19 professional basketball players were evaluated. The MR and LR shoulder were measured through goniometry and photogrammetry in addition to the test for shoulder posterior shortening. Results: There were no significant differences between genders or between rotations (LR and MR) when dominant and non-dominant shoulders were compared. Concerning the shortening test, no statistically significant differences were observed either. There were no correlations between RM decrease and the test for shoulder posterior shortening. Conclusion: No changes in mobility of the glenohumeral joint in professional basketball athletes in this sample, or correlation between ROM of MR and shortening of the shoulder posterior shortening were found.

Keywords: throwing, posterior capsule, range of motion.

INTRODUCTION

The shoulder plays a vital role in in many athletic activities. Throwing appears as one of the main gestures which involve this joint being present in many sports such as baseball, handball, tennis and basketball, with different techniques depending on each sport though. Athletes who practice throws above the head present higher probability in developing shoulder injuries[1].

The physical exam of throwing athletes may present adaptations in the range of motion (ROM) of medial and lateral rotation of the dominant shoulder when compared with the non-dominant one[2]. Such fact may be confirmed by the results of many studies which demonstrate significant increase of glenohumeral lateral rotation (LR) and decrease in the medial rotation (MR) on the shoulder of throwers[2-7]. The deficit in the medial rotation of the dominant shoulder compared with the non-dominant is named GIRD (*glenohumeral internal rotation deficit*).

It is believed that the reason for this alteration is the result of a natural adaptation of the shoulder developed in throwing athletes. Theories correlate the increase of lateral rotation and the GIRD with the presence of microtrauma in the static and dynamic restrictors, involving contracture of the posterior capsule and bone adaptations in the humerus version[2].

There are many hypothesis on the etiology of the deficit of the medial rotation, one of them states that it is a result of a contracture and thickening of the postero-inferior portion of the glenohumeral capsule, which occurs due to the repetitive microtrauma during the phases of late cocking and follow-through of the throwing movement[1,2,8]. In that case, the loss of medial rotation exceeds the lateral rotation gain; thus, the deficit is attributed to the alterations in the soft tissues, being considered pathological[4].

Some authors suggest that the bone adaptations interfere on the ROM alteration as much as the soft tissues adaptations. They mention that the retroversion increase of the proximal humerus results in increase of lateral rotation with consequent decrease of medial rotation. In those cases, it is observed by the authors that the total ROM of shoulder rotation (lateral rotation plus medial rotation) is equal both on the dominant and non-dominant shoulder; that is to say, for each acquired degree of lateral rotation, one degree of medial rotation is lost. It is believed that this is a physiological adaptation which does not cause damage to the shoulder function[2,4].

Due to the suggestive correlation between alterations in shoulder mobility in throwers and injuries, added to the lack of articles involving basketball athletes, the aim of this study was to verify the existence of alterations in mobility of the glenohumeral articulation in professional basketball athletes as well as to verify the existence of correlation between ROM of MR and shoulder posterior shortening.

METHOD

Subjects

19 professional basketball players were evaluated; out of these, 10 were female (25.8 ± 4.1 years) and nine male (25.1 ± 3.4). The characteristics of these subjects are presented in table 1.

As exclusion criteria, the subjects should not present history of surgery or injury on the shoulder and elbow which had resulted in time away from the sport in the last 12 months.

All participants signed a Free and Clarified Consent Form and the study was approved by the ethics committee of the institution (CEP 1467/08).

Previously to the study, a pilot with non-throwers was performed with the aim to train and familiarize the examiners with the measurement techniques. All measurements were performed by two physiotherapists. The measurement techniques were similar to the ones described in previous studies[2-4,9,10].

The measurement of the ROM of lateral and medial rotation was performed in two ways: goniometry and biophotogrammetry.

Table 1. Characterization of the subjects.

		Men	Women
Time of training[a]		16.3 ± 3.7	14.5 ± 4.5
Training frequency	Days/week	6.2 ± 0.4	5,8 ± 0,4
	Hours/day	4.6 ± 1.1	5,0 ± 0,6
Bodybuilding[b]		3.0 ± 0.8	3.8 ± 0.4
Position		5 small forwards, 2 point guards, 2 centers	6 small forwards, 2 point guards, 2 centers
Ethnic group		2 black, 6 white, 1 pardo	6 black, 4 white
Dominance		8 right-handed, 1 left-handed	8 right-handed, 2 left-handed

[a] Values in years presented in mean ± standard deviation.
[b] Values presented in days/week

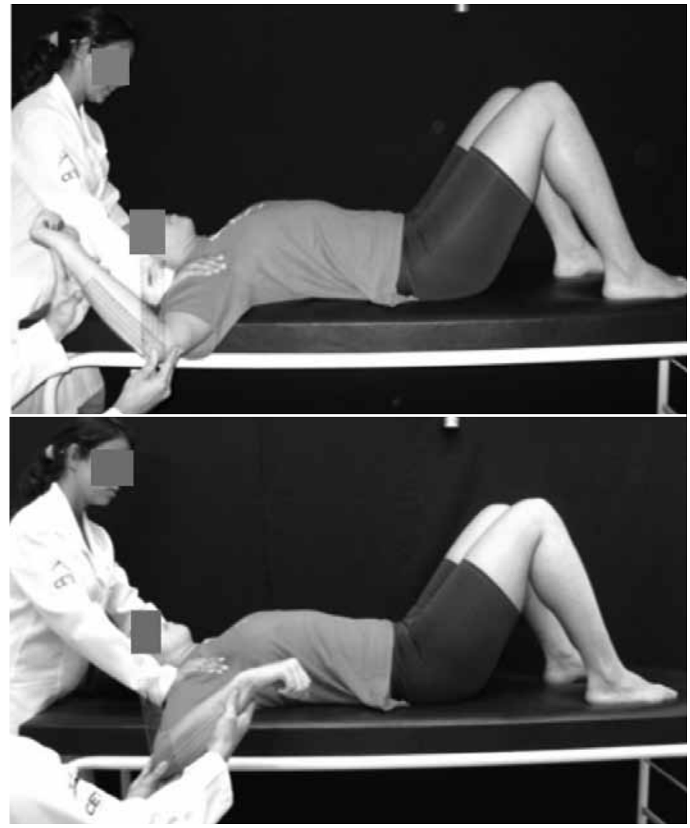

Figure 1. Evaluation of the ROM of medial rotation and lateral rotation through goniometry.

Goniometry

The isolate ROM of LR and MR of the glenohumeral joint was obtained through stabilization of the scapula and of the humerus rotation in the glenoid. The subject was positioned at dorsal decubitus on the stretcher with the hip and knee flexed at approximately 90° each. The shoulder to be examined was at initial position of 90° of abduction and 90° of elbow flexion, with the arm perpendicular to the ground. The humerus was stabilized at neutral horizontal position (humerus at the acromial process level) with a towel. From that position (0° of glenohumeral rotation), the examiner A, passively, performed the shoulder rotation while the examiner B stabilized the scapula. The maximal ROM was defined as the end of the rotation or until the scapula movement was noticed (figure 1).

The axis used for the goniometer was the olecranon for both measurements of lateral and medial rotation, the steady arm was perpendicularly aligned to the ground and the mobile arm was aligned between the olecranon and the ulnar styloid process.

Biophotogrammetry

Biophotogrammetry consists of computer measurement of the ROM through a digital photography in pre-determined conditions and with markers placed on the body surface of the evaluated individual in order to serve as reference points for subsequent measurement.

The images were obtained with a Sony digital camera, model *Cyber-Shot* DSC-S750, with 7.2Mp of resolution. Resolution of 5.0Mp was used for all images. The camera was placed on a tripod 200cm away from the stretcher, adjusted at the same height. The tripod was horizontally and vertically leveled through a bubble lever. A plumb line with two circular and reflexive markers of 13mm of diameter, distant from each other in 50cm (figure 2) was used for vertical reference of the photo. The SAPO software for posture evaluation, version 0.67, was used for the photos analysis.

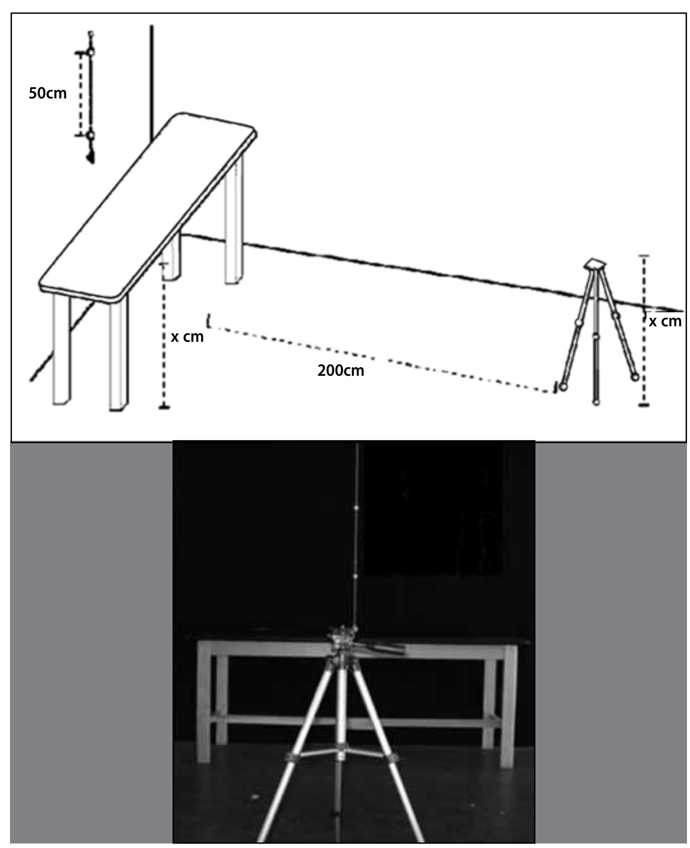

Figure 2. Evaluation place and instruments.

The subjects were positioned in the same way described for goniometry and two circular, self-adhesive and reflexive markers of 13mm of diameter were placed on each upper limb: one placed on the ulnar styloid process and the other on the olecranon. Examiner A stabilized the scapula with one of the hands and with the other passively performed rotation on the shoulder of the athlete (figure 3).

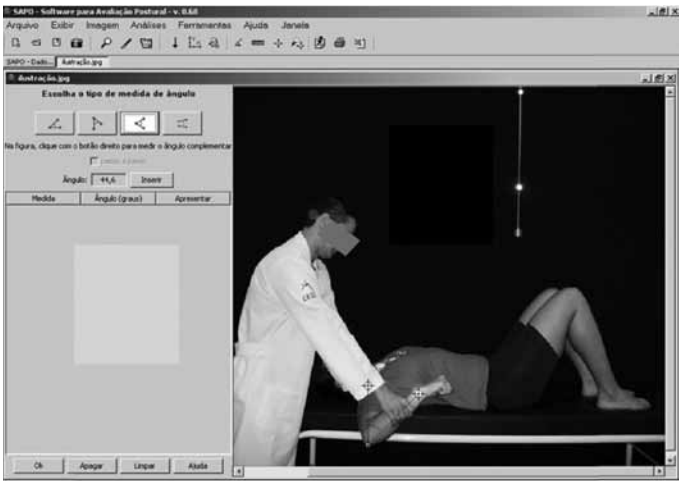

Figure 3. Evaluation of the ROM of medial rotation and lateral rotation through biophotogrammetry.

Similarly to in the goniometry, the maximum ROM was defined as the end of the rotation or until the scapula movement was noticed. When the maximum ROM was reached, the photography was taken by examiner B.

Both in the goniometry and biophotogrammetry, the measurements were bilaterally performed, always by the same examiner. The sequence of the kind of measurement (goniometry and biophotogrammetry), as well as the shoulder (right and left) was defined by a simple draw for each individual.

GIRD measurement

The GIRD was calculated by the difference of the medial rotation between the dominant and non-dominant shoulders in degrees. Likewise, the difference of the lateral rotation and the total ROM was calculated (lateral rotation plus medial rotation) between shoulders.

Shoulder posterior shortening measurement

The measurement of the shoulder posterior shortening was performed by the method described and validated by Tyler *et al*., 1999[9]. The subject was positioned at lateral decubitus, on the non-tested side, with hip and knee flexed at 90°, and with the entire body in contact with the stretcher. The non-tested arm was under the head of the athlete. The scapular movement was passively restricted by the stabilization of the lateral border of the scapula at retraction position, and the evaluated shoulder started the test at 90° of abduction and with the humerus at 0° of rotation (figure 4). Examiner A passively performed horizontal adduction while kept the humerus at neutral rotation and the scapula stabilized.

The maximum ROM was defined as the end of the horizontal adduction or until the scapula movement was noticed. When the maximum ROM was reached, the examiner B measured the distance of the medial epicondyle up to the stretcher.

The shoulder posterior shortening was calculated by the difference in the measurement of the horizontal adduction between the dominant limb and the non-dominant limb. The longer the distance between the medial epicondyle and the stretcher, the greater the shortening.

The measurements were bilaterally performed and always by the same examiner.

Figure 4. Evaluation of the shortening of the posterior capsule.

STATISTICAL ANALYSIS

The data were tested concerning the normality distribution by the Shapiro-Wilk test and are presented as mean and standard deviation. The analysis of variance of repeated measures was used for comparison between the ranges of motion of medial rotation, lateral rotation and total amplitude between the dominant side, contralateral side and male and female genders. For that reason, the sphericity was verified by the Mauchly W. test and it was not violated. The correlations between the capsule shortening test and deficit of the internal rotation were done by the Pearson coefficient. The significance was set at 5% ($P < 0.05$). All analyses were performed in the SPSS 13.0 program.

RESULTS

There was not statistically significant difference between the evaluation methods, goniometry and biophotogrammetry (table 2). Thus, for data analysis only the biophotogrammetry values were used.

No significant difference was observed between the female and male genders which present similar ROM shoulder rotation (table 3).

Significant differences of ROM of LR and MR between the dominant and non-dominant shoulders have not been found in this sample (table 3).

In the posterior shortening test, no statistically significant differences have been observed when the dominant shoulder ($P = 1.00$) and non-dominant shoulder ($P = 1.00$) were compared. The same test did not present differences between genders (table 4).

No correlations were found between decrease of MR and the shoulder posterior shortening test in men ($r = 0.21$), in women ($r = 0.24$) or in the total of subjects ($r = 0.17$).

Table 2. Goniometry x biophotogrammetry[a].

Men	Gonio	Photo	P
LR (d)	111.8 ± 7.7	111.1 ± 8.1	1.00
LR (nd)	105.8 ± 15.6	105.2 ± 11.5	1.00
MR (d)	70.8 ± 6.3	70.2 ± 7.9	1.00
MR (nd)	70.4 ± 9.4	73.3 ± 6.0	1.00
Women	**Gonio**	**Photo**	**P**
LR (d)	114.4 ± 11.3	112.7 ± 12.8	1.00
LR (nd)	113.8 ± 11.1	117.9 ± 11.8	1.00
MR (d)	73.2 ± 8.9	71.6 ± 8.4	1.00
MR (nd)	75.3 ± 11.4	73.7 ± 8.5	1.00

* [a]Values presented in mean (°) ± standard deviation.
* d: dominant shoulder; nd: non-dominant shoulder.
* significant difference (P < 0.05).

Table 3. ROM of shoulder rotation[a].

	Men	Women	P
LR (d)	111.1 ± 8.1	112.7 ± 12.8	1.00
LR (nd)	105.2 ± 11.5	117.9 ± 11.8	1.00
P	1.00	1.00	-----------
MR (d)	70.2 ± 7.9	71.6 ± 8.4	1.00
MR (nd)	73.3 ± 6.0	73.7 ± 8.5	1.00
P	1.00	1.00	------------
Total (d)	181.7 ± 10.5	186.8 ± 14.9	1.00
Total (nd)	178.5 ± 13.6	194.6 ± 13.1	0.32
P	1.00	0.34	------------

* [a]Values presented in mean (°) ± standard deviation.
* d: dominant shoulder; nd: non-dominant shoulder.
* significant difference (P < 0.05).

Table 4. Test for shoulder posterior shortening**®**.

	Men	Women	P
d	22.1 ± 6.2	18.1 ± 5.8	1.00
nd	21.5 ± 5.9	19.3 ± 5.4	1.00
P	1.00	1.00	

* [a]Vaues in centimeters presented in mean ± standard deviation.
* d: dominant shoulder ; nd: non-dominant shoulder.
* significant difference (*P* < 0.05).

DISCUSSION

The GIRD and shoulder posterior shortening correlation with injuries is not well-established in the literature; however, Harryman *et al.*, in 1990, state that asymmetric tension in the capsule may result in alterations of glenohumeral arthrokinematics, predisposing to the development of injuries[11]. When in throwing position (90° abduction and shoulder maximum lateral rotation), the shortening of the posterior capsule will promote a postero-superior subluxation of the humeral head which, as consequence, will dislocate the center of the joint rotation. This dislocation redisposes to the impact of the rotator cuff between the glenoidal lip and the humeral head. Thus, the lip will also be prone to injuries, since the new position of the humeral head may increase the peel-back mechanism due to the increase of rotational torque of the tendon of the biceps over the superior region of the glenoid lip predisposing to injuries in SLAP[1-5].

Myers *et al.*, 2006, demonstrated that baseball throwers with internal impact presented significant increase of GIRD and shoulder posterior stiffness[2]. Tehranzadeh *et al.*, 2007, verified through magnetic resonance, that baseball athletes with GIRD presented: thickening of the posterior capsule, postero-superior subluxation of humeral head, partial injuries of the supraspinal, infraspinal and SLAP type injuries. The results of these studies suggest that there may have been a relation between shortening of the posterior capsule, deficit of the medial rotation and shoulder dysfunctions[12].

The presence of GIRD in the sports which involve overhead throws is already well-reported in the literature and is more frequent in baseball, tennis and handball. Although basketball is considered a throwing sport, no study which evaluates the shoulder mobility in these athletes has been observed.

Downar and Sauers, 2005, evaluated the GIRD in 27 professional baseball players through passive goniometry. The dominant shoulder presented statistically significant difference in the MR compared with the non-dominant shoulder ($P = 0.001$)[3].

Ellenbecker *et al.*, in 1996, evaluated 203 tennis players, who presented significant difference ($P < 0.001$) of MR between shoulders (GIRD). In a subsequent study in 2002, the authors evaluated 117 tennis players, who presented decrease in total ROM of rotation of the dominant shoulder ($P < 0.001$); however, there was no significant difference in the MR[13].

Pieper, in 1994, could confirm increase in maximum lateral rotation of the dominant shoulder in comparison with the non-dominant one of professional handball players with mean of 10 to 15°, as well as considerable decrease of medial rotation. The author suggests that this loss is due to shortening of the posterior capsule caused by fibrotic alterations occurred in consequence of the repetitive sports movement[7].

In our study the rotations and posterior shortening were evaluated in 19 professional basketball players, who did not present statistically significant differences between the dominant and non-dominant shoulders, neither between genders.

It is believed that the lack of agreement between our results and the mentioned published articles must be because they have been conducted with distinct sports with different throwing types in the biomechanical aspect. Moreover, basketball is considered a sport of overhead bilateral activities in which unilateral alterations are not necessarily expected.

In baseball, during the late cocking phase, the shoulder takes the maximal lateral rotation position (170°-180°) and abduction between 90° and 100°[14]. This extreme ROM required in the baseball throw is closely related to the power and velocity which will determine the performance of the gesture.

Adrian and Cooper, 1995, describe basketball as a sport which involves three types of throw: overhead (throw), lateral (pass) and low (low pass). The overhead throw in basketball emphasizes the technique and accuracy, contrary to baseball and other sports which aim at strength and velocity to obtain better performance. Based on this, the basketball throw is performed with low velocities and less strength; therefore, it is believed that the osteomyoarticular adaptation may be different in comparison to the baseball throw.

Regarding the posterior shortening, the test described and validated by Tyler *et al.*, in 1999 was used, performed at lateral decubitus and maximum horizontal adduction. The authors showed high reliability of the intra-examiner test (CCI = 0.92), besides good inter-examiner reliability (CCI = 0.80)[9].

Tyler *et al.*, in a subsequent article in 2000, referred to the test as shortening of the posterior capsule, changing the name of the test[10]. This new definition may bring some confusion about which structures are measured in the test, since clinically speaking, it is difficult to separate the posterior capsule of the rotator cuff (infraspinal and teres minor), considering hence, that both structures could play the role of limiting horizontal adduction.

Tyler *et al.*, in 1999, applied their test in baseball players and found significant increase of the posterior shortening of the dominant shoulder. Additionally, they presented in their results a moderate correlation (r = -0.61) between increase of the shoulder posterior shortening and GIRD[9].

Conversely, Downar and Sauers, in 2005 did not observe significant difference in the test for posterior shortening (P = 0.09) or in the correlation between MR and the test for shoulder posterior shortening ($r = -0.15$) in baseball athletes, corroborating the results of our study[3].

This clash in results shows that the relation between shoulder posterior shortening and GIRD is not well-defined in the published work and still need further investigation.

Methods of ROM evaluation

Many studies use goniometry to measure the shoulder ROM[2,4,5,15]. However, the reliability of this method is questionable. Thus, besides goniometry, we also used biophotogrammetry for measurement of shoulder ROM, with the aim to compare the methods. In our study there was no significant difference between the goniometry and the biophotogrammetry ($P = 1.00$). Therefore, for analysis of the other data, only the biophotogrammetry values have been used, which differs our methodology from previous studies. Although there is not reliability of this evaluation method, which represents a limitation of our study, we used it since it is a more objective and controllable technique when compared to the goniometry. We suggest that further studies perform this reliability.

The performance of only one measurement of the rotations and the posterior shortening test is another limitation in this study. Such fact occurred due to the low time availability of the athletes. We suggest that future studies perform the mean of three measurements for higher reliability of results.

CONCLUSION

Alterations in the mobility of the glenohumeral joint in professional basketball athletes or correlation between the ROM of MR and shoulder posterior shortening have not been found in our sample.

All authors have declared there is not any potential conflict of interests concerning this article.

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