

ISOKINETIC PEAK TORQUE AT THE SHOULDER JOINT IN YOUNG VOLLEYBALL ATHLETES WITH AND WITHOUT INJURY HISTORY

PICO DE TORQUE ISOCINÉTICO DE ROTADORES DO OMBRO DE JOVENS ATLETAS DE VOLEIBOL COM E SEM HISTÓRICO DE LESÃO

Whendel Mesquita do Nascimento¹, Rafael Martins da Costa², João Otacílio Libardoni dos Santos¹, Mateus Rossato¹ and Rodrigo Ghedini Gheller¹

¹Universidade Federal do Amazonas, Manaus-AM, Brasil.

²Universidade Federal de Santa Catarina, Florianópolis-SC, Brasil.

ABSTRACT

Joint shoulder injuries are quite common in volleyball athletes. Studies suggest that muscle imbalance between the internal and external rotator muscles of the shoulder may be related to such lesions. The objective of this study was to compare the concentric torque peaks (PT) of external and internal rotators of the shoulder in volleyball players with (HL) and without history of injuries in joint shoulder (SH). Participated of present study 21 male volleyball players (age: 17.2 ± 1.96 years, height: 183.6 ± 6.63 cm, weight: 75.1 ± 11.50 kg, fat: $13.4 \pm 2, 77\%$) divided into 2 groups: HL (n = 8); SH (n = 13). Two series of 5 maximal concentric repetitions of internal (RI) and external rotation (RE) of the shoulder were performed at speeds of 60 and 180 °/s for later calculation of the conventional ratio PT concentric for RE at both velocities evaluated (60 and 180 °/s) were significantly higher for the HL group. PT concentric in RI was higher compared to RE in both groups. Only the conventional rate at 60°/s was significantly higher for HL players. It is concluded that athletes with a history of shoulder injury present muscular imbalance, and this factor can be considered an aspect that has led to the appearance of the injury event.

Key words: Isokinetic dynamometry. Sport. Rehabilitation. Muscular balance..

RESUMO

Lesões articulares no ombro são bastante comuns em atletas de voleibol. Estudos sugerem que o desequilíbrio muscular entre os músculos rotadores internos e externos do ombro podem estar relacionados a tais lesões. O objetivo deste estudo foi comparar os picos de torque (PT) concêntricos de rotadores externos e internos do ombro em jogadores de voleibol com (HL) e sem histórico (SH). Participaram 21 jogadores de voleibol do sexo masculino (idade: $17,2 \pm 1,96$ anos; estatura: $183,6 \pm 6,63$ cm; peso: $75,1 \pm 11,50$ kg; gordura: $13,4 \pm 2,77\%$) divididos em 2 grupos: HL (n=8); SH (n=13). Foram realizadas duas séries de 5 repetições concêntricas de rotação interna (RI) e externa (RE) do ombro nas velocidades de 60 e 180°/s para posterior cálculo das razões convencionais. O PT concêntrico para RE em ambas velocidades avaliadas (60 e 180°/s) foram significativamente superiores para o grupo HL. O PT concêntrico na RI foi maior comparado a RE em ambos os grupos. Apenas a razão convencional à 60°/s, foi significativamente maior para jogadores HL. Conclui-se que os atletas com histórico de lesão de ombro apresentam desequilíbrio muscular, podendo este fator ser considerado um aspecto que tenha levado ao aparecimento do evento lesivo.

Palavras-chave: Dinamometria isocinética. Esporte. Reabilitação. Equilíbrio muscular.

Introduction

In volleyball, some technical fundamentals such as serve and attack require movements with great amplitude and velocity of the segments related to the shoulder joint¹. These actions, associated with a high number of repetitions, cause overload, increasing the risk of injury to this joint². Shoulder injuries are the third most common injury in volleyball players, accounting for between 8 and 20% of all injuries occurring in the sport, following only the ankle and knee joints^{3,4}.

Research indicates^{5,6} that approximately 0.60 to 0.65 injuries occur at the shoulder joint every 1,000 hours of volleyball training. Shoulder injuries, although they do not have the highest incidence, are responsible for the longer training times and competitions, with an

average of 6.2 weeks⁵. The factors associated with high shoulder joint injury rates are the anatomy of the joint, which presents little stability, history of injury, training overload and imbalance of muscle forces between the internal and external rotators of the shoulder^{1,7,8}.

In relation to the muscles of the shoulder complex, these have important functions for producing strength, power and stability during hitting or attacking⁹. However, as the agonist muscles act concentrically to accelerate the movement of the upper limb, the antagonist muscles act eccentrically to decelerate movement¹⁰. Studies suggest that muscle imbalance between internal and external rotators of the shoulder may be related to the appearance of injurious events in the shoulder region in volleyball athletes^{7,11}. Muscular imbalance between the internal and external rotators of the shoulder has been studied in athletes of various sporting modalities such as volleyball players^{7,8}, baseball¹² and handball¹³, which have powerful movements generated in the shoulder joint in common.

Although many studies have already assessed peak torques in the shoulder joint of volleyball players^{4,8,14,15} little is known about such parameters in athletes who present a history of injury in this joint. This hypothesis supports that athletes with a history of injury have lower torque values of internal and external rotators and greater muscular imbalances when compared to athletes without a history of injury. In this way, the present study aimed to compare isokinetic peak torques (PT) during the internal and external rotation of the shoulder in players with and without a history of shoulder injury.

Materials and methods

The present study was characterized by being of the transversal and descriptive type, which evaluated the isokinetic peak torque of volleyball players.

Participants

Participants in the study were 21 male players from the Amazon volleyball team in the juvenile and adult category (17.2 ± 1.96 years, 83.6 ± 6.63 cm, 75.1 ± 11.50 kg, $13.4 \pm 2.77\%$ G), which were divided into 2 groups. The group was composed of players with a history of shoulder injuries (HI = 8 participants) and the group without a history of injury (WI = 13 participants). The selection of the participants was done intentionally, using the follow inclusion criterion: a) practice the modality for a minimum of two years continuously; B) train at least three times a week; C) not present any type of injury currently that could prevent the accomplishment of the protocol of tests. All athletes answered a questionnaire to identify lesions in the shoulder joint. The questions involved questions about training time, previous existence of a shoulder injury, type of injury, if there was a withdrawal from the training and how long the training paused because of the injury. In order to be inserted in the HI group, the athlete should report the occurrence of a damaging event that would result in withdrawal from the training, without the need for surgical intervention.

The size of the sample was calculated posteriori with a difference of at least 10 N·m detected between the variables, 10 N·m standard deviation, a test power of 80%, a significance level of 5% and a monocausal hypothesis test. The resulting n of the applied parameters was 12 individuals for each group.

Procedures

All the participants signed the Informed Consent Form (ICF). In cases where the individual was a minor, the ICF was given to the guardian so that they would release them for participation in the research. The research project was approved by the Ethics and Research Committee on Human where the study was developed (CAAE: 51299115.0.0000.5020).

To begin the evaluation, the athletes were positioned on the isokinetic dynamometer (Biodex System 4 Pro Isokinetic Dynamometer, Biodex Medical, Shirley, NY, USA) according to the manufacturer's recommendations, with the stabilization of the pelvic belt and diagonal to the trunk to avoid compensations with the movement of the body, with the hip flexed at 90° . Only the shoulder of the dominant side was evaluated, which was positioned with an abduction of 80° and the elbow flexed at 80° , associated with a 20° horizontal shoulder flexion as proposed by Cornu et al.¹⁶. All the repetitions were performed with a range of motion of 80° , where the initial position of the movement (position of the shoulder in external rotation) was determined by the evaluated one himself, being advised to adopt a comfortable position for the articulation of the shoulder. From this initial point, an 80° range of motion was limited.



Figure 1. Evaluated Positioning

Source: The authors

Then the participants performed warm-up and familiarization, which consisted of the execution of movements similar to those of the evaluation in the concentric mode, but in submaximal effort. Subsequently, the test started with two sets of 5 concentric actions for internal rotators (IR) and external rotators (ER). The velocities used were 60 and $180^\circ \cdot s$. The one-minute interval between sets was observed at the same speed, three minutes between sets of different speeds. It was decided to start the evaluations with the lowest speed and with concentric action to provide greater safety for the evaluated participant (Stickley et al., 20087). In addition, the recovery time between the series was enough to restore the anaerobic system. Thus, there was no influence of the effort exerted in one series on the other. The variables used were: a) concentric PT of internal rotators $60^\circ \cdot s$ (PTIR60) and $180^\circ \cdot s$ (PTIR180); B) concentric PT of external rotators at $60^\circ \cdot s$ (PTER60) and $180^\circ \cdot s$ (PTER180); C) Conventional ratio, defined as the quotient calculated as follows: PT of external rotators / PT of internal rotators (ER:IR), at both speeds.

Statistical analysis

For the statistical analysis, the largest PTs obtained for each of the velocities evaluated (60 and $180^\circ \cdot s$) were selected. Data are presented as mean and standard deviations. The normality of the data was tested using the Shapiro Wilk test ($p > 0.05$). Torque values and conventional ratios between H and WH groups were compared by the Student t-test for independent samples. The paired Student t test was also used to compare the peak torque between the IR and ER for each group. The effect size (ES) was calculated using the Cohen formula (1988¹⁷) and the results were based on the following criteria: $ES \leq 0.2$ small; $ES = 0.2-0.8$ moderate effect; $ES > 0.8$ large effect (Cohen, 1988). For all analyzes the value of the statistical significance adopted was $p \leq 0.05$. Statistical analyzes were performed in SPSS

version 20.0.

Results

In relation to the HI group, the mean distance from competitions and training was two weeks, with tendinitis and bursitis being the main causes. Table 1 shows concentric peak torque values for internal and external rotators of the shoulder, as well as the conventional ratios (ER / IR) at speeds of 60 and 180 °·s for H and WH groups.

Table 1. The peak torque, conventional reasons for internal and external rotators of the shoulder for the groups with history of injury (HI) and without injury (WI) at the speed of 60 and 180 °

Gr.	PTIR60 N·m	PTER60 N·m	p	ES	PTIR180 N·m	PTER180 N·m	p	ES	RC60	RC180
HI	59,5±10,0 [#]	50,7±6,6 [*]	0,023	0,5 (mod)	58,2±8,9 [#]	47,6±6,7 [*]	0,008	0,6 (mod)	0,87±0,1 [*]	0,83±0,11
WI	54,1±11,6 [#]	41,7±9,3	0,001	0,5 (mod)	50,9±0,3 [#]	39,3±7,8	0,001	0,7 (mod)	0,77±0,0	0,78±0,11
p	0,271	0,018	-	-	0,107	0,019	-	-	0,05	0,344
ES	0,2 (small)	0,5 (mod)	-	-	0,5 (mod)	0,5 (mod)	-	-	0,6 (mod)	0,2 (small)

Note: * $p \leq 0.05$ compared to WI group. # Significant difference, $p \leq 0.05$ in relation to ER. mod= moderate

Source: The authors

The concentric PT for both 60° and 180° were significantly higher for HI. In both groups (HI and WI), the PT of internal rotators was higher than that of the external rotators for both velocities evaluated (60 and 180°·s). Relative to the conventional ratio, significant differences were found for HI at the rate of 60°. No significant differences were observed in PT of internal rotators at speeds of 60 and 180°·s between groups (Table 1).

Discussion

The objective of the present study was to compare the PTs of internal and external rotators of volleyball players with and without history of injury in this joint. The main results obtained in the present study show that PT of external rotators, in both velocities evaluated (60°·s and 180°·s), are higher in the HI group. This data is opposite to those reported by Stickley et al.⁷, who performed an isokinetic evaluation with 38 female volleyball players and observed that PT results from external rotators were similar between athletes with and without a history of shoulder injury. These data are also reinforced by the findings by Hadzic et al.⁸. The authors evaluated experienced volleyball players, and observed no difference in isokinetic torque of the shoulder joint between players with and without a history of injury. The hypothesis was that HI athletes had lower PT values of internal and external rotators. A lower neuromuscular performance in the HI group would be associated with the fact that athletes with a history of injury have a shoulder more depressed with the lateralized scapula on the dominant side. This suggests that the trapezius and rhomboid muscles are stretched as well as the posterior muscles of the shoulder, such as the atrophied infraspinatus. Therefore, these changes could affect force production (Kugler et al.¹⁴). However, these findings could not be confirmed.

According to Escamilla et al.⁹, the time of practice or the total hours of individual training may be related to a greater production of strength of the players, regardless of whether or not they present a history of injury. Thus, the different characteristics of the

subjects such as gender, training time and the methodologies adopted in the studies may have contributed to these differences of results of the present study as well as others.

Moreover, in this investigation, it was observed that the conventional ratio (ER / IR) at 60°. S is higher in the HI group compared to WI. Ellenbecker and Davies¹⁸ recommend that for injury prevention the ER / IR ratio should be between 0.66 and 0.75. Consequently, external rotators must have at least 2/3 of the internal rotator strength. Interestingly, the participants in the present study who had a history of injury produce on average a ratio of 0.87, values much higher than those recommended by Ellenbecker and Davies¹⁸, whereas subjects with no history of injury have a ratio of 0.77. The values of the conventional ratio (ER / IR) observed in the HI group (0.87) may suggest that they have internal rotator strength deficits or a very high level of external rotator power, which could cause imbalance in the relation between the internal and external rotators of the shoulder.

In the present study, the highest PT values for internal rotators compared to external rotators in both groups were found. This result corroborates with the results obtained by van Cingel et al.¹⁵ and McHugh¹⁹ in athletes and non-athletes without a history of injury, respectively and by Hadzic et al.⁸ in athletes with and without a history of injury. The largest IR PT compared to ER is expected, because there are muscle groups with a larger cross-sectional area responsible for the performance of the shoulder IR²⁰.

The present study limited itself to evaluating only the concentric actions of internal and external rotators of the shoulder at two angular velocities (60 and 180o.s). In addition, the number of participants was relatively low. Further studies are suggested, involving eccentric PT evaluation and analysis of functional reasons. In practical terms, it is recommended that volleyball players without a history of shoulder injury and especially players with a history of injury perform muscle strengthening programs to correct the relationship between the internal and external rotators of the shoulder.

Conclusions

We conclude that HI participants have higher PT of external shoulder rotators when compared to WI participants. In addition, athletes with shoulder HI have a greater muscle imbalance, when evaluated by the conventional ratio (ER / IR).

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Author address: Whendel Mesquita do Nascimento. Av. General Rodrigo Octavio Jordão Ramos, 1200 - Coroado I, Manaus - AM, 69067-005. whendelmesquita_ledehu@hotmail.com