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Original Article

Isokinetic power of shoulder rotators in handball players: sectional study description

Força isocinética dos rotadores de ombro em jogadores de handebol: estudo seccional descritivo

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ABSTRACT

Introduction: The repetitions attributed to the shoulders, mainly to the internal rotator muscles, during the throwing movements increase the risk of injury. Thus, it is necessary to ensure an adequate balance between the internal rotator (IR) muscles and their antagonists, external rotators (ER). **Objective:** To describe the strength and muscle balance of internal and external shoulder rotators in handball players. **Methods:** Descriptive sectional study with 58 handball athletes. Muscle function was assessed by the isokinetic dynamometer, the variables analyzed were the peak torque (TP) between the right and left shoulders and the antagonist/agonist ratio. **Results:** The lowest TP value in women ranged from 2.18 at angular speed of 300º/s (ER) to 33.0 at angular speed of 60º/s (IR). For the ER/IR ratio, the lowest value was 0.11 and the highest 0.79. For males, the lowest PT value was 27.5 (ER) at an angular speed of 300º/s, a higher value of 69.5 (IR) at angled speed of 60º/s. The RE/IR ratio ranged from 0.54 to 0.71. **Conclusion:** It was shown that the highest values of strength are in the dominant shoulder, for both sexes, which is considered normal. However, we also found a deficit in the ER/IR ratio above the cutoff point indicated in the literature, suggesting a significant muscle imbalance.

Key-words: Shoulder, Handball, Isokinetic Dynamometer.

RESUMO

Introdução: As repetições atribuídas aos ombros, principalmente aos músculos rotadores internos, durante os movimentos de arremesso aumentam o risco de lesão. Assim, é preciso garantir um equilíbrio adequado entre os músculos rotadores internos (RI) e os seus antagonistas, rotadores externos (RE). **Objetivo:** Descrever a força e equilíbrio muscular rotadores internos e externos dos ombros em praticantes de handebol. **Métodos:** Estudo seccional descritivo com 58 atletas de handebol. A função muscular foi avaliada pelo dinamômetro isocinético, as variáveis analisadas foram o pico de torque (PT) entre os ombros direito e esquerdo e a relação antagonista/agonista. **Resultados:** O menor valor do PT nas mulheres variou de 2,18 na velocidade angular de 300º/s (RE) a 33,0 na velocidade angular de 60º/s (RI). Para relação RE/RI o menor valor foi de 0,11 e o maior de 0,79. Já para

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a sexo masculino o menor valor do PT foi 27,5 (RE) na velocidade angular de 300º/s, maior valor de 69,5 (RI) na velocidade angular de 60º/s. E a relação RE/RI variou de 0,54 a 0,71. **Conclusão:** Foi demonstrado que os maiores valores de força estão no ombro dominante, para ambos os sexos, o que é considerado normal. Contudo, contatamos também um déficit na relação RE/RI acima do ponto de corte indicado pela literatura, sugerindo um significativo desiquilíbrio muscular.

Palavras-chave: Ombro, Handebol, Dinamômetro Isocinético.

Introduction

Handball is characterized by being a collective sport, of high intensity, with repetitive movements and a high degree of contact between athletes [1]. To fulfill the objective of the sport, which is scoring goals, the handball athlete performs a ballistic movement, called throwing [2].

Handball players perform about 48 thousand shoulder throwing movements during the season. The average throwing speed of the dominant arm varies between 55 and 75 km/ h in female handball athletes. The non-dominant arm is about 30% weaker [3].

Risk factors for shoulder pain can be divided into two main categories: intrinsic and extrinsic. Intrinsic risk factors include weakness or imbalance of the rotator muscles. The main role of the rotator cuff muscles is the dynamic stability of the humeral head during active movements of the upper extremity in its glenoid cavity. When pairs of forces induced by the rotator muscles are not properly balanced or equalized, abnormal glenohumeral mechanics occur [4].

In this perspective, an assessment is needed that can measure the relationship between the strength of the external and internal rotators, to estimate the muscle strength profile of this population. Therefore, the aim of this study is to describe the isokinetic strength and muscle balance profile of shoulder rotators in handball athletes.

Material and Methods

This is a descriptive sectional study. It belongs to a larger study entitled: "Clinical and functional profile of handball athletes", previously accepted and approved by the Research Ethics Committee (CEP) of the Institute of Health Sciences (Protocol: 1.636.360).

The study was carried out at the Physiotherapy school clinic of the Federal University of Bahia (UFBA), Rua Padre Feijó, 312, Vale do Canela, Salvador/ BA. The research period was from July to August 2016. The sample consisted of 58 athletes from the three adult teams (18 to 42 years old) of handball from the city of Salvador/BA who were in pre-season. Inclusion criteria: Adult athletes (18 to 60 years old) of handball teams from the city of Salvador. Exclusion criteria: Participants who did not attend one of the evaluation stages or who had not been competing in competitions for at least two years.

Assessment instruments

Questionnaires were applied to investigate demographic and sports data. These questionnaires summarize information about age, height, weight,

sex, which team you play in, active position, time of practice of the sport, dominant upper limbs for sports gestures, training volume, gym training and number of championships per half.

The Nordic questionnaire was translated and validated for the Portuguese language, it consists of questions related to chronic, acute and traumatic injuries related to sports practice [5-6].

Muscle evaluation by the isokinetic dynamometer

The Biodex S4 Pro device was used to assess the muscular strength of the athletes, there was no parameter of choice or draw to choose which shoulder would be evaluated first. To evaluate the performance of the shoulder muscle groups, the participant was positioned in the machine chair according to the position oriented by the manufacturer necessary to evaluate each body segment respecting the positioning of the articular center to the axis of rotation of the machine [7].

The evaluation was carried out bilaterally, with the same procedure, with one shoulder being evaluated after the other. Three series of ten concentric contractions were made at different angular velocities. For the best study of peak torque, slow angular speeds were used, because the lower the angular speed, the greater the torque, and in this study the speed was 60º/s. For the evaluation of power and resistance, fast speeds are used, being respectively 90º/s and 300º/s. Between the series, a rest of 30 seconds was adopted.

At the time of the measurement, the evaluator used verbal encouragement so that the participant would extract the maximum effort during the movement. The assessment was conducted by two properly trained assessors. The forces of internal and external rotation of the shoulders were evaluated, with the patient seated, arms abducted and elbows flexed at 90º, with horizontal abduction of 20º to respect the scapular plane, 0º of orientation of the dynamometer and 5º of inclination, seat positioned at 0º rotation, with 85º inclination.

The axis of rotation was positioned longitudinally across the head of the humerus stem, in a horizontal plane. The resistance was positioned in the palm of the hand, held with closed fingers. The isokinetic variables analyzed were: peak torque (Nm) of both arms, Deficit (difference in strength between the dominant and non-dominant limbs - relationship between limbs), ER / IR ratio (Ratio of the antagonist to the agonist - intra-limb relationship).

Ethical aspects

Participants were previously informed and in detail about the procedure to be performed. They received and signed the Free and Informed Consent Form (ICF) authorizing their inclusion in the research. The harmful risks offered by the isokinetic apparatus are minimal. Even so, participants who complained of some unusual discomfort or / and did not recover within three days, were instructed to seek the physiotherapy school clinic for symptom relief and recovery from previous state. All participants received advice on which muscle groups would need differentiated attention to improve muscle balance.

Data description

Descriptive statistics was performed using measures of central tendency. Continuous variables were described using mean and standard deviation and categorical variables using proportions. The variables were expressed in

absolute and percentage values - n (%). For the elaboration of the database, the software Statistical Package for Social Sciences (SPSS), version 20.0 for Windows was used.

Results

After fulfilling the inclusion criteria, 58 handball athletes of both sexes were evaluated, with an average age of 25.5 ± 5.73 (minimum of 18 and maximum of 42 years). The other demographic and sporting characteristics are shown in Table I.

Table I. Demographic and sports characteristics.

Table 1 - Demographic and sporting data

Variables	Gross Amount	Proportion (%)
Gender n(%)		
Female	27.0	0.466
Male	31.0	0.534
Dominant member		
Right	48.0	0.879
Left	9.0	0.103
Right and Left	1.0	0.017
Gym. training frequency		
Never	18.0	0.31
Sometimes	27.0	0.466
Always	13.0	0.224
	Mean	**SD**
BMI(Kg/m)	24.58	3.07
Training frequency (Times per week)	2.43	0.7
Practice time (years)	10.56	5.19
Competitions by semester	2.51	1.17

BMI= Body Mass Index.

According to the data presented, there was no significant difference between genders. As for sports data, the majority throws with the right arm (right-handed), with only one report of an ambidextrous player.

The information from the Nordic questionnaire was summarized in Table II, the majority of the sample (86%) had pain in some part of the body in the last 12 months, with the shoulder joint being the second most affected with 51.7%. Regarding the impairment of sports activities, 13.8% of the sample were removed from sports activities due to shoulder pain, with 12.1% looking for a

health professional. In a short-term perspective (last 30 days), essentially important for the pre-season period, about 38 (65%) athletes presented pain, and in 11 of them (19%) they referred to shoulder pain.

Table II. Nordic Questionnaire

	Pain in the last 12 months		Impeded from activities (12		Health Professional (12 Months)		Paim - 30 Days	
	YES	NO	YES	NO	YES	NO	YES	NO
GENERAL	**50 (86%)**	**8 (13.8%)**	**25 (43.1%)**	**33 (56%)**	**30 (51.7%)**	**28 (48%)**	**38 (65.5%)**	**20 (34.5%)**
NECK	5 (8.6%)	53 (91.4%)	0 (0%)	58 (100%)	1 (1.7%)	57 (98.3%)	4 (6.9%)	54 (93.1%)
SHOULDER	**30 (51.7%)**	**28 (48.3%)**	**8 (13.8%)**	**50 (86.2%)**	**7 (12.1%)**	**51 (87.9%)**	**11 (19%)**	**47 (81%)**
BACK	17 (29.3%)	41 (70.7%)	0 (0%)	58 (100%)	2 (3.4%)	56 (96.6%)	4 (6.9%)	54 (93.1%)
ELBOW	6 (10.3%)	52 (89.7%)	0 (0%)	58 (100%)	0 (0%)	58 (100%)	2 (3.4%)	56 (96.6%)
WRIST	14 (24.1%)	44 (75.9%)	3 (5.2%)	55 (94.8%)	5 (8.6%)	53 (91.4%)	7 (12.1%)	51 (87.9%)
LOW BACK	21 (36.2%)	37 (63.8%)	3 (5.2%)	55 (94.8%)	5 (8.6%)	53 (91.4%)	9 (15.5%)	49 (84.5%)
HIP	15 (25.9%)	43 (74.1%)	0 (0.0%)	58 (100%)	2 (3.4%)	56 (96.6%)	5 (8.6%)	53 (91.4%)
KNEE	34 (58.6%)	24 (41.4%)	13 (22.4%)	45 (77.6%)	14 (24.1%)	44 (75.9%)	15 (25.9%)	43 (74.1%)
ANKLE	21 (36.2%)	37 (63.8%)	13 (22.4%)	45 (77.6%)	13 (22.4%)	45 (77.6%)	10 (17.2%)	48 (82.8%)

With regard to muscle function assessed by the isokinetic dynamometer, the variables of choice were the peak torque (PT) between the right and left shoulders and the antagonist/agonist ratio, in female athletes (Table III) and male athletes (Table IV). The lowest PT value in women ranged from 2.18 at the angular speed of 300º/s (External rotator) to 33.0 at the angular speed of 60º/s (Internal rotator).

Table III. Assessment of isokinetic muscle strength of the shoulder (female)

AV	Movement	Segment	Average PT (Nm)	SD	Défict (%)	ER/IR
60º/s	Internal Rotation	R	33,0	5.99		0.8
		L	32.22	5.25	2.4	0.7
	External Rotation	R	25.81	6.03	6.9	
		L	24.03	5.49		
90°/s	Internal Rotation	R	30.9	5.83	3.1	0.8
		L	29.93	4.8		0.8
	External Rotation	R	24.48	5.78	5.7	
		L	23.08	4.72		
300°/s	Internal Rotation	R	19.86	7.2	10.6	0.1
		L	17.76	6.7		0.1
	External Rotation	R	2.18	5.31	12.4	
		L	2.49	5.44		

SD(standard deviation), PT (Peak Torque), R (Right), L (Left), ER/IR (External Rotation/Internal Rotation, AV (Angular Velocity).

Table IV. Assessment of isokinetic muscle strength of the shoulder (male).

AV	Movement	Segment	Average PT (Nm)	SD	Déficit (%)	ER/IR
60º/s	Internal Rotation	R	69.97	16.76		0.7
		L	66.6	15,0	4.8	0.7
	External Rotation	R	46.51	6.55	0.0	
		L	46.49	8.03		
90°/S	Internal Rotation	R	79.75	76.55	22.0	0.6
		L	62.19	14.45		0.7
	External Rotation	R	44.57	6.91	0.2	
		L	44.46	7.24		
300°/S	Internal Rotation	R	50.81	7.2	2.4	0.5
		L	49.61	6.7		0.5
	External Rotation	R	27.66	10.5	1.7	
		L	28.14	9.27		

SD(standard deviation), PT (Peak Torque), R (Right), L (Left), ER/IR (External Rotation/Internal Rotation, AV (Angular Velocity).

Discussion

In this study, the average age of 25 years was below that presented by Mazón et al. [8], which was 30 years. This difference can be explained by the level of professionalization. Our sample, in addition to being formed by a younger audience, does not have enough support, compared to professional teams.

Handball training and competitions require high use of musculoskeletal structures [3]. The average frequency of training in our sample was twice a week, with a practice time of 10 years, and at least two competitions every six months, which, in our understanding, exposes these athletes to joint overload, especially in the shoulder joint, keep in mind that the sport requires a great demand for repetitions of specific movements such as passes and throws. The strength of the shoulder joint in its ability to produce greater accelerations in the IR movement for the success of the action has two consequences: it can induce muscle imbalances and increase the likelihood of musculoskeletal injury [9].

In this study there was a considerable imbalance in the use of upper limbs, approximately 88% used the right shoulder for throwing. Thus, in addition to performing day-to-day activities with the dominant shoulder, they performed handball movements in a repetitive and exhaustive manner. 86% of athletes reported some type of musculoskeletal injury in the last 12 months, and 65.5% started the season with some injury complaint. Thus, we can see that the number of athletes who continue their sports activities even though they are in pain or injured is large, and that culturally, it is natural [10].

In the case of musculoskeletal pain, the shoulder occupied an important place, being the second most complained joint during the last 12 months (51.7%), as well as in the last 30 days (19%). These data are similar to those in the literature, which shows the shoulder joint as the second most affected in sports that require repetitive movements above the head and at high speed [11].

Isokinetic evaluations revealed that males registered the highest peak torque during all angular velocities compared to females. Through the evaluation with different angular velocities in the isokinetic dynamometer, it was observed that as the angular velocity printed on the lever arm is increased, the

torque production decreases (inversely proportional). According to Tunstall et al. [12], the increase in the speed of concentric muscle contraction reduces the ability to form cross-bridges which translates into a reduction in the production of strength. In some cases, the angular velocity may be greater than the capacity to generate tension through muscle contraction, which would cancel out the peak torque.

In addition, observing the quantitative analysis of strength, major muscle imbalances were found in the female gender, especially during the test at an angular speed of 300º/s. This information is extremely important since the tests at higher speeds seek to be closer to the reality of the sports movement. During the test at 300º/s, a very low ER/ IR ratio was found for females (0.1), which implies a considerable muscle imbalance with a greater predominance of internal rotators. Correia [10] proposes measuring the ER/IR ratio as a useful indicator to identify muscle imbalances in athletes' shoulders and that this relationship is usually presented in the form of a rational number, where 1 would correspond to identical forces in both directions of rotation. However, in profile studies, internal rotators tend to have higher peak torque.

Thus, we believe that the strength of the internal rotators has a greater strength potential, given the development of it within the function. However, major imbalances between IR and ER can express potential damage due to rotator cuff breakdown, which when associated with sports demand favor the predisposition of musculoskeletal injuries.

It has been established that the cutoff point in muscle imbalance in relation to laterality (deficit -dominant versus non-dominant) up to 10% is considered normal, that is, values above this cutoff point indicate that there are significant muscle imbalances between members [13-15]. Considering that in handball the shoulder is the anatomical region that has the highest incidence of repetitive efforts, this numerical difference between the limbs can be explained by the throwing gesture being done predominantly by the dominant arm that encourages homolateral muscle development. Our findings suggest deficits above 10% in both sexes. In females, significant differences in speed of 300°/s were evidenced, both for internal rotation and external rotation of the shoulder. In males, this difference was observed only in the internal rotation of the angular velocity of 90°/s.

We alert you to the fact that the strength assessments were performed only for concentric contraction. In addition, further research is suggested with the purpose of creating benchmarks of strength, deficits and ER/IR ratio.

Conclusion

According to the sample studied, the highest values of strength are in the dominant shoulder, for both sexes, which is considered normal. However, we also found a deficit in the ER / IR ratio above the cutoff point indicated in the literature, suggesting a significant muscle imbalance. For females, differences are observed at a speed of 300°/s, both for internal rotation and external rotation of the shoulder. In males, the differences were observed only in the internal rotation of the angular velocity of 90°/s.

References

1. Langevoort G, Myklebust G, Dvorak J, Junge A. Handball injuries during major international tournaments. Scan J Med Sci Sports 2007;17(4):400-7. https://doi.org/10.1111/j.1600-0838.2006.00587.

2. Benno E, Andreoli VC, Carrera EF, Abdalla RJ, M. C. Lesões músculo-esqueléticas no ombro do atleta: mecanismo de lesão, diagnóstico e retorno à prática esportiva. Rev Bras Ortop 2001;36(10):389-93. Disponível em: http://www.rbo.org.br/how-to-cite/368/pt-BR

3. Clarsen B, Bahr R, Andersson SH, Munk R, Myklebust G. Reduced glenohumeral rotation, external rotation weakness and scapular dyskinesis are risk factors for shoulder injuries among elite male handball players: a prospective cohort study. Br J Sports Med 2014;48(17):1327-33. https://doi.org/10.1136/bjsports-2014-093702

4. Forthomme B, Croisier JL, Delvaux F, Kaux JF, Crielaard JM, Gleizes-Cervera S. Preseason strength assessment of the rotator muscles and shoulder injury in handball players. J Athl Train 2018;53(2):174-80. https://doi.org/10.4085/1062-6050-216-16

5. Clarsen B, Myklebust G, Bahr R. Development and validation of a new method for the registration of overuse injuries in sports injury epidemiology. Br J Sports Med 2013; 47(8):495-502. https://doi.org/10.1136/bjsports-2012-091524

6. Pinheiro F, Amaral T, Bartholomeu T, Carvalho CV. Validação do Questionário Nórdico de Sintomas Osteomusculares como medida de morbidade. Rev Saúde Pública 2002;36(3):307-12. https//doi.org/10.1590/S0034-89102002000300008.

7. Wilk E. Isokinetic Testing: goals, standards and knee test interpretation. In: Biodex Medical System. Biodex System 4. Advantage Software. Operations Manual. Disponível em: https://www.biodex.com/sites/default/files/850000man_08262revc.pdf

8. Mazón J, Garcia-Sanchez PC. Incidencia lesional en el ámbito del Balonmano. El papel del fisioterapeuta y el entrenamiento en un equipo de Balonmano de nivel Medio. Revista Kronos 2010;9(18). https://doi.10.1016/j.apunts.2013.06.002

9. Renan H, Marcelo B, Gustavo T, Benno E, Saulo S, Ronaldo C. Musculoskeletal injuries in young handball players: a cross-sectional study. Fisioter Pesqui 2015;22(1):84-9. https://doi.10.590/1809-2950/13466522012015

10. Pezarat-Correia P. Perfil muscular do ombro de atletas praticantes de acções de lançamento. Revista Portuguesa de Fisioterapia no Desporto 2010;4(1):34-42. http://docplayer.com.br/23551851-Perfil-muscular-do-ombro-de-atletas-praticantes-de-accoes-de-lancamento.html

11. Mendonça ML, Bittencourt Netto NF, Anjos MTS, Silva AA, Fonseca ST. Isokinetic muscular assessment of the shoulder joint in athletes from the male under-19 and under-21 Brazilian volleyball teams. Rev Bras Med Esporte 2010;16(2):107-11. https://doi.10.1590/S1517-86922010000200006

12. Tunstall.H, Mullineaux R, Vernon T. Criterion validity of an isokinetic dynamometer to assess shoulder function in tennis players. Sports Biomech 2005;4(1):101-11. https://doi.10.1080/14763140508522855

13. José S, Daniele D, Juliano P, Cintia F. Bilateral asymmetry of knee and ankle isokinetic torque in soccer players u20 category. Rev Bras Cineantropom Desempenho Hum 2015;17(2):195-204. https://doi.10.5007/1980-0037.2015v17n2p195

14. Aurelio Z, Amador R, María T. Variables personales y deportivas y lesiones en jugadores de balonmano: un análisis descriptivo. Revista de Ciencias del Deporte 2011;7(1). http://www.e-balonmano.com/ojs/index.php/revista/article/view/64

15. Benck T, David C, Carmo C. Déficits no equilíbrio muscular em jovens atletas de ginástica feminina. Rev Bras Ciênc Esporte 2016;38(4):342-8. https://doi.org/10.1016/j.rbce.2016.01.008