COMPARACIÓN DEL TIEMPO HASTA MOMENTO MÁXIMO ENTRE JUGADORES DE BALONMANO PLAYA Y LANZADORES DE DISCIPLINAS SIN BALÓN

Comparison of the Time to Peak Torque Between Beach Handball Players and Athletes of Non-Ball Throwing Disciplines

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RESUMEN
El objetivo de este trabajo es analizar las diferencias en el comportamiento de los músculos rotadores del complejo articular del hombro de jugadores de balonmano playa de élite (BHP) y en atletas de disciplinas deportivas sin lanzamiento de balón (ANTD). Para ello, se comparó el tiempo hasta el momento máximo entre los BHP y los ANTD. Setenta ANTD y veintiséis BHP participaron en el estudio. Para medir el tiempo hasta el momento máximo se utilizó un dinamómetro isocinético Biodex System 3. Se encontraron diferencias significativas (p>0,01) entre los grupos de estudio en la subvariable tiempo al momento máximo de la rotación interna a 180°/s. Los BHP obtuvieron un tiempo de 225,0 ms (SD ±132,2) en la rotación interna a 180º/s y los atletas de las disciplinas deportivas sin lanzamiento de balón 272,7 ms (SD ±137,4). Los BHP consiguen alcanzar el momento máximo en menos tiempo que los ANTD a altas velocidades en la rotación interna del brazo dominante.

PALABRAS CLAVE: isocinético, manguito rotador, momento máximo.

ABSTRACT
The aim of this work is to analyse differences in the behaviour of the rotator muscles in the shoulder joint complex of elite beach handball players (BHP) and athletes of non-ball throwing disciplines (ANTD). Therefore, the difference between the time to peak torque between BHP and athletes of ANTD was compared. Seventy male of ANTD, and twenty-six male BHP participated in the study. In order to measure the time to peak torque a System 3 Biodex isokinetic dynamometer was used. Significant differences (p>0,01) between the study groups in subvariable time to peak torque internal rotation at 180°/s were found. The BHP obtained a time of 225,0 ms (SD ±132,2) in the internal rotation at 180°/s and the ANTD obtained a time of 272,7 ms (SD ±137,4). BHP take less time than ANTD to reach the peak torque at high speeds on the internal rotation of the dominant arm.

KEYWORDS: isokinetic, rotator cuff, peak torque.

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1. INTRODUCTION

Beach handball is a fast growing sport right now. Taking into account the rising of beach volleyball and thinking about promoting team handball Gianni Buttarelli (President of Sequax Lazio Handball Team) and Franco Schiano (President of a class B Italian team) create beach handball (2), born in Italy in 1992. In only twenty-five years, this sport is already played across all five continents and is constantly growing. Scientific studies are required to increase progression since this is a little researched sport even though the number of studies has recently increased.² ³ ⁴ ⁵ ⁶ ⁷

In this study, we aimed at assessing the explosive strength in beach handball. In this sport, explosive strength could be one of the most important conditional aspects so that players can reach optimal output.⁸ ⁹ Throws and jumps must be carried out with maximum explosiveness in order to achieve the objective. In this specific case, it is important to reach the maximum peak torque possible; however, it is even more important to reach it as fast as possible. One of the actions that take place at higher speed in beach handball could be the throw. Among the publications related to beach handball, throwing speed data have not been collected, however they have in handball throws. The speed of these throws can range between 26 and 28 metres per second.¹⁰

Throwing efficacy does not only depend on speed, as the relation between throwing speed and execution accuracy is inversely proportional.¹¹ In many throwing situations,
one of the main aspects related to efficacy would be to apply strength as quickly as possible\textsuperscript{12,13}. In this case, we would be discussing explosive strength\textsuperscript{14}.

Regarding the study of explosive strength measurements, different instruments to analyze this strength are normally used. In most of the studies reviewed, Bosco Tests were done. Squat jump, countermovement jump, drop jump and Abalakov\textsuperscript{15,16} are the most used types of jumps, using platforms of strength\textsuperscript{17,18} or platforms of contact\textsuperscript{19} for assessment. We can either use dynamometers or measuring the time and distance in throws of different devices. In this sense, Singh\textsuperscript{20} compared the explosive strength and the maximum strength of basketball and handball players’ arms with a dynamometer and with a medicine ball. Palao and Valadés\textsuperscript{21} carried out an adaptation of the Bosco Tests, offering the same possibilities of assessment as the aforementioned tests but aimed at the upper limbs. They proposed the use of the medicine ball and assessed the speed or the distance of the throw after the reception of the medicine ball letting it fall from a fixed height.

Since beach handball is quite a new sport, there are very few scientific research studies about explosive strength. Among the few studies published, we found that

Gehrer and Werkmeister\textsuperscript{22} cited Montagni and Cardinale (1996), who measured jump height and contact time, through squat jump and countermovement jump, and throw while jumping respectively. Zapardiel et al.\textsuperscript{23} measured explosive strength in beach handball sportsmen and sportswomen with squat jump, countermovement jump and abalakow.

Likewise, Dechechi et al.\textsuperscript{24} used the triple jump to measure the explosive strength of the lower body part in beach handball sportswomen. Among the studies that assessed explosive strength of the upper body part in beach handball, the one by Dechechi et al.\textsuperscript{25} used 3-kg medicine balls throws for the assessment.

In our study aimed at measuring explosive strength, an isokinetic dynamometer and the variable time to peak torque have been used. However, the time to reach peak torque has been measured on few occasions. Among the ones who did, we found the study by Mattiello-Rosa et al.\textsuperscript{26} that assessed the imbalance in subjects with impingement syndrome in the shoulder joint. Another study analyzing the time to peak torque was the one by Huston and Wojtys\textsuperscript{27} who researched the possible neuromuscular factors in knee injuries.

Regarding the method used by studies with dynamometers, the speed and number of repetitions of measurement are based on the objectives set forth in the isokinetic assessments. Slow speeds (60°/s and 120°/s) are used for the measurement of the maximum strength and power, and faster speeds (180°/s and 300°/s) for measuring the resistance strength and explosive strength\textsuperscript{28}. At least three repetitions are needed for de Biodex Software to calculate the test data. The repetitions per set recommended in

\textsuperscript{24} DECHECHI, C. J., NASCIMENTO, C. M., NUNES, R. C., ALMEIDA, A. G., & DE MACEDO, D. V. Effects of 12 physical training sessions on a female beach handball team performance. EHF Web Periodical, 2009 [cited 05/03/2016].
\textsuperscript{25} DECHECHI, C. J., NASCIMENTO, C. M., NUNES, R. C., ALMEIDA, A. G., & DE MACEDO, D. V. Effects of 12 physical training sessions on a female beach handball team performance. EHF Web Periodical, 2009 [cited 05/03/2016].
the manual for slow speeds are 5, and from 10 to 15 for fast speeds. A greater number of repetitions per set at slow speeds may create too much variability in the coefficient of variation and invalidate the test. At fast speeds, a greater number of repetitions is recommended to measure fatigue29.

We have not found any studies that assess explosive strength in beach handball with isokinetic dynamometry nor any studies aimed at observing whether beach handball can develop strength in one way or another.

For the reasons mentioned above, our main objective in this study is to compare the time to peak torque of the rotator muscles in the shoulder of elite BHP and of athletes of non-throwing sports.

2. METHODS

Participants

Seventy male ANTD (5 left-handed, 65 right-handed), and twenty-six male BHP (6 left-handed, 20 right-handed) participated in the study. Their ages ranged from 19 to 35 (mean ±23.5 years old). The characteristics of age, height and weight are shown in Table 1. All participants signed informed consent forms and the Research Ethics Committee of the University of Alcalá issued a favourable report about the method of this study, following the guidelines of the Declaration of Helsinki in both cases.

Table 1. Descriptive data of the study sample

<table>
<thead>
<tr>
<th></th>
<th>Age (years)</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Min Max</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td>ANTD</td>
<td>23.3 ± 3.3</td>
<td>19 35</td>
<td>176.3 ± 6.1</td>
</tr>
<tr>
<td>BHP</td>
<td>24.7 ± 3.4</td>
<td>19 31</td>
<td>181.3 ± 6.8</td>
</tr>
</tbody>
</table>

ANTD: Athletes of Non-Ball Throwing Disciplines; BHP: Beach Handball Players. Min: Minimum. Max: Maximum

Measures and Procedures

The isokinetic variable studied was the time to peak torque. This is time interval measured from the beginning of the peak torque repetition to the point where peak

torque occurs for that repetition. It is calculated independently for the away and toward components of the repetition.

In order to measure the time to peak torque, a System 3 Biodex isokinetic dynamometer was used (Biodex Medical Systems, New York, USA). Subjects performed the warm up that consisted of five minute bike exercise and two minutes of joint mobility of the upper limbs. Subsequently the dynamometer was calibrated and the concentric-concentric bilateral internal-external movement protocol was chosen. Both the dominant and the non-dominant arms were assessed, as well as the external and internal rotation. The arm was placed in a neutral position (30° arm flexion, 45° of abduction and 90° of elbow flexion). Range of motion was delimited to 90°. Stabilized subjects with pelvic and chest straps level remained seated. Three submaximal familiarization repetitions were performed at each speed.

Each arm performed five repetitions at 60°/s and fifteen to 180°/s. There was a thirty second break between sets and there was five minutes to change the arm. During the isokinetic evaluation the subjects were given standardized verbal encouragement to develop maximal strength in all contractions. The maximal peak torque of the five or fifteen repetitions was used to identify the time to peak torque.

**Statistical Analysis**

SPSS Statistics 22 was used for statistical analysis. Normality and homogeneity were studied using the Kolmogorov-Smirnov test. The results showed no parametric variables except in variables internal rotation (dominant and non-dominant arm) to the angular velocity of 60°/s. Subsequently, the non-parametric variables were analyzed using the U Mann-Whitney test. The variables showed normal homogeneity of variances were checked by Levene test and compared using Student's t test. The level of statistical significance was established at p <0.05.

3. RESULTS

No significant differences between the study groups in any of the sub-variables of time to peak torque were found. Table 2 shows the descriptive results of the variable time to peak torque at 60°/s.

Table 2. Time to peak torque at 60°/s

<table>
<thead>
<tr>
<th></th>
<th>TMMRED60°/s</th>
<th>TMMREND60°/s</th>
<th>TMMRID60°/s</th>
<th>TMMRIND60°/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANTD</td>
<td>262,9 ±140,7</td>
<td>262,5 ±142,7</td>
<td>572,9 ±233,9</td>
<td>544,4 ±266,7</td>
</tr>
<tr>
<td>BHP</td>
<td>253,3 ±120,7</td>
<td>267,2 ±132,3</td>
<td>511,1 ±251,0</td>
<td>540,4 ±183,0</td>
</tr>
</tbody>
</table>

TMMRED60°/s: time peak torque dominant arm external rotation at 60°/s. TMMREND60°/s: time peak torque non dominant arm external rotation at 60°/s. TMMRID60°: time peak torque dominant arm internal rotation at 60°/s. TMMRIND60°: time peak torque non dominant arm internal rotation at 60°/s. ANTD: Athletes of Non-Ball Throwing Disciplines; BHP: Beach Handball Players.

Even though we did not find significant differences in the 60°/s velocity in any of the variables, there is a notable difference regarding the lower time used by beach handball players in the internal rotation of the dominant arm.

Only significant differences (p>0.01) between the study groups in sub variable time to peak torque internal rotation at 180°/s were found. Table 3 shows the descriptive results of the variable time to peak torque at 180°/s. ANTD take longer to reach peak torque but the differences are only significant in subvariable internal rotation at 180°/s.

Table 3. Time to peak torque at 180°/s

<table>
<thead>
<tr>
<th></th>
<th>TMMRED180°/s</th>
<th>TMMREND180°/s</th>
<th>TMMRID180°/s</th>
<th>TMMRIND180°/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANTD</td>
<td>296,4 ±227,0</td>
<td>310,8 ±241,8</td>
<td>272,7* ±137,4</td>
<td>259,2 ±120,1</td>
</tr>
<tr>
<td>BHP</td>
<td>272,4 ±185,2</td>
<td>299,6 ±233,0</td>
<td>225,0* ±132,2</td>
<td>235,7 ±121,3</td>
</tr>
</tbody>
</table>

*p>0.01. TMMRED180°/s: time peak torque dominant arm external rotation at 180°/s. TMMREND180°/s: time peak torque non dominant arm external rotation at 180°/s. TMMRID180°: time peak torque dominant arm internal rotation at 180°/s. TMMRIND180°: time peak torque non dominant arm internal rotation at 180°/s. ANTD: Athletes of Non-Ball Throwing Disciplines; BHP: Beach Handball Players.

The tendency that shows the variable internal rotation in the dominant arm is notable. In the 60°/s velocity, the difference was not significant but the BHP showed lower times and greater differences than in the rest of variables. As speed increased to 180°/s, the tendency of lower times in BHP remained and the differences became significant.
4. DISCUSSION

The results of this study show that BHP take less time to reach peak torque in the movement of internal rotation of the shoulder at high speeds. This could be due to changes in the neuromuscular system by repeated passing and throwing of this discipline.

Studying this variable was considered important because it could show whether BHP reached peak torque faster than ANTD in shoulder rotation movement. The lower values in relation to the variable time to peak torque in the internal rotation of BHP may indicate the influence of beach handball training on players of this sport\textsuperscript{31, 32, 33}.

In relation to the studies that analyze the isokinetic variable time to peak torque in the field of training, Huston and Wojtys\textsuperscript{34} compared elite with sedentary and amateur sportspeople. In this case, they carried out an assessment of the quadriceps and the hamstring muscles. The elite sportspeople reached peak torque before, with statistically significant differences, in the quadriceps at 60º/s, and in the hamstring muscles at speeds tested, 60º/s and 240º/s. It was also observed that, as isokinetic speed increased, the differences decreased. The results, the same as in our study, reveal differences in time to peak torque due to a greater activity and training of specific movement. The discrepancy between our study and these results is based on the fact that the greater differences in our study are found at high speeds (180º/s). We think that the reason is that our study is based on a shoulder assessment that bears throws at more than 130 km/h\textsuperscript{35}, speeds that cannot be reproduced in any action of the lower body part.

In the field of medicine, researches analyzing time to peak torque aim at observing the imbalances that might have the subjects with impingement syndrome. Mattielo-Rosa et al. tried to relate the imbalances between the internal and external rotator muscles and the time to peak torque. Surprisingly enough, the subjects with impingement syndrome obtained lower values in the time to peak torque than the control group, while differences were not found in the ratios of the peak torque internal-external rotators of the dominant arm when subjects with impingement syndrome and control group were compared. Mattielo-Rosa et al. concluded that in these cases the lower values of time to peak torque are related to variations in the coordination between the internal and external shoulder rotators. However, the BHP in our study obtained lower values, with statistically significant differences, in the time to peak torque in the internal rotation at 180°/s, in comparison with non-ball throwing athletes. In this case, it could be considered that there could be a greater coordination in BHP in a similar action, throw-internal rotation at high speeds, to the one taking place in this sport.

In a study of isokinetic assessment regarding the upper body part, Bernard et al. compared tennis players, sedentary subjects and athletes in wheelchairs, and they did not find significant differences in the average power of any of the speeds studied (60°/s and 180°/s). A comparison in the external and internal rotation in both upper and lower limbs was carried out. Bernard et al. could not find a coherent explanation of the results, mainly because athletes in wheelchairs developed a greater power on the non-dominant side. The authors wonder whether this is a specificity of the wheelchair propulsion. Codine et al., in a similar research about the influence of sport on rotator cuff’s balance in subjects who played different sports (tennis, athletics and baseball) and in sedentary subjects, did not find significant differences in relation to average power. Codine’s results do not coincide with the results of our study. However, in the case of Bernard et al. the differences in the non-dominant arm of athletes in

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wheelchairs could be generated by the propulsion style and, in this case, it would coincide with our results.

In other studies where explosive strength was assessed without isokinetic dynamometers, significant differences related to explosive strength were not found when subjects not grouped according to sports disciplines were compared\textsuperscript{42}. In the study by Aznar et al.\textsuperscript{43}, students in health sciences and sports were compared. It was intended to observe whether the students’ age would determine explosive strength of the lower body part. In this case, when development is reached age does not determine the values of explosive strength. However, statistically significant differences related to explosive strength of the lower body part were revealed when subjects grouped according to sports discipline were compared. When Bencke\textsuperscript{44} compared young swimmers, gymnasts, tennis players and handball players, higher values, with significant differences, were obtained in gymnasts’ jumps, followed by handball players, swimmers and tennis players. In this case, it is thought that the type of sport, with higher or lower involvement of the jumps, develops higher or lower explosive strength in the lower body part. These data could be coherent with the data obtained in our study and could denote that a specific sport determines the values of explosive strength.

In the same way, and also in a study in which explosive strength was assessed without isokinetic dynamometer, Singh\textsuperscript{45} corroborates the results of our study in a research comparing explosive strength in the shoulder joint of basketball and handball players. Handball is a sport in which players carry out the same passing and throwing actions as beach handball players. Handball players obtained higher values of explosive strength with statistically significant differences.

To conclude, the action of the variable time to peak torque in internal rotation coincides with the throwing movement in BHP and the angular velocity, 180°/s, is closer to the

speed that can be reached in a movement of this type. This may show a relationship between throwing by BHP and the low values in the study variable.

5. CONCLUSION

BHP take less time than ANTD to reach the peak torque on the internal rotation of the dominant arm.

The isokinetic variable time to peak torque is a good indicator of the explosive strength that a subject can develop.

Other lines of research

Beach handball is a very recent discipline compared to its predecessor, traditional handball, and it shows clear differentiated features. Therefore, it will be necessary to start studying beach handball players’ physiological profile and the differences in relation to traditional handball players' profile.

REFERENCES


