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Campinas/SP, Brasil<https://doi.org/10.5628/rpcd.17.S4A.29>**Muscle rate of torque
development in female
futsal players****KEYWORDS:**

Torque. Female.

Dynamometer.

ABSTRACT

This study aimed to analyze the maximum rate of torque development (peak RTD) of knee extensors and flexors of futsal players in the dominant (DM) and non-dominant member (NDM), as well as the interval time in which this value is reached. Eighteen futsal female players with no history of knee's injury were evaluated (21.0 ± 2.8 years; 56.4 ± 6.1 Kg; 1.60 ± 0.1 m) in a series of 5 repetitions of knee extension and flexion of DM and NDM at an angular velocity of 180° s^{-1} . The peak RTD of knee extensors and flexors was calculated by the derivative of torque/ time. No significant difference in extensor peak RTD between DM and NDM ($p = .97$) and in flexors peak RTD ($p = .47$) were found. Time interval for maximum TDR achievement was between 0-100ms. There was no difference in the peak RTD of muscle groups analyzed between DM and NDM, and time interval in occurred the peak RTD reveals symmetry between lower limbs, and time appropriate time for producing torque quickly.

Taxa de desenvolvimento de torque muscular em atletas de futsal feminino

RESUMO

Este estudo teve como objetivo analisar a máxima taxa de desenvolvimento de torque (pico TDT) dos extensores e flexores do joelho de jogadores de futsal no membro dominante (MD) e não dominante (MND), bem como o intervalo de tempo em que esse valor é alcançado. Dezoito jogadoras de futsal sem histórico de lesão de joelho foram avaliadas (21.0 ± 2.8anos; 56.4 ± 6.1Kg; 1.60 ± 0.1m) em uma série de 5 repetições de extensão e flexão do joelho do MD e MND a uma velocidade angular de 180°·s⁻¹. O pico TDT dos extensores e flexores do joelho foi calculado pela derivada da torque / time. Não foram encontradas diferenças significativas no pico TDT extensor ($p = .97$) e flexores ($p = .47$) entre MD e MND. O intervalo de tempo em que ocorreu o pico de TDT foi entre 0-100ms. A não diferença dos picos TDT dos grupos musculares analisados entre os MD e MND, e o intervalo de tempo em que ocorreu o pico TDT revela a simetria entre os membros inferiores dos atletas, e tempo adequado para a produção de torque de forma rápida.

PALAVRAS CHAVE:

Torque. Feminino.
Dinamômetro.

INTRODUCTION

Futsal players are known by developing maximum strength in a short period of time, especially in knee's extensors and flexors, providing greater efficiency in tasks such as sprints and changes of directions (Eniseler, Sahan, Vurgun, & Mavi, 2012; Greco, da Silva, Camarda, & Denadai, 2013; Requena et al., 2009). Literature points out that in sports movements, the time accepted to exert force is very limited, approximately 50-250ms, while is needed longer time to reach the maximum muscle force (> 300ms) (Aagaard, Simonsen, Andersen, Magnusson, & Dyhre-Poulsen, 2002; Andersen, Andersen, Zebis, & Aagaard, 2010; Angelozzi et al., 2012; Blazevich, Horne, Cannavan, Coleman, & Aagaard, 2008; Molina & Denadai, 2012; Morel et al., 2015; Oliveira, Rizzato, & Denadai, 2013). Thus, in the practice of sports as the futsal, to achieve higher rate of torque development (RTD) values in the initial phase of contraction is important to the successful performance of the tasks (Blazevich et al., 2008; Greco, da Silva, Camarda, & Denadai, 2012; Molina & Denadai, 2012). In the early stages of muscle contraction (Aagaard et al., 2002), RTD is a useful parameter to evaluate the dynamic of muscle contraction in sports activities (Angelozzi et al., 2012; Greco et al., 2013; Holtermann, Roeleveld, Engstrom, & Sand, 2007; Tillin, Jimenez-Reyes, Pain, & Folland, 2010), as well the joint stability in order to promote actions to prevent injuries (Andersen et al., 2010; Angelozzi et al., 2012; Jay et al., 2013; Morel et al., 2015).

Studies analyzed the RTD in different populations, both in isometric conditions (Aagaard et al., 2002; Angelozzi et al., 2012; Blazevich et al., 2008; Heggelund, Fimland, Helgerud, & Hoff, 2013; Holtermann et al., 2007; Mebes et al., 2008; Oliveira et al., 2013) as for dynamic conditions (Greco et al., 2013; Molina & Denadai, 2012; Oliveira et al., 2013). However, dynamic analysis takes into consideration the factors that influence the muscle ability to generate force, as the type of muscle contraction, contraction velocity and range of motion. Consequently, the value of RTD in this condition has a greater relationship with the sport practice.

In clinical practice, the RTD is the ratio of torque/ time calculate between 0 ms and 250 ms, which is obtained between variation of strength to the varying time (Aagaard et al., 2002; Andersen et al., 2010; Angelozzi et al., 2012; Blazevich et al., 2008; Greco et al., 2012; Heggelund et al., 2013; Holtermann et al., 2007; Mebes et al., 2008), resulting in an average value. This found studies analyzed the average values RTD in sedentary and trained healthy subjects, and soccer athletes. When evaluating athletes is interesting know the maximum RTD, for evaluate the exact moment when has a greater increment of muscle strength, important factor to be used in power training. However, in athletes the maximum RTD occur in the beginning of movement, due to its important for performance of the tasks in game. Thus, it is necessary to know the maximum of the acceleration of dominant and non-dominant member of these athletes, instead of the average value, to assist in the training of prescription.

Therefore, the aim of this study was to analyze the maximum rate of torque development (peak RTD) of knee extensors and flexor in dominant and non-dominant member, and the period time at which the peak RTD occurs.

METHODS

SUBJECTS

We analyzed the performance of the best trial of 18 amateur female futsal players aged 21.0 ± 2.8 years (mean \pm standard deviation), body mass of 56.4 ± 6.1 kg and height 1.60 ± 0.1 m. All athletes filled out the inclusion criteria of study, which is the absence of previous injuries in knee joint to the realization of isokinetic test in dominant and non-dominant member. The exclusion criteria were pathology on lower-limb muscles, with no contra-indication to maximal effort, and at least five years of futsal practice participated in the study.

After receiving information about the experimental procedures, a consent form was signed, approved by the Ethics Committee of the Faculty of Medical Sciences, State University of Campinas (No 1201/2010-CEP).

INSTRUMENTS

A Biodex Medical Systems 3 (New York, USA), with a sampling frequency of 100Hz, was used for the isokinetic testing of knee extension torque. Subjects were seated in the dynamometer chair and had the dominant hip, thigh, and tibia stabilized by straps. The knee joint axis of rotation was aligned with the dynamometer's axis of rotation. Gravity correction was obtained with the participant's lower limbs positioned over the machine's lever arm at 30° of knee flexion, where the limb passive torque values were measured and the dynamometer software corrected automatically these values (Fillyaw, Bevins, & Fernandez, 1986).

PROCEDURES

Participants went through a familiarization procedure in the dynamometer aimed at providing the athletes with a previous experience of the maximal effort test. Before the test, athletes had a five-minute warm-up trial on a cycle ergometer, cycling at their preferred cadence.

Each subject performed 1 set of 5 knee extension and flexion repetitions at $180^\circ \cdot s^{-1}$ with dominant (DM) and non-dominant (NDM) member. The method of contraction used was the concentric, both to extension/flexion knee, with the knee joint range of motion limited between 90° and 0° of flexion (0° = full extension).

After find the peak torque of extensors and flexors it was possible calculate the peak RTD by the derived, torque as a function of time derivation in the corresponding time interval. This variation interval goes from the beginning of the movement till the instant at which the maximum torque is reached. So, the peak RTD ($N \cdot m \cdot s^{-1}$) was calculated for knee extensors and flexors of DM and NDM of athletes.

STATISTICAL ANALYSIS

All statistical procedures were analyzed in software Matlab[®]. As the data had normal distribution, ANOVA was performed to compare peak RTD between DM and NDM and between muscle groups. For all statistical comparisons, the level of significance considered was $\alpha = 5\%$.

RESULTS

Table I showed no difference between the DM and NDM in the peak RTD of extensor ($p = .97$) and of flexor muscle group ($p = .47$). This result shows a similar behavior in the peak RTD muscle groups among the members, indicating that the muscle response to torque production in a short period of time in the DM and NDM are similar in movement execution of extension/flexion knee.

TABLE 1. Values of means peak RTD of knee extensors and flexors from dominant (DM) and non-dominant member (NDM) at $180^\circ \cdot s^{-1}$.

	PEAK RTD ($N \cdot m \cdot s^{-1}$)	
	DM	NDM
Extensors	578.58 ± 99.12	560.32 ± 96.36
Flexors	356.57 ± 113.86	334.04 ± 115.05

Note: Peak RTD = maximum torque development ratio

Another factor observed is the time interval used to accelerate and thereby reach the peak torque of extensor/flexor muscle group. In both lower limbs, the athlete accelerates at the beginning of movement so as after wards achieve the peak torque. The instant time in which occurred the peak RTD of muscles groups was between 0-100ms.

DISCUSSION

The analysis of the peak RTD of knee extensors and flexors, and the time instant at this peak RTD occurred, was possible to observed muscular performance of the lower limbs of futsal players female.

The non-difference between DM and NDM may be due to the training that athletes are subjected (Aagaard et al., 2002; Andersen et al., 2010; Behm & Sale, 1993; Hakkinen et al., 1998), in that is required of athletes the use of both lower limbs in carrying out different tasks, such as the kick and change of direction. Thus, under normal conditions the training conducted is the same for both lower members, especially during specific activities training aiming gain strength, power and muscular resistance.

The values peak RTD of the female athletes show symmetry between the lower limbs, with results consistent with those found in the literature (Ageberg, Roos, Silbernagel, Thomee, & Roos, 2009; Pinczewski et al., 2007), and that reveals to the efficiency of muscle performance and promotion of joint stability in the DM and NDM.

This information is relevant not only for verify performance, but also for observe the neuromuscular balance in the DM and NDM, once the contralateral imbalance may be a risk of musculoskeletal injuries and consequently compromise the performance. Thus, the RTD is a parameter that deserves attention not only for showing athlete's performance in sports movements execution (Greco et al., 2013), as well as being a way to assess joint stability in order to prevent injuries (Andersen et al., 2010; Angelozzi et al., 2012).

The dynamic and intensity of a futsal game requires athletes to develop muscle contractions as fast as possible of the antagonists muscle groups, for example, extensors and flexors of the knee. In the functional tasks, the need to produce torque rapidly may be more important than maximum torque (Crockett et al., 2013; Jay et al., 2013), for successful performance of the tasks. This confirms the relevance of analysis of peak RTD as evaluation parameter of the athlete's performances.

According Morel et al. (2015) the peak RTD is an important factor in movements characterized by reduced contractions times (< 250ms) such as sprinting, jumping or kicking performed throughout practice sports. In the present study, the peak RTD of knee extensor and flexor occurred between 0ms and 100ms, within the expected time interval. This enables check the ability the female futsal athletes of to accelerate as quickly possible the muscle groups involves in practice sport.

Angelozzi et al. (2012) report that the rapid attainment of peak RTD can be a factor of stability and joint protection if it occurs between 30ms to 70ms after the beginning of muscle contraction. The present study the athletes presented an interval time around 0ms to 100ms for development peak RTD of knee extensors and flexors, reflecting an interval time adequate for prevent excessive forces about knee joint and prevent injuries.

In this way, the female futsal athletes have symmetry between the lower limbs important to the performance of tasks, what reflects stability joint and injury prevention in order to contribute to the maintenance of sports performance.

This study has as limitations the analysis only of performance female athletes futsal, it is necessary in future studies analyze the athletes male futsal to know the profile of the athletes futsal and so contribute in the specific training of the muscles involved in practicing of futsal.

CONCLUSION

The symmetry between the lower limbs and the capacity of torque production in a short period of time of the extensor and flexor muscle groups corroborates to the achievement of greater efficiency of the tasks performed in futsal.

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