Rev Bras Cineantropom Hum

original article

DOI: http://dx.doi.org/10.5007/1980-0037.2017v19n6p644

Comparison of two classification criteria of lateral strength asymmetry of the lower limbs in professional soccer players

Comparação de dois critérios de classificação de jogadores de futebol profissional da assimetria lateral de força dos membros inferiores

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Abstract – Prospective studies have indicated that assessing muscle function by the isokinetic test in the preseason is able to identify muscle strength variables that can be associated with injuries in the hamstring muscles of professional soccer players. However, the results are conflicting and could be related to the different cutoff points for the categorization of athletes in asymmetric or symmetric. Based on these conflicting results, the present study aims to: i) Identify the cutoff points of lateral asymmetry (LA) of the 95% confidence interval for the peak torque in soccer players, evaluated by the isokinetic test, taking into consideration the mean population value; ii) Compare LA between 15% cutoff point proposed in literature and the upper limit of 95% confidence interval (UP) of the study population. Sixty-four professional soccer players performed five knee flexion and extension repetitions at rate of 60°/s, with a one-minute interval. To determine the cutoff point for strength asymmetries, the UP was used, and for the purpose of diagnostic concordance of information among the different values, the McNemar's χ^2 test was applied. The proportion between symmetric and asymmetric athletes was not different from the 15% cutoff point and the general population, both for knee flexors (χ^2 = 0.5, p = 0.250) and the knee extensors (χ^2 = 2.0, p = 0.125). It was concluded that the cutoff point of 15% referenced in literature for the general population provides similar diagnostic information for the classification of professional soccer players.

Key words: Asymmetry; Lower limbs; Soccer.

Resumo – *Estudos prospectivos têm indicado que avaliar a função muscular pelo teste isocinético na pré-temporada é capaz de identificar variáveis da força muscular que se associam a lesões nos músculos posteriores da coxa em jogadores de futebol, entretanto, os resultados são conflitantes e podem estar relacionados aos diferentes pontos de corte para categorização do atleta em assimétrico. Diante de resultados antagônicos, o presente estudo objetivou: i) Identificar o ponto de corte da assimetria lateral (AL) do intervalo de confiança de 95% para o pico de torque em jogadores de futebol, avaliado no teste isocinético, levando em consideração a média populacional; ii) Comparar a AL entre o valor de corte de 15%, proposto pela literatura, e o limite superior do intervalo de confiança de 95% (LS) da população estudada. 64 jogadores de futebol profissional realizaram cinco repetições máximas de flexão e extensão do joelho na velocidade de 60°/s com intervalo de um minuto entre repetições. Para determinação do ponto de corte da AL, utilizou-se o LS e para a concordância da informação diagnóstica entre os diferentes valores de corte foi aplicado o teste* χ^2 *de McNemar. A proporção entre simétricos e assimétricos não foi diferente entre os valores de corte de 15% e o populacional, tanto para os flexores do joelho* (χ^2 = 0.5; p = 0.250) *quanto para os extensores do joelho* (χ^2 = 2.0; p = 0.125). *Conclui-se que, o ponto de corte populacional proporciona uma classificação dos atletas de futebol profissional similar ao valor de 15% referenciado na literatura.*

Palavras-chave: *Assimetria; Futebol; Membros inferiores.*

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Received: March 10, 2017
Accepted: October 22, 2017

INTRODUCTION

The essential skills decisive for soccer game success are performed at high intensity and short duration[1]. Soccer is characterized by presenting situations with high impact and direct contact between players, favoring the risk for the occurrence of injuries[2,3]. It is estimated that between 50 and 60% of injuries suffered during sports activities occur during soccer practice[4] and among them, non-traumatic muscle injuries in the lower limbs represent 55.4% of the total[5]. Non-traumatic muscle injuries, in addition to generating high financial costs for clubs, prevent athletes from performing their activities and decrease the team's sports performance[6], and the Fédération Internationale de Football Association (FIFA) reports that the annual cost for the treatment of injuries is estimated in 30 billion dollars[7].

The risk factors associated with injuries have been the subject of studies to improve the understanding of epidemiological and traumatological patterns in order to identify and establish possible preventive measures to reduce the incidence of injuries in sports practice. Prospective studies[8,9] have indicated that the evaluation of muscle function through isokinetic dynamometry in the preseason is able to identify variables related to the capacity of force production as predictors of injuries in the hamstring muscles, especially in sports where there is a high risk of muscle injury. Croisier et al.[9] and Askling et al.[10] showed that athletes who underwent additional training for the hamstring muscles or compensatory training to reduce muscular imbalances were less involved with muscle injuries during the competitive season. These results confirm the need to assess and, whenever necessary, correct muscular deficits.

In addition to assessing muscle performance, isokinetic dynamometry can also be applied for the diagnostic of muscle deficits in specific groups and correct them [11], evaluate the results of physical interventions[9] and determine if the individual is able to return to his or her sports or labor activities[10,12]. The isokinetic test is applied, as a matter of priority, in an open kinetic chain[13], evaluates the musculature of the lower limbs separately and presents valid and reliable measures for the identification of muscular deficits[14] with the aim of comparing the agonist / antagonist musculature (H / Q ratio) and among contralateral limbs (lateral asymmetry)[15,16]. For these comparisons, the isokinetic parameters most commonly reported in literature are torque (maximum or mean torque), work, power and fatigue index.

When considering the maximum torque parameter (peak torque) to associate lateral asymmetry and non-traumatic muscle injuries, some studies refer to different normative values or cutoff points ranging from 8 to 15% for the characterization of athletes as asymmetric and prone to muscle injuries in the lower limbs[8,9,16], regardless of sport practiced. The cutoff point of 15% is the most commonly used in literature[9,11,16]. However, Bell et al.[17] reported that the normative values of lateral asymmetry can vary according to the sport practiced, especially in those in which dominance can play a significant role, as in the case of soccer. Thus, the normative values for the cutoff point of lateral asymmetry for the identification of athletes who are more likely to suffer non-traumatic muscle injuries should be specific to the sport practiced, to the applied task and to the calculated parameter. Thus, the aim of the present study were: 1) To identify the cutoff point of lateral asymmetry of the 95% confidence interval for the peak torque in soccer players, evaluated by the isokinetic test, taking into account the mean population value; 2) To compare the lateral asymmetry between 15% cutoff value proposed in literature, and the upper limit of 95% confidence interval of the study population.

METHODOLOGICAL PROCEDURES

Sample

Sixty-four athletes of different positions (Defenders: 14; Wing-backs: 5; Midfielders: 27; Forwarders: 17; Goalkeeper: 1) and different competitive teams competing for the A (43 athletes) and B (21 athletes) series of the Brazilian Soccer Championship. Athletes were evaluated in the competitive preseason, that is, they had not performed previous systematized training, and presented the following characteristics (mean ± standard deviation): age of 26.9 ± 4.4 years, body mass of 76.7 ± 8.5kg and height of 1.78 ± 6.5m. The present study was approved by the Research Ethics Committee of the Federal University of Minas Gerais, according to CAAE protocol: 61278716.9.0000.5541. Prior to participating in this study, club and athlete officers received all information regarding goals, methodological procedures, and gave informed consent by means of the free and informed consent form.

Instrumentation

For the anthropometric characterization of athletes, body mass and height were measured using a digital scale with coupled stadiometer (Filizola model, Brazil) with accuracy of 0.1kg and 0.01m, respectively. The Biodex 3 System Pro® isokinetic dynamometer was used to quantify the concentric isokinetic peak torque of knee flexor and extensor muscles normalized by body mass at rate of 60º/s.

Procedures

Before starting the isokinetic test, athletes performed a five-minute preparatory activity on a stationary cycle ergometer (Maxx®, Hidrofit®, Brazil) with load corresponding to 2% of body mass. The athlete was then positioned sitting on the isokinetic dynamometer with chair positioned at 85° of hip flexion and the axis of the equipment movement was aligned with the lateral epicondyle of the femur. In order to minimize accessory voluntary movements, belts were used to fix the trunk and thigh to be tested. All subjects were instructed to remain comfortable with their arms crossed over the trunk.

Athletes performed five maximal repetitions of knee flexion and extension in the concentric-concentric mode at rate of 60°/s with a one-minute interval between repetitions. This procedure was performed bilaterally and alternately, and the choice of the first limb to be tested was performed in a paired manner. The angular velocity of 60°/s was chosen, since athletes identified with bilateral asymmetry at angular velocity of 60°/s with normative values (cutoff points) above 15% are 4.66 times more likely to develop muscle injuries in hamstring muscles[9]. In addition, muscle strength evaluated at low speeds allows recruiting a larger number of motor units, characterizing a better representation of the maximum work performed by the evaluated musculature.

The parameter analyzed was the peak torque of knee flexors and extensors, which reflect the maximum point of force application along the full range of motion, normalized by body mass (Nm/kg)[18]. The concentric action with the highest peak torque among the five attempts was used to extract the parameter of interest and to calculate the lateral asymmetries of knee flexors and extensors[16].

Statistical analysis

For descriptive analysis, data were presented as mean and standard deviation. Lateral asymmetries of force were quantified by the symmetry index (SI) and calculated in percentages by means of equation 1, where positive SI indicates higher values of the right lower limb, and negative SI indicates higher values of the left lower limb[19]. The athlete's preference limb was not taken into account. Equation (1): SI (%) = [(right limb value - left limb value) / (highest limb value)] X 100.

In order to estimate the mean population symmetry index value according to data collected from 64 professional soccer players, the upper limit value (ULV) of the 95% confidence interval was used. The ULV, that is, the maximum acceptable value so that the sample mean does not represent a significant deviation from normality, is given by equation 2 and was calculated for the lateral asymmetries of the peak torque of knee flexors and extensors. Equation (2): ULV = (population mean value) + (1.64 X Standard Error of the Mean). The standard error of the mean (SEM) is given by dividing the standard deviation by the sample size square root.

After determining the ULV for the lateral asymmetry of force at the peak torque of knee flexors and extensors, subjects were then classified as symmetric when the their SI value was lower than the ULV and lower in module to the reference literature value of 15%, and asymmetric, when their SI value was higher than the ULV and higher in module to the reference literature value of 15%. Then, to verify the concordance of the diagnostic information among the different cutoff values used in the present study, the McNemar X^2 test was applied, in addition to the effect size, determined by the Phi de Cramér. All statistical procedures were performed in the SPSS 18.0 software (SPSS, Chicago, IL). The significance level adopted by the present study was 5% ($p < 0.05$).

RESULTS

Table 1 presents the descriptive results (mean ± standard deviation) of the normalized peak torque (PT) for the flexor and extensor musculature of the right and left knee and SI for the peak torque at rate of 60°/s .

Table 1. Descriptive data for peak torque and symmetry index

Variables	Mean ± SD
PT right knee flexors (Nm/kg)	1.98 ± 0.31
PT left knee flexors (Nm/kg)	2.13 ± 0.98
PT right knee extensors (Nm/kg)	3.31 ± 0.44
PT left knee extensors (Nm/kg)	3.26 ± 0.60
SI_PT_flex (%)	11.08 ± 1.67
SI_PT_ext (%)	10.46 ± 1.13

PT = peak torque at rate of 60°/s; SI = symmetry index; SD = standard deviation.

When considering flexor and extensor asymmetries as a categorical variable, two classification criteria were adopted. The first classification criterion used was the 15% value based on literature[9,11,16,20] and the second criterion was to establish cutoff points based on data distribution of the study, as performed by Impellizzeri et al.[13]. The upper limit value for the lateral peak torque asymmetries obtained for a sample of 64 professional soccer players was 13.80% for knee flexor muscles and 12.32% for knee extensor muscles. These values were then used as a reference for a new classification of individuals as symmetric or asymmetric so that a comparison of the diagnostic information with cutoff value of 15% was performed. The percentage difference between the cutoff point of the lateral asymmetry of the peak torque of knee flexors obtained from the upper limit value (13.80%) and the reference criterion (15%) was 8%. For the peak torque of knee extensors, the percentage difference was 17.8% from the upper limit value (12.32%) and the reference criterion (15%).

Table 2 shows the classification of individuals as symmetric or asymmetric taking into account the different cutoff values used by the present study and the results of the X^2 proportion test.

Table 2. Classification of individuals as symmetrical and asymmetric according to the different cutoff values used in the present study

		Flexor muscles			Extensor muscles*		
Cutoff value		12.32%		p	13.8%		p
15%		S	A		S	A	
	S	48	2	0.250	48	3	0.125
	A	0	14		0	12	

* = 1 excluded athlete, "S" = Symmetric; "A" = Asymmetric; p = significance level.

With the results obtained by the McNemar's X^2 test, sufficient evidence was not found for the alternative hypothesis to be proven, which stated that the proportion between symmetric and asymmetric athletes would be statistically different among cutoff values for both knee flexors (X^2 = 0.5 , p = 0.250, TE = 0.917) and knee extensors (X^2 = 2.0, p = 0.125, TE = 0.868).

DISCUSSION

The present study aimed to calculate the cutoff point for lateral asymmetry of force in the peak torque identified in the isokinetic test for professional soccer players, based on the population mean, and to compare the distribution of asymmetric and symmetric players between the cutoff value commonly used in literature of 15%[9,11,16] and the population cutoff value. However, with the results found by the present study, it was not possible to infer that the classification of individuals as symmetric and asymmetric is statistically different between values proposed in literature and the value calculated from the population mean, for both evaluated musculatures.

Soccer training and game situations over a number of years provide a difference in the amount of practice between lower limbs and may lead to the development of chronic asymmetric adaptations at neuromuscular level between lower limbs, especially for muscle strength[11]. Thus, athletes' exposure and the time of soccer practice[11] can be determinant for the manifestation of lateral asymmetry of force, which predisposes athletes to muscular injuries because they produce high mechanical overloads in the musculoskeletal structures due to continuous and unequal impacts of sport activities between lower limbs.

The experimental procedures proposed in the present study to assess muscle strength and identify lateral asymmetries of force between lower limbs were similar to other studies[11,16,21], which also evaluated professional soccer players in isokinetic equipment in the preseason. In the study by Menzel et al.[16], the authors present descriptive data of peak torque for the knee extensor muscles for each lower limb. The peak torque values normalized by body mass found by the authors were 3.36 ± 0.51 (Nm/kg) for the right lower limb and 3.43 ± 0.57 (Nm/kg) for the left lower limb, values similar to those obtained in the present study (3.31 ± 0.44 Nm/kg for right lower limb, 3.26 ± 0.60 Nm/kg for left lower limb). In addition, in relation to lateral asymmetry of the knee extensor muscles, the mean values found in the present study (10.43%) are similar to those of Menzel et al.[16] (9.14%) and Impellizzeri et al.[13] (8.26 %), showing that the muscle strength values of the knee extensors and lateral strength asymmetries of force of the present study are similar to the means of other studies that also used isokinetic dynamometry[11,16].

As there is still no consensus in scientific literature regarding the cutoff value for peak torque, which values range from 8% to 15%, to categorize the sample as symmetric or asymmetric[9,21,23], the present study calculated the limit value from the maximum acceptable so that the sample mean did not represent a significant deviation from normality for the present sample.

Specifically, the 15% cutoff point for categorizing athletes as symmetric and asymmetric is referenced in literature for different motor tasks such as horizontal jumps, vertical jumps and isokinetic test, regardless of execution speed, athlete's fitness level and characteristics of the sports practiced. However, Impellizzeri et al.[13] reported that the use of tests with different motor requirements would provide unequal lateral force asymmetry values. Accordingly, Bell et al.[17] reported that the asymmetry values could vary according to the sports practiced, especially in those in which dominance can play a significant role, as in soccer. Therefore, the cutoff points for the categorization of soccer players regarding asymmetry should be specific to the sports practiced, the population evaluated, the task required and the parameter calculated.

Despite the percentage difference between the new reference criterion calculated for soccer players and the criterion referenced in literature, sufficient evidence was not found for the alternative hypothesis to be proven, which stated that the proportion between symmetric and asymmetric athletes would be statistically different between the two normative values for the cutoff point for both knee flexor muscles and knee extensor muscles. The percentage difference among cutoff points of the lateral asymmetry of peak torque of knee flexors obtained from the upper limit value (13.80%) and the reference criterion (15%) was 8%. For the peak torque of knee extensors, the percentage difference was 17.8% from the upper limit value (12.32%) and the reference criterion (15%).

Further studies should be carried out to verify the cutoff value for soccer players of different levels of income, age, gender and ethnicity. The angular velocity and the dispersion of the analyzed variable should also be considered[16]. These considerations would lead to different cutoff values for different variables and evaluation methods, thus allowing interventions specific to the evaluated group.

CONCLUSIONS

It could be concluded that the cutoff values were lower than those referenced in literature, but the frequency of asymmetric and symmetric athletes was not significantly different. Based on the results of this study, the use of the 15% cutoff point provides classification of athletes similar to the method used to determine the cutoff point based on the mean of the evaluated population. It is noteworthy that this similarity in the classification of athletes between the two types of cutoff points occurred for variable peak isokinetic torque in professional adult soccer players. Therefore, the analysis of cutoff points of different methods is suggested to evaluate asymmetries as in performance variables obtained in the vertical jump in double platform and in horizontal monopodal jumps, because different tests can provide important information.

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