LOWER-EXTREMITY SIDE-TO-SIDE STRENGTH ASYMMETRY OF PROFESSIONAL SOCCER PLAYERS ACCORDING TO PLAYING POSITION

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Abstract:

Previous studies have utilized screening values of 10-15% of lower-extremity side-to-side strength asymmetry in soccer players with conflicting results. The purpose of this study was to determine differences in screening values for side-to-side asymmetry in soccer players according to their playing position, as well as to compare the differences in strength asymmetry between particular playing positions. Seventy-nine Brazilian male professional soccer players (age 26.1±5.3 years; body mass 79.8±14.4 kg; body height 180.4±12.9 cm) were grouped into playing positions of: goalkeepers, side backs, central backs, central defending midfielders, central attacking midfielders, and forwards. They performed maximal knee extension and flexion concentric and knee flexion eccentric actions on their preferred and non-preferred legs at 1.047 rad·s^{-1}. Forwards and goalkeepers had hamstrings concentric peak torque asymmetry (18.0±9.9%) and eccentric peak torque asymmetry (20.1±10.7%) significantly greater than 10% ($p<.05$). All other playing positions had values less than 15%. Our results indicate that the use of either 10 or 15% asymmetry cut off may result in different conclusions, which may affect decision-making regarding strength ratios. Furthermore, if 10% is used as a screening value, hamstrings strengthening programs based on bilateral equivalency should be prescribed for goalkeepers and forwards to reduce asymmetry.

Key words: *isokinetic assessment, knee imbalance, peak torque*

Introduction

Lower extremity strength and asymmetry in soccer has been a primary focus of investigation in numerous studies (Brophy, Silvers, Gonzales, & Mandelbaum, 2010; Croisier, Ganteaume, Binet, Genty, & Ferret, 2008; Fousekis, Tsepis, & Vagenas, 2010; Hagglund, Walden, & Ekstrand, 2013; Volpi & Taioli, 2012), like it has been possible differences in strength and asymmetry between particular playing positions (Carvalho & Cabri, 2007; Magalhães, Oliveira, Ascensão, & Soares, 2001; Ruas, Minozzo, Pinto, Brown, & Pinto, 2015; Weber, Silva, Radaelli, Paiva, & Pinto, 2010). Most professional soccer players have reported an increased side-to-side strength asymmetry between limbs (Croisier, et al., 2008; Fousekis, et al., 2010; Rahnama, Lees, & Bambaecichi, 2005; Ruas, Minozzo, et al., 2015), which may result from differential demands on the preferred (kicking) leg compared with the non-preferred (supporting) leg (Brophy, et al., 2010; Fousekis, et al., 2010). This is a consequence of the nature of the game, which requires players to repeatedly kick, dribble and tackle the ball using primarily their preferred, kicking, leg (Fousekis, et al., 2010; Rahnama, et al., 2005; Ruas, Minozzo, et al., 2015). In fact, different playing position demands and tasks performed have been found to alter lower-extremity strength in soccer players (Carvalho & Cabri, 2007; Oberg, Ekstrand, Moller, & Gillquist, 1984; Ruas, Minozzo, et al., 2015), which may also affect their strength asymmetry (Carvalho & Cabri, 2007; Magalhães, et al., 2001; Ruas, Minozzo, et al., 2015; Weber, et al., 2010). Based on this, sports medicine clinicians commonly use peak torque assessment in the lower-extremities based on bilateral equivalence (Croisier, et al., 2008; Rahnama, et al., 2005) when designing rehabilitation and strength programs. An accurate preseason strength assessment has been shown to be critical for the prescription of specific strengthening programs to players with asymmetry in order to avoid injury and improve muscle performance (Croisier, et al., 2008).

The use of isokinetic dynamometers for the screening of lower extremity side-to-side peak torque is important for designing strength-training programs aiming at the restoration of normal function (Croisier, Forthomme, Namurois, Vanderthommen, & Crielaard, 2002; Croisier, et al., 2008; Davies, Heiderscheit, & Brinks, 2000; Rahnama, et al., 2005; Ruas, Minozzo, et al., 2015), and team strength norms have commonly been used in professional soccer clubs (Croisier, et al., 2008; Ruas, Minozzo, et al., 2015; Ruas, Pinto, Brown, Mil-Homens & Pinto, 2015). However, different screening approaches for injury risk have been used. Previous studies have varied comparison values from 10% (Eniseler, Sahan, Vurgun, & Mavi, 2012; Kramer & Balsor, 1990; Rahnama et al., 2005), 15% (Croisier, et al., 2002; Croisier, et al., 2008; Ruas, Minozzo, et al., 2015; Weber et al., 2010) to a range of 10-15% (Carvalho & Cabri, 2007; Magalhães, et al., 2001) when determining side-to-side asymmetry in soccer players, ending in conflicting results. This could lead to the misinterpretation by clinicians and coaches when using side-to-side asymmetry results for return to play. Additionally, to our knowledge, only two studies have verified normative values for side-to-side asymmetry through statistical comparison (Croisier, et al., 2008; Ruas, Minozzo, et al., 2015), and no previous study has determined the differences between the use of different screening approaches for side-to-side asymmetry between particular playing positions.

There is an extensive use of different side-to-side asymmetry strength normative values in soccer players with little or no regard to playing position (Carvalho & Cabri, 2007; Croisier, et al., 2002; Croisier, et al., 2008; Eniseler, et al., 2012; Kramer & Balsor, 1990; Magalhães, et al., 2001; Rahnama, et al., 2005; Ruas, Minozzo, et al., 2015; Weber, et al., 2010). The aim of this study was to determine the differences between either 10% or 15% as screening values for side-to-side asymmetry in soccer players according to their playing position, as well as to compare the differences in strength asymmetry between particular playing positions.

Methods

Participants

Seventy-nine male Brazilian professional soccer players from the Southern First Division clubs participated in this study (26.1±5.3 years; 79.8±14.4 kg; 180.4±12.9 cm). They trained four times per week on average, and were free of any musculoskeletal lower-extremity injuries. Prior to the participation, all participants read and signed the University Review Board-approved informed consent form based on the Declaration of Helsinki of ethical principles for medical research involving human subjects. Players' dominant side was identified as their preferred leg when performing soccer tasks, such as kicking, passing, tackling, and dribbling (Brophy, et al., 2010; Fousekis, et al., 2010; Ruas, Minozzo, et al., 2015). They were also divided into groups according to their playing position: goalkeepers (GK; n=8; 26.4±6.9 years; 99.8±35.9 kg; 189.8±6.5 cm), side backs (SB; n=13; 27.0±4.9 years; 77.6±5.8 kg; 177.9±8.2 cm), central backs (CB; n=14; 26.4±5.7 years; 83.6±7.6 kg; 183.6±5.1 cm), central defending midfielders (CDM; n=12; 28.1±4.6 years; 77.5±6.4 kg; 179.4±5.2 cm), central attacking midfielders (CAM; n=15; 24.5±5.8 years; 72.6±5.0 kg; 175.8±4.2 cm), and forwards (FW; n=17; 25.0±4.7 years; 77.1±7.1 kg; 180.3±6.3 cm).

Testing procedures

All participants were tested at preseason (no official games), and refrained from physical activities one day before testing. Prior to testing, a 5-minute no load warm-up was performed on a cycle ergometer (Movement Technology, BM2700). They then sat on a CYBEX Norm isokinetic dynamometer (Ronkonkoma, NY) and had straps applied across their thighs and chest in order to avoid superfluous movement (Brown & Weir, 2001). The dynamometer's axis of rotation was aligned with the lateral condyle of their test knee (Brown, et al., 2005; Brown & Weir, 2001; Brown, Whitehurst, Bryant, & Buchalter, 1993). Quadriceps and hamstrings concentric and hamstrings eccentric peak torque (PT) were measured on the preferred and non-preferred leg in randomized order, from 90° of knee flexion to 0° of knee extension at 1.047 rad·s^{-1}. Quadriceps and hamstrings concentric strength was tested prior to hamstrings eccentric strength. A specific isokinetic warm-up of 10 repetitions at 2.094 rad·s^{-1}, as well as a specific warm-up of 5 repetitions at 1.047 rad·s^{-1} were performed prior to testing. All tests involved 5 repetitions with 90-second rest between legs. Instructions were given to push and pull as hard and fast as possible, and verbal encouragement was given during the test, but no visual feedback was provided (Ruas, Minozzo, et al., 2015; Ruas, Pinto, et al., 2015). The highest peak torque value of the 5 reps was used to calculate side-to-side percentage differences between the preferred and non-preferred legs.

Statistical analyses

All analyses were performed using SPSS 18.0 (Statistical Package for Social Sciences, Chicago, IL, USA). Kolmogorov-Smirnov tests confirmed the normality of data distribution and one-sample *t*-tests were used to compare playing position side-to-side asymmetry PT mean values with 10% and 15% values. A 2 x 2 x 6 (leg x muscle x playing position) repeated-measures ANOVA was used to compare concentric peak torque. A 2 x 6 (leg x playing position) repeated-measures ANOVA was used to compare hamstrings eccentric peak torque.

An *a priori* alpha level of .05 was used to determine statistical significance.

Results

Group scores for the limb, muscle and action are shown in Table 1. For concentric peak torque, there were no interactions, and there was no main effect for leg or playing position. However, there was a main effect for muscle ($p<.001$), in which quadriceps was greater than hamstrings. For hamstring eccentric peak torque, there was no interaction or main effect for playing position, but there was a main effect for leg where strength of the preferred leg was greater ($p=.039$) than of the non-preferred leg. For side-to-side asymmetry of quadriceps concentric PT, no playing position group demonstrated side-to-side asymmetry mean values greater than 15% ($p>.05$) (Figure 1). Forwards' hamstrings concentric PT was significantly greater than 10% ($p=.0043$), having greater hamstrings concentric values of the preferred than of the non-preferred leg (Figure 2). Goalkeepers' hamstrings eccentric PT was significantly greater than 10% ($p=.032$), having greater hamstrings eccentric values of the preferred than of the non-preferred leg (Figure 3).

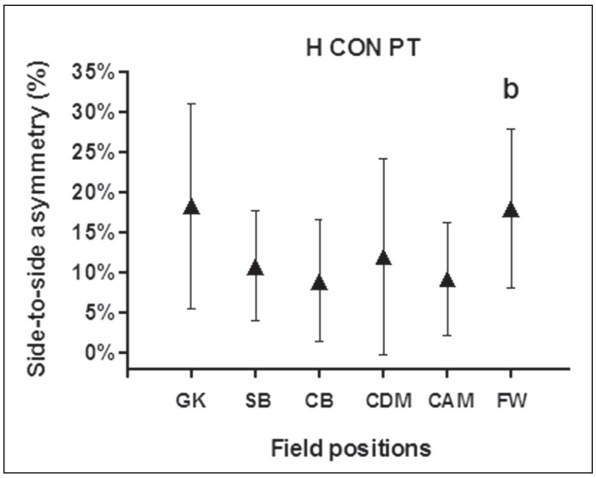

Figure 2. Means and SD of hamstrings (H) concentric (CON) peak torque (PT) side-to-side asymmetry (%) at 1.047 rad·s^{-1}. [b] FW significantly greater than 10%. GK=goalkeepers; SB=side backs; CB=central backs; CDM=central defending midfielders; CAM=central attacking midfielders; FW=forwards.

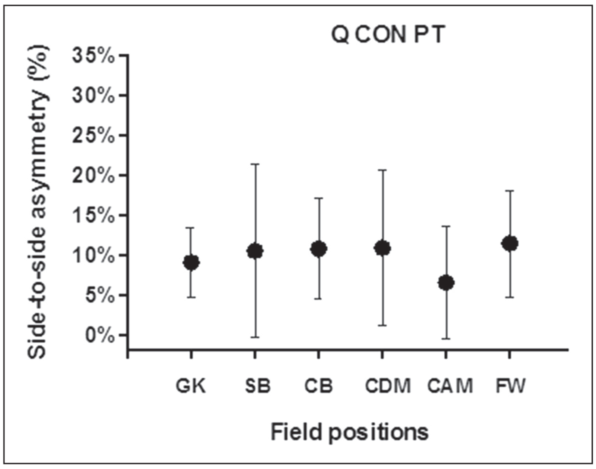

Figure 1. Means and SD of quadriceps (Q) concentric (CON) peak torque (PT) side-to-side asymmetry (%) at 1.047 rad·s^{-1}. GK=goalkeepers; SB=side backs; CB=central backs; CDM=central defending midfielders; CAM=central attacking midfielders; FW=forwards.

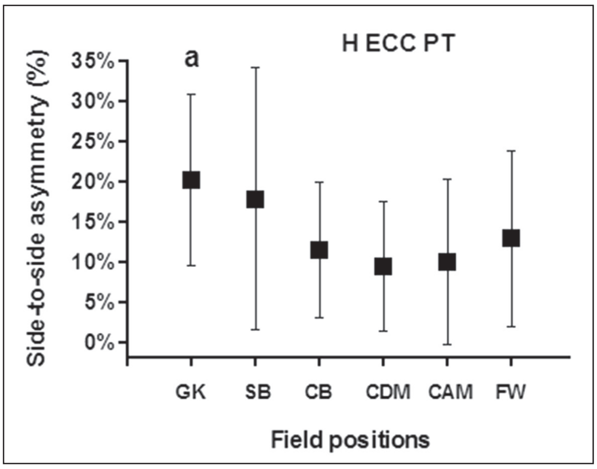

Figure 3. Means and SD of hamstrings (H) eccentric (ECC) peak torque (PT) side-to-side asymmetry (%) at 1.047 rad·s^{-1}. [a] GK significantly greater than 10%. GK=goalkeepers; SB=side backs; CB=central backs; CDM=central defending midfielders; CAM=central attacking midfielders; FW=forwards.

Table 1. Means±SD of quadriceps concentric peak torque (Q CON PT), hamstrings concentric peak torque (H CON PT), and hamstrings eccentric peak torque (H ECC PT) of the preferred and non-preferred legs at 1.047 rad·s^{-1}

Playing position	Q CON PT (N·m)		H CON PT (N·m)		H ECC PT (N·m)	
	Preferred	Non-preferred	Preferred	Non-preferred	Preferred	Non-preferred
GK	299.5±30.6	277.9±33.3	173.8±33.1	150.8±31.5	235.6±51.2	197.1±36.5
SB	252.8±48.3	267.7±35.4	157.1±20.8	162.2±24.7	194.0±46.2	206.0±34.8
CB	262.5±47.3	264.8±50.4	172.4±33.8	164.4±36.0	211.8±39.8	202.1±45.6
CDM	264.6±26.5	257.3±42.3	154.3±35.5	162.0±33.3	210.4±43.1	199.1±53.8
CAM	248.9±31.7	253.2±17.2	152.5±26.2	149.7±22.4	193.6±35.2	192.0±27.4
FW	257.8±42.4	250.6±42.4	146.2±37.2	141.4±39.1	197.4±41.8	190.3±39.9

GK=goalkeepers; SB=side backs; CB=central backs; CDM=central defending midfielders; CAM=central attacking midfielders; FW=forwards.

Discussion and conclusions

The aim of this study was to compare side-to-side strength asymmetry in soccer players according to their playing position, as well as to determine if there were differences in using either 10% or 15% as the screening value. Our results revealed that no playing position presented values greater than 15%; however, GK and FW presented side-to-side strength asymmetry significantly greater than 10%, having greater preferred than non-preferred hamstrings eccentric and concentric values. This demonstrates that, if a 10% comparative value is considered, hamstring strengthening of the non-preferred leg should be recommended for players in these playing positions to reduce asymmetry. Based on this, our results demonstrate that the use of a range of 10-15% may be problematic and lead to erroneous conclusions related to screening for side-to-side asymmetry, which could result in misinterpretation and erroneous decision making during the preseason.

Our findings showed that FW and GK presented side-to-side asymmetry PT mean values greater than 10%, having greater hamstrings concentric and eccentric strength of the preferred than of the non-preferred leg, thus demonstrating bilateral differences. Ensieler et al. (2012) assessed hamstrings concentric strength using a 10% comparative value and found that initial test scores were high in the entire squad only at the tests speeds greater than 1.047 rad·s^{-1}. This is in agreement with Rahnama et al. (2005), who found that 28 out of 48 players had strength imbalances greater than 10%, especially in the hamstrings at 2.09 rad·s^{-1}. Magalhães et al. (2001) found that only GK had hamstrings and quadriceps scores greater than 10% at 1.57 rad·s^{-1}, although their 10-15% range led them to conclude that all playing positions were within side-to-side asymmetry norms and at reduced risk of injury. We are not able to directly compare their results to our study because they did not verify normative values through statistical comparison. However, a possible reason for the increased hamstrings eccentric asymmetry found in GK may be due to the repeated specific movements they perform during games, such as goal kicks and one leg take-offs and landings, that most often requires use of their preferred leg (Eirale, Tol, Whiteley, Chalabi, & Holmich, 2014; Lees & Nolan, 1998; Luxbacher, 2005; Ruas, Minozzo, et al., 2015). When comparing strength and asymmetry differences between playing positions at 1.047 rad·s^{-1}, a recent report concluded that due to the specificity of training, GK were a completely different playing position and should not be included in general team strength interpretations (Ruas, Minozzo, et al., 2015). Carvalho and Cabri (2007) found that FW were the playing position that had the greatest difference between the preferred and non-preferred hamstrings concentric peak torque in professional soccer players tested at 1.047 rad·s^{-1}, which is in agreement with our findings. The rationale for this may be in that FW repeatedly use their preferred leg in order to accomplish their main function: scoring goals (Carvalho & Cabri, 2007; Hagglund, et al., 2013; Reilly, Bangsbo, & Franks, 2000).

When analyzing side-to-side asymmetry in soccer players, most studies have used 15% as the comparison value (Croisier, et al., 2002, 2008; Ruas, Minozzo, et al., 2015; Weber, et al., 2010). Ruas, Minozzo et al. (2015) found that all playing positions had smaller values than this normative value. This is in agreement with our results and also with the investigations that have used a 10-15% range in asymmetries tested at slow testing speeds, such as 1.57 and 1.047 rad·s^{-1} (Carvalho & Cabri, 2007; Magalhães, et al., 2001). One explanation for this is importance of strength of the non-preferred leg to support coordinative motor actions of the preferred leg (Magalhães, et al., 2001; Rahnama, et al., 2005; Ruas, Minozzo, et al., 2015; Weber, et al., 2010). However, the use of general normative values has been questioned (Ruas, Minozzo, et al., 2015; Ruas, Pinto, Hafenstine, Pereira, & Brown, 2014) since asymmetry may be position-specific (Carvalho & Cabri, 2007; Ruas, Minozzo, et al., 2015), altering strength patterns in a particular fashion (Davies, 2000; Kramer & Balsor, 1990). Results of the present study are in agreement with this. A generalization of 10-15% may lead to misinterpretations and affect resistance training program design.

This player profile study may benefit soccer teams in the interpretation of strength asymmetry across playing positions. Our results demonstrated that GK and FW presented greater preferred than non-preferred hamstrings eccentric and concentric leg strength values if 10% side-to-side asymmetry is used as the screening value. This would indicate hamstrings strengthening is needed in these playing positions to reduce asymmetry in our study sample. However, all playing positions were within the normative value of 15%, which may lead to misinterpretations and affect decision-making regarding strength training. Validity of 10% and 15%, as the screening values, should be verified by means of longitudinal studies, including the incidence and specificity of leg injuries.

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