IDENTIFICATION OF BILATERAL ASYMMETRIES IN LOWER LIMBS OF SOCCER PLAYERS BY VERTICAL JUMPS ON A DOUBLE FORCE PLATFORM

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The purpose of this study was to identify bilateral dynamic asymmetries of the lower limbs of forty six Brazilian professional soccer players by countermovement jumps on a double force platform. Maximal ground reaction force, impulse and maximal power output were registered and bilateral asymmetries identified if the bilateral difference was greater than 15%. A two factor structure of bilateral differences was found represented by maximal force and impulse production/maximal power output. Impulse production and maximal power output are more reliable indicators for bilateral asymmetries than maximal ground reaction force. In order to analyze dynamic bilateral asymmetries more completely, it seems to be necessary to apply a combination of different test procedures which consist of vertical jumps, isokinetic tests and maximal isometric contractions.

KEY WORDS: bilateral dynamic asymmetries, lower limbs, counter movement jump, soccer.

INTRODUCTION: Most soccer players have a dominant leg for kicking. This unilateral demand might lead to differences in motor ability especially strength and coordination and result in a functional asymmetry of the lower limbs that causes mechanical overload and compensatory mechanisms affecting movement technique and posture (Maupas et al., 2002). The possible consequences are higher injury risks and performance restrictions. Therefore, the analysis of asymmetries of athletes' motor behavior is important in order to prevent injuries and to control training, recuperation and therapeutic processes. Various aspects of bilateral characteristics and differences of the lower extremity, as anatomic structure, strength, cycle ergometry, locomotor kinematic, kinetic and muscle activity characteristics have been investigated and according to Schot et al. (1994) "the results of those studies are equivocal and appear to be greatly dependent upon research methodology". Methods for diagnosis of strength asymmetries are isokinetic dynamometry (Petsching et al., 1998; Maupas et al., 2002), function hop and jump tests (Noyes et al., 1991; Petsching et al., 1998) and landings (Schot et al., 1994). The main limitation of isokinetic evaluation is the constant angular velocity which does not characterize sport movements where the angular velocities vary constantly. As the physical demand of soccer players is composed by kicks, vertical jumps and locomotion with maximal acceleration over short distances, countermovement jumps can be considered an adequate analysis method because of the kinetic and kinematic similarity between the movement patterns of test and athletic movement. As variability of movement and performance is a natural biologic phenomenon, bilateral asymmetry is a consequence of that movement and performance fluctuation. Usually a difference of more than 15% between the right and left leg concerning an investigated variable is considered significant (Petsching et al., 1998; Noyes, et al., 1991). In the studies of Noyes et al., (1991) and Petsching et al., (1998), where bilateral differences were analyzed by hop and jump tests, kinetic variables (e.g. forces, impulse, power) were not measured. Therefore, in this study, significant lateral differences should be identified by kinetic variables of a countermovement jump. As different kinetic variables during the impulse phase of a countermovement jump can be used in order to identify lateral asymmetries, the aim of this study was to analyze the factorial structure of lateral differences concerning maximal force, peak of power output, impulse, and to investigate the possible differences of diagnostic information if different variables are used as criterion.

METHOD:

Data Collection: The subjects of this study were 46 professional soccer players of two teams of the First Brazilian National Soccer League (age: 25.37 + 1.23 years). Every athlete performed three countermovement jumps with a recovery interval of 2 min on a double force platform that registered the vertical ground reaction force separately for each leg at a frequency of 1 KHz. The jump with the best performance (highest rise of Center of Gravity) was selected for further analysis. In order to avoid the influence of upper limb movement on the vertical impulse, the hands were fixed at the hips and the athletes were requested to jump as high as possible (Figure 1).

Figure 1: Countermovement jump on a double force platform.

Analyzing the force-time characteristics of the impulse phases of the right and left leg separately by the use of DasyLab V4.0 software, the following variables were determined: Maximal vertical force (Fmax), maximal power output (Pmax) and impulse (I). The maximal vertical force was the peak of the ground reaction force. The maximal power output was determined as the maximum of the product of the instant vertical velocity of the Center of Gravity and the instant vertical force. The impulse was determined as the integral of the force-time curve (with the initial weight supported by each leg as baseline). The differences of these variables between the right and left leg were calculated and amounts equal or greater than 15% were considered as lateral asymmetries according to Petsching et al. (1998).

Data Analysis: In order to discover if the analyzed variables represent the same or different characteristics, the factorial structure was determined by a principal component factor analysis with Varimax rotation. That way, independent orthogonal factors can be extracted.
Lateral significant asymmetries were identified separately for each variable (Fmax, Pmax, I) if the difference between the right and left leg exceeded 15%. The correspondence of identified bilateral asymmetry and symmetry based on these variables was verified by the calculation of the contingency coefficient.

RESULTS: The factor analysis of lateral differences results in two independent factors which explain 98.8% of variance (Table 1). Factor 1 can be characterized by the lateral difference of impulse (ΔI) and Factor 2 by the lateral difference of maximal force (ΔFmax).

The results of the calculation of contingency coefficients which analyze the correspondence of diagnostic information (lateral asymmetry or symmetry) if different variables are used as criterion, are shown in Table 2-4. No significant contingency coefficient was found between the criterions maximal force and impulse with only 30% of correspondence of identified lateral asymmetry and between maximal force and maximal power output where the rate of correspondence is only 41%. The criterions ΔI and ΔPmax instead, lead to nearly identical diagnostic information (89% of correspondence) with a significant contingency coefficient (Table 2-4). All cases of lateral asymmetry identified by the criterion “impulse” are also identified if maximal power output is applied as criterion (Table 4).

Table 1 Results of factor analysis

Variables	Factors 1	2
ΔFmax	.319	**.947**
ΔI	**.957**	.263
ΔPmax	**.905**	.402

Table 2 Crosstabulation of diagnostic information between ΔFmax and ΔI

		Fmax Symmetry	Asymmetry
ΔI	Symmetry ΔI	**18**	1
	Asymmetry	26	**1**

Contingency coefficient: .038, p= .798

Table 3 Crosstabulation of diagnostic information between ΔFmax and ΔPmax

		Fmax Symmetry	Asymmetry
ΔPmax	Symmetry	**13**	1
	Asymmetry	31	**1**

Table 4 Crosstabulation of diagnostic information between ΔPmax and ΔI

		ΔPmax Symmetry	Asymmetry
ΔI	Symmetry	**14**	5
	Asymmetry	0	**27**

DISCUSSION: As the factor analysis of the investigated variables of the ground reaction force reveals an independent two factorial structure. Maximal force and impulse (or maximal power output) represent represent the independent factors, and consequently lead to different results if applied as criterion for the identification of lateral asymmetry. This result of the factor analysis is confirmed by the results of the analysis of contingency coefficients. As the physical demand of the lower limbs in soccer is the creation of an impulse either for the acceleration of the athlete or shooting the ball, lateral asymmetry appears as different impulse production of the right and left leg which can be adequately identified by a countermovement jump on a double force platform. Maximal power output leads to similar results if used as criterion for the identification of lateral asymmetries, but seem to be more sensible criterion. All impulse asymmetries are also maximal power output asymmetries and those cases identified as symmetric power output have also symmetric impulse production. Only 5 cases with symmetric impulse production are identified as asymmetric power output. The reason why maximal force as criterion for the identification of bilateral asymmetries represents an independent factor and does not correlate significantly with impulse production or maximal power output might be that the resistance of each leg at a countermovement jump, which is only about 50% of body weight, is to low to produce a maximal concentric force close to the maximal isometric force. According to Schmidtbleicher (1992) the correlation of maximal force of concentric and isometric contractions is very high if the load of the concentric contractions is close to the maximal isometric force.

CONCLUSION: Hop and jump tests are characterized by a greater similarity of movement pattern with soccer specific movement techniques than isokinetic tests that makes them appropriate for the identification of bilateral asymmetries of impulse production and maximal power output. The maximal vertical ground reaction force instead, is not a valid criterion for the identification of bilateral asymmetries, probably because the resistance (body weight distributed to the legs) is to low to estimate the maximal voluntary contraction force reliably. In order to analyze dynamic bilateral asymmetries more completely, it seems to be necessary to apply a combination of different test procedures which consist of vertical jumps, isokinetic tests and maximal isometric contractions.

REFERENCES:

Maupas, E., Paysant, J., Datie, A.M., Martinet, N. & André, J.M. (2002). Functional asymmetries of the lower limbs. A comparison between clinical assessment of laterality, isokinetic evaluation and electrogoniometric monitoring of knees during walking. *Gait and Posture*, 16, 304-312.

Noyes, F.R., Barber, S.D. & Mangine, R.E. (1991). Abnormal lower limb symmetry determined by function hop tests after anterior cruciate ligament rupture. *American Journal of Sports Medicine*, 19, 513-518.

Petsching, R., Baron, R. & Albrecht, M. (1998). The relationship between isokinetic quadriceps strength test and hop tests for distance and one-legged vertical jump test following anterior cruciate ligament reconstruction. *Journal of Orthopaedic & Sports Physical Therapy*, 28, 23-31.

Schmidtbleicher, D. (1992). Training of Power Events. In Komi, P. V. (Ed.), *Strength and Power in Sport* (pp.381-395). Oxford: Blackwell Scientific Publ.

Schot, P.K., Bates, B.T. & Dufek, J.S. (1994). Bilateral performance symmetry during drop landing: a kinetic analysis. *Medicine and Science in Sports and Exercise*, 26, 1153-1159.

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