

IMPULSE PRODUCTION OF DOMINANT AND NON-DOMINANT LIMBS OF YOUNG SOCCER PLAYERS

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The aim of this study was to compare the impulse production between the dominant and non-dominant limb of soccer players during countermovement jumps on a double force platform. A bilateral difference of more than 15% was considered as significant. Therefore a nonparametric contingency test between dominant or non-dominant limbs and the existence of lateral differences, and a paired t-test were performed. No significant differences were found for impulse production between dominant and non-dominant limbs ($p=0,067$). However, for 15 of the 36 individuals (41%) a more than 15% greater momentum production was found for the dominant than for the non-dominant limb. For identification of individual bilateral differences, countermovement jumps on a double force platform seem to be an adequate method.

KEY WORDS: bilateral differences, impulse production, soccer.

INTRODUCTION:

Most of the soccer players have a dominant limb for kicking (McCurdy & Langford, 2005; Lees & Nolan, 1998; Kramer & Balsor, 1990). This unilateral demand might lead to functional asymmetry and differences in motor ability especially strength and coordination (Haaland, Hoff, 2003; Kearns, Isokawa, Abe, 2001). Functional asymmetry of the lower limbs can be one of the factors responsible for mechanical overload and compensatory mechanisms affecting movement technique and posture (Maupas *et al.*, 2002). Therefore, unilateral demand tends to result in different characteristics of flexibility (Rahnama, Less, Bambacichi, 2005) and strength of the dominant limb in relation to the non-dominant (Kramer, Balsor, 1990). The possible consequences are higher injury risks and performance restrictions. Therefore, the analysis of asymmetries of athletes' motor behavior is important for injury prevention and training control. Isokinetic dynamometry is one of the methods applied for assessment of muscular force and strength characteristics (Kramer, Balsor, 1990; Rahnama, Less, Bambacichi, 2005). However, a disadvantage of isokinetic dynamometry is the difference of movement and innervation pattern in relation to sport movements. Therefore researches had used vertical jump tests for analysis of lateral differences of the lower limbs (Petsching *et al.*, 1998; Barber *et al.*, 1990). Vertical jump test are considered with the highest sensitivity in order to detect lower limb functional limitations in subjects after anterior cruciate ligament reconstruction (ACL). Therefore, vertical jump tests are widely applied for the analysis of lateral differences. According to Petsching *et al.* (1998), a bilateral difference of more than 15% is considered significant and might affect performance and increase injury risk. Since 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 in soccer. Since the variable that determines the propulsion of the ball or the athlete's body is the momentum, the aim of this study was to analyze the differences in momentum production of the dominant and non-dominant limb of soccer players by countermovement jumps on a double force platform.

METHOD:

Data collection: 36 male young soccer players from an elite Brazilian soccer club participated in this study. The mean of age, height and body mass was $12,92 \pm 0,28$ years, $1,69 \pm 0,83$ meters and $57,9 \pm 9,27$ kg, respectively. Subjects were only included in the

study if they had no recent injury of the lower limbs and spine. This study was approved by the ethic and research committee of UFMG (CAAE-0564.0.203.000-06). According to Chavet et al. (1997) the dominant limb of each player was determined by a questionnaire. All subjects performed three countermovement jumps on a double force platform (PLA3-1D-7KN/JBAZb, Staniak, Poland) with a recovery interval of 60 seconds between the jumps. The ground reaction forces were registered separately for each limb at a frequency of 500 Hz. Subjects were instructed to fix their hands at the hips, in order to avoid upper limbs' movements and to jump with maximal effort (Figure 1).



Figure 1: Countermovement jump on a double force platform

The momentum was determined as the integral of the force-time curve in relation to the body weight. The difference of momentum between the dominant and non-dominant limb were calculated according to Barber *et al.* (1990) and Clark (2001) as:

(momentum of dominant limb–momentum of non-dominant limb)/greatest momentum of both

That way, positive values indicate a greater momentum production of the dominant limb and negative values greater momentum production of the non-dominant limb.

Data Analysis: Mean, standard deviation and relative frequencies were considered for descriptive analysis. In order to identify differences in momentum production two different methods were applied. First a paired t-test, comparing the momentum production of dominant and non-dominant limb, was performed. The second test was the determination of the contingency coefficient between lateral differences of momentum production higher than 15%, according to the criterion of Petsching, Baron, Albrecht (1998), considered as significant bilateral differences. All statistical procedures were performed by SPSS 11.0 ($p < 0.05$).

RESULTS:

No significant differences ($p = 0,067$) of impulse production between dominant and non-dominant limbs were found (Table 2).

Table 2- Mean and standard deviation of impulse for dominant and non dominant limbs

	Mean	sd	Maximum	Minimum
Dominant limb (Ns)	65,03	11,82	87	36
Non-dominant limb (Ns)	68,78	11,66	97	45

Twenty seven subjects (75%) informed to have their right lower limb as the dominant and 9 (25%) presented the left lower limb as dominant. Even though no significant difference of

impulse production between dominant and non-dominant limbs was found, it was observed that 10 subjects (27,8%) presented bilateral differences higher than 15%.

The nonparametric contingency test (Table 3), analyzing the correlation between dominant/non-dominant kicking limb and dominant/non-dominant impulse production, revealed that the non-dominant (support limb) tends to produce higher impulse than the kicking limb (contingency coefficient=0.522, $p=0,053$). Eight of the ten players with significant lateral differences of impulse production produced higher momentum with their support limb than the kicking limb.

Table 3- Crosstabulation of dominant kicking limb and dominant impulse production

		Dominant kicking limb	
		right	left
Dominant impulse production	right	2	6
	left	2	0

DISCUSSION:

The results revealed that 27 subjects (75%) presented the right limb as dominant kicking limb and 9 (25%) the left limb. These results corroborate with Carey et al. (2000), who observed that most soccer players have their right limb as their dominant limb.

Motor behavior characteristics caused by unilateral demands have been investigated by several authors and different approaches (McCurdy, Langford, 2005; Kramer, Balsor, 1990; Haaland, Hoff, 2003; Maupas *et al.*, 2002). Lateral asymmetries in human behavior are related to preference and to performance. Rahnama et al. (2005) showed that asymmetries are characterized by higher performance of the dominant limb in relation to the non-dominant limb, especially in fine motor tasks.

Since soccer players usually have a dominant limb for kicking and dribbling (Kramer, Balsor, 1990), it seems that this dominance increases the possibility to develop lower limbs' strength asymmetry in young soccer players (Rahnama et al., 2005). Nevertheless, studies that compared strength between dominant and non-dominant limbs in professional adult soccer players, did not observe these differences (Zakas, 2006). This can probably be explained by the application of more sophisticated training methods and physical preparation methods in professional soccer in order to avoid lateral differences.

CONCLUSION:

Even though no significant difference (greater than 15%) between dominant and non-dominant limb was found for mean impulse production, 10 athletes (27,8%) presented significant bilateral asymmetry. 80% of those subjects with bilateral asymmetry of impulse production produce higher impulse with the support limb. The incidence of bilateral differences seems to be higher in young soccer players than in professional athletes. Although these findings are not statistically significant at the 5% level, they point out the importance of regular performance assessment in order to avoid the development of lateral differences by the application of adequate training methods. Vertical jump tests on a double force platform seem to be an adequate method for the analysis of lateral differences in order to minimize injury risks and to avoid mechanical overload during rehabilitation. It should be verified, if countermovement jumps on a double force platform could be substituted by other functional tests with less technical requirements, such as the single hop test for distance, since the application of motor tests are easier to integrate in the training process of young soccer players. In order to fully analyze lateral differences, it seems necessary to evaluate different age groups of young and adult athletes with different diagnostic methods (isokinetic dynamometry, motor and biomechanic tests).

REFERENCES:

- Barber, SD.; Noyes, FR.; Mangine, RE.; McCloskey, JW.; Hartman, W. Quantitative assessment of functional limitation in normal and anterior cruciate ligament deficient knees. *Clinical Orthopaedic and Related Research*. 1990, v. 255, p. 204-214.
- Carey PD, Smith G, Smith, TD, Shepherd WJ, Skriver J, leod L, Rutland A. Footedness in World Soccer: an analysis of France 98. *Journal of Sports Sciences*. 2000; (19): 855-864.
- Chavet, P; Lafortune, MA; Gray, JR. Asymmetry of lower extremity response to external impact loading. *Human Movement Science*. 1997; (16): 391-406.
- Clark, NC. Funcional performance testing following knee ligament injury. *Physical Therapy in Sports*. 2001; (2): 91-105.
- Haaland E, Hoff J. Non-dominant leg training improves the bilateral motor preference of soccer players. *Scand J Med Sci Sports*. 2003; (13): 179-184.
- Kearns, CF; Isokawa, M; Abe, T. Architectural characteristics of dominant leg muscles in junior soccer players. *European Journal of Applied Physiology*. 2001; 85: 240-243.
- Kramer JF; Balsor, BE. Lower extremity preference and knee extensor torques in intercollegiate soccer players. *Can. J. Spt. Sci*. 1990; 15(3):180-184.
- Lees, A; Nolan, L. The biomechanics of soccer: A review. *Journal of Sports Sciences*. 1998; 16: 211-234.
- Maupas, E; Paysant, J.; Datie, AM.; Martinet, N.; André, JM. Functional asymmetries of lower limbs. A comparison between clinical assessment of laterality, isokinetic evaluation and electrogoniometric monitoring of knees during walking. *Gait and Posture*. 2002; (16): 304-312.
- McCurdy, K.; Langford, G. Comparison of unilateral squat strength between the dominant and non-dominant leg in men and women. *Journal of Sports Science and Medicine*. 2005; (4): 153-159.
- Petsching R, Baron R, Albrecht M. The relationship between isokinetic quadriceps strength test and hop tests for distance and one legged vertical jump test following anterior crucate ligament reconstruction. *Journal of Orthopaedic & Sports Physical Therapy*. 1998; 28(1):23-31.
- Rahnama N, Less A, Bambacichi E. A comparison of muscle strength end flexibility between the preferred and non-preferred leg in English soccer players. *Ergonomics*. 2005; 48(11-14): 1568-1575.
- Zakas, A. Bilateral isokinetic peak torque of quadriceps and hamstring muscles in professional soccer players with dominance on one or both two sides. *Journal of Sports Medicine Phys. Fitness*. 2006; 46(1): 28-35.