ANALYSIS OF LOCOMOTION VELOCITY AND LATERAL DIFFERENCES OF STRENGTH PARAMETERS OF FOOTBALL (SOCCER) PLAYERS

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The aim of this study was the analysis of lateral differences of strength parameters of the lower limbs and locomotion velocity of right and left turns in football. Nineteen junior athletes from a Brazilian National League football (soccer) club participated in this study. The locomotion velocity was analysed by a sprint test with and without 90° turns using double light barriers. In order to identify lateral differences of muscular strength characteristics, squat jumps (SJ) with one leg were performed on a force plate. Except for the maximal rate of force development and the time dependent variables of the SJ, all coefficients of retest-reliability were higher than 0.85. A reference table for the evaluation of specific locomotion velocity characteristics and strength of the lower limbs was developed. Significant correlation was found between the maximal force and the dominant leg (preferred kicking leg).

KEY WORDS: locomotion velocity, strength, lateral differences, football (soccer).

INTRODUCTION: According to results of Winkler (1985), Reilly (1994) and Luhtanen (1994), top level football players perform up to 100 sprints and acceleration runs during a 90 minute football game. Approximately the 65% of these runs do not exceed a distance of 16m. Another attribute of rapid locomotion in football is the change of movement direction during these sprints, as a consequence of the anticipated and unexpected changes in the movement of players and ball. Differences of sprinting velocity between runs with a turn to the right or left side may be caused by a habitual motor program (movement technique) or by lateral differences of strength parameters of the legs (physical condition). As most football players have a dominant leg for kicking and other movements, the unilateral demand may cause these lateral differences. Another consequence of lateral differences of strength characteristics was get by Kollath (1992) who found differences of velocity gain between right and left foot contact phases during the first 6 steps of a sprint. According on these facts, the physical demand in football is characterized by maximal acceleration over short distances with change of moving direction. This is different to the demand of a 100m sprinter and makes it necessary to apply specific diagnostic procedures. Nevertheless, the common tests for locomotion velocity in football are characterized by sprints over a distance of at least 30m without changing the locomotion direction (Weineck, 1992). Therefore, the aim of this study was the development of a test procedure for:

- Evaluation of locomotion velocity with turns to the right and left side in a 15m run and lateral differences,
- Identification of lateral differences concerning strength parameters of the legs using a force plate, and
- Identification of possible correlations between lateral differences of strength parameters and locomotion velocity.

The reliability of the test procedures was verified by a retest. In order to rate the individual performance and to create an individual profile of the athletes, a reference table, based on the results of one of the best Brazilian junior teams, was developed.

METHODS: The subjects of this study were 19 football players from one of the best Brazilian junior teams (18 - 20 years, 18.58 ± 0.77 years). They performed a velocity test and one leg squat jumps on a force plate. The velocity test was composed by a straight run over a distance of 15m, a 15m run with a 90° turn to the right side and a 15m run with a 90° turn to the left side after 7.5m. The positions of the double light barriers were at the starting point, 7.5m and 15m (Fig.1). The athletes started from an upright position with the front foot placed at the first light barrier and an individual distance between front and rear foot. The starting instant was determined by the athlete. For the measurement of running times, double photo cells were fixed 100 cm and 120 cm over the ground, so that they were switched on when the trunk passed. The times were measured in 0.001s. Strength parameters were determined by one leg squat jumps (one leg on the force plate and the other suspended) on a force plate (AMTI OR5-6, 1 KHz, Fig.2). According to Schmidtbleicher (1992), the correlation of maximal force (F_{max}) and maximal rate of force development (G_{max}) of concentric and isometric contractions is very high if the load of the concentric contractions is close to the maximal isometric force. Based on these results F_{max}, G_{max}, t_{Fmax}, t_{Gmax} and G_{mean} (average rate of force development = F_{max}/t_{Fmax}) were determined seperately for the right and left leg (Fig.3). All tests were performed 5 times and the best performance was considered for further analysis. This procedure was repeated 3 days later and the coefficients of retest-reliability were determined. In order to quantify lateral differences in the velocity test with turns to the right and left side respectively, the difference of running time was calculated ($\Delta t = t_r - t_l$). Positive (negative) values indicate faster movement velocity with turns to the left (right) side. The same procedure was applied for the variables determined by the squat jumps. In this case, positive (negative) values indicate higher F_{max}, G_{max}, G and longer t_{Fmax} and t_{Gmax} for the right (left) leg. In order to analyse possible influence (contingency test) of lateral dynamic differences in the one-leg SJ and dominant/non-dominant leg (preferred leg for kicking) on lateral differences in the velocity test, tests of contingency (Chi-Square tests) were applied. If the absolute value of lateral differences (without consideration of the side of dominance) was higher than the percentile 80, it was classified according to the side of preference as a lateral difference. In a second step the side of lateral preference was identified. This resulted in a classification of the analysed variables of each athlete (attributes: "no lateral difference"; "preference of the right leg"; "preference of the left leg"). Finally, (nonparametric) contingency coefficients were calculated between lateral differences of dynamic parameters and lateral differences in the velocity test and between dominant/non-dominant leg and lateral differences in the velocity *test*.

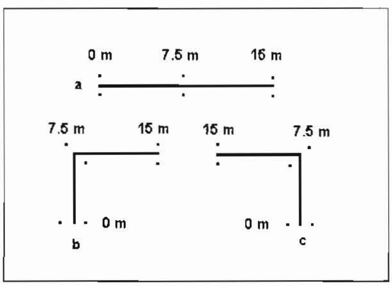

Figure 1. Position of light barriers.

Figure 2. One-leg Squat Jump.

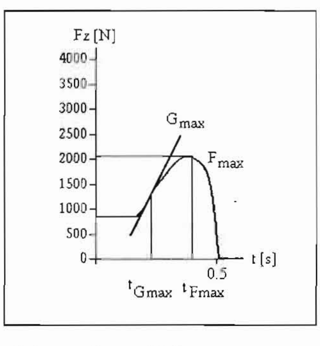

Figure 3. Strength characteristics of Squat Jump (SJ).

RESULTS: Except for the maximal rate of force development (G_{max}) and for the time dependent variables (t_{Gmax}, t_{Fmax}) the retest reliability coefficients for all variables examined in one-leg (SJ) and in the velocity tests were higher than 0.85. Therefore, the variables concerning the maximal rate of force development (G_{max} and t_{Gmax}) were excluded from further analyses. Table 1 shows the descriptive statistics of all variables with retest reliability coefficients being higher than 0.85. Based on these descriptive statistics, tables for evaluation of movement velocity and lateral differences can be elaborated according to the percentiles (e.g. 20^{th}, 40^{th}, 60^{th} and 80^{th} percentiles, Table 2).

Table 1. Coefficients of retest reliability and descriptive statistics.

Variables	*Symbol*	*Coefficient of reliability*	*mean*	*sd*
Maximal concentric force	F_{max}	0.884	1.854 BW	0.144 BW
Mean rate of force development	G	0.865	6.373 BW/s	1.809 BW/s
Lateral difference of F_{max}	ΔF_{max}	0.863	5,12 %	1,96 %
Lateral difference of G	ΔG	0.852	7,22 %	4,81 %
Running time for turns to the right	tr	0.974	2.839 s	0.109 s
Running time for turns to the left	tl	0.978	2.906 s	0.098 s
Difference of running time (tr - tl)	Δt	0.935	0.067 s	0.094 s

BW - body weight

Table 2. Classification of strength parameters of lower limbs and locomotion velocity.

Variables		*very poor*	*poor*	*regular*	*good*	*very good*
F_{max}	[BW]	< 1.70	1.70 - 1.75	1.76 - 1.95	1.96 - 2.00	> 2.00
G	[BW/s]	< 4.9	4.90 - 5.19	5.20 - 7.39	7.40 - 8.0	> 8.0
ΔF_{max}	[%]	> 10.0	10.0 - 7.0	6.9 - 3.1	3.0 - 1.0	< 1.0
ΔG	[%]	> 20	20 - 10	9.9 - 5.0	4.9 - 2.0	< 2.0
tr; tl	[s]	> 3.02	3.02 - 2.91	2.90 - 2.76	2.75 - 2.69	< 2.69
Δt	[s]	> 0.19	0.19 - 0.15	0.14 - 0.07	0.06 - 0.02	< 0.02

BW - body weight

Only one significant ($p < 0.05$) contingency coefficient was found; this was between the dominant leg and the maximal concentric force. This means that the maximal force is higher for the kicking leg than for the non-dominant leg. Significant contingency coefficients between lateral preferences in the sprint tests and dynamic variables could not be found.

DISCUSSION: Probably, due to the homogenity of the physical condition level of this group of top level football players, it was not possible to identify dynamic parameters with significant influence on lateral differences in short acceleration movements with change of direction. The dominant leg for kicking usually produces higher maximal force but this does not seem to influence the ability of changing the moving direction with maximal acceleration. Due to the small samples (only 19 athletes) which are from the same club, the classification of the dynamic parameters as well as the performance in the velocity test proposed in Tab. 2 has only a limited validity, which means that these classifications are restricted to the rating within the team. Therefore, it is necessary to obtain more data from athletes of the same and similar performance level. A greater and more heterogeneous sample probably results in the identification of more athletes with greater lateral differences and consequently in the possible identification of significant correlation between lateral differences of dynamic parameters and ability of changing locomotion direction during high acceleration. Nevertheless the above described test of locomotion velocity in football provides precise and differenciated information about the agility and specific velocity (capacity of acceleration) of football players. An individual profile of any athlete can be identified and based on these information and so the physical preparation training can be individualized.

CONCLUSION: Specific tests according to the demands in football are necessary to analyze adequately the agility and velocity of locomotion with change of movement direction and maximal acceleration. Due to the short movement time, the test requires double light barriers. The reliability of the above described procedure is very high ($r_{tt} > 0.97$) and lateral differences can be identified with adequate precision. The one-leg squat jump test also provides reliable results concerning the maximal force (Fmax), mean rate of force development (G) and lateral differences of these dynamic parameters. Further studies with more heterogeneous groups and athletes in rehabilitation treatment are necessary in order to identify possible correlations between lateral differences in accelerated locomotion and dynamic parameters. Based on data from athletes with different age and performance levels, it will be possible to use this information for talent selection and individual physical preparation. The described test procedures can be easily and quickly applied, which makes them suitable for routine application during the training process.

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