THE RELATION BETWEEN DIFFERENT PHASES OF SPRINT RUN AND SPECIFIC STRENGTH PARAMETERS OF LOWER LIMBS

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The sprint is determined by the ability to accelerate, the magnitude of maximal velocity and the ability to maintain velocity against the onset of fatigue. For the sprint coach it is important to have objective information concerning horizontal velocity, in the different phases of sprinting and the key mechanisms to these different phases. The aim of our study is to examine the relationships between the different phases of 100m sprinting and the results obtained with different tests, where we quantify the capability to produce force in isometric, and stretch shortening cycle (SSC) contraction modes. The inexistence of correlation between different phases of sprint, and the tests seem hard to explain. Different explanation could be given.

KEY WORDS: sprint running, evaluation, SSC strength, isometric strength, rate of force development

INTRODUTION: Sprint performances depend on many parameters. Improving one of these parameters may improve the whole performance. The sprinters will require more than just the finish time, to evaluate and prepare properly their racing proficiency. The sprint is determined by the ability to accelerate, the magnitude of maximal velocity and the ability to maintain velocity against the onset of fatigue. Objective information concerning horizontal velocity, in the different phases of sprinting: start, acceleration (ACC), transition (Acc), maximal running (MAX), and deceleration (DEC), is indispensable to make proper coaching decisions.

Knowing the best way to improve these different phases of sprinting it is an important goal to the coach. For that, the coach applies a battery of tests to monitor the effects of training, but the tests have to measure the important abilities to the different phases of sprinting. The dilemma is to develop assessment batteries which will provide insights into the key mechanisms, and because is difficult to mimic the sprinting actions the assessment of strength or power is often limited to non-specific tasks.

The muscle strength can be measured in several situations (tests). Many have been the attempts to obtain predictions to the sprint performance, and some authors have tried to find relations between sprint (or sprint phases) and different kind of tests (to measure muscle strength).

The different methodologies used on those studies have turned the comparisons very difficult. Using the different type of muscles actions factor, we can find studies that examined the relationships between 1) sprint phases or sprint and stretch shortening cycle (SSC) tests (Grosser, 1979; Mero et al., 1981; Nesser et al.1996; Kukolj et al., 1999; Hennessy and Kilty, 2001; Berthoin et al., 2001; Bret et al., 2002; Kale et. al., 2004); 2) sprint phases or sprint and isokinetic tests (Alexander, 1989; Guskiewicz et al., 1993; Delecluse, 1994; Nesser et al., 1996; Blazevich and Jenkins, 1998; Dowson et al., 1998; Chelly and Denis, 2000; Morin and Belli, 2003); 3) sprint phases and isometric tests (Mero et al., 1981;Young et al., 1995).

With a more detail look at those studies, we can find different SSC tests, different velocities and joints in isokinetic tests, different joint and joint angles in isometric tests, different measurements instrumentations, different type and number of subjects, etc.

The aim of our study is to examine the relationships between the different phases of 100m sprint run (ACC, MAX and DEC) and the results obtained with different tests, where we quantify the capability to produce force in isometric, and SSC contraction modes, to discriminate between sprinters of different capacity.

METHODS: Ten athletes from "athletic power events" (6 sprinters, 2 jumpers, and 2 hurdles, age 24,5 ± 2,43 years) were assessed for sprint running, rate force development (RFD) and

vertical SSC actions. The subjects wear spike shoes, on an outdoor synthetic track surface during the two 90m running. Time of each thirty meters interval (ACC - 30m, MAX - 60, DEC - 90m) was recorded using photocells (Brower Timing Systems).
The RFD was measured during the first 100ms, from the best of three maximal isometric contraction 1) in the plantar flexion of the ankle during a sitting position with the knee and ankle angles at 90°, and 2) in the extension of the knee during a lay down position with the knee at 110° angle. The forces were recorded using two different strain-gauge dynamometers.
The long vertical SSC action was measured from the best of three countermovement jump (CMJ) and the short vertical SSC action from the best of three drop jump (DJ) (from a 40 cm height). The SSC actions were recorded using electronic contact mat system.

RESULTS AND DISCUSSION:

Table 1 Measures values of sprint (sprint – 90 m), acceleration phase (ACC – 30 m), maximum phase (MAX – 30 m), and deceleration phase (DEC – 30 m) in seconds. Squat jump (SJ height), Countermovement jump (CMJ height) and drop jump (DJ height) in centimeters, drop jump (DJ contact) in seconds, and drop jump coefficient (DJc – height / contact time). Rate force development (RFD) during 100ms, from extension of the knee (RFD Knee), and from plantar flexion of the ankle (RFD Ankle).

Variables	Sprint 90m (sec)	ACC 30m (sec)	MAX 30m (sec)	DEC 30m (sec)	SJ height (cm)	CMJ height (cm)	DJ height (cm)	DJ contact (sec)	DJc (Coefficient)	RFD Knee (Ns)	RFD Ankle (Ns)
Mean	10,22	4,01	3,04	3,17	45,3	49,1	41,7	0,194	224,1	9805	3839
SD	0,29	0,11	0,10	0,15	7,2	6,9	8,7	0,064	42,2	1307	1656

Table 2 Correlation matrix for between the variables: sprint (sprint – 90 m), acceleration phase (ACC - 30m), maximum phase (MAX - 30m), deceleration phase (DEC – 30 m), Squat jump (SJ height), Countermovement jump (CMJ height), drop jump (DJ height), drop jump (DJ contact), drop jump coefficient (DJc), Rate force development from the knee (RFD Knee), and from the ankle (RFD Ankle). ** Correlation is significant at the 0.01 level, and * Correlation is significant at the 0.01 level.

	Sprint 90m									
ACC 30m	,918(**)	ACC 30m								
MAX 30m	,992(**)	,920(**)	MAX 30m							
DEC 30m	,939(**)	,732(**)	,910(**)	DEC 30m						
SJ height	-0,404	-0,393	-0,413	-0,351	SJ height					
CMJ height	-0,411	-,507(*)	-0,413	-0,280	,933(**)	CMJ height				
DJ height	-0,396	-,534(*)	-0,402	-0,232	,685(**)	,817(**)	DJ height			
DJ contact	-0,094	-0,276	-0,061	0,028	0,405	,541(*)	,709(**)	DJ contact		
DJc	-0,271	-0,184	-0,318	-0,260	0,114	0,085	0,118	-,597(*)	DJc	
RFD Knee	-0,150	-0,369	-0,324	0,063	,834(*)	,814(*)	,812(*)	0,511	0,188	RFD Knee
RFD Ankle	-0,395	0,069	-0,376	-0,404	,734(*)	0,681	0,703	0,437	0,052	,712(*)

The inexistence of correlation between sprint and the different phases of sprint, and the jumping ability (SSC tests) and the leg extensor's RFD, with the exception between ACC – CMJ and ACC- DJ height (respectively $p = 0.045$, $r = -0.51$ and $p = 0.033$, $r = -0.53$), seem hard to explain. Different explanation could be given.
1) The sample of subjects tested in the present study was a homogeneous one, or and a small one.
2) The athletes perform SSC acyclic vertical tests (CMJ, and DJ), like the coach normally do during training, with no control of the take-off velocity, knee angular velocity, knee range of movement, instead of SSC cycle horizontal tests (hopping or bounding 5 H; 5 B or 10 B - more specific to sprinting), controlling the major kinematics parameters.

3) Possibly it is more exact and specific to evaluate the force of lower limbs joints in the angular position at witch are produce the force in sprint movement.The leg-press movement test is commonly used to evaluate the maximal force and RFD of the legs (multi-joint isometric test) but producing force on these position (and plantar flexion with ankle and knee at 90° angle), don't mimics the muscular action during the support leg in a sprint running movement (see Figure 1).
The strength depends on different characteristics of the movement, like body posture (joint angles), movement velocity, type and amount of resistance, etc. Muscular tension depends on the muscle length and joint angle. When a joint angle varies the strength also change due to a different tension produce by those muscles and those muscle work through different moment arms. Isometric dynamometry is one of the most accepted methods for assessing neuromuscular function in sport science and we considered the RFD during 100ms it is more specific for sprinting, because correspond to the time available to produce force, that is limited to contact time. Although the reliability of these isometric parameters of neuromuscular function is well-established (Viitasalo *et al.*, 1981), their external validity in athletic assessment is still a topic of debate (Wilson and Murphy, 1996). While some authors have found a significant correlation ($p \leq 0.05$) between rate of force development and sprinting (Mero *et al.*, 1981; Young *et al.*, 1995), others have failed to find a significant relationship between static measures of neuromuscular function and dynamic performance (Baker *et al.*, 1994; Kukolj *et al.*, 1999).

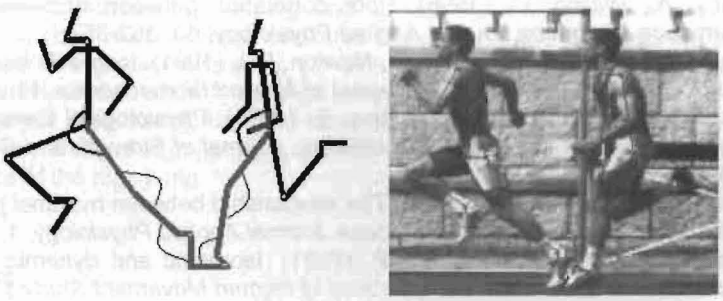

Figure 1 Lower limbs joint angles variation: ankle (100° and 110°), knee (160° and 160°) and hip (145° and 235°) of support leg at touch-down and take-off in sprint running.

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