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Biomechanical analysis of assisted and resisted sprinting.

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Introduction

While the biomechanics of sprint running have been relatively well researched (e.g., Mero et al., 1992, *Sports Med*, 13(6): 376-392), there have been very few investigations of the biomechanics of the various drills and exercises commonly used in sprint training (e.g., Knicker, 1997, Biomech in Sports XV: 17-21; Corn & Knudson, 2003, *J Str Cond Res*, 17(1): 72-75). Thus, there is a lack of understanding by researchers and coaches as to the benefits and/or effectiveness of many of the drills and exercises used in sprint training. Despite the popularity of both resisted and assisted methods of sprint training, and the commercial availability of various devices for carrying out the training, the evidence to support these training methods has been largely anecdotal. As a result, it remains unclear as to what biomechanical, neuromuscular and physiological changes may be induced by this type of training, as well as its effectiveness in improving performance.

Resisted sprinting involves increasing the horizontal load against which the athlete must run. The purpose of the exercise is to emphasize the athlete's ability to accelerate. Volkov and Lapin (1979, *MSSE*, 11(4): 332-337) suggested that sprinters reach maximum speed between 4-5 sec after the start. Mehrikadze and Tabatschink (1983, *Modern Athlete & Coach*, 21: 8) found that sprinters reach their top speed between 50-70m into a race. During these early stages of a race, the sprinter usually demonstrates greater trunk lean, shorter stride length, longer ground contact time and possibly a greater stride frequency than might be observed once a constant running speed is achieved. It is hypothesised therefore that resisted sprinting will demonstrate technique characteristics more closely related to the sprint start (up to 5 sec) than the technique kinematics of free sprinting.

Assisted sprinting drills purport to increase sprint performances by training an athlete's ability to increase the magnitude and/or duration of their top sprint speed. This "overspeed" training method, which pulls the athlete along, allows for a greater emphasis on the recovery phase of the stride thus increasing stride frequency while maintaining length. Maintaining a good upright posture is a critical technique element during assisted sprinting. Assisted sprinting may be carried out using several methods, one of which involves the use of a pulley-based system that provides a mechanical advantage to the coach who pulls the athlete along as they run. It is hypothesised that assisted sprinting will be characterised by technique kinematics that resemble free sprinting. This will involve greater hip range of motion, longer stride lengths and more upright posture than what may be observed in the earlier stages of a sprint race (under 5 sec).

Objective

The purpose of this study was to examine the kinematics of sprinting under resisted and assisted conditions as compared to free sprinting and sprint starts.

Design

Quasi-experimental design.

Setting

University of Alberta, Edmonton.

Subjects

The subjects (n = 6) were members of the University of Alberta varsity track and field team.

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Intervention/Main Outcome Measures

Each subject completed 3 trials of each of the four conditions: free sprinting (FS), assisted sprinting (AS), resisted sprinting (RS), and a sprint start (SS). Each sprint was approximately 50m in distance. Subjects were filmed in the sagittal plane by two digital video cameras (60 Hz) with overlapping fields of view allowing for approximately a 10-meter total field of view, enough for two full strides to be filmed. The APAS™ system was used to carry out the 2D kinematic analysis. Linear kinematic measures of interest included: average running speed; stride rate; stride length; and, ground support time. Angular kinematic measures of interest included: average trunk angle; thigh range of motion and peak velocity; upper arm range of motion and peak velocity; and, knee range of motion and peak velocity.

Main Results

The average running speeds were 9.40 m/s for FS, 10.04 m/s for AS (+6.8% vs. FS), 8.74 m/s for RS (-7.1% vs. FS), and 8.76 m/s for SS (-6.8% vs. FS). The average running speed for AS was significantly greater than for RS and SS but not FS. There were no significant differences in stride rate between any of the conditions. Stride length was significantly greater in AS than in RS or SS but not FS. Ground support time was found to be significantly shorter in AS as compared to RS and SS but not FS.

Average trunk angle for AS was significantly greater than for both RS and SS but not FS. Trunk angle for FS was significantly greater than SS. No significant differences were found between any of the conditions for range of motion of the knee, thigh or upper arm. Similarly, no significant differences were found between any of the conditions for peak angular velocities of flexion or extension at the knee, thigh or upper arm.

Conclusions

No significant effects on stride rate were found in the present study. This runs counter to the common notion among many practitioners that assisted sprinting can be used to induce increases in stride rate, with the goal of enhancing neuromuscular function. This is also reflected in the lack of significant differences in range of motion or peak angular velocities of the upper arm and thigh segments and the knee joint. Significant changes in stride length in AS seem to be the result of the external force being applied through the towing device. The kinematics of the AS condition seems to mimic the FS condition while the kinematics of the RS condition seems to mimic the SS condition, as speculated. The extent to which AS and RS are effective at altering an athlete's performance under normal sprinting conditions (SS and FS) is unclear.

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Commentary

The findings of this study raise some questions about the use of assisted and resisted sprint training methods. Coaches and athletes using these methods should ensure that the training modality is meeting the desired training demands following the principles of specificity and overload. It is unclear what exactly are the short and long-term benefits of these training modalities.