EFFECT OF PELVIC MOTION ON SOCCER KICKING PERFORMANCE

T. Bull Andersen & H. Sørensen
Institute of Sport, University of Aarhus, Denmark

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INTRODUCTION: When two-dimensionally simulating proximal to distal movement patterns (i.e. gait, sprint, kicking and throwing movements) pelvic (or shoulder) motion is usually not modelled individually for each leg (or arm). However, it can be observed that during these motions, pelvic rotation and translation causes hip acceleration (Dörge et al, 1999). Hence, the purpose of the present study was to investigate the effect of pelvic motion on the succes of a soccer kicking motion.

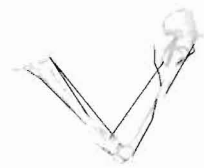

Figure 1. Screenshot of the model at the beginning of the simulated motion.

METHODS: A two-dimensional forward simulation model of one leg was constructed using SIMM (Software for Interactive Musculoskeletal Modelling). The model consisted of four rigid segments (pelvis, thigh, shank, and foot) connected by three joints (ankle, knee and hip) with eight muscle groups (soleus, gastrocnemius, tibialis anterior, vastii, hamstrings, rectus femoris, iliacus and gluteii) (see Figure 1). Furthermore, a ball was modelled as a damped spring according to results from a laboratory experiment. Muscles were modelled as Hill-type muscle-tendon actuators where each muscle was represented by a contractile element, a parallel elastic element and a series elastic element (Piazza & Delp, 1996). Input to a simulation of movement of the system were initial positions and velocities of the segments and stimulation of each muscle throughout the simulation time. A video analysed movement was used to kinematically drive the pelvic motion. Four experiments were conducted: (1) no movement of the pelvis, (2) only pelvic rotation about the hip joint, (3) only pelvic translation, and (4) both pelvic rotation and translation. The stimulation of each muscle consisted of two stimulation levels (between 0 and 100% MVC) and one timing parameter (time of change between the two stimulation levels) which were optimised to maximise ball velocity.

RESULTS: The results (see Figure 2) show that kinematically forcing only rotation of pelvis increased ball velocity by 5% (2) and kinematically forcing pelvic tranlsation increased ball velocity by 38% (3). A combination of rotation and translation yielded a 42% increase (4). The increases where calculated after the horizontal velocity of the pelvis had been subtracted.

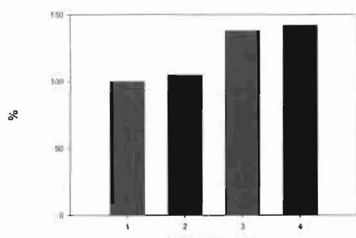

Figure 2. Ball velocities in percent of the velocity obtained without pelvic motion.

DISCUSSION AND CONCLUSIONS: The results indicate that pelvic motion is a prime factor when performing fast unloaded leg extensions. Rotation of pelvis about the hip joint only caused changes in muscle lengths during the movement, whereas translation of pelvis could be used to gain momentum of the kicking leg (i.e., segmental energy transfer). Based on the present results, it can be concluded that there was a sligth improvement caused by more optimal working conditions for the hip flexors. A more pronounced improvement was caused by the pelvic translation which facilitated energy transfer to the shank.

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