NEUROMUSCULAR DIFFERENCES BETWEEN ISOKINETIC AND SPORT MOVEMENTS: IMPLICATIONS FOR TRAINING - PERFORMANCE PREDICTION.

Vasilios Baltzopoulos
Biomechanics Group, Department of Exercise and Sport Science, Manchester Metropolitan University, Hassall Rd, Alsager ST7 2HL, U.K.

INTRODUCTION

Isokinetic dynamometry has certain unique advantages because it allows the assessment of muscle function during isolated joint motion and controlled angular velocity conditions. These advantages lead to the widespread use of isokinetic dynamometry as a training and performance prediction method for various sports. However, the relationship between isokinetic tests of muscle function and performance in sporting activities is not clear. Some studies reported significant correlations between isokinetics and performance in swimming, cycling, skiing and other activities (Bosco, et al., 1983), whereas others reported weak or non existing relationships in swimming, jumping, cycling and kicking (Mognoni, et al., 1994). One of the main reasons for these contradictory findings is the failure of such studies to consider in detail the differences in the mechanical function of the neuromuscular system (e.g., muscle activation, length and velocity) during the different activities. The purpose of this study, therefore, was to examine differences in muscle length and velocity between isokinetic tests and sport/ functional activities.

METHODS

Two dimensional angular kinematic data (hip, knee and ankle angles) from an isokinetic knee extension test at 300 deg/s, the stance phase of running (4 m/s) and a simulated football kicking action were collected using a two-dimensional video analysis system. These data were used to drive a musculoskeletal model of the lower limbs using the Software for Interactive Musculoskeletal Modelling (SIMM) (Delp, & Loan, 1995) on a Silicon Graphics workstation. This system enables the accurate estimation of musculotendinous unit length and velocity changes during the simulated activities.

RESULTS

The rectus femoris (RF) muscle is one of the major agonist muscles during the activities examined in this study. The length of the rectus femoris and patellar tendon unit during the different activities is shown in Figure 1. It can be seen that the length of the muscle is increasing (eccentric action) during running whereas it decreases (concentric action) in isokinetic dynamometry and the extension phase of the kicking action. During the stance phase of running the RF length increased from **0.463** m to **0.494** m and the maximum linear velocity of contraction of the musculotendinous unit was **0.264** m/s. During the kicking action the RF length increased from **0.411** m to **0.482** m during the knee flexion phase and then decreased to **0.396** m at the end of the extension movement during the kicking action. The maximum lengthening velocity was **0.32** m/s and the maximum shortening velocity was **0.36** m/s. During the isokinetic test the RF length decreased from **0.486** m to **0.428** m and the velocity was approximately constant with a maximum of **0.15** m/s. It is evident from these data that there are considerable differences in the length and velocity of contraction in this important and dominant knee extensor muscle. The relationship between musculotendinous unit (rectus femoris-patellar tendon) length and velocity is shown in Figure 2.

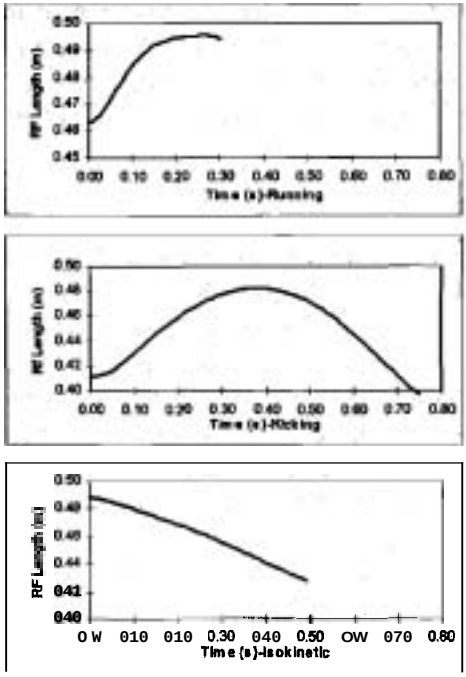

Figure 1. Rectus femoris (RF) and patellar tendon unit length during isokinetic dynamometry, running and kicking actions.

DISCUSSION

The usual approach to determine a predictor test or training method for a particular sport or activity is to correlate a measure of performance with the scores (measurements) in different laboratory-based tests (predictor tests) that are easier to conduct and reproduce. For example, in order to determine whether an isokinetic test or another laboratory-based test is a good predictor of performance, a number of subjects is tested in both and then the statistical relationship between performance and laboratory test is determined.

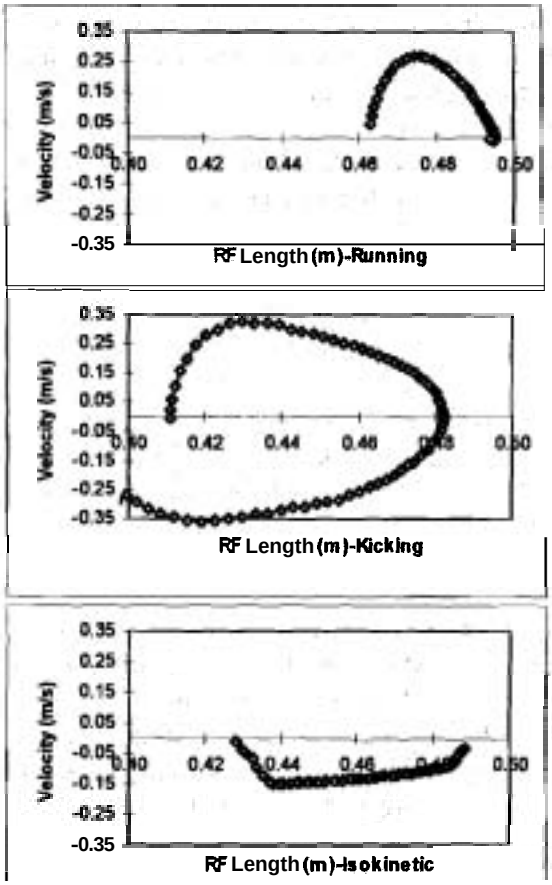

Figure 2. The relationship between musculotendinous unit (rectus femoris-patellar tendon) length and velocity during isokinetic dynamometry, running and kicking actions.

Such an approach can be misleading because it does not consider the differences in mechanical and neuromuscular function between the activities. For example, Poulmedis et al. (1988) tested football (soccer) players using isokinetic dynamometry (30 and 180 deg/s) and concluded that the isokinetic tests measures were related to kicking performance. On the contrary, Mognoni et al. (1994) concluded that there was no relationship between isokinetic measures at 60, 180, 240 and 300 degls and kicking performance. The results of the present study indicate that there could be significant differences in neuromuscular function and mechanics even between activities that appear to be similar and suggest that a more appropriate and informed approach is required for the determination of a predictor/training test in order to prevent such erroneous conclusions. A suggested approach for this purpose is shown in Figure 3.

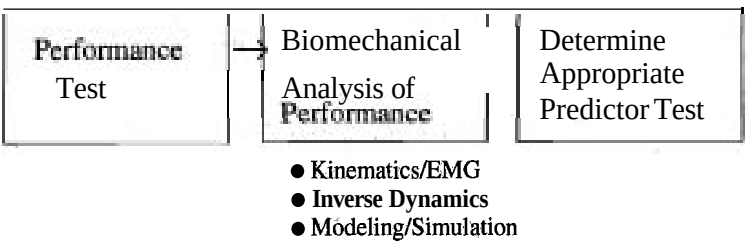

Figure 3. A schematic representation of a more appropriate approach for the determination of a performance predictor test based on neuromuscular and mechanical function agreement between performance and laboratory-based predictor test.

In this approach different levels of biomechanical analysis of the performance can be used (Kinematic/EMG, Joint moment determination using inverse dynamics, Musculoskeletal Modelling-Simulation) in order to determine the neuromuscular and mechanical characteristics of the performance. Based on this information, an appropriate laboratory-based predictor test or training method can be devised that has similar characteristics to the performance. This will ensure that a statistical relationship has a biomechanical/physiological basis and therefore it can be used with confidence for the prediction of performance.

CONCLUSIONS

These results indicate that there are significant neuromuscular mechanics differences between common sporting-functional activities and isokinetic exercise, indicating that such isolated joint-controlled velocity tests should not be used alone for specific training or performance prediction.

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