DIFFERENCES BETWEEN RESULTANT JOINT AND MEASURED MOMENTS BY A DYNAMOMETER DURING ISOMETRIC CONTRACTION AT THE KNEE JOINT

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INTRODUCTION

Isokinetic dynamometers have been often used to estimate muscle forces, to examine history dependent properties of muscle, to describe the muscle architecture, and to determine the mechanical properties of the tendon and aponeurosis of the muscle. It is usually assumed that the moment measured by the dynamometer is equivalent to the resultant joint moment and that the joint angles during loading are identical to those during unloading. Herzog (1988) reported, the influence of the relative motion of the knee to the dynamometer on the resultant knee moments are negligible (lower than 2.2%), when the joint axis and the axis of rotation of the dynamometer arm are carefully aligned before each experimental movement. Herzog (1988) examined only one subject. So it is possible that for this subject, the influence due to the non rigidity of the dynamometer arm-shank foot system was small. Therefore the purposes of this study were to examine two hypotheses: (a) during isometric contractions there is a significant difference in the moments measured by a dynamometer and the resultant moments at the knee joint, and (b) during isometric contractions there is a significant difference in the knee angles at similar resultant moments during the loading and the unloading phases.

METHODS

Twenty seven long distance runners (weight: 77.06 ±7.77 kg, height: 182 ±6 cm) participated in the study. All subjects performed isometric maximal voluntary contractions (MVC) and contractions induced by electrostimulation (Compex 2) at four different knee-hip angle combinations on a Biodex-dynamometer (tab.1).

Table 1: Examined knee and hip joint positions

<table>
<thead>
<tr>
<th>Position</th>
<th>Knee angle</th>
<th>Hip angle</th>
<th>Contraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pos. 1</td>
<td>115°</td>
<td>140°</td>
<td>MVC + stimulation</td>
</tr>
<tr>
<td>Pos. 2</td>
<td>170°</td>
<td>140°</td>
<td>stimulation</td>
</tr>
<tr>
<td>Pos. 3</td>
<td>140°</td>
<td>140°</td>
<td>stimulation</td>
</tr>
<tr>
<td>Pos. 4</td>
<td>80°</td>
<td>140°</td>
<td>stimulation</td>
</tr>
</tbody>
</table>

The kinematics of the leg were recorded using the vicon system (8 cameras 120 Hz). The examined parameters (moments and angle values) were identified and analysed at 0, 15, 30, 45, 60, 80 and 100% of the maximum resultant moment of each trial. For the electrostimulation trials, also the unloading phase was analysed at the corresponding percentages.

RESULTS AND DISCUSSION

The values measured at the dynamometer overestimate the resultant moment at the knee joint. However, individual differences are seen. The average differences between the maximal resultant and measured moment ranged between 3.5 and 7.3 %. The maximal differences in the 5 examined variations ranged between 8.6 and 16.8 % (fig.1).

Figure 1: Mean ±SD, minimal (min) and maximal (max) values of the moment differences (resultant vs. measured) at the knee joint during maximal voluntary contraction (MVC) and stimulation (Stim) (n= 27)

At all positions, except at position 4 which showed only 3° rotation, the measured leg rotation around the knee ranged between 10 and 15°. Another important finding of this study was, that in all cases the knee angles showed significant differences (p<0.05) between the loading and the unloading phases at the same resultant knee joint moments (fig. 2).

Figure 2: Knee angles at the loading-unloading phases with stimulation (mean ±SD, n= 27)

SUMMARY

From this we can conclude that (a) the measured and the resultant moments at the knee joint are different and (b) the knee angles at the same resultant joint moment are also different for the loading and the unloading phases. The observed differences may lead to erroneous results concerning the following: (a) diagnostic of muscle architecture, (b) estimation of muscle forces and (c) estimation of the strain and hysteresis of the tendon and aponeurosis.

REFERENCES