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Effects of sustained maximal and submaximal isometric knee extension contractions on electromechanical delay

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EFFECTS OF SUSTAINED MAXIMAL AND SUBMAXIMAL ISOMETRIC KNEE EXTENSION CONTRACTIONS ON ELECTROMECHANICAL DELAY.


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INTRODUCTION

Electromechanical delay (EMD) represents the time course of excitation contraction coupling and subsequent tension development in the muscle fibre (Cavanagh and Komi, 1979). Peripheral fatigue is an acute response to exercise. The nature of the response will depend on the type of contraction, duration of the exercise and extent to which the contraction is continuously sustained (Vøllestad and Sejersted, 1988; Maclaren et al., 1989; Enoka and Stuart, 1992). The response may involve dysfunction of neuromuscular propagation, excitation - contraction coupling or the contractile apparatus (Vøllestad and Sejersted, 1988, 1988; Maclaren, 1989; Enoka and Stuart, 1992). Since the time course of these processes determines EMD (Cavanagh and Komi, 1979), fatigue may produce an elongation in EMD and the change may be a function of the type of contraction that produced the fatigue. Therefore the measurement of EMD may be an important parameter in the study of local muscular fatigue. The aim of the study was to investigate the effects of sustained isometric knee extension on EMD of the quadriceps muscle.

METHOD

Twelve male subjects performed the isometric contraction at maximal (100%MVC, T100) and submaximal (50%MVC, T50) levels till fatigue, which was defined as a 15% reduction in contraction force. Before, immediately after, and at 5 min and 10 min after the exercise, subjects performed three MVC in response to an auditory signal and three electrically stimulated contractions, during which EMD was measured. At the same time intervals, skin-puncture blood samples were obtained to analyse blood lactate and plasma potassium ion concentration changes.

RESULTS

Following the T100 and T50 there were significant reductions in peak force of MVC ($p<0.05$), however, no significant changes were found in other muscle contractile properties and EMD (table 1).

Table 1 Peak force ($F_{\text{peak}}$), peak rate of force development ($\text{RFD}_{\text{peak}}$) and maximum electromechanical delay ($\text{EMD}_{\text{max}}$) of maximum voluntary contractions (MVC) of knee extensors, measured pre and post sustained isometric contractions at 100% MVC ($T_{100}$) and 50% MVC ($T_{50}$) levels.

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SE</th>
<th>Pre-Exercise</th>
<th>Post-Exercise</th>
<th>Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_{\text{peak}}$ (N)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_{100}$</td>
<td>772.7 ± 34.8</td>
<td>710.5 ± 27.1*</td>
<td>774.4 ± 31.5</td>
<td>775.6 ± 31.3</td>
</tr>
<tr>
<td>$T_{50}$</td>
<td>737.3 ± 33.6</td>
<td>666.3 ± 33.1*</td>
<td>727.9 ± 29.9</td>
<td>715.0 ± 32.1</td>
</tr>
<tr>
<td>$\text{RFD}_{\text{peak}}$ (N/ms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_{100}$</td>
<td>6.15 ± 0.81</td>
<td>6.00 ± 0.48</td>
<td>6.19 ± 0.40</td>
<td>6.77 ± 0.36</td>
</tr>
<tr>
<td>$T_{50}$</td>
<td>5.12 ± 0.48</td>
<td>4.87 ± 0.39</td>
<td>5.28 ± 0.34</td>
<td>5.91 ± 0.55</td>
</tr>
<tr>
<td>$\text{EMD}_{\text{max}}$ (ms)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$T_{100}$</td>
<td>43.4 ± 2.3</td>
<td>47.4 ± 3.8</td>
<td>41.4 ± 1.9</td>
<td>45.1 ± 2.4</td>
</tr>
<tr>
<td>$T_{50}$</td>
<td>40.6 ± 2.8</td>
<td>44.9 ± 2.7</td>
<td>43.7 ± 1.8</td>
<td>41.1 ± 2.5</td>
</tr>
</tbody>
</table>

* $p \leq 0.05$, compared with pre-fatigue value, detected by repeated measures ANOVA.
DISCUSSION AND SUMMARY

The major finding of this study is that EMD of MVC was found not to be influenced by either maximal (T100) or submaximal (T50) sustained isometric contractions. Both endurance trials only induced moderate decrements in Fpeak and no decrees in RFDpeak. This may indicate that the contractile mechanisms were not significantly impaired. Further it is speculated that the reason muscle contractile parameters were not affected by the endurance trials was the limited exercise time to exhaustion. Further investigations to examine the effect of low level sustained isometric contractions on electrical, contractile, metabolic and fractionated reaction time properties may be important in explaining fatigue in occupational activities that require prolonged static contractions.

REFERENCES


