INTRA-MUSCULAR EMG SHOWS VARYING COACTIVATION PATTERNS IN INDIVIDUAL THIGH MUSCLES DURING ISOMETRIC FLEXOR AND EXTENSOR ACTIONS

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INTRODUCTION

Antagonist activation during agonist muscle actions (coactivation) has been frequently reported, especially for the hamstrings during maximal knee extensor actions (e.g. Baratta *et al.* 1988). Typically, myoelectrical activity has been recorded using surface electrodes (cf., however, Onishi *et al.* 2002). Surface EMG has limitations, e.g. risk of "cross-talk" between neighbouring muscles and limited accessibility to deep muscles. Still, differences between individual muscles have been indicated (Aagaard *et al.* 2000). The aim of this study was to investigate activation patterns, particularly coactivation, of all major agonist and antagonist thigh muscles during isometric knee extensor and flexor actions at different knee angles using intra-muscular fine-wire EMG recordings.

METHODS

So far five male physical education students have participated in the study. Their mean (± SD) age, stature and body mass were 27 ± 4 years, 1.84 ± 0.07 m and 81 ± 6 kg, respectively.

Intra-muscular EMG recordings were made from the knee extensors: Vastus Lateralis (VL), Vastus Medialis (VM), Vastus Intermedius (VI), and Rectus Femoris (RF), and the knee flexors: Biceps Femoris caput longum (BFl) and Biceps Femoris caput breve (BFs), Semitendinosus (ST) and Semimembranosus (SM). Two insulated silver wire electrodes with a bared tip of 2-3 mm (inter-electrode distance 1 cm) were inserted into each of the 8 muscles. Electrode placement was guided and confirmed by real-time ultra sound.

Maximal (MVC) unilateral isometric knee extensor and flexor actions were performed in a sitting position with the knee at either of three angles, 20, 50 and 80^o (0^o = straight leg). Average torque and EMG were calculated over a 1 s window of steady torque production. EMG values for each muscle when acting as agonist as well as when acting as antagonist were normalized to one value, namely the highest value obtained for that particular muscle at any of the angles tested.

RESULTS

The agonist activation of individual thigh muscles during MVC at different knee angles ranged 70-100%. RF, ST and BFl showed the largest changes with knee angle, RF and ST having the lowest relative activation at the most flexed knee position and BFl at the most extended one.

The antagonist activation varied between 3-20% for the flexors during MVC extension and 5-8% for the extensors during MVC flexion. Among the flexors BFl showed the lowest level of activation (3-6%) irrespective of knee angle. There was a tendency towards higher values at more flexed knee angles for all flexor muscles acting as antagonists.

The mean MVC knee extensor torque was 131 Nm, 290 Nm, and 341 Nm at 20, 50 and 80^o knee angle. The corresponding values for MVC knee flexion torque were 154, 132, and 97 Nm, respectively.

DISCUSSION

The results indicate that there is, indeed, coactivation of antagonist muscles, both during maximal voluntary isometric knee flexion and extension. Generally the variation with knee angle was relatively small. The highest levels of coactivation were seen in the knee flexors, with the exception of the long head of biceps femoris. Interestingly, the biceps femoris muscle has been suggested, based on surface EMG recordings, to have the most prominent role as a knee stabilizer, possibly assisting the anterior cruciate ligament, during knee extension (Aagaard *et al.* 2000). If so, that function appears, from the present data, to be carried out mainly by the short head of this muscle. The results were consistent among the subjects studied, but more observations are needed to obtain conclusive results.

REFERENCES

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