MUSCLE ACTIVITY AND ARCHITECTURE VARIATION DURING LENGTHENING CONTRACTIONS IN ISOTONIC AND ISOKINETIC MODES

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INTRODUCTION

Eccentric exercise (EE) involves muscular contractions against a load higher than the torque exerted by the muscle itself. EE are frequently used in rehabilitation protocols or training sessions to improve the production of muscular force [1]. EE are classically performed at a constant speed (isokinetic, IK) or against a constant external load (isotonic, IT). These differences in mechanical stress could induce different contributions and adaptations of the neuromuscular system. Thus, this study was designed to compare the effects of the solicitation mode (IT *vs*. IK) on the muscle activity and architecture during lengthening contractions.

METHODS

Twelve male students volunteered to participate in this study. They each performed a familiarization session followed by a testing session that was performed one week later. The study was conducted on an ergometer (Biodex® System 3 Pro customized) that was developed in a previous study to elicit standardized eccentric IT and IK contractions [2]. During the testing session, subjects warmed-up before performing four sets of eccentric knee flexions, ranging from 30° to 90° (0° = full leg extension), two sets of 8 IT flexions, occurring at 120% of the maximal repetition, and two sets of *n* maximal IK flexions, *n* corresponding to the number of repetitions performed to reach the amount of external work realized in IT mode at the same average angular velocity.

During each set, the mechanical parameters (external work, angular velocity, joint angle), the surface electromyographic activity (SEMG) of the agonist (*vastus lateralis*, *VL*; *vastus medialis*, *VM*; *rectus femoris*, *RF*) and the antagonist muscles (*semitendinosus*, *ST*; *biceps femoris*, *BF*) were recorded. Simultaneously, the muscular architecture of *VL* (muscle thickness, fascicle angle; fascicle length) was characterized by ultrasonography (Philips® HD3). Each parameter was calculated on 5 degrees-windows in order to establish the variations as a function of joint angle. Three-way (mode x muscle x angle) for SEMG activity and two-way (mode x angle) for *VL* architecture repeated measures ANOVAs were used to test potential effects of solicitation mode, muscle and knee joint angle on SEMG activity and muscle architecture.

RESULTS AND DISCUSSION

In standardized conditions, the level of quadriceps activity was on average 4.7% higher in IT mode than in IK mode (F = 13.3; p = 0.004). Moreover a main effect was found for the solicitation mode of the agonist muscles (F = 11.8; p = 0.006) and the knee joint angle (F = 88.8; p < 0.0001) on normalized agonist muscles activity level. The agonist muscle activity level was 26.8% higher on average in IT than in IK mode from 30° to 50°. Interestingly, it was 14.1% higher in IK than in IT mode from 65° to 85° (Fig. 1). The solicitation mode had no effect on antagonist co-activity level. Antagonist muscles activity was significantly higher in *BF* than in *ST* (10.8% *vs*. 4.8%).

Muscle thickness (p = 0.99), fascicle angle (p = 0.4) and fascicle length (p = 0.8) were not influenced by the solicitation mode (n = 8).

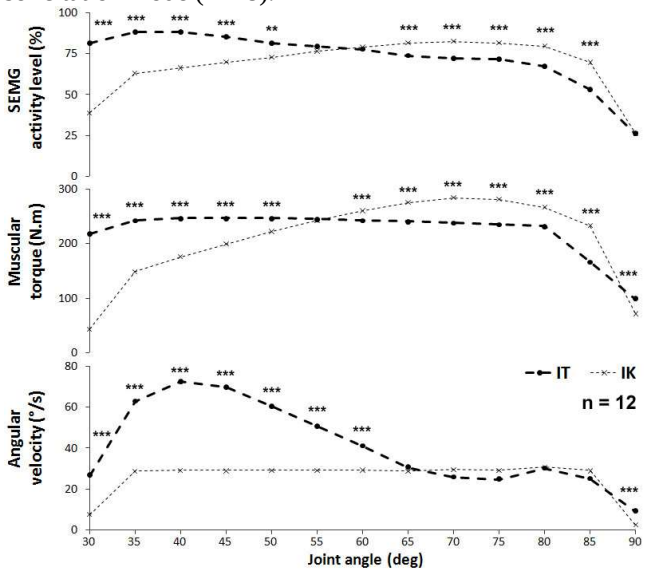

Figure 1: Means of SEMG agonist activity level (%RMS in maximal isometric contraction), muscular torque and angular velocity during isotonic (IT) and isokinetic (IK) knee eccentric flexions as a function of joint angle. *p<0.05; **p<0.01; ***p<0.001

Differences observed in agonist activity match the mechanical constraint differences (muscular torque, angular velocity) observed between IT and IK modes. Indeed, the angular velocity and the torque exerted in IT mode from 30 to 55° knee angle are higher than in IK, and lower from 65 to 85°. A previous study on the concentric regimen showed that agonist activity was higher in IT mode only at 85, 75 and 45° [1]. Thus, the higher agonist activity in IK mode from 65 to 85° is specific to eccentric contraction.

CONCLUSION

This study showed that quadriceps SEMG activity is higher in stretched angles in the IT mode and in flexed angles in the IK mode, during eccentric contractions. This work is the first step in determining the specific effects of IT and IK modes on neuromuscular system. Indeed, we are presently testing chronic adaptations induced by IT and IK eccentric training programs. The differences of the physiological constraints observed in this study suggest specific neural adaptations at flexed and stretched joint angle according to the mode of eccentric training used.

REFERENCES

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