Fatigue is different among quadriceps muscles after submaximal isometric contractions

Desbrosses Kévin1,2, Babault Nicolas3, Meyer Jean-Pierre2, Pousson Michel1
1 INSERM ERIT-M 0207, UFR STAPS Dijon, France
2 Laboratoire de Physiologie du Travail, INRS Nancy, France
3 Performance motrice et santé, UFR STAPS Strasbourg, France

Introduction
Differences in activation among quadriceps muscles have been shown during submaximal fatiguing exercises (Rochette et coll., 2003). Nevertheless, few investigations have addressed fatigue effects on the different knee extensor muscles after a submaximal isometric contraction maintained until exhaustion. Thus, the present study was designed to firstly investigate whether neuromuscular fatigue differs among the three superficial knee extensor muscles and secondly to examine its knee-joint angle dependency.

Methods
Fourteen subjects performed two isometric fatiguing sessions of the quadriceps muscles. Each session was conducted at a given knee-joint angle (40° and 100°, 0° = full extension of the knee joint) randomly presented. The fatiguing exercise consisted in a submaximal effort [40% of the maximal voluntary contraction (MVC)] maintained until exhaustion. Before and after each fatiguing contraction, we assessed MVC, activation level (AL, estimated by means of the twitch interpolation technique), peak doublet torque (Pt) and electromyographic activity [quantified by the Root Mean Square Value (RMS)] of vastus lateralis (VL), vastus medialis (VM) and rectus femoris (RF) muscles.

Results
Time to exhaustion was more than twice longer (p<0.05) at 40° (219.1 ± 15.6 s; mean ± SE) as compared to 100° (102.9 ± 9.4 s) whereas the decline of MVC (19.84 ± 1.84 %) and AL (3.51 ± 0.74 %) was similar (p<0.05) at the two knee-joint angles. Pt decrease was greater (p<0.05) at 100° (24.99 ± 2.24 %) than at 40° (10.64 ± 4.26 %). Changes in RMS.M-1 (i.e., RMS value normalised with M-wave peak-to-peak amplitude) were different among muscles: a decline (p<0.05) was just recorded at 40° for VL and VM muscles, and only at 100° for RF muscle (Fig.1).

Discussion/Conclusion
Our results demonstrated a fatigue dependency on knee-joint angle that was differently expressed among the three superficial knee extensor muscles. Indeed, a central failure (i.e., RMS.M-1 decline) was recorded at 40° for mono-articular muscles (VL and VM) and at 100° for the bi-articular RF muscle. Thus, in spite of a similar function (i.e., the knee extension), the synergist quadriceps muscles demonstrate dissimilar fatigue patterns which could be due to different muscle recruitment in relation to the knee-joint angle and consequently to the intrinsic mechanical properties of each muscle.

References