Muscle Activation Capacity: Effects of Method, Stimuli Number and Joint Angle

Bampouras T, Reeves ND, Baltzopoulos V and Maganaris CN.
Institute for Biophysical & Clinical Research into Human Movement, Manchester Metropolitan University, Alsager, United Kingdom.

To assess the sensitivity of existing measurement methods for muscle activation capacity to potential errors introduced by a) evoking inadequate force by stimulation and b) neglecting differences in series elasticity between conditions, the effect of different number of stimuli and joint angle on the interpolation twitch interpolation technique [ITT = (1- superimposed stimulus torque / resting stimulus torque) x 100] and central activation ratio (CAR = maximal voluntary contraction torque / maximal voluntary contraction torque + superimposed stimulus torque) was examined. Ten subjects performed knee extension maximal voluntary contractions at 30 and 90^{o} knee flexion angles (0^{o} is full knee extension). Singlets, doublets, quadruplets and octuplets of supramaximal intensity were applied via percutaneous quadriceps muscle stimulation at rest and during the plateau phase of the contraction. A mixed-design 2 x 2 x 4 repeated factorial ANOVA was used to examine for differences in activation capacity between methods, knee joint angles and stimuli number, and simple effects tests were used for post hoc analysis where appropriate. Joint angle had a significant effect ($P < 0.05$) on the ITT method, while stimuli number had a significant effect ($P < 0.05$) on the CAR method. At 30^{o}, the CAR produced higher activation capacity values for the singlet, doublet and quadruplet by 14-16% compared to the ITT method ($P < 0.05$), but no difference was found for any number of stimuli at 90^{o} between the two methods ($P > 0.05$). It is, therefore, suggested that in the quantification of voluntary drive during contraction with the ITT and CAR methods, consideration be given not only to the number of stimuli applied but also to the effect of series elasticity due to joint angle differences, since these factors may affect differently the outcome of the calculation, depending on the approach followed.