THE EFFECT OF PENNATION ANGLE CHANGES DURING CONTRACTION ON THE ESTIMATED TRICEPS SURAE MOMENT

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INTRODUCTION: Forward dynamics simulations are important tools in biomechanics research but the accuracy of the muscle model parameters (such as pennation angle, optimal fibre length, force-velocity relationship etc.) is critical for realistic force and joint moment estimations. The pennation angle in particular determines the efficiency of force transmission to the tendon. The purpose of this study was to investigate changes in the modelled triceps surae complex and its predicted maximum moment using a computer based musculoskeletal model when incorporating *in vivo* measured pennation angle values.

METHODS: The Software for Interactive Musculoskeletal Modelling (SIMM) (Delp et al., 1990) was used to obtain the triceps surae maximum isometric moment at ankle angles of -15^{o} (dorsiflexion), 0^{o} (neutral ankle position), $+15^{o}$ and $+30^{o}$ (plantarflexion). Moments were estimated using pennation angle values a) based on literature pennation angle data used normally in the SIMM model and b) from *in vivo* pennation angle measurements. Pennation angle measurements were taken using ultrasonography (Esaote Biomedica, Italy) from gastrocnemius medialis, gastrocnemius lateralis and soleus in six males during maximum isometric plantarflexions using an electromechanical dynamometer (Lido Active, Loredan Biomedical, USA) at ankle angles of -15^{o}, 0^{o}, $+15^{o}$ and $+30^{o}$.

RESULTS: The estimated triceps surae moment using cadaveric pennation angle data were approximately 122 Nm, 85 Nm, 17 Nm and 0 Nm at ankle angles of -15^{o}, 0^{o}, $+15^{o}$ and $+30^{o}$ respectively. The corresponding estimated moments taken incorporating the experimentally observed pennation angles in the model were approximately 106 Nm, 72, Nm, 17 Nm and 0 Nm. Substantially overestimated moment values at ankle angles of -15^{o} (15%) and 0^{o} (18%) were obtained when using cadaveric pennation angle data from the literature compared with the model moment predictions taken incorporating *in vivo* pennation angle data.

CONCLUSIONS: The findings of this study suggest that a realistic model estimation of the moment generating capacity around a joint requires the incorporation of changes in the muscle pennation angle occurring during contraction.

REFERENCES:

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