*Estimation of muscle forces using hand musculoskeletal model*

The muscle forces generated by FCR and FDS during each trial were based on a previously developed musculoskeletal model of the five fingers and wrist involving 23 degrees of freedom (DoF) actioned by 42 muscles (Goislard et al., 2012). Briefly, the model is based on an inverse dynamics approach and finds the muscle forces that balance the net joint moment about all DoFs while minimizing a muscle stress criterion (Crowninshield and Brand, 1981). The capacity of each muscle to generate a moment is represented by its moment arm and line of action about each DoF, determined using anthropometry and joint angles (An et al., 1983; Lemay & Crago, 1996), as well as its PCSA (Chao et al., 1989; Ramsay, 2009). The model was run at each time step to balance the net moment, τ, measured by the ergometer in the current joint position, ϴw or ϴmcp.

For FCR, the full model was used and all 42 muscle forces were estimated, though only the value obtained for FCR was used in further analyses. All finger joint angles were assumed zero, in accordance with the straight-hand posture adopted by the subject. The net moment about these joints were also assumed zero as the fingers were left free, i.e. not in contact with the ergometer.

For FDS, since the net moments about the wrist and the interphalangeal joints of the finger were not known, a simplified version of the model was used. The four MCP joints were modeled as one DoF, which withstood a total net moment corresponding to that measured by the ergometer and balanced by all 27 muscles crossing these four joints. From the 27 muscle forces estimated by this model, only that from FDS was used in further analyses.

*References*

An KN, Ueba Y, Chao EY, Cooney WP, Linscheid R.L. Tendon excursion and moment arm of index finger muscles. *J Biomech.* 1983;16:419–425.

Chao EY, An KN, Cooney WP III, Linscheid RL. *Biomechanics of the Hand: A Basic Research Study*. Singapore, SG: World Scientific; 1989. p. 53-72.

Crowninshield RD, Brand RA. A physiologically based criterion of muscle force prediction in locomotion. *J Biomech*. 1981;14(11):793-801.

Goislard de Monsabert B, Rossi J, Berton E, Vigouroux L. Quantification of hand and forearm muscle forces during a maximal power grip task. *Med Sci Sports Exerc*. 2012;44(10):1906-16.

Lemay MA, Crago PE. A dynamic model for simulating movements of the elbow, forearm, an wrist. *J Biomech*. 1996;29(10):1319-30.

Ramsay JW, Hunter BV, Gonzalez RV. Muscle moment arm and normalized moment contributions as reference data for musculoskeletal elbow and wrist joint models. *J Biomech*. 2009;42:463–473.