# A MEASUREMENT DEVICE AND METHOD FOR DETERMINING NEUROMUSCULAR PROPERTIES OF THE ELBOW EXTENSORS

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**INTRODUCTION:** The knowledge of individual muscle properties is important in various fields in sports science, e.g. for planning and evaluating a training program or as input parameters for simulations. So far, most methods to obtain such individual muscle properties are either invasive, expensive or they only lead to movement specific results. A method for non-invasively determining movement independent muscle properties of the knee extensor was recently described in detail by Siebert, Sust, Thaller, Tilp & Wagner (2007). We present an analogous method for determining neuromuscular properties of the elbow extensors.

**METHOD:** 7 male and 5 female subjects (26.2 ± 5.4 yrs, 1.76 ± 0.10 m, 71.8 ± 8.5 kg) performed 4 dynamic and 2 isometric movements on an purpose-built inclined arm press moving a sledge. The force as well as the position and velocity of the sledge were measured as a function of time. To describe the movements mathematically we have used a Hill-type muscle model including the activation and the geometry of the elbow joint. Using a modified Levenberg-Marquardt algorithm (Siebert et al., 2007) we identified the model parameters that were not measured directly, amongst others Hill's parameters $a$, $b$, $c$ leading to the isometric force $f_{iso}$, the maximum contraction velocity $v_{max}$ and the maximum power $p_{max}$ of the elbow extensor model muscle, and a parameter $A$ describing the activation (see e.g., Siebert et al., 2007; Thaller & Wagner, 2004). To find a feasible method of measuring the model input parameters for the elbow joint, we evaluated data of 100 anatomical specimens of the elbow joint (Windisch, Tesch, Grechenig & Peicha, 2006).

**RESULTS:** For the elbow model muscles we identified the following values: $f_{iso}$ = 9381 ± 3872 N, $p_{max}$ = 267 ± 113 W, $v_{max}$ = 0.36 ± 0.07 m/s, and $A$ = 10.2 ± 3.6 $s^{-1}$. Evaluation of the anatomical preparations showed a correlation of the distance between the olecranon and the distal insertion of the m. anconeus and the width of the triceps tendon at the olecranon.

**DISCUSSION AND CONCLUSION:** The results confirm that individual differences in the muscle properties are very large (cf. e.g., Siebert et al., 2007; Thaller & Wagner, 2004). For most applications it is therefore necessary to compute individual parameters. In contrast to the method for determining the knee extensor properties the influence of adjacent joints and muscles on the performed elbow extension movements is larger. This is due to anatomical differences and to the different position of the body in the measuring device. Therefore, these effects have to be included in the model. Our investigation of the anatomical specimens of the elbow joint lead to a feasible method to obtain values for the anthropometric input parameters for the model equations.

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