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T01: EMG modeling

ESTIMATION OF MUSCLE FIBER CONDUCTION VELOCITY IN PINNATE MUSCLES: A SIMULATION STUDY

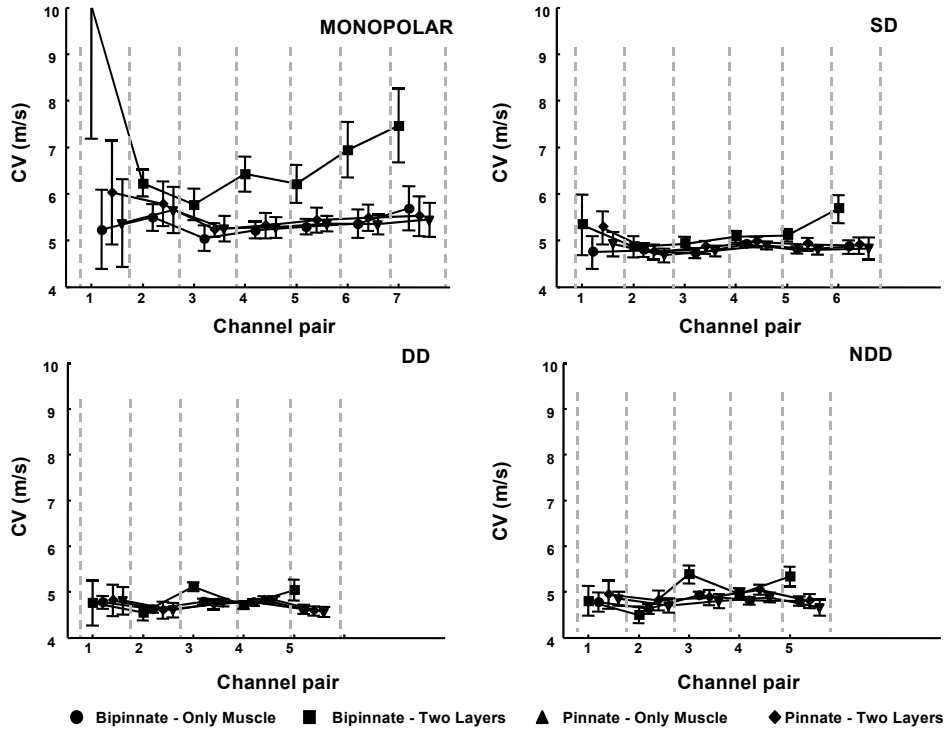
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AIMS: The aim of this simulation study was to assess the feasibility of estimating muscle fibre conduction velocity (CV) from surface electromyographic (EMG) signals in muscles with one and two pinnation angles.

METHODS: The volume conductor consisted of a layered medium simulating anisotropic muscle tissue and isotropic homogeneous subcutaneous tissue. The muscle tissue was homogeneous in case of one pinnation angle and inhomogeneous for bipinnate muscles (two fibre directions). Interference EMG signals were obtained by simulating recruitment thresholds and discharge patters of a set of 100 or 200 motor units for the pinnate and bipinnate muscle, respectively. CV was estimated from two surface EMG channels in case of monopolar, single differential, double differential, and Laplacian recordings.. The simulated CV value was in all cases 4 m/s.

RESULTS: Estimates of CV from the pinnate and bipinnate muscle are shown in the Figure. The bias in CV was on average larger than 0.8 m/s in all cases.



ESTIMATED CV FOR THE FOUR MODELS CONSIDERED (PINNATE AND BIPINNATE, WITH AND WITHOUT SUBCUTANEOUS LAYER) FOR MONOPOLAR (A), SINGLE DIFFERENTIAL (B), DOUBLE DIFFERENTIAL (C), AND LAPLACIAN (D) RECORDINGS.

CONCLUSIONS: The main factors affecting CV estimates were the end-plate and end-of-fibre components due to the scatter of the projection of end-plate and tendon locations along the fibre direction, as a consequence of pinnation. The same problem

arises for muscles with the line of innervation zone locations not perpendicular to fibre direction. These results provide an interpretation of the positive bias in CV estimates from surface EMG signals, usually observed in experimental conditions.