Use of the matched wavelet transform to assess motor unit recruitment properties of epimysial electrodes

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Introduction

Motor unit (MU) recruitment properties of implanted epimysial electrodes were investigated by measuring the time scale variation in the evoked M-wave. Compression or expansion in the M-wave's time scale is reported to be indicative of the recruitment of larger or smaller MUs respectively. This study analysed time-scale variation of M-waves derived from experimental trials and a mathematical model using a matched wavelet transform (MWT).

Method/Design

During experimental trials, the surface M-waves were detected from four paralysed hand muscles of two men with tetraplegia injured in the C5 spinal cord region. During each trial, a linearly increasing stimulation ramp (0 - 200 μs over 10 s) was applied using implanted epimysial electrodes. A model was used to simulate the expected results for different types of fibre recruitment. The results from the experiments and the model underwent analysis using the wavelet transform and were compared.

Results/Discussion

M-wave time scale underwent progressive compression in three of the paralysed muscles. Alternatively, in one paralysed muscle, the M-wave time scale progressively expanded during higher stimulus levels (100 - 200 μs). The mathematical model simulated the evolution of the surface M-wave during three types of MU recruitment: ordered, reverse and random. Simulated M-waves resultant from orderly recruitment of MUs (small to large) underwent progressive time scale compression. Such time scale compression was similar to that demonstrated in the three paralysed muscles, indicated above, during higher stimulation intensities. In addition, simulated M-waves produced by reverse MU recruitment reflected progressive expansion in time scale similar to that found in the other the paralysed muscles. Such correlations in time scale behaviour support the proposal that MUs in three of the paralysed muscles studied were recruited in an ordered manner from smallest to largest. Also, the behaviour of M-wave time scale during simulated reverse recruitment of MUs supports the suggestion that one muscle's MUs were recruited in a reversed order from largest to smallest. It is possible that electrode placement relative to the muscle motor point may influence the type of recruitment achieved.

References:

Heasman JM, Scott TRD, Flynn RY, Vare VA, Gschwind CR (2001) Relationship of M-wave Time Scale Variation With Motor Unit Recruitment Evaluated Using the Matched Wavelet Transform. Proceedings of the 6th Annual International FES Society Conference, Cleveland, p211.