RELIABILITY OF MUAP PROPERTIES IN MULTI-CHANNEL ARRAY EMG RECORDINGS OF TRAPEZIUS AND SCM

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Abstract

Test-retest reliability was assessed for parameters describing motor unit action potential shapes, obtained from multi-channel surface EMG signals.

1 Introduction

Muscle activity can be assessed non-invasively by means of surface electrodes placed at the skin overlying a muscle. When multi-channel array electrodes are used, it is possible to extract motor unit action potentials (MUAPs) from the EMG signals with a segmentation approach based on the Continuous Wavelet Transform [1]. MUAPs can a.o. be characterized by parameters describing their amplitude (RMS_{MUAP}) and their frequency content ($FMED_{MUAP}$, median frequency of the power spectrum of the MUAP shape). RMS_{MUAP} is related to the size of the motor unit (MU), the frequency content is a.o. related to the conduction velocity of the MU [2]. Furthermore, the number of MUAPs per second (MUAP Rate) provides a measure for the input of the central nervous system to the muscle [3]. The objective of the present study was to determine the test-retest reliability of the mentioned parameters during different tasks of the shoulder and neck muscles.

2 Methods

8-channel linear arrays [4] were placed on the upper trapezius (UT) and sternocleidomastoid (SCM) muscles of 12 healthy subjects. Placement was done in accordance with the SENIAM guidelines. Subjects performed 3 tasks: shoulder abduction (90 degrees), ironing (subjects had to touch two ends of an horizontally placed bar in front of them repetitively), and 90 degrees head turning towards the non-dominant side. The protocol was performed twice while electrodes remained in place (trials 1 and 2) and repeated at a second day (trial 3).

RMS and median frequency of the power spectrum (FMED) of the EMG signal were calculated. MUAPs were extracted using the segmentation part of the decomposition software described in [1] and MUAP Rate was calculated. RMS and median frequency of the power spectrum of the extracted MUAP shapes were averaged acros all MUAPs (RMS_{MUAP} and $FMED_{MUAP}$). Intra-class correlation coefficients (ICC) were calculated to assess repeatability (trial 1 x 2) and test-retest reliability (trial 1 x trial 3).

3 Results

In 3 subjects, the UT muscle was not active during the ironing task and in 3 subjects, SCM data quality was insufficient. Table 1 shows the ICCs.

Table 1 ICCs. Upper: trial 1 x 2, lower: trial 1 x3

	Shoulder abduction	Ironing	Head turning
RMS	0.97 0.85	0.91 0.86	0.96 0.84
FMED	0.98 0.92	0.95 0.93	0.91 0.76
MUAP Rate	0.92 *	0.64 0.84	0.93 0.60
RMSMUAP	0.94 0.78	0.78 0.91	0.95 0.83
FMEDMUAP	0.97 0.87	0.93 0.79	0.95 0.76

*Statistical model resulted in estimation of negative variances. ICC could not be calculated.

4 Discussion

All parameters except MUAP Rate showed good reliability. ICC estimation for MUAP Rate was not valid for the shoulder abduction tasks. Probably MUAP Rate is not a reliable measure for this task due to the relatively high contraction level resulting in superimposed MUAPs, which leads to detection errors. Even though MUAP Rate could not in all cases be reliably estimated, the MUAP shape parameters showed a good to excellent reliability that is comparable to that of the global variables.

References

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