sEMG normalization - a reliability study on females with and without trapezius myalgia

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1. Introduction

Work related musculoskeletal disorders (WMSDs) are one of main health problems among industrialized countries [1]. Surface electromyography (sEMG) is the only non-invasive method that provides direct information about muscle activation during work related activities, especially on neck/shoulder region [2]. Since sEMG amplitude is sensible to many factors, the signal needs to be normalized [3,4].

However, to our knowledge, no previous study has evaluated the reliability of normalization methods for the trapezius muscle, considering the variability of this measure on women with and without painful conditions on the neck/shoulder region.

Therefore, the aim of this study was to evaluate the within-day and between-day reliability of sEMG normalization methods involving maximal and submaximal isometric contractions of the trapezius muscle in women with and without trapezius myalgia.

2. Methods

Twenty women were divided into two groups – healthy and chronic trapezius myalgia. sEMG was recorded in two days, with a 7-days interval. The three portions of dominant trapezius muscle - descending (DT), transverse (TT) and ascending (AT) - were evaluated during maximal and submaximal isometric contractions.

2.1 Data acquisition and analysis

Active single differential electrodes were placed 2 cm lateral to the midpoint between C7 and acromion for DT [2]; 20% medial to midpoint between the medial border of the scapula and T3 for TT; 33% medial to midpoint between the medial scapular and T8 for AT [5]. The signals were acquired at 1000 Hz, with gain of 2000.

The maximal voluntary isometric contractions (MVC) were composed by 3 5-sec contractions, with manual resistance and verbal encouragement. For submaximal contractions, also known as reference voluntary isometric contractions (RVC), limb weight and a dumbbell of 1 kg provided resistance, and 3 5-sec trials were performed. The order of contractions and muscle portions was randomized.

All signals were processed using MatLab. They were corrected for offset; band-pass filtered at 30-450 Hz (zero-lag 8th order Butterworth); RMS converted using a 200-ms moving window, 50% overlapped. The mean RMS amplitude obtained during rest was removed from the signals (noise level) in a power basis. The RMS peak value was obtained from the 3 MVC for each muscle portion, and the mean RMS value was obtained from the 3 RVC.

2.2 Statistical analysis

The within and between-day reliability analysis was based on ICC, relative coefficient of variation (\%CV=SD/mean x 100) [6], and relative standard error of measurement (\%SEM= SEM/mean x 100) [7]. The between-day agreement was also analyzed using the Bland-Altman analysis that evaluates the difference between means (DM) and the limits of agreement (LOA) of 95%. These data were also expressed in percentage [8]. All tests were run in SPSS software and Microsoft Excel, with significance level of 0.05 (5%).

3. Results

The within-day reliability for both groups is presented in Table 1. All contractions showed very good within-day reliability (ICC > 0.81) [9]. The healthy group showed a good reliability for maximal and submaximal contractions, but the last one presented smaller values of \%CV, showing more consistent data for RVC. The same pattern was found for the trapezius myalgia group. Even though the trapezius myalgia group showed...
high ICC for both contractions on the AT, there was a small tendency of more reliable values for the maximal MVC (slightly smaller values of %CV and %SEM).

The results for between-days reliability are shown in Table 2. For the healthy group, both TT and DT had higher reliability for submaximal than for maximal contractions (good ICC rates for TT, and very good for DT). On the other hand, the AT in this group had higher reliability between-days with maximal contractions. In the trapezius myalgia group, the trend of more reliable values for submaximal contractions was maintained. For all muscle portions, submaximal contractions showed higher ICC values, smaller %SEM values as well as LOAs ranges, indicating better agreement between measurements in day 1 and day 2 when compared to maximal contractions.

4. Discussion

In general, the results showed that submaximal contractions are more reliable than maximal contractions within and between-days, for subjects with or without trapezius myalgia. These findings are consistent with previous studies assessing others muscles, and may be related to the difficulty to control and monitor the effort performed by the subjects during maximal efforts. Moreover, women with trapezius myalgia are unable to perform their maximal exertions due to pain.

Similar results were found for the trunk muscles regarding the between-days reliability considering ICC scores and %SEM, considering subjects with and without pain [10]. Another study also showed a reduction in the undesirable variability of submaximal contraction when compared to maximal ones, through the analysis of CV [11]. Therefore, the use of submaximal isometric contractions for sEMG normalization of the trapezius muscle in subjects with and without trapezius myalgia can be recommended. Further studies should investigate the effect of this normalization when applied to compare sEMG of different occupational tasks.

Table 1. Within-day reliability for healthy and Chronic Trapezius Myalgia Group

<table>
<thead>
<tr>
<th></th>
<th>Healthy Group</th>
<th>Trapezius Myalgia Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ICC</td>
<td>%CV</td>
</tr>
<tr>
<td>MVC DT</td>
<td>0.96</td>
<td>9.34</td>
</tr>
<tr>
<td>RVC DT</td>
<td>0.97</td>
<td>8.66</td>
</tr>
<tr>
<td>MVC TT</td>
<td>0.86</td>
<td>20.06</td>
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<tr>
<td>RVC TT</td>
<td>0.88</td>
<td>13.18</td>
</tr>
<tr>
<td>MVC AT</td>
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</tr>
<tr>
<td>RVC AT</td>
<td>0.88</td>
<td>11.38</td>
</tr>
</tbody>
</table>

MVC = maximal voluntary contractions, RVC = reference (submaximal) voluntary contractions, DT = descending trapezius, TT = transverse trapezius, AT = ascending trapezius

Table 2. Between-day reliability for healthy and Chronic Trapezius Myalgia Group
MVC = maximal voluntary contractions, RVC = reference (submaximal) voluntary contractions, DT = descending trapezius, TT = transverse trapezius, AT = ascending trapezius, L = lower boundaries, U = upper boundaries

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References


