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TRAPEZIUS CLAVICULAR PORTION - EMG ACTIVATION DURING MAXIMAL ISOMETRIC CONTRACTIONS

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INTRODUCTION

Trapezius muscle has been widely studied considering its important role in scapular stabilization [1,2]. Typically, it is divided in three portions: upper, middle and lower. The electromyography (EMG) of the upper portion is usually recorded with electrodes positioned in the line between C7 and the acromion [3,4]. However, it is known that the uppermost region of trapezius is inserted on the distal clavicle and produces clavicular elevation and retraction [1]. The evaluation of the clavicular portion should be considered, since alterations in its activity can be related with changes in clavicular kinematics and, consequently, in scapular movements [2]. Considering the importance of an adequate normalization procedure for EMG analysis [5], the purpose of this study was to determine which positions elicit higher EMG activation in two electrode sites described in the literature for trapezius clavicular portion evaluation during maximal isometric voluntary contractions (MVIC).

METHODS

Seventeen healthy subjects (8 males and 9 females), with a mean age of 24 years (from 20 to 28 years) and free of shoulder pain were evaluated. This study was approved by the Ethics Committee of the University.

Surface EMG signal was collected with a 8-channel Bagnoli EMG System (DelSys, Boston, USA), using active, double-differential electrodes, at a sampling frequency of 2000 Hz. Electrodes were positioned in two sites (Figure 1A), based on previous descriptions found in the literature: (1) between the occiput and C7, at the level of C3 [6]; and (2) 20% lateral to the midpoint between the origin and insertion of the muscle fibers [7]. Considering that the origin of these fibers extends from the superior nuchal line to C6 spinous process [1], the reference points for the electrode positioning were standardized from the level of C3 to the most lateral point of the clavicle. The electrode positioning was confirmed by palpation during a resisted shoulder elevation.

The MVIC were performed in five positions (Figure 1B-F) previously described in the literature [3, 4, 7]. For all positions, participants performed three MVIC against manual resistance of the examiner while received standardized verbal encouragement, during 5-s each, with 1-min of rest between them, in randomized order.

The EMG signal was processed using the MatLab software version 7.0.1(MathWorks Inc., Natick, USA). Data were filtered with a bandwidth from 30 to 450 Hz and the root-mean-square (RMS) was calculated using a 20-ms moving window with 50% overlap. The highest EMG amplitude (peak RMS) was determined for each trial, excluding the first and the last seconds, and used for the statistical analyses performed with SPSS for Windows 17.0 software (SPSS Inc, Chicago, IL, USA). The intraclass correlation coefficient (ICC 3,1) was used to determine the trial-to-trial reliability for each evaluated position. Repeated-measures ANOVA were conducted, with a *post-hoc* Tukey test, to compare the highest EMG amplitude among the MVIC positions, for each electrode site, considering an alpha level of 5%.

RESULTS AND DISCUSSION

For the electrode site 1, both positions with head rotation and lateral flexion, combined either with shoulder abduction or elevation, elicited higher EMG amplitude than the others, with no difference between them, although 70% of the participants had the highest EMG amplitude at the first one (Table 1). Both positions also presented high test-retest reliability. For the electrode site 2, the highest EMG amplitude was elicited at shoulder abduction combined with head rotation and lateral flexion (Table 1). More than 50% of the participants presented the maximal EMG amplitude in this position, which presented a high test-retest reliability (Table 1).

The highest EMG amplitude observed during the positions with head rotation and lateral flexion occurs considering that this is the action of the upper trapezius unilateral contraction when the upper extremity is fixed. While the electrode site 1 presented the highest EMG amplitude at both positions with head rotation and lateral flexion, independent of the arm position, the electrode site 2 showed the highest activation when shoulder was abducted. These differences can be attributed to different fascicles from which the electrodes may have captured the signal. Considering its location, it seems that the electrode 1 captured mainly the signal from the fascicles originated from the superior nuchal line to C3. These fascicles present a small volume and cross-sectional area [1] and, therefore, may have a minor influence on clavicular movements. The electrode site 2 can have captured the signal from all fascicles from the uppermost

trapezius, including the largest fascicles originated from C3 to C6, that can contribute in a greater proportion to clavicle elevation and retraction [1]. During shoulder elevation, the predominant clavicular movement seems to be the elevation. However, when the shoulder is abducted to 90º, besides elevating the clavicle also retracts [8], which could explain a higher EMG amplitude at shoulder abduction than shoulder elevation. As both clavicular retraction and elevation are produced directly and indirectly, respectively, by the trapezius clavicular portion [1], this could explain the higher EMG amplitude recorded at this position compared with all the others.

CONCLUSIONS

It can be concluded that the position at 90º of shoulder abduction, with the head at ipsilateral lateral flexion and contralateral rotation, is the best to perform MVIC contractions to normalize the EMG signal of trapezius clavicular portion, for both electrode sites.

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REFERENCES

1. Johnson G, et al. *Clinical Biomechanics*. **9**:44-50, 1994.
2. Ludewig PM, et al. *Manual Therapy*. **16**:33-39, 2011.
3. McLean L, et al. *Journal of Electromyography and Kinesiology*. **13**:169–80, 2003.
4. Ekstrom RA, et al. *Journal of Electromyography and Kinesiology*. **15**:418-428, 2005.
5. De Luca CJ. *Journal of Applied Biomechanics*. **13**:135-163, 1997.
6. Johnson GR, et al. *Clinical Biomechanics*. **20**:155-161, 2005.
7. Holtermann A, et al. *Journal of Electromyography and Kinesiology*. **19**:896-902, 2009.
8. Ludewig PM, et al. *The Journal of Bone and Joint Surgery*. **91**:378-389, 2009.

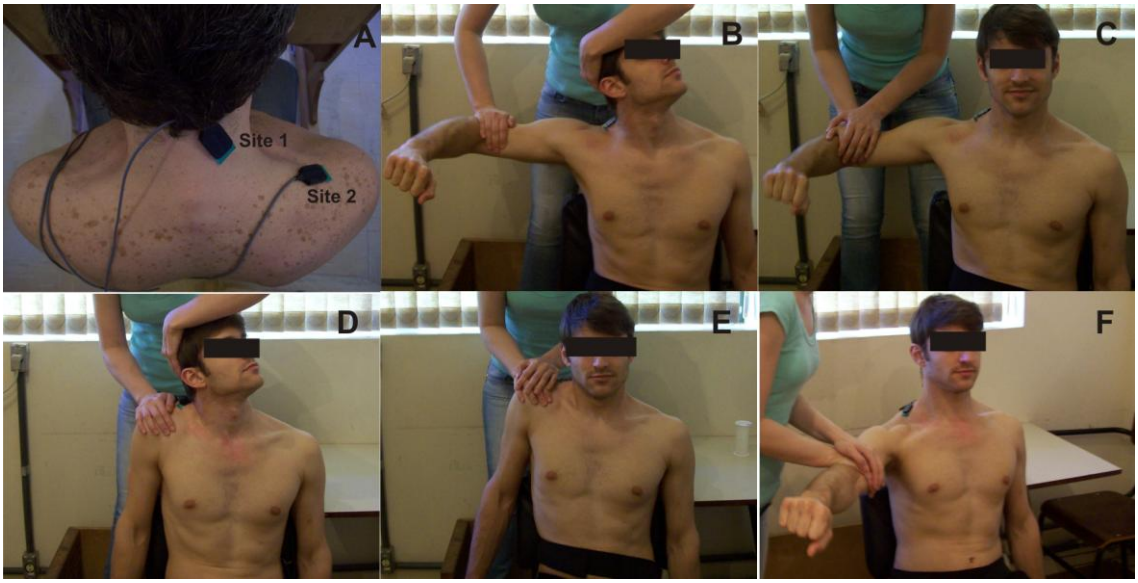

Figure 1: Electrode sites (A), and the positions tested for maximal isometric contractions: shoulder abduction with head rotation and lateral flexion (B); shoulder abduction (C); shoulder elevation with head rotation and lateral flexion (D); shoulder elevation (E); and scaption (F).

Table 1: Mean and standard deviation of peak RMS (in mV) during the maximal voluntary isometric contractions (MVIC), percentage of subjects that obtained the highest EMG amplitude in each MVIC position and test–retest reliability for the two electrode sites for trapezius clavicular portion evaluation.

	Shoulder abduction with head rotation and inclination	**Shoulder abduction**	**Shoulder elevation with head rotation and inclination**	**Shoulder elevation**	**Shoulder abduction in scapular plane**
Electrode site 1					
Mean peak RMS (SD)	2.27 (0.99)*	1.38 (0.84)	1.93 (0.97)*	1.30 (1.00)	1.46 (0.85)
% Subjects with maximum RMS	70.59	0	23.53	0	5.88
ICC	0.91	0.90	0.91	0.95	0.68
Electrode site 2					
Mean peak RMS (SD)	3.34 (0.65)#	2.91 (0.75)	2.80 (0.90)	2.72 (0.92)	2.88 (0.85)
% Subjects with maximum RMS	52.94	23.53	5.88	11.76	5.88
ICC	0.92	0.91	0.90	0.91	0.86

*Both positions produced greater EMG amplitude than the others, with no difference between them.
Greater EMG amplitude than the other positions.