Effect on anterior temporalis surface EMG of eyes open-closed condition

**ABSTRACT**

**Background** The use of rest surface EMG of jaw elevator muscles is still debated. The low voltage recorded in anterior temporalis muscle by electromyography (EMG) in rest position could be affected by electronic noise or by activity coming from other muscles. Our goal was to evaluate the physiological behaviour of the anterior temporalis by surface EMG at mandible rest position during open or closed eyes condition in healthy young subjects without both malocclusion and visual defect.

**Methods** Surface EMG of anterior temporalis, masseter, digastric, sternomastoid muscle and mandible kinesiographic movement were recorded in 20 young, healthy individuals during open-closed eyes condition.

**Results** No significant difference was found in surface EMG of anterior temporalis comparing eyes closed to eyes open condition.

**Conclusion** Physiology of open-closed eyes in healthy, young subjects without malocclusion and visual defect does not imply a change in surface EMG of anterior temporalis muscle.

**Keywords:** Electromyography; Anterior temporalis muscle.

**Introduction**

Surface EMG and poligraphy of the stomatognatic system are widely used to study the electrical muscle activity and to analyse the mandible movement during both functional activity (clenching, swallowing, etc.) [Farella et al., 2008; Ferrario et al., 2007] and at rest [Escorpizo and Moore, 2007; Torisu et al., 2006].

The rest condition has been studied either in order to justify the tonic activity of muscles or to deny it, ascribing to elastic forces the primary role in mandible postural position [Miles, 2007; Peck et al., 2002; Wake, 1974; Yemm and Berry, 1969].

Recent controlled studies on individuals suffering from neuropathic and myofascial pain compared to healthy people showed higher sEMG values for anterior temporalis muscle in eyes closed and at rest mandible condition [Bodere et al., 2005; Monaco et al., 2010].

With mandible position at rest myopic children showed with open eyes higher values of anterior temporalis EMG compared to closed eyes condition. Children without visual defect did not exhibit the same behaviour [Monaco et al., 2006].

The ocular correction in myopic children with functional mandibular lateral deviation induced a significant reduction of eyes open EMG in the anterior temporalis area at rest mandible position [Monaco et al., 2006].

Although the quoted works justify the rest EMG studies over the anterior temporalis area, it is possible that the EMG value could be affected by cross talk activity during open-closed eyes conditions coming from muscles other than anterior temporalis (levator palpebrae superioris, orbicularis oculi, frontalis etc.), or by mandible movement obtained through the activity of stomatognatic muscles (lateral pterigoid, masseter, digastic, anterior and posterior temporalis muscles) but not related to open-closed eyes activity. This effect, if present, could be taken into account considering the recording and the interpretation of anterior temporalis EMG at mandible rest position.

The aim of our work was to evaluate the effect of closed-open eyes condition on sEMG of anterior temporalis area at mandible rest position under continuous check of mandible position and movement in healthy, young subjects without both malocclusion and ocular defects.

**Methods**

This study screened 2134 students of l’Aquila University, Italy.

Subjects were selected according to the following inclusion criteria.

1) Absence of neuromuscular pathology, and no history of neuromuscular pathology.
2) Absence of cephalalgia and migraine.
3) Absence of neuropathic or myofascial pain.
4) Presence of full dentition, absence of problem regarding the third molar.
5) Dental class I relationship (according to Angle’s classification).
6) Observable deviation of anterior tooth midlines < 0.5 mm with alignment at mouth open.
7) Absence of skeletal asymmetry.
8) Absence of any anterior or posterior/lateral cross-bite.
9) No history of orthodontic treatment.
10) No signs or symptoms of TMD (according to the RDC questionnaire) [Dworkin and LeResche, 1992].
11) Absence of visual or motor extrinsic defects.

For the study 20 individuals (12 females, 8 males), mean age 21.5 (SD 1.23), were selected from the 2134 initial candidates, and regarded as “normal” for the aim of the present work.

The study was approved by the Ethics Committee of the School of Dentistry, University of L’Aquila, Italy

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University of L’Aquila and a signed informed consent was obtained from all subjects.

Recording procedure
The subject was in an upright seated position on a wooden comfortable chair.
The head was positioned with the Frankfort plane parallel to the floor.
The recording room was silent and lightly illuminated.

EMG recording
The activity of 4 pair of muscles were recorded: right and left anterior temporalis, right and left masseter, right and left digastic, right and left sternomastoid.
Pre-gelled bipolar surface electrodes (diameter 10 mm, inter-electrode spacing 21 mm, impedance 10 hz max 50 ohms single differential was used (Duo-Trode, Myotronics, Inc. Wa 98032, USA). To avoid cross talk interference and the effect of innervation point the position of the electrodes over masseter and anterior temporalis area was chosen according to Castroflorio et al. [2005]. The sternomastoid electrode was positioned over the lower portion of the muscle according to Falla et al. [2002]. The anterior digastic electrode was positioned 1 cm posterior and lateral to the mandible symphysis. A ground electrode was placed on the middle portion of the clavicle. Neither electrode nor electrode position were changed during the kinesiographic recording. The acquisition data session lasted 15 minutes or less. The raw EMG signal (K7i polygraph, Myotronics, Inc. Wa 98032, USA) was sampled at 880 hz, filtered (band pass 20-440 hz, notch filter) and amplified, with A/D conversion of 12 bit. The mean EMG amplitude of each 15 second epoch was automatically calculated as Root Mean Squared. The results are given in microvolt.

Open-closed eyes test
A researcher instructed the subjects to open and close the eyes without any effort. Three 15 seconds EMG with closed eyes and three 15 seconds EMG with open eyes, without muscle artefacts, were collected with the mandible at rest position for each subject. The vision field was free, there were only white walls in the room. The sequence open-closed or closed-open eyes was randomly assigned before the test. Kinesiographic traces of mandible position were recorded at the same time during EMG recording. It was considered reliable and accepted for the analysis an EMG recording without mandible movement from rest position during all the time of the kinesiographic recording. One second before the end of kinesiographic recording, and 4 sec. after the end of EMG recording the examined subject was asked to close the teeth in habitual occlusion. The shift of the vertical track allowed to evaluate the freeway space between rest position and occlusion, excluding the cases where the at rest mandible position was obtained in occlusal contact, because it caused higher masseter and anterior temporalis EMG values. ARABO. In this case the recording was not accepted.

Statistics
Statistics were performed in blind condition. The EMG recording session and the statistical analysis were carried out by different individuals. No information about THE condition (open-closed eyes), reason and aim of the study were given to the statistician. For the open-closed eyes test the mean of the three 15 second epochs were compared to the mean of the tree relative other condition (closed Vs open eyes).
After testing the normality (Shapiro-Wilk normality test, W=0.979) of the EMG values distribution, a paired mean comparison test (two dependent samples mean comparison test-paired Student t-test) was performed using STATA package. The significant level was set at 0.05.

Results
Results are reported in Table 1.

Discussion
Our work concerns the surface EMG of anterior temporalis in open and closed eyes condition at mandible rest position. Clancy et al. [2002] stated that the electronic instrumentation used to amplify and filter the EMG signal prior to signal recording or acquisition is a source of broad band noise. Whitham et al. [2007; 2008] demonstrated that electrical signals in rest condition came from muscle activity. Moreover, Bodère et al. [2005] showed a significant difference in anterior temporalis sEMG values at rest mandible position in relaxed dorsal decubitus comparing healthy people with neuropathic or miofascial pain patients.
According to THE above mentioned works our data can be considered as true EMG values.
The data cannot be interpreted as noise values, even if some kind of electronic noise affected them.

<table>
<thead>
<tr>
<th></th>
<th>Closed eyes</th>
<th>Open eyes</th>
<th>t-test vs open</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTA</td>
<td>1.52 (SD 0.91)</td>
<td>1.65 (SD 1.09)</td>
<td>P=0.61</td>
</tr>
<tr>
<td>LM M</td>
<td>0.95 (SD 0.35)</td>
<td>1.15 (SD 0.80)</td>
<td>P=0.73</td>
</tr>
<tr>
<td>RMM</td>
<td>0.96 (SD 0.37)</td>
<td>1.18 (SD 0.61)</td>
<td>P=0.91</td>
</tr>
<tr>
<td>RTA</td>
<td>1.26 (SD 0.45)</td>
<td>1.51 (SD 1.06)</td>
<td>P=0.81</td>
</tr>
<tr>
<td>LSC</td>
<td>1.50 (SD 0.61)</td>
<td>1.66 (SD 0.85)</td>
<td>P=0.72</td>
</tr>
<tr>
<td>LDA</td>
<td>1.84 (SD 0.77)</td>
<td>1.79 (SD 0.86)</td>
<td>P=0.57</td>
</tr>
<tr>
<td>RDA</td>
<td>1.70 (SD 0.86)</td>
<td>1.84 (SD 1.07)</td>
<td>P=0.66</td>
</tr>
<tr>
<td>RSC</td>
<td>1.56 (SD 0.49)</td>
<td>1.84 (SD 0.95)</td>
<td>P=0.84</td>
</tr>
</tbody>
</table>

Table 1 - EMG values (microvolt) comparing the open with closed eyes condition. The EMG data collected with closed eyes and those with open eyes did not show any significant difference.

TABLE 1 - EMG values (microvolt) comparing the open with closed eyes condition.
Our data showed no significant difference of EMG over the anterior temporalis area at mandible rest position comparing eyes closed with eyes open condition in young healthy people with normocclusion and without visual defects.

Our study disagrees both with Widmalm et al. [2007], who stated that the EMG of anterior temporals area performed with open eyes in healthy people could be affected by cross talk, and with Whitham et al. [2007; 2008] who recorded lower EMG values with closed eyes compared with open eyes (no significant difference) in healthy subjects. Visual and oculomotor defects have been excluded in our sample group and it is possible that, in agreement with other authors [Kawamura, 1967; Miralles et al., 1998; Monaco et al., 2006] part of the debated effect regarding the increase of anterior temporals EMG values in open eyes condition could be due to the lack of visual and oculomotor check in the above mentioned works.

Conclusion

This study concerns the effect of open-closed eyes condition on surface EMG of the anterior temporals area, suggesting orbicularis oculi does not cause an increase of anterior temporals EMG following eyes closure without forcing. A simple check of mimic expression and anterior temporalis EMG following eyes closure without suggesting orbicularis oculi does not cause an increase of anterior temporals EMG values in open eyes condition could be due to the lack of visual and oculomotor check in the above mentioned works.

References


