Visual input effect on EMG activity of masticatory and postural muscles in healthy and in myopic children

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ABSTRACT. ***Aim*** *The purpose of this study was to evaluate the activity of Anterior Temporal, Masseter, Sternocleidomastoid and Anterior Digastric muscles in response to changes in visual input in subjects with defective vision by means surface electromyography.* ***Methods*** *A total of 20 children, aged between 7 and 13 years, were evaluated. In the study group 10 children with myopic defects were enlisted, selected among patients afferent to the paediatric dentistry clinic. Ten subjects with normal vision, the control group, were chosen through the Pair Matching procedures, so that each myopic child had a matching age case control. Both study group and control group patients maintained mandible at rest with teeth apart and were submitted to a 15-sec electromyography (EMG) recording with closed eyes followed by a 15-sec EMG recording with open eyes.* ***Results/Statistics*** *The Root Mean Square (RMS) values were elaborated to obtain means and standard deviation. Statistical analysis was undertaken using the Student's T-test for independent samples. Analysis of the results demonstrated a marked difference in tonic activity of temporal anterior muscles at open eyes between the myopic and the normal groups.* ***Conclusion*** *The findings suggest that in the evaluation of masticatory muscles tenderness, such as episodic tension type headaches, attention should be paid to vision defects.*

KEYWORDS: *Visual input, Masticatory muscles, Postural muscles, Electromyography.*

Introduction

The Stomatognatic apparatus is a component of the craniomandibular system, and it represents an entryway to external stimuli: relationship among occlusion, masticatory muscle system [Murch, 1973; Oddsson, 1989] and head posture [Barber and Sharpe, 1998; Guillame, 1991] have been recently confirmed. In this complex system adaptive modifications can be inducted either by a sensorial dysfunction or by an inadequate stimulation deriving from a discrepancy of contiguous systems information [Schmid and Mongini, 1985].

Several studies supported anatomical linkage between stomatognatic and ocular systems [Monaco et al, 2003; Monaco et al., 2004]. It has been observed that a modification of ocular proprioception modifies head and body posture [Pradham et al., 2000; Brodie, 1950; Goltz et al., 1996].

Electromyography has been widely applied to estimate oro-facial muscle function or dysfunction. Association between EMG activity of jaw and neck muscles with TMD signs/symptoms as well as malocclusion, parafunctions and posture has been investigated. Nevertheless, little importance is emphasized on either EMG parameters with visual input or their association with vision defects.

Among the various neuromuscular factors that affect EMG of the jaw elevators, extraocular muscle activity recognized by means anterior temporal muscles could be significant. Interaction between the muscles of the neck and the extraocular muscles of the myopic eye have been noted in such subjects [Valentino and Fabozzo, 1993].

The alteration of dental occlusion can induce some fluctuations in visual focusing [Sharifi Milani et al., 1998], and the visual input effect on the EMG activity of Sternocleidomastoid and Masseter muscles at rest has been proved too [Miralles et al., 1998].

As a consequence of these studies the aim was to

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determine how the activity of stomatognatic muscles was influenced by ocular defects. We expect a significant modification of EMG values by changing visual input.

Materials and methods

A total of 20 children aged between 7 and 13 years (mean age 9±8 months), was evaluated.

In the study group 10 children with myopic defects were enlisted, selected among patients afferent to the paediatric dentistry clinic.

Ten subjects with normal vision, the control group, were chosen through the Pair Matching procedures, so that each myopic child had a matching age case control.

All subjects were investigated by surface EMG. Each individual underwent two recordings of the surface EMG activity at rest (teeth apart), with eyes closed and open. During the first EMG recordings each child was asked to keep their eyes closed. During the second EMG recordings each child was asked to keep their eyes open while looking straight ahead and to keep their lips in normal soft contact. The group of myopic children performed the recordings without lenses.

Recordings were performed to previously instructed children. EMG recording time for each trial was 15 seconds.

Each individual was seated in a wooden chair with headrest in a comfortable stance. EMG activity was recorded by K7 (Myotronic Inc.; Seattle, Wash), using bipolar surface electrodes at single differential with interelectrode distance of 1 cm. The surface electrodes were placed with adhesive tape to the skin over the superficial masseter (LMM, RMM), anterior temporal (LTA, RTA), anterior digastric (RDA, LDA) and sternocleidomastoid (LSC, RSC) bilaterally and parallel to the muscle fibres. Eight channel surface electromyographic equipment was used (Myotronics). The signals obtained were amplified, recorded and computed using a clinical aimed software (K7-Myotronics Inc-Seattle); the Root Mean Square (RMS), expressed in microvolt, was used as amplitude indicator of the signal. EMG of the subjects were examined by the same operator without knowledge of the recording purpose.

A paired t-test for independent samples was performed to obtain a comparison between mean and variance values of electromyographic data. Differences of a p value <.05 were regarded as significant. To facilitate data introduction in the statistic software program, all the absolute values expressed in microvolts (RMS) were multiplied by 10.

Results

Comparison according to the age of the individuals showed no significant differences between the groups (p<0.4).

Tables 1 and 2 illustrate the mean values, in microvolts, and standard deviation (parenthesis) of EMG activity at rest with closed and open eyes for the anterior temporal, masseter, sternocleidomastoid and anterior digastric muscles of the children with normal vision (control group).

Tables 3 and 4 show the mean values and standard deviation of EMG activity at rest with closed eyes and open eyes for the anterior temporal, masseter, sternocleidomastoid and anterior digastric muscles of the children with myopic vision (study group).

Tables 5 and 6 show within-group comparisons of the mean values and standard deviation of EMG activity at rest with eyes closed and eyes open for the anterior temporal, masseter, sternocleidomastoid and anterior digastric muscles respectively both in control and study group. In myopic patients (study group) a higher (p<0.005) and a more weakly

	LTA	LMM	RMM	RTA	LSC	LDA	RDA	RSC
OBSERVATIONS	10	10	10	10	10	10	10	10
MEAN	17.2	13.6	14.5	17.7	23.6	24.5	32	24.7
SD	(7.4)	(3.6)	(4.6)	(6.2)	(6.8)	(11.2)	(19.5)	(10.3)

[1].LTA = Left Temporalis Anterior; LMM= Left Masseter; RMM= Right Masseter; RTA = Right Temporalis Anterior; LSC= Left Sternoscleidomastoid; LDA = Left Digastric; RDA = Right Digastric; RSC = Right Sternocleidomastoid

Table 1 - *Mean Value and Standard Deviation of Electromyographic Activity at Rest with closed eyes in the Stomatognatic Muscles of Control subjects.*

	LTA	LMM	RMM	RTA	LSC	LDA	RDA	RSC
OBSERVATIONS	10	10	10	10	10	10	10	10
MEAN	18.7	13	12.8	17.8	23.1	24.4	26.8	22.9
SD	(8.6)	(3.8)	(2.5)	(10.2)	(10.2)	(10.7)	(8.5)	(8.5)

[1].LTA = Left Temporalis Anterior; LMM= Left Masseter; RMM= Right Masseter; RTA = Right Temporalis Anterior; LSC= Left Sternoscleidomastoid; LDA = Left Digastric; RDA = Right Digastric; RSC = Right Sternocleidomastoid

TABLE 2 - *Mean Value and Standard Deviation of Electromyographic Activity with open eyes in the Stomatognatic Muscles of Control Patients.*

	LTA	LMM	RMM	RTA	LSC	LDA	RDA	RSC
OBSERVATIONS	10	10	10	10	10	10	10	10
MEAN	22.5	16.2	15.3	19.5	24.6	24.3	22.4	22.3
SD	(11.5)	(8.1)	(10.4)	(7.2)	(8.3)	(11.2)	(8.05)	(10.9)

[1].LTA = Left Temporalis Anterior; LMM= Left Masseter; RMM= Right Masseter; RTA = Right Temporalis Anterior; LSC= Left Sternoscleidomastoid; LDA = Left Digastric; RDA = Right Digastric; RSC = Right Sternocleidomastoid

TABLE 3 - *Mean Value and Standard Deviation of Electromyographic Activity with closed eyes in the Stomatognatic Muscles of Study Patients.*

	LTA	LMM	RMM	RTA	LSC	LDA	RDA	RSC
OBSERVATIONS	10	10	10	10	10	10	10	10
MEAN	32.6	17.3	14.9	24.2	20.8	27	25.9	18.4
SD	(13.29)	(7.9)	(9.7)	(9.8)	(6.5)	(10.7)	(10.2)	(6.3)

1. LTA = Left Temporalis Anterior; LMM= Left Masseter; RMM= Right Masseter; RTA = Right Temporalis Anterior; LSC= Left Sternoscleidomastoid; LDA = Left Digastric; RDA = Right Digastric; RSC = Right Sternocleidomastoid

TABLE 4 - *Mean Value and Standard Deviation of Electromyographic Activity with open eyes in the Stomatognatic Muscles of Study Patients.*

($p<0.08$) significant statistical difference are present respectively in LTA and RDA muscles. No significant differences were observed in all pairs of muscles in the control group.

Tables 7 and 8 show between-group comparisons of the mean values and standard deviation of EMG activity at rest with closed and open eyes respectively. In the closed eyes condition it is possible to observe an identical pattern of EMG activity in both control and study group.

The only significant differences observed in the EMG activity levels between myopic and control subjects with opened eyes were observed in both left and right anterior temporal muscle respectively $p<0.005$ and $p< 0.05$.

Discussion

This study allows us to show the role visual input plays in the stomatognatic system through its influence on EMG activity.

The results of EMG activity at rest observed in healthy patients with closed and open eyes, agrees with Holmgren [Holmgren et al., 1985], who did not find

CONTROL PATIENTS	CLOSED EYES	OPENED EYES
LTA	17.2 (7.4)	18.7 (8.6)
LMM	13.6 (3.6)	13.0 (3.8)
RMM	14.5 (4.6)	12.8 (2.5)
RTA	17.7 (6.2)	17.8 (10.2)
LSC	23.6 (6.8)	23.1 (10.2)
LDA	24.5 (11.2)	24.4 (10.7)
RDA	32.0 (19.5)	26.8 (8.5)
RSC	24.7 (10.3)	22.9 (8.5)

[1].Mean values and in parentheses Standard Deviation; * = P < .05; ** = P < .005; *** = P < .0005; **** = P < .00005

TABLE 5 - *Paired Comparison of EMG Activity at rest in the Stomatognatic muscles upon Variation in the Visual Input in Control group.*

CONTROL PATIENTS	CLOSED EYES	OPENED EYES
LTA	22.5 (11.5)	**32.6**** **(13.3)**
LMM	16.2 (8.1)	17.3 (7.9)
RMM	15.3 (10.4)	14.9 (9.7)
RTA	19.5 (6.2)	**24.2** (9.8)
LSC	24.6 (8.3)	20.8 (6.5)
LDA	24.3 (11.2)	27 (10.7)
RDA	22.4 (8.0)	25.9 (10.3)
RSC	22.3 (10.9)	18.4 (6.3)

[1].Mean values and in parentheses Standard Deviation; * = P < .05; ** = P < .005; *** = P < .0005; **** = P < .00005

TABLE 6 - *Paired Comparison of EMG Activity at rest in the Stomatognatic muscles upon Variation in the Visual Input in Study group.*

CONTROL PATIENTS	CLOSED EYES	OPENED EYES
LTA	17.2 (7.4)	22.5 (11.5)
LMM	13.6 (3.6)	16.2 (8.1)
RMM	14.5 (4.6)	15.3 (10.4)
RTA	17.7 (6.2)	19.5 (7.2)
LSC	23.6 (6.8)	24.6 (8.3)
LDA	24.5 (11.2)	24.3 (11.2)
RDA	32.0 (19.5)	22.4 (8.0)
RSC	24.7 (10.3)	22.3 (10.9)

[1].Mean values and in parentheses Standard Deviation; * = P < .05; ** = P < .005; *** = P < .0005; **** = P < .00005

TABLE 7 - *Paired Comparison of EMG Activity at rest in the Stomatognatic muscles at closed eyes in Study and Control group.*

CONTROL PATIENTS	CLOSED EYES	OPENED EYES
LTA	18.7 (8.6)	**32.6**** **(13.3)**
LMM	13.0 (3.8)	**17.3*** **(7.9)**
RMM	12.8 (2.5)	14.9 (9.7)
RTA	17.8 (10.2)	**24.2** **(9.8)**
LSC	23.1 (10.2)	20.8 (6.5)
LDA	24.4 (10.7)	27 (10.7)
RDA	26.8 (8.5)	25.9 (10.3)
RSC	22.9 (8.5)	18.4 (6.3)

1.Mean values and in parentheses Standard Deviation; * = P < .05; ** = P < .005; *** = P < .0005; **** = P < .00005

TABLE 8 - *Paired Comparison of EMG Activity at rest in the Stomatognatic muscles at open eyes in the Study and Control group.*

any significant changes in resting masseter activity upon variation of visual input and disagrees with previous studies that found a significant decrease with closed eyes of the mentioned muscles [Miralles et al., 1998]. To the author's knowledge, this is the first study focusing on the effect of visual input on the electromyographic activity of the temporal, masseter, sternocleidomastoid and anterior digastric muscles at rest in subjects with myopic vision and in paediatric dental patients with normal vision.

These results underline that:

- a change in the visual input does not induce a modification in the stomatognatic muscles system basic tone in children with normal vision;

- the myopic children showed an increase of anterior temporal activity at rest

Masticatory muscles activity, controlled by the trigeminal nerve, is regulated by several inputs coming from proprioception of neuromuscular spindles. These inputs have an important role in the maintenance and in the modifications of muscular base tone.

Proprioception messages coming from the muscles of the neck are integrated in the central nervous system and they contribute to control the balance and body orientation in the space-time surrounding it. Centripetal impulses from the muscles of the neck proprioceptors cooperate with the labyrinth impulses to promote the oculomotor muscular activity through the cervical-vestibular-ocular reflex.

Some important encephalic nuclei (trigeminal nuclei, oculomotor nuclei, vestibular nuclei, accessorial nerve nuclei) are integrated in the medial longitudinal fasciculus. Moreover ocular proprioceptive receptors send afferences to trigeminal and cuneate nuclei.

This study confirms the physiologic links of these anatomical structures: a modification of the proprioceptive ocular afferences can be reflected on the stomatognatic one. The EMG evaluations comported different RMS values as a consequence of the proprioceptive input change.

The results suggest that the relation between stomatognatic and oculomotor system is underestimated and the use of EMG could permit the integrate study of the two systems.

Conclusion

The significant change in EMG activity, mainly observed at opening eyes in myopic children, suggests that this bioelectric device could improve the diagnosis of vision defects of unaware patients or to control lenses adequacy. Anterior temporal tone increase for worsening of vision could be associated to episodic tension-type headache with increased levels of tenderness and/or EMG of pericranial muscles and clinically relevant in differential diagnosis of headache.

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