Clinical Study

Longitudinal changes in muscle activity of masseter and anterior temporalis before and after Lefort I osteotomies, An EMG study

Access this article online
Website: www.amsjournal.com
DOI: 10.4103/2231-0746.92776
Quick Response Code:

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ABSTRACT

Aims: The aim of this study was to compare the levels of electromyography (EMG) activity of masseter and anterior temporalis present presurgically with changes in the intensity of muscle activity that took place post surgically for a period of 6 months follow up. **Settings and Design:** Ten patients with vertical maxillary excess were selected from the department of Oral and Maxillofacial surgery at Saveetha Dental College and Hospitals, Chennai. **Materials and Methods:** Electromyography was used as a kinesiology tool to study muscle function of Masseter and Anterior Temporalis of all ten subjects pre surgically and post surgically with a 6 month follow up. **Statistical Analysis Used:** The statistical package SPSSPC+ (Statistical Package for Social Science, Version 4.0.1) was used for statistical analysis. Mean and standard deviation were estimated from the sample. The tests that were used for the statistical analysis were one way ANOVA and student's T test. **Results:** The final inference elucidates that the muscular activity of masseter and temporalis are improved during chewing and clenching in the postoperative 6 months period when compared to preoperative values. The duration was constant at 7 milliseconds for both the positions. **Conclusions:** From this study, it can be concluded that there is a strong correlation between vertical maxillary excess and associated weak musculature. Electromyography has been used as an important tool to demonstrate improved muscle activity after surgical correction of vertical maxillary excess and improvement in functional deficits associated with this dentofacial deformity. From this study it can be concluded that surgical correction of vertical maxillary excess improves occlusion, leading to increased eccentric tooth contacts, increased mean amplitude and increased mean power frequency of the muscles all of which translate into improved muscle activity.

Keywords: Electromyography, masseter, temporalis, vertical maxillary excess

INTRODUCTION

Patients with dental and skeletal malocclusions have been shown to have poor masticatory performance because of fewer occlusal contacts.[1] Surgical repositioning of the teeth and bones in such patients has been shown to improve masticatory performance.[2] Patients with vertical maxillary excess have weaker facial and masticatory musculature than normal individuals.[3] It has been postulated that the weaker musculature may contribute to the development of the characteristic facial skeleton.[4] A number of parameters have been used to identify functional deficits in patients with this dentofacial deformity. Today, EMG, which involves the study of motor unit activity, is used as a kinesiologic tool to study muscle function.[5] Among the various muscle functions, clenching and chewing are the most frequent movements.[6] Over the past 50 years, several studies have been conducted to study the relationship between different facial forms and their effect on muscle activity.[7] This study has been conducted to assess the effects of vertical maxillary excess on muscle activity and compare the changes in intensity of muscle

activity after surgical correction.

MATERIALS AND METHODS

In this study EMG recording surface electrodes were used to record the amount of electrical activity associated with muscular motor unit potentials. The surface electrodes were small silver discs about 1 cm in diameter and covered with jelly. One electrode was placed over the belly and one over the tendon. When recording, disc electrodes were held 3 cms apart with muscle stimulated by electric impulse. The amplitude is generally of several millivolts.

Ten patients were selected for this study. All the ten patients had a vertical maxillary excess and were scheduled to undergo a Le Fort 1 osteotomy with superior repositioning of the maxilla. The age groups of the patients ranged from 22 to 27 years. All the ten patients were undergoing pre surgical orthodontic treatment. There were no associated temporomandibular joint problems in any of the patients. The subjects were explained in detail about the procedure and a written consent was obtained.

Patient preparation

The patient was made to sit in a relaxed upright position and the skin was cleaned with surgical spirit. Electrodes were placed in the motor centers of anterior temporalis and masseter.

Anatomical landmarks

For masseter and anterior temporalis, 50mm anterior to the tragus of the ear(A) 20mm inferior to point A(B) and 20 mm below towards the angle of the mandible indicated the active motor centre for masseter. Superior to point A by 25 mm, point (C) was marked. Again 25 mm superiorly at an angle of 45 degrees towards the outer canthus of eye point (D) was marked, which was the active motor center of temporalis.

Instrumentation – Electromyography

Recording the EMG requires a system that had electrodes to pick up electrical potential from

- Contracting phase (input phase)
- Amplifier which processes
- The small electrical signal (processor phase)
- Display which converts the electrical signal to visual and/or audio signals for data analysis (output phase)

The statistical package SPSS+(Statistical Package for Social Science, Version 4.0.1) was used for statistical analysis. Mean and standard deviation were estimated from the sample. The tests that were used for the statistical analysis were one way ANOVA and student's T test. A *P* value < 0.05 was considered significant.

EMG recording procedure

Whenever a muscle fiber contracts, the surface membrane undergoes depolarisation so that an action potential can be recorded from the fiber. The contraction is not synchronous and their action potentials summate so that relatively large complex potential is recorded. These impulses stimulate the muscle and a muscular response is obtained. EMG registers signals of muscle contractility through action potentials delivered by the motor neurons. Highly refined bipolar electrodes are sensitive to these signals and once amplified, are visible as EMG recordings.

The equipment used was grass polygraph and amplifier (Nicolet Viking Vt) and amplified signals were directly recorded on paper, Hewlett Packard LA. Each direct EMG trace was converted to a mean voltage trace by an electronic averaging circuit connected to the polygraph. The speed used for recording was end of each trace recording, calibrating each test and baseline recordings were performed. EMG recordings were taken in the following positions, maximum voluntary bite force and chewing.

The amplitude for every muscle was measured by a maximum peak calculated from the baseline and was represented by millivolts and the total number of peaks were calculated as the duration (ms). Representative clinical and EMG as results are shown in Figures 1 to 6. The Figures 1 to 6 illustrate EMG recordings of masseter and temporalis taken preoperatively and postoperatively during maximum voluntary bite force.

The numerical values that were obtained from the polygraph were tabulated for individual patients.

RESULTS

The results obtained indicated that there was no significant difference in the amplitude of muscle activity during isometric clenching and chewing in the preoperative period and postoperative period one month after surgery for both masseter and anterior temporalis. There was a significant increase in the postoperative period six months after surgery in the muscle efficiency of masseter and temporalis [Tables 1-3].

Table 2 shows the comparison made in the muscle activity of masseter taken preoperatively with postsurgical EMG recordings taken after a gap of one month and again, after six months

The comparison between the preoperative and 6 months postoperative changes in the mean amplitude for M_1 in P_1 and P_2 showed that the *P* value was < 0.0001 and hence, statistically significant.

Table 3 illustrates EMG recordings done on temporalis preoperatively with readings taken postsurgically after a gap of one month and again, after six months

The comparison between the preoperative and 6 months postoperative changes in the mean amplitude for M_2 in P_3 and P_4 showed that the *P* value was 0.001 and hence, statistically significant.

DISCUSSION

EMG can be used for diagnostic purposes to detect pathologies in muscles like myotonias by comparing with muscle activity in normal individuals. EMG also proves useful for studying the deleterious effects of TMJ disorders on muscle acitivity.[8]

The growth of the face occurs as a response to functional needs

Figure 1: Electrodes placed in temporalis

Figure 2: Electrodes placed in Masseter

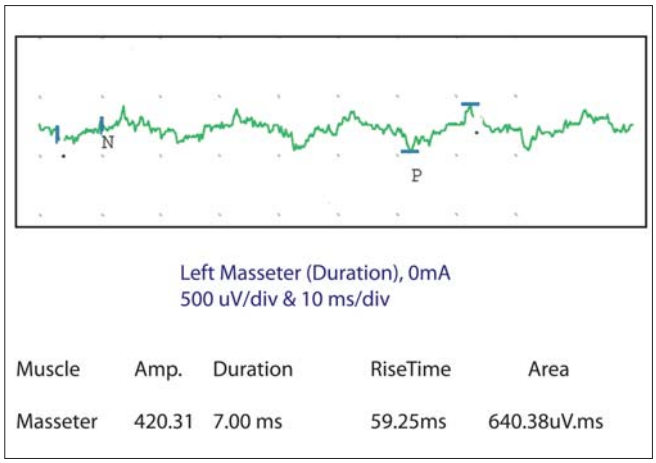

Figure 3: Preoperative EMG recording of masseter taken during maximum voluntary bite force

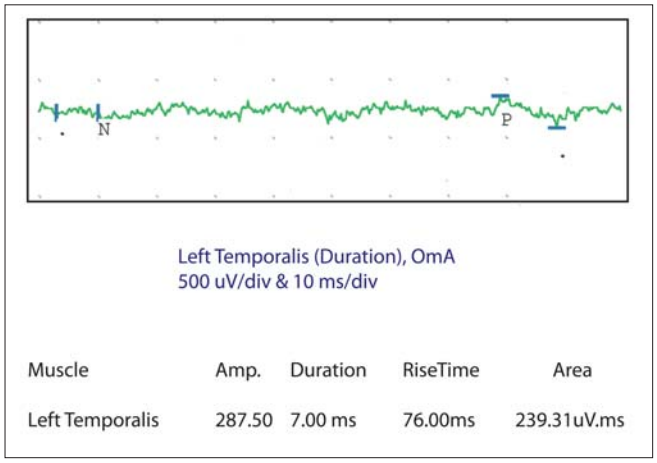

Figure 4: Preoperative EMG recording of temporalis taken during maximum voluntary bite force

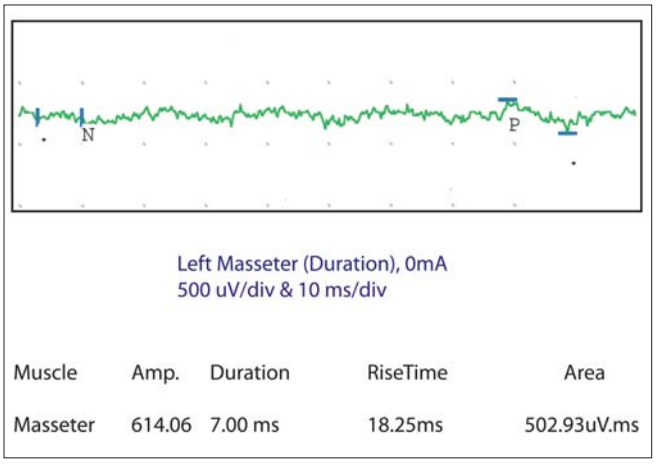

Figure 5: Postoperative EMG recording of masseter taken during maximum voluntary bite force

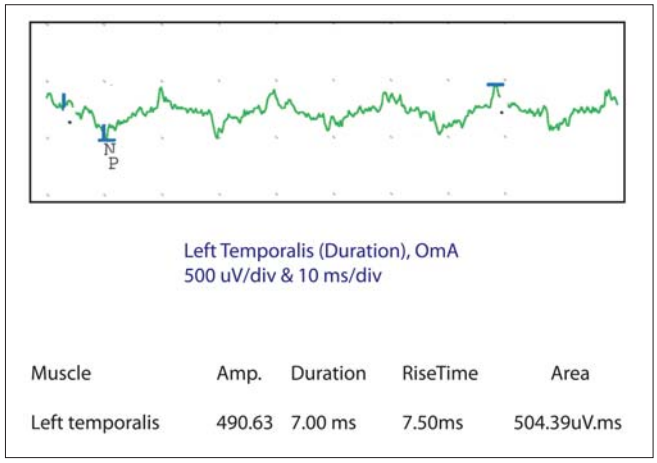

Figure 6: Postoperative EMG recording of temporalis during maximum voluntary bite force

mediated by the surrounding soft tissue including the muscles of mastication.[9] There is a correlation between dentofacial deformities and the masticatory performance of such patients. In this study, patients with vertical maxillary excess were treated surgically and the relationship between the muscle activity and changed facial morphology were compared with pre surgical muscle activity during isometric clenching and chewing. The muscle activities of anterior temporalis and masseter were recorded with the help of surface electrodes using Nicolet Viking VT machine. The results obtained indicated that there was a significant increase in the postoperative period 6 months after surgery in the muscle efficiency of masseter and temporalis. There

Table 1: Comparison of Changes in Amplitude of Masseter and Temporalis before and after lefort I osteotomy

Masseter – Voluntary bite force	Maximum amplitude – 630.05 preoperatively Maximum amplitude-556.05 one-month postoperatively Maximum amplitude - 790.14 six-months postoperatively
Masseter – Chewing	Maximum amplitude – 485.31 preoperatively Maximum amplitude - 630.50 one-month postoperatively Maximum amplitude - 937.06 six-months postoperatively
Temporalis – Voluntary bite force	Maximum amplitude – 620.04 preoperatively Maximum amplitude - 640.75 one-month postoperatively Maximum amplitude - 902.56 six-months postoperatively
Temporalis – Chewing	Maximum amplitude – 590.63 preoperatively Maximum amplitude - 596.01 one-month postoperatively Maximum amplitude - 950.15 six-months postoperatively

Table 3: Mean Standard Deviation and test of significance of mean amplitude between different time points for M_2. The *P* value was 0.001 and hence, statistically significant

Variable	Time Points Compared	Amplitude Mean ± S.D.	*P* – Value
P_3	Preoperative	351.21 ± 134.08	
	Postoperative One Month	362.36 ± 140.39	
	Change	11.15 ± 40.37	0.41 (NS)
	Postoperative 6 Months	481.82 ± 169.93	
	Change	130.62 ± 88.67	0.001 (SIG)
P_3	Postoperative One Month	362.36 ± 140.39	
	Change		
	Postoperative 6 Months	481.82 ± 169.93	
	Change	119.47 ± 77.32	0.001 (SIG)
P_4	Preoperative	343.08 ± 144.01	
	Postoperative One Month	367.09 ± 148.67	
	Change	24.01 ± 44.13	0.12 (NS)
	Postoperative 6 Months	482.69 ± 198.19	
	Change	139.61 ± 99.05	0.002 (SIG)
P_4	Postoperative One Month	367.09 ± 148.67	
	Change		
	Postoperative 6 Months	482.69 ± 198.19	
	Change	115.60 ± 103.67	0.006 (SIG)

M_2 - Temporalis, P_3 - Maximum Voluntary Bite Force, P_4 - Chewing, SIG - Significance, NS - Non Significance

was no significant difference in the amplitude of muscle activity during isometric clenching and chewing in the preoperative period and postoperative period one month after surgery for both masseter and temporalis.

The final inference elucidates that the muscular activity of the Masseter and the Temporalis are improved during chewing and maximum clenching in the postoperative 6 months period when compared to preoperative values. The duration was constant at 7 milliseconds for both the positions. In comparing the study of William W. Wood on masticatory function with our findings, it is

Table 2: Mean Standard Deviation and test of significance of mean amplitude between different time points for M_1.

Variable	Time Points Compared	Amplitude Mean ± S.D.	*P* – Value
P_1	Preoperative	311.70 ± 135.79	
	Postoperative One Month	346.70 ± 129.63	
	Change	35.0 ± 62.48	0.11 (NS)
	Postoperative 6 Months	428.43 ± 159.64	
	Change	116.73 ± 38.46	<0.0001 (SIG)
P_1	Postoperative One Month	346.70 ± 129.63	
	Change		
	Postoperative 6 Months	428.43 ± 159.64	
	Change	81.73 ± 65.46	0.003 (SIG)
P_2	Preoperative	330.40 ± 149.50	
	Postoperative One Month	364.07 ± 147.16	
	Change	33.67 ± 60.79	0.11 (NS)
	Postoperative 6 Months	477.89 ± 206.80	
	Change	147.48 ± 79.74	<0.0001 (SIG)
P_2	Postoperative One Month	364.07 ± 147.16	
	Change		
	Postoperative 6 Months	477.89 ± 206.80	
	Change	113.82 ± 90.85	0.003 (SIG)

M_1- Masseter, P_1 - Maximum Voluntary Bite Force, P_2 - Chewing

seen that maximum activity occurs during clenching in intercuspal position.[10] Increasing the number of eccentric tooth contacts increases the muscle activity during both chewing and clenching. Maximum activity is demonstrated by the elevator muscles. From this study it can be concluded that surgical correction of vertical maxillary excess improves occlusion, leading to increased eccentric tooth contacts and increased mean power frequency of the muscles all of which translate into improved muscle activity.

In a study done by Di Palma E,[11] 2 groups were involved. One group was a control group and the other group was candidates for orthognathic surgery. EMG studies revealed a neuromuscular imbalance determined by an occlusal stability in candidates for surgery thus emphasizing the important role of occlusion. In another study by Di Palma E[12] the muscle activity of 19 patients were studied before and after orthognathic surgery. EMG studies showed that improvement gained by surgical intervention was predominantly due to better occlusal stability. A study was done by Trawitzki[13] on masticatory muscle activities 3 years after orthognathic surgery.13 patients were evaluated and it was concluded that there were significant EMG changes in this time period. Therefore, EMG can be used as an important tool to demonstrate improved muscle activity after surgical correction of vertical maxillary excess and improvement in functional deficits associated with this dentofacial deformity.

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Cite this article as: Priyadarsini M, Muthushekar MR. Longitudinal changes in muscle activity of masseter and anterior temporalis before and after Lefort I osteotomies, An EMG study. Ann Maxillofac Surg 2011;1:131-5.

Source of Support: Nil, **Conflict of Interest**: None declared.