Journal of Taibah University Medical Sciences (2023) 18(2), 356–365

Taibah University

Journal of Taibah University Medical Sciences

www.sciencedirect.com

Original Article

Electromyographic evaluation of masseter and temporalis muscle activity after periodontal surgery: A prospective clinical trial

Vamsi E. Santosh, Ramesh S.V. Konathala, MDS *, Gautami S. Penmetsa, MDS, Sruthima N.V.S. Gottumukkala, MDS, Mohan K. Pasupuleti, MDS and Vintha Jaswitha

Department of Periodontics and Implantology, Vishnu Dental College, Bhimavaram, India

Received 28 April 2022; revised 25 July 2022; accepted 16 September 2022; Available online 12 October 2022

الملخص

أهداف البحث: بعد علاج اللثة، يتم استعادة الهياكل الداعمة للأسنان لتعمل وبالتالي يتحسن نشاط العضلات. تهدف الدراسة إلى تقييم تأثير أمراض اللثة على نشاط العضلات من خلال تخطيط كهربية العضل والإدراك الذاتي لعلاج دواعم السن من خلال استبانة تأثير الفم على الأداء اليومي.

طرق البحث: تم تضمين ستين شخصا يعانون من التهاب دواعم السن المتوسط إلى الشديد. بعد علاج اللثة غير الجراحي، بعد 4-6 أسابيع، تمت إعادة تقييم حالة اللثة. تم التخطيط لجراحة السديلة بأعماق جيب ذات سبر ثابت ≥ 5 مم. تم تسجيل جميع المعلمات السريرية في الأساس، 3 و 6 أشهر. تم قياس نشاط العضلات من العضلة الماضغة و العضلة الصدغية باستخدام تخطيط كهربية العضل وتم تسجيل درجات تأثير الفم على الأداء اليومي في الأساس و بعد 3 أشهر.

النتائج: تم تخفيض متوسط درجات مؤشر اللويحة، وسبر عمق الجيب ، ومستوى التعلق السريري من خط الأساس إلى 3 أشهر. تمت مقارنة متوسط درجات مخطط كهربية العضل في الأساس و 3 أشهر بعد الجراحة. كان متوسط مجموع نقاط تأثير الفم على الأداء اليومي قبل وبعد العلاج اللثوي مختلفا بشكل كبير.

الاستنتاجات: توجد علاقة ذات دلالة إحصائية بين المعلمات السريرية ونشاط العضلات والإدراك الذاتي للمريض. لذلك، يمكن الاستنتاج أن جراحة السديلة اللثوية الناجحة أظهرت تحسنا في كفاءة المضغ والإدراك الذاتي من خلال استبانة تأثير الفم على الأداء اليومي.

الكلمات المفتاحية: تخطيط كهربية العضل؛ مقياس ضغط؛ نشاط عضلي؛ أمراض اللثة؛ جيب اللثة

* Corresponding address: Department of Periodontics and Implantology, Vishnu Dental College, Bhimavaram, India.

E-mail: rameshksv@vdc.edu.in (R.S.V. Konathala)

Peer review under responsibility of Taibah University.

ELSEVIER Production and hosting by Elsevier

Abstract

Objectives: Following periodontal treatment, tooth supporting structures are restored to functionality and hence improve muscle activity. In this study, we aimed to investigate the influence of periodontal disease on muscle activity by electromyography and the subjective perception of periodontal therapy through the Oral Impact on Daily Performance (OIDP) questionnaire.

Methods: Sixty subjects with moderate to severe periodontitis were included. Periodontal condition was reevaluated 4–6 weeks after non-surgical periodontal therapy (NSPT). Subjects with persistent probing pocket depths $\geq$5 mm were designated for flap surgery. All clinical parameters were recorded at baseline, 3 months and 6 months after surgery. The activities of the masseter and temporalis muscles were measured by electromyography and OIDP scores were recorded at baseline and 3 months.

Results: The mean plaque index scores, probing pocket depths, and clinical attachment levels were reduced from baseline to 3 months. Mean EMG scores were compared at baseline and 3 months post-surgery. The mean OIDP total score prior to and after periodontal therapy was significantly different.

Conclusion: There was a statistically significant correlation between clinical parameters, muscle activity and a patient's subjective perception. Therefore, it can be concluded that successful periodontal flap surgery led to improvements in masticatory efficiency and subjective perception, as determined by the OIDP questionnaire.

1658-3612 https://doi.org/10.1016/j.jtumed.2022.09.013

Keywords: Electromyography; Masseter; Muscle activity; Periodontal disease; Periodontal pocket

Introduction

Mastication is a rhythmic isotonic and isometric contraction of the masticatory muscles during the everyday application of the stomatognathic system and maintains muscle tone in the resting posture of the mandible.[1,2] Mastication plays a vital role in the digestive process in which the teeth are supported by the periodontal ligament (PDL) which both supports the teeth and carries perception *via* mechanoreceptors.[3] Mechanoreceptors present on the PDL can carry spatial relations or responses when occlusal forces act to break up food. Inflammation of the PDL or tooth loss can result in the loss of receptors and cessation of afferent flow in the PDL results in neuromuscular alterations.[4] Periodontal therapy serves to limit and remove the causative factors of disease and facilitate the regeneration of the supporting structures of lost teeth, thus improving the compromised muscle activity caused during the process of disease.

Masticatory muscles, especially the masseter (MST) and temporalis (T) function as a power muscle to maintain harmony of the occlusal relationships of the teeth and represent the primary determinant for muscular activity.[5] Despite a lack of evidence in the literature, it is believed that periodontal regenerative procedures may help to recover mechanoreceptors, depending upon the type of procedure.[4] However, very little importance has been given to investigate the change in masticatory muscle activity caused by periodontal disease. Although various objective techniques have been developed to assess the functionality of the masticatory muscle, the application of electromyography (EMG) in periodontics provides a significantly more accurate procedure than manual palpation or touch when recording the electrical activity of masticatory muscles. Electromyography of the temporal and masseteric muscles has been found to be beneficial in the identification of masticatory problems in clinical investigations. Thus, utilizing the benefits of EMG to detect changes in muscle activity will help in assessing improvements following periodontal therapy.

An individual's satisfaction or ability to chew after periodontal therapy is an important subjective indicator to assess the improvement in mastication and the quality-of-life, as an individual's ability to eat and communicate might be jeopardized by tooth loss. There are also likely to be repercussions on social and everyday activities, thus creating a negative impact on the individual and creating a significant effect on the quality-of-life.[4] The quality-of-life, as perceived by an individual, refers to the assessment of his/her well-being, including all emotional, social and physical aspects of an individual's life. The World Health Organization (WHO) recognizes oral health related quality of life (OHRQoL) as an essential aspect of the Global Oral Health Program and also as an intrinsic aspect of general health and well-being. The Oral Impact on Daily Performance (OIDP) questionnaire is a component of the OHRQoL that was created to give an additional subjective parameter for assessing the impact of oral issues on everyday activities, including mastication.[6]

Little is known about the specific impact of periodontal therapy on masticatory muscle activity. Hence, this study aimed to investigate the electrical activity of the masseter and temporalis in an objective manner and evaluate the quality-of-life of patients before and after periodontal treatment in a subjective manner.

Materials and Methods

Study design

This was a prospective clinical trail conducted at Vishnu Dental College during the period November 2019 to December 2021. Signed informed consent was obtained from all patients and all clinical procedures were conducted in accordance with the Declaration of Helsinki and Good Clinical Practice principles.

Outcome measures

This study focused on two primary outcomes. First, muscle activity of the masseter and temporalis before and after non-surgical periodontal therapy (NSPT) and surgical periodontal therapy (SPT) was assessed by EMG (BIOPAK). Second, the subjective perception of each patient with regards to the quality-of-life was evaluated by a specially prepared OIDP questionnaire which was given to the patients prior to and after periodontal therapy.

We also investigated several secondary outcomes, including plaque index,[25] probing pocket depth (PPD, as measured from the gingival margin to the base of the pocket), clinical attachment level (CAL; as measured from the cemento-enamel junction to the base of the pocket) and mobility (Miller's index, 1958).

Sample size

Sample size analysis was performed with G Power 3.1 software. For a group of subjects being measured across two time intervals at a 5% level of significance, the power of this study was 80%. For an expected effect size of 0.3736, 60 observations across two different time intervals were required. Considering a 10% dropout, 66 participants were included. However, six patients dropped out (for various reasons) and only 60 were considered for statistical analysis. Participants with chronic periodontitis received a preliminary assessment that included a medical and dental history (Figure 1).

Patient eligibility

We included patients who had not had periodontal treatment during the previous 6 months and those with periodontitis stage II and III, grade B and C (AAP classification, 2017).[7] We included patients with ≥20 teeth (the presence of two premolars and the first molar was mandatory in all quadrants) and a minimum of three teeth involved with a probing pocket depth of $\geq$5 mm and horizontal bone loss.

We excluded patients with parafunctional habits, disorders of the temporomandibular joint (TMJ) with clicking sounds/deviation, neuropsychiatric symptoms, those taking anti-depressants, smokers, pregnant or breastfeeding females, those with uncontrolled systemic disorders (i.e., patients with an HbA1C >7 or a blood pressure >140/90 mmHg), those with known hemorrhagic disorders, endocrinal disorders, the presence of arthritis, rheumatism, osteoporosis, oral breathing, sinus infection and the use of drugs influencing periodontal condition and patients using orthodontic appliances. We also exclude patients with missing opposing teeth, patients with grade II or III mobility, caries-affected teeth or other dental issues, the presence of splints, implants, fixed prosthesis and patients requiring occlusal corrections.

Assessment of parafunctional habits

Self-reports and clinical examinations were used to assess bruxism signs in the oral cavity, such as masticatory muscle tenderness, indentations on the tongue or lip, and/or linea alba on the inner cheek, destruction to the dental hard tissues, and wearing of the teeth (mechanical). We used the tooth-wear index (TWI) by Smith and Knight to evaluate incisal and occlusal wear on a scale of 0–4. The need for occlusal equilibration was assessed by TekScan before and after surgery.[8]

Assessment of periodontal health condition

Periodontal parameters such as plaque index (PI), probing pocket depth (PPD), clinical attachment level (CAL) and mobility were examined at baseline and 3 months after treatment using a UNC-15 probe to the nearest millimeter. Periodontal clinical parameters were recorded at 4–6 weeks after NSPT and 3 months after surgery.

Recording the electrical activity of the masseter and temporalis

Individuals were comfortably seated on a chair with their head placed upright and were asked to clench their teeth (Figure 2). Before palpating the bulge of the muscle, the area of skin was sterilized with Povidone iodine. Electrical activities of the muscles were then recorded using a BioEMGIII system [BioPAK, B Research, Inc] with a common mode rejection ratio of >130 dB at 60 Hz, (>120 dB, 30 to 500 Hz) with a signal-to-noise ratio of 1,000,000 to 1 voltage, a range of −3.0 to +3.0 V DC, and a band width of 30–1000 Hz. Surface bipolar, self-adhesive, pre-gelled electrodes with an inter-electrode distance of 40 mm were placed bilaterally over the thickest portion of the MST and most anterior portion of the temporalis parallel to the direction of muscle fibers with a ground electrode behind the neck. Illuminating blue light-emitting diodes were used to confirm that the connectors had been fully inserted.

Initially, as the muscles were silent and at rest, we recorded a resting EMG (rEMG) and compared this with the clenching EMG (cEMG). Individuals were asked to keep their jaws at rest and the rEMG was recorded thrice with a 2 min interval. Later, they were asked to clench as hard as possible on cotton roll placed between the maxillary and mandibular posterior teeth bilaterally for approximately 5 s. Then, the cEMG was recorded three times during voluntary maximal clenching 2 min intervals. The mean values of the three recordings at rest and in function were then considered for further assessment.

Surgical protocol

All subjects underwent NSPT including scaling & root planning with patient education and motivation regarding oral hygiene maintenance. Periodontal re-examination was carried out after 4–6 weeks and periodontal parameters were recorded. Baseline EMG recordings (rEMG and cEMG) were taken followed by flap elevation. Surgery was delayed until the plaque and bleeding scores have reduced and the patients' soft tissue architecture had improved. Those subjects with persistent probing pocket depths $\geq$5 mm were designated for flap surgery (Figure 1a). A single investigator used surgical loupes (3.5X) to perform all flap procedures. Periodontal flap surgery involved two horizontal incisions, namely sulcular and interdental incisions, followed by the elevation of a full thickness mucoperiosteal flap to gain access to the affected root surface and 2 mm of marginal bone. Debridement of the diseased granulation tissue was thorough, and osseous adjustments were made as required before the flaps were approximated and covered with a periodontal dressing (Figure 3). After 3 months of periodontal flap surgery, rEMG and cEMG recordings were taken, along with OIDP scores.

Post-operative care

For three days, all the participants were asked to take painkillers when required. For one week, the individuals were not allowed to brush their teeth on the surgery site and were ordered to use 0.2% chlorhexidine mouthwash. After one week, the periodontal dressing and stitches were removed; the patients also received oral hygiene instructions.

Recording of EMG at rest and during function

Surface bipolar, self-adhesive, pre-gelled electrodes, with an inter-electrode distance of 40 mm, were placed bilaterally over the thickest portion of the MST and the most anterior portion of the temporalis parallel to the direction of muscle fibers with a ground electrode behind the neck. Muscle activity of the masseter and temporalis was recorded by electromyography and OIDP scores were recorded 1 week after NSPT and at 3 months post-surgery. Individuals were requested to keep their mouths open (at rest) and resting EMG (rEMG) was recorded three times with a two-minute interval between each recording. Later, they were asked to clench as hard as possible on a single cotton roll that was 3.7 cm in length with diameter of 0.8 cm placed between the maxillary and mandibular posterior teeth bilaterally for about 5 s. Then, with a 2-min gap, clenching EMG (cEMG) was recorded three times during voluntary maximum clenching. For further evaluation, the mean value of three recordings at rest and in function was used (Figures 4 and 5).

The impact of periodontal treatment on mastication

The Oral Impact on Daily performance (OIDP) questionnaire was given in both English and vernacular language. Subjects were requested to rate their experience of the most affected activities of his/her oral health during initial examination and 3 months following periodontal treatment.[4] The frequency and intensity of activities were graded as no effect to extreme and were scored from 1 to 5. The frequency and intensity scores for each question were multiplied and the sum of eight questions was considered.

The electrical activity of the masseter and temporalis were recorded with individuals comfortably seated on a chair in an upright position and were asked to clench their teeth. Before palpating the bulge of the muscle, an area of skin was sterilized with Povidine iodine. Electrical activities of the muscles were recorded using a BioEMGIII system [BioPAK, B Research, Inc]. At 60 Hz, the common mode rejection ratio was more than 130 dB. Surface bipolar, self-adhesive, pre-gelled electrodes with a 40 mm inter-electrode spacing and a ground electrode behind the neck were placed bilaterally across the thickest part of the MST and the most anterior portion of the temporalis, parallel to the direction of muscle fibers.

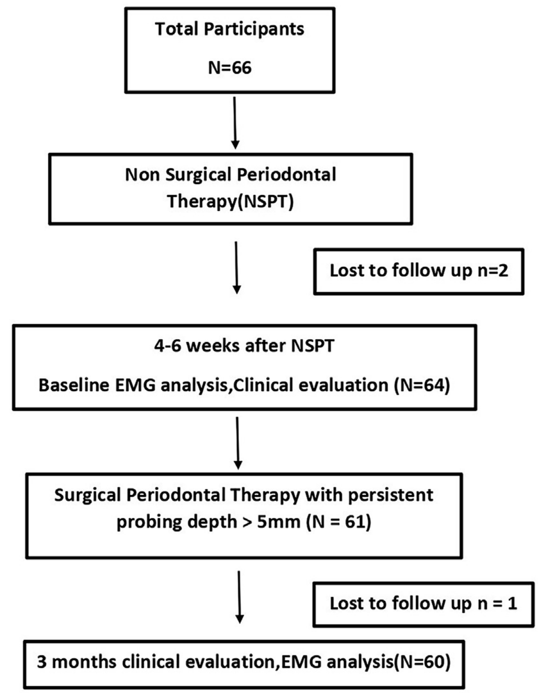

Figure 1: Methodology flow chart.

Statistical analysis

Data were subjected to Kolmogorov—Smirnov and Shapiro—Wilk tests to determine the pattern of distribution. Upon testing, the data was found to follow the normal distribution. Hence, parametric tests were employed for subsequent statistical analysis. We used SPSS software (V.25, IBM, NY) for intra-group comparisons of all clinical parameters (PI, PPD and CAL) and EMG. The OIDP was analyzed by paired t tests. Intra group comparisons of mobility were performed by Wilcoxon's signed rank test and correlation analysis was performed with Pearson's correlation analysis. $P < 0.05$ was considered statistically significant.

Results

All clinical parameters from baseline to 3 months, including periodontal metrics such as PI, PPD, and CAL showed a statistically significant improvement (Table 1, Figure 1b). There was a significant improvement in the teeth with initial mobility to 3 months after periodontal surgery. During the 3 months of evaluation, there was a significant reduction in mobility ($P < 0.001$) where there were no teeth with Grade 2 mobility (0%), while 66.7% of teeth showed Grade 1; 33.3% showed no mobility (Table 2).

EMG analysis was performed during rest and clench at baseline and 3 months post-surgery. The right and left temporalis (RT) showed significantly higher cEMG activity at 3 months (74.135 ± 34.01 µV and 74.08 ± 31.05 µV) than baseline (71.20 ± 41.25 µV and 60.29 ± 30.80 µV). Similarly, the right masseter showed significantly higher cEMG activity at 3 months (75.66 ± 26.70 and 54.94 ± 21.54 µV) than at baseline (61.01 ± 26.17 and 52.63 ± 19.48 µV) (Table 3). The mean OIDP total score was reduced significantly (p-0.000) after periodontal surgery with a mean score of 56.03 at baseline and 12.03 3 months post-operatively (Table 4). The highest OIDP recorded before treatment was 128 with a significant reduction (to 22) after periodontal treatment.

At baseline, the mean rEMG scores of all muscles showed a very low negative correlation with PPD and CAL. At 3 months re-evaluation, the mean rEMG values showed a very low negative correlation for RT and LT muscles and a low negative correlation of RM and LM muscle activity with PPD. Also, there was a very low negative correlation of rEMG of all the muscles to CAL values at 3 months. However, there was no significant correlation in the resting muscle activity of any of the muscles with PPD and CAL (Table 5).

At baseline, the cEMG values of all muscles except RM showed a low negative correlation; the RM showed a very low negative correlation with PPD although this was not statistically significant. Similarly, LM and RT showed a low negative correlation with CAL while RM and LT showed a very low negative correlation with CAL with no statistical significance. Three month re-evaluation showed no positive correlation of the cEMG values to PPD and CAL except RT which showed a very low positive correlation to PPD (Table 5).

At baseline, all muscles except LT showed a low negative correlation between rEMG and OIDP scores. However, at 3 months re-evaluation, all the muscles except for RT showed a positive correlation between rEMG and OIDP scores. The LT rEMG scores showed a medium positive correlation (r-0.405) which was statistically significant ($P = 0.026$). The cEMG scores at baseline, except for RM, showed a low positive correlation whereas RM showed a very low negative correlation. At 3 months re-evaluation, the cEMG values for RM and LM showed a very low positive correlation with

Figure 2: Recording of electrical muscle activity in patients.

OIDP while RT and LT showed a very low negative correlation with OIDP scores suggestive of an improvement in masseter muscle activity compared to the temporalis muscle (Table 6).

Discussion

Mastication in the presence of teeth plays a significant role in maintaining the homeostasis of the body.[4] Compromised dental elements result in clinical consequences that not only affect masticatory efficiency but also reduces the patient's subjective perception leading to nutritional deficiency and functional asymmetry of the masticatory muscles.[9]

Inflammation and infection of the tooth supporting structures result in progressive destruction of the periodontal ligament, pocket formation with alveolar bone loss, and recession, thus leading to tooth loss. This results

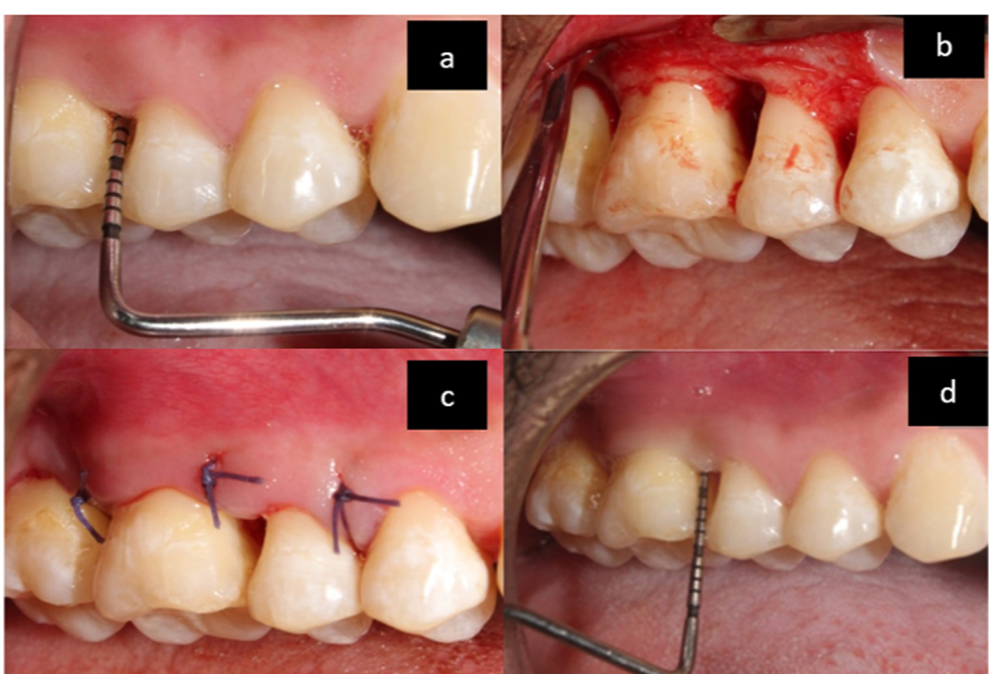

Figure 3: (a) Initial probing depth of 7 mm in relation to (irt) 16 (b) flap elevation irt 15, 16, 17 (c) flap closure and sutures placed (d) reduction of probing pocket depth to 4 mm at 3 months.

Figure 4: EMG recordings at rest, at clench with cotton rolls and at rest after clench at baseline.

Figure 5: EMG recordings at rest, at clench with cotton rolls and at rest after clench at 3 months.

Table 1: Intra-group comparisons of plaque index (PI), probing pocket depth (PPD) and clinical attachment level (CAL) at baseline and 3 months.

Clinical variables	Baseline	3 months	Δ, P-value
	Mean ± SD	Mean ± SD	
PI	1.38 ± 0.22	1.17 ± 0.17	0.21 ± 0.05, P = 0.000**
PPD	6.16 ± 0.66	3.52 ± 0.31	2.63 ± 0.66, P = 0.000**
CAL	6.58 ± 0.85	4.00 ± 0.41	2.55 ± 0.9, P = 0.000**

**Highly statistically significant P < 0.001.

Table 2: Intra-group comparisons of mobility at baseline and 3 months.

Mobility	Baseline	3 months	P-value
	n (%)	n (%)	
Grade 0	8 (13.3)	20 (33.3)	<0.001**
Grade 1	12 (20.0)	40 (66.7)	Significant
Grade 2	40 (66.7)	0 (0.0)	
Grade 3	0 (0.0)	0 (0.0)	
Total	60 (100.0)	60 (100.0)	

**Highly statistically significant P < 0.001.

Table 3: Intra-group comparisons of electromyography (EMG) at baseline and 3 months.

	EMG	Baseline	3 months	Δ, P-value
		Mean ± SD	Mean ± SD	
Rest	RM	3.68 ± 1.35	3.16 ± 1.51	0.52 ± 0.16, P = 0.055
	LM	2.30 ± 1.41	3.19 ± 1.39	0.89 ± 0.02, P = 0.000**
	RT	3.85 ± 2.48	3.00 ± 2.22	0.86 ± 0.26, P = 0.100
	LT	3.73 ± 2.04	3.14 ± 2.27	0.60 ± 0.23, P = 0.600
Clench	RM	61.01 ± 26.17	75.66 ± 26.70	14.66 ± 0.53, P = 0.002*
	LM	52.63 ± 19.48	54.94 ± 21.54	2.31 ± 2.06, P = 0.028*
	RT	71.20 ± 41.25	74.135 ± 34.01	2.93 ± 7.24, P = 0.004*
	LT	60.29 ± 30.80	74.08 ± 31.05	13.81 ± 0.25, P = 0.000**

Right masseter (RM), left masseter (LM), right temporalis (RT), left temporalis (LT).
**Highly Statistically significant P < 0.001; *statistically significant P < 0.05.

Table 4: Intra-group comparisons of Oral Impact on Daily Performance (OIDP) questionnaire scores at baseline and 3 months.

Duration	Mean ± SD	P-value (ANOVA test)	Δ, P-value
Baseline	56.03 ± 22.11	P = 0.000**	44.00 ± 15.12, P = 0.000**
3 months	12.03 ± 6.99		

**Highly statistically significant P < 0.001.

Table 5: Correlation between clinical parameters and electromyography (EMG).

Baseline	EMG	Clinical parameters					
		PI		PPD		CAL	
	Rest	r-value	P-value	r-value	P-value	r-value	P-value
	RM	0.083	0.662	−0.068	0.721	−0.064	0.736
	LM	0.048	0.801	−0.032	0.866	−0.179	0.343
	RT	0.093	0.624	−0.089	0.640	−0.071	0.700
	LT	0.130	0.493	−0.009	0.962	−0.355	0.054
	Clench						
	RM	−0.011	0.953	−0.159	0.401	−0.016	0.933
	LM	0.063	0.740	−0.305	0.101	−0.351	0.057
	RT	0.076	0.689	−0.235	0.211	−0.214	0.256
	LT	0.234	0.213	−0.308	0.097	−0.183	0.333

Table 5 (*continued*)

3 Months	EMG	Clinical parameters					
		PI		PPD		CAL	
	Rest	r-value	P-value	r-value	P-value	r-value	P-value
	RM	0.013	0.945	−0.325	0.079	−0.230	0.221
	LM	−0.103	0.945	−0.349	0.058	−0.179	0.343
	RT	0.397	0.029*	−0.069	0.717	−0.136	0.473
	LT	0.211	0.263	−0.002	0.991	−0.116	0.541
	Clench						
	RM	−0.020	0.916	−0.028	0.883	−0.007	0.970
	LM	−0.075	0.693	−0.148	0.435	−0.120	0.520
	RT	0.043	0.821	0.074	0.697	−0.063	0.740
	LT	0.043	0.821	−0.045	0.813	−0.030	0.874

Plaque index (PI), probing pocket depth (PPD), clinical attachment level (CAL).
*Statistically significant $P < 0.05$.

Table 6: Correlation between electromyography (EMG) & the Oral Impact on Daily Performance (OIDP) questionnaire.

	EMG	Baseline		3 months	
		r-value	P-value	r-value	P-value
Rest	RM	−0.246	0.189	0.258	0.168
	LM	−0.051	0.789	0.348	0.059
	RT	−0.241	0.200	−0.018	0.926
	LT	0.053	0.782	0.405	0.026*
Clench	RM	−0.099	0.601	0.013	0.947
	LM	0.318	0.086	0.007	0.970
	RT	0.244	0.193	−0.059	0.756
	LT	0.201	0.286	−0.055	0.773

Right masseter (RM), left masseter (LM), right temporalis (RT), left temporalis (LT).
*Statistically significant $P < 0.05$.

in a reduction in the number of mechanoreceptors per unit area on the PDL bearing occlusal stresses, thus resulting in a reduction in threshold excitation. As a result, significant biting pressures focused on minor areas will be controlled by feedback reactions from that area's periodontal tissues, thus limiting the activity of the masticatory muscles.[3,10,11]

Microneurographic studies demonstrated the absence of sensory input results in diminished masticatory force and unclear spatial control of jaw movements during chewing.[12] The loss of periodontal tissues resulted in distinct masticatory abnormalities which can be attributed to the periodontal ligament's impaired sensory function.[13] Mechanoreceptors in the periodontal ligament send information to the brain regarding forces exerted by the teeth in the neurological regulation of masticatory action. Inflammation and reduced periodontal support cause defective mechanoreceptor innervations, thus resulting in low threshold levels, thus compromising masticatory force control and reducing a patient's quality of life.[9,10,13,14]

As a result, alleviating inflammation may encourage these receptor units to respond more quickly, thus increasing mastication. Therefore, a well-planned and performed periodontal therapy can significantly improve the quality of receptors in the periodontium, thereby recuperating the neuromuscular function of the masticatory system and the quality of life.[9]

Of the major muscles of mastication (masseter, temporalis, medial and lateral pterygoid), the medial pterygoid is difficult to reach, and the lateral pterygoid is a relatively small muscle and may not be the major contributor during the masticatory process. Therefore, the masseter and temporalis muscles were chosen for electromyographic evaluation in our study.[6]

Masticatory muscle activity is influenced by various factors such as age, gender, dentulous conditions, the number of years of being edentulous, oral conditions, denture stability and the presence of parafunctional habits.[15–17] Sensory feedback is altered in edentulous subjects, thus resulting in alterations of the efficiency of the muscles and smaller masticatory forces when compared to dentulous patients.[18] Similarly, a reduction in the masticatory efficiency and masticatory load can be observed in periodontal disease[19,20]

In periodontal disease, the occlusal equilibrium is flawed, and very little importance has been placed on evaluating the change in masticatory muscle activity due to periodontal disease; thus, little is known as to how to regain the lost mechanoreceptors after periodontal regenerative procedures.[3,4] This lack of knowledge impelled us to investigate masticatory function in patients with periodontitis. Of the various procedures used to restore the periodontal health of an individual, flap surgery is the most common surgical procedure performed to gain access to the underlying structures, thus alleviating periodontal inflammation.

Until now, there has been no evidence in the literature pertaining to masticatory muscle activity after periodontal flap surgery.. In this study, we observed a considerable improvement in periodontal clinical indicators after flap surgery with a mean CAL gain of 2.5 mm from baseline to 3 months; this was a statistically significant change. There was also a remarkable improvement in mobile teeth; in that mobility improved from absent to moderate. None of the patients complained of developing mobility following periodontal surgery, thus indicating successful periodontal treatment and good patient compliance following oral hygiene instructions.

sEMG permits non-invasive examinations by addressing bioelectrical phenomena related to the muscular contraction of muscles responsible for chewing, swallowing and posture of the head. Therefore, this method can help to assess the improvement of muscles after periodontal therapy.[21]

In a previous study, the electromyographic activity (EMG) of masticatory muscles (AT and MST) were reduced in patients with chronic periodontitis when compared to periodontally healthy patients.[9] In another study, Lamba et al. compared the masticatory muscle activity of healthy and periodontitis subjects and reported similar rEMG values in both groups; these findings were comparable to the results of the current study in which rEMG values were similar before (i.e., diseased periodontium) and after the treatment of periodontal disease (healthy periodontium).[9] Also the cEMG values of the masseter muscle were greater in the periodontitis group (51.87 ± 16.43 μV); these values were similar to those acquired in the current study (54.94 ± 21.54 μV). There was a significant improvement in temporalis and masseter muscle activity from baseline to 3 months following periodontal treatment in the present study; this was consistent with a previous study in which there was a significant improvement in cEMG activity after non-surgical periodontal therapy in patients with aggressive periodontitis.[11]

In the present study, a week negative correlation was found between periodontal parameters and rEMG and cEMG activity. However, an earlier study also reported a negative correlation which was statistically significant.[9]

According to Edel and Wills, the periodontal ligament is accountable for monitoring the force directed on the teeth; the presence of periodontal inflammation changes the mechanoreceptor threshold levels.[22] Williams et al. demonstrated that inflammatory damage to the periodontal ligament impairs sensory function, thus resulting in reduced control of excessive bite force and reduced masticatory activity; these authors concluded that a reduced periodontal ligament may influence the neural control of masticatory actions due to deprivation or changes in sensory function.[23]

Variations in the improvement of muscle activity on either side during rEMG and cEMG can be attributed to various factors such as unilateral chewing, thus avoiding the affected side or changing dietary habits causing a reduction in nutritional bioavailability. This may increase the risk of gastrointestinal disorders by affecting the quality-of-life.[24]

The true end points of periodontal therapy, as perceived by patients, are subjective in nature; in the present study, we used the oral impact on daily performance (OIDP) questionnaire, a global socio-dental index of oral health-related quality of life.[24]

In the present study there was a significant difference in mean OIDP total score prior after periodontal flap surgery. These results show that periodontal treatment improved the quality-of-life; this was similar to a previous report.[4] Pearson correlation analysis showed that with an enhancement in clinical periodontal parameters, the OIDP scores reduced from baseline to 3 months, thus indicating enhancement in the patient's quality-of-life but with a weak correlation. Furthermore, correlation between EMG activity and OIDP questionnaire showed that the patient's subjective perception and quality-of-life had improved from baseline to 3 months with an improvement in muscle activity. The present study demonstrates periodontal disease can exert impact on a patient's perceptions concerning oral health and that there is a significant association between OHRQoL and periodontal disease, as confirmed previously.[9] There is relatively little data linking periodontal therapy with everyday activity performance; this makes comparisons to past studies in this sector difficult. To enhance awareness of the influence on everyday performance, new methodologies with larger samples and longer follow-up periods are essential. Although the correlation was not statistically significant, there was an improvement in masticatory efficiency after successful periodontal flap surgery, as indicated by subjective perception through the OIDP questionnaire.

Limitations

Multicentric case control trials with large sample sizes and individuals with varying degrees of periodontal disease and demographic characteristics would provide more conclusive results. The inclusion of bite force analysis and correlations with electromyographic activity before and after treatment would have yielded more accurate findings.

Conclusion

Periodontal treatment had a significant impact on masticatory muscle function in the masseter muscle when compared to the temporalis muscle, thus resulting in an increased quality-of-life.

Source of funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not for profit sectors.

Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

The institutional ethics committee (Reference: VDC/IEC/2018/19) approved the trial protocol on 23rd November 2018, which was also filed with the Clinical Trials Registry of India (CTRI/2019/11/022074).

Consent

All the participants were informed and written consent was taken before their participation in the study.

Authors contributions

VSE, RSVK, and SNVSG carried out the research and collected the data. VSE and KSVR designed and supervised the study, visualized and validated the data, acquired funding, and reviewed draft material. The data were organized, analyzed, and interpreted by GSP, NVSG, MKP AND VJ, RSVK and NVSG reviewed the article. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

References

1. Soboleva U, Laurina L, Slaidina A. The masticatory system–an overview. **Stomatologija 2005**; 7(3): 77—80.
2. Ashraf H. To determine the influence of the complete denture prosthesis on masticatory muscle activity in elderly patients: an in vivo study. **IJOPRD 2011**; 1(1): 35—40.
3. Pereira LJ, Gazolla CM, Magalhães IB, Dominguete MH, Vilela GR, Castelo PM, et al. Influence of periodontal treatment on objective measurement of masticatory performance. **J Oral Sci 2012**; 54(2): 151—157.
4. Pereira LJ, Gazolla CM, Magalhães IB, Ramos-Jorge ML, Marques LS, Gameiro GH, et al. Treatment of chronic periodontitis and its impact on mastication. **J Periodontol 2011**; 82(2): 243—250.
5. Raju DS, Naidu LD. Electromyography-electromyography in orthodontics in particular and dentistry in general: a review-II. **Ann Dent 2012**; 4(4): 42—48.
6. Sischo L, Broder HL. Oral health-related quality of life: what, why, how, and future implications. **J Dent Res 2011**; 90(11): 1264—1270.
7. Caton JG, Armitage G, Berglundh T, Chapple ILC, Jepsen S, Kornman KS, et al. A new classification scheme for periodontal and peri-implant diseases and conditions - introduction and key changes from the 1999 classification. **J Clin Periodontol 2018**; 45: S1—S8.
8. Smith BG, Knight JK. An index for measuring the wear of teeth. **Br Dent J 1984 Jun 23**; 156(12): 435—438.
9. Lamba AK, Tandon S, Faraz F, Garg V, Aggarwal K, Gaba V. Effect of periodontal disease on electromyographic activity of muscles of mastication: a cross-sectional study. **J Oral Rehabil 2020**; 47: 599—605.
10. Borges Tde F, Regalo SC, Taba Jr M, Siéssere S, Mestriner Jr W, et al. Changes in masticatory performance and quality of life in individuals with chronic periodontitis. **J Periodontol 2013 Mar**; 84(3): 325—331.
11. Alshams M, Othman M, Haddad I, Sulaiman AA. Evaluating the effects of non-surgical periodontal treatment on masticatory function in patients with aggressive periodontitis: a preliminary study. **J Clin Diagn Res 2019**; 13: 14—16.
12. Trulsson M, Johansson RS. Encoding of tooth loads by human periodontal afferents and their role in jaw motor control. **Prog Neurobiol 1996**; 49(3): 267—284.
13. Johansson AS, Svensson KG, Trulsson M. Impaired masticatory behavior in subjects with reduced periodontal tissue support. **J Periodontol 2006**; 77(9): 1491—1497.
14. Van Steenberghe D, van den Bergh A, de Vries JH, Schoo WH. The influence of advanced periodontitis on the psychophysical threshold level of periodontal mechanoreceptors in man. **J Periodontal Res 1981**; 16(2): 199—204.
15. Gaszynska E, Kopacz K, Fronczek-Wojciechowska M, Padula G, Szatko F. Electromyographic activity of masticatory muscles in elderly women - a pilot study. **Clin Interv Aging 2017**; 12: 111—116.
16. Gadotti I, Hicks K, Koscs E, Lynn B, Estrazulas J, Civitella F. Electromyography of the masticatory muscles during chewing in different head and neck postures - a pilot study. **J Oral Biol Craniofac Res 2020**; 10(2): 23—27.
17. Adhikari H, Kapoor A, Prakash U, Srivastava A. "Electromyographic pattern of masticatory muscles in altered dentition" Part II. **J Conserv Dent 2011**; 14(2): 120—127.
18. Alajbeg IZ, Valentic-Peruzovic M, Alajbeg I, Illes D, Celebic A. The influence of dental status on masticatory muscle activity in elderly patients. **Int J Prosthodont 2005**; 18(4): 333—338.
19. Barbe AG, Javadian S, Rott T, Scharfenberg I, Deutscher HCD, Noack MJ, et al. Objective masticatory efficiency and subjective quality of masticatory function among patients with periodontal disease. **J Clin Periodontol 2020**; 47(11): 1344—1353.
20. Palinkas M, Borges TF, Junior MT, Monteiro SAC, Bottacin FS, Mestriner-Junior W, et al. Alterations in masticatory cycle efficiency and bite force in individuals with periodontitis. **Int J Health Sci (Qassim) 2019**; 13(1): 25—29.
21. Nishi SE, Basri R, Alam MK. Uses of electromyography in dentistry: an overview with meta-analysis. **Eur J Dent 2016**; 10: 419—425.
22. Edel A, Wills DJ. A method of studying the effects of reduced alveolar support on the sensibility to axial force on the incisor teeth in humans. **J Clin Periodontol 1975**; 2(4): 218—225.
23. Williams WN, Low SB, Cooper WR, Cornell CE. The effect of periodontal bone loss on bite force discrimination. **J Periodontol 1987**; 58: 236—239.
24. Jamal MZ. *Computational intelligence in electromyography analysis-a perspective on current applications and future challenges*. Australia: Intech Open; 2012. pp. 427—448. Chapter 18, Signal acquisition using surface EMG and circuit design considerations for robotic prosthesis.
25. Silness J, Loe H. Periodontal disease in pregnancy. II. Correlation between oral hygiene and periodontal condtion. **Acta Odontol Scand 1964 Feb**; 22: 121—135.

How to cite this article: Santosh VE, Konathala RSV, Penmetsa GS, Gottumukkala SNVS, Pasupuleti MK, Jaswitha V. Electromyographic evaluation of masseter and temporalis muscle activity after periodontal surgery: A prospective clinical trial. J Taibah Univ Med Sc 2023;18(2):356—365.