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Original Research

Comparative Evaluation of Masticatory Efficiency in Patients with and without Fixed Partial Denture: An Electromyographic Study

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ABSTRACT:

Context: Mastication is the initial stage of digestion, relying on the coordinated function of the masticatory system, which includes muscles, bones, ligaments, teeth, and nerves. The loss of posterior teeth reduces masticatory efficiency due to diminished occlusal contacts and reduced periodontal receptor feedback, affecting jaw muscle activity. **Aims:** This study aims to evaluate the impact of fixed partial dentures on masticatory muscle activity by analyzing the masseter and anterior temporalis muscles function in maximum intercuspation with and without biting force, using surface electromyography. **Settings and Design:** This in-vivo, single-blind, cross-sectional study consist 5 participants whose muscle activity was analyzed. **Materials and Methods:** A total of five participants were included in the study and categorized into two groups: Group 1: Individuals without fixed partial dentures and Group 2: Individuals rehabilitated with fixed partial dentures. For the both the groups muscle activity was checked in maximum intercuspation under biting force and without biting force. **Statistical Analysis Used:** Statistical analysis was performed using SPSS software v.11.5, with the level of significance set at $p \leq 0.05$. The data were analyzed using Analysis of Variance (ANOVA). **Results:** The findings revealed a significant increase in muscle activity following rehabilitation with FPDs, emphasizing the complex relationship between dental restoration and masticatory function. **Conclusion:** The masseter and anterior temporalis muscles were examined due to their accessibility for surface electrode recordings.Neuromuscular patterns and EMG activity appeared to be influenced by continuous sensory feedback from the dentition, occlusal balance, periodontal ligaments, and temporomandibular joints.

Keywords: Electromyography, Canine Guided Occlusion, Maximum Intercuspation, Biting Force, Masticatory Muscles

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INTRODUCTION

Masticatory efficiency largely depends on dental integrity, particularly the number of posterior occlusal contacts, the type of prosthesis used to replace missing teeth, and the function of jaw-closing muscles. Occluding teeth and periodontal receptors provide crucial feedback to these muscles, ensuring efficient mastication. Consequently, the loss of posterior teeth can lead to diminished masticatory performance and decreased overall muscle activity. [1] This study aims to assess the relationship between dental status and masticatory function by comparing the muscle activity of the masseter and anterior temporalis before and after rehabilitation with fixed partial dentures. Surface electromyography (EMG) was utilized to evaluate muscle activity in maximum intercuspation, both with and without applied biting force. Since posterior occlusal contacts, prosthetic rehabilitation, and masticatory muscle function collectively influence chewing efficiency, the absence of posterior teeth can result in a decline in muscle activity due to insufficient sensory feedback from the periodontal receptors. [1] EMG is widely employed in the evaluation of jaw-closing and masticatory muscle function, capturing electrical activity during maximum intercuspation. It is also instrumental in analyzing parafunctional habits such as bruxism, temporomandibular disorders (TMD), and posture

maintenance. Additionally, EMG studies have examined how occlusal conditions and prosthetic treatments influence masticatory muscle function. This study specifically evaluates EMG activity in masticatory muscles of individuals with a canine-guided occlusion scheme following fixed partial denture placement. It further examines the motor function of the masseter and anterior temporalis muscles in maximum intercuspation, both with and without applied biting force. [2]

MATERIAL AND METHODS

A total of five participants were included in the study and categorized into two groups: Group 1: Individuals without fixed partial dentures and Group 2: Individuals rehabilitated with fixed partial dentures. Inclusions criteria were participants eligible with unilateral loss of a single posterior tooth, requiring replacement with a fixed partial denture, age between 18 and 50 years, no significant dental or periodontal pathology, rehabilitation with a porcelain-fused-to-metal (PFM) fixed partial denture, presence of Class I occlusion and canine-guided occlusion if present. Participants were excluded if they had symptoms of temporomandibular disorders (TMD), history of recent occlusal splint therapy, parafunctional habits such as bruxism or clenching and skeletal malocclusions. The study was reviewed and approved by institutional ethical committee with reference number: IPDC/370. Written informed consent was obtained by each individual participating in the study. Electromyographic (EMG) evaluation was performed to assess the activity of the masseter and anterior temporalis muscles in both groups. Muscle function was recorded in maximum intercuspation, both with and without biting force.EMG signals were recorded using the Biopac Sys MP150WSW unit to evaluate the activity of the masseter and anterior temporalis muscles bilaterally. Surface bipolar, self-adhesive electrodes were employed, maintaining an inter-electrode distance of 20 mm. A bipolar electrode configuration was used, with the ground electrode positioned below the earlobe. To minimize electrode impedance, meticulous skin preparation was performed before electrode placement. EMG recordings began 5-6 minutes post-electrode placement to ensure optimal skin conductivity. Four Ag-Cl composition electrodes (dimensions: 4.0 cm × 3.6 cm) were placed symmetrically on both sides of the temporalis and masseter muscles, ensuring precise alignment with the middle of the muscle fibers. Temporalis electrode was positioned vertically along the anterior margin of the muscle, approximately 3 cm from the zygomatic arch and lateral to the eyebrow. Masseter electrode was aligned parallel to the muscle fibers, with its upper pole positioned at the intersection of the tragus-labial commissural and exocanthion-gonion lines. EMG recordings were obtained twice for each participant: Before fixed partial denture (FPD) fabrication and two weeks after FPD fabrication.

The EMG recording system comprised an isolated preamplifier with an input impedance >100MΩ, connected to a computer for data storage and analysis. Participants were seated upright in a dental chair with the Frankfort plane parallel to the floor. Each subject was instructed to achieve maximum intercuspation three times for approximately three seconds each. EMG measurements were conducted by a single blinded operator, ensuring unbiased data collection. The primary EMG variable assessed was the peak EMG activity of the masseter and anterior temporalis muscles during maximum intercuspation. The processed EMG data were subjected to statistical analysis to assess the impact of FPD on masticatory muscle function. Statistical analysis was performed using SPSS software v.11.5, with the level of significance set at $p \leq 0.05$. The data were analyzed using Analysis of Variance (ANOVA) within the General Linear Model with Repeated Measures framework. For multiple comparisons of mean values and contrasts, the Bonferroni test was applied. Additionally, t-tests were conducted to assess the homogeneity of both groups in terms of age and baseline EMG activity of the masseter and anterior temporalis muscles before fixed partial denture rehabilitation.

RESULTS

The electromyographic (EMG) activity of the masseter and anterior temporalis muscles was evaluated under two conditions: without biting force and with biting force, both before and after rehabilitation with a fixed partial denture (FPD). For the masseter muscle without biting force, the mean EMG value increased from 99.51 μV without FPD to 244.50 μV with FPD. Under biting force, the mean EMG value for the masseter further increased from 137.50 μV without FPD to 302.70 μV with FPD. Similarly, for the anterior temporalis muscle, without biting force, the mean EMG value rose from 104.20 μV without FPD to 247.20 μV with FPD. With biting force, the anterior temporalis showed an increase from 138.80 μV without FPD to 297.70 μV with FPD. These results indicate that the placement of a fixed partial denture significantly enhanced the muscle activity of both the masseter and anterior temporalis muscles. The increase in EMG activity suggests an improvement in neuromuscular function and masticatory efficiency following prosthetic rehabilitation. (Table 1).

Mean differences in electromyographic (EMG) activity of the masseter and anterior temporalis muscles under two biting conditions — with and without biting force — comparing results before and after placement of fixed partial dentures (FPDs). In the masseter muscle, without biting force, the mean EMG value increased from 99.51 μV before FPD to 244.55 μV after FPD, with a statistically significant F-

value of 106.796 and a p-value of 0.000. Under biting force, the masseter muscle showed an increase from 137.50 μV before FPD to 302.70 μV after FPD, again statistically significant with an F-value of 685.742 and a p-value of 0.000. Similarly, for the anterior temporalis muscle, without biting force, the mean EMG value rose from 104.23 μV to 247.23 μV after FPD placement, with an F-value of 186.463 and a p-value of 0.000. With biting force, the anterior temporalis muscle increased from 138.89 μV to 297.70 μV, with an F-value of 223.720 and a p-value of 0.000. In all comparisons, the differences were statistically highly significant ($p < 0.001$). These findings demonstrate that fixed partial dentures significantly improve the masticatory muscle activity under both resting and active conditions, reinforcing the role of prosthetic rehabilitation in restoring efficient neuromuscular coordination. (Table 2) An intergroup comparison of electromyographic (EMG) activity for the masseter and anterior temporalis muscles, analyzing the differences between patients without fixed partial dentures (FPD) and those rehabilitated with FPDs, under both biting and non-biting conditions. For the masseter muscle without biting force, the mean EMG activity increased from 99.51 μV in the non-FPD group to 244.55 μV in the FPD group, with a statistically significant F-value of 106.796 and a p-value of 0.000. With biting force, the masseter muscle showed an increase from 137.50 μV without FPD to 302.70 μV with FPD, again highly significant (F-value 685.742, $p = 0.000$). Similarly, for the anterior temporalis muscle, without biting force, the mean EMG activity rose from 104.23 μV in the non-FPD group to 247.23 μV in the FPD group, with a highly significant F-value of 186.463 and p-value of 0.000. Under biting force, the anterior temporalis showed an increase from 138.89 μV without FPD to 297.70 μV with FPD, with an F-value of 223.720 and p-value of 0.000. Across all comparisons, results were statistically significant, indicating that patients rehabilitated with fixed partial dentures exhibited a substantial improvement in masticatory muscle activity compared to those without prosthetic rehabilitation. This underscores the positive effect of fixed partial dentures on neuromuscular efficiency and occlusal stability during maximum intercuspation. (Table 3)

Table 1: Muscle Activity – Without Fixed Partial Denture and With Fixed Partial Denture

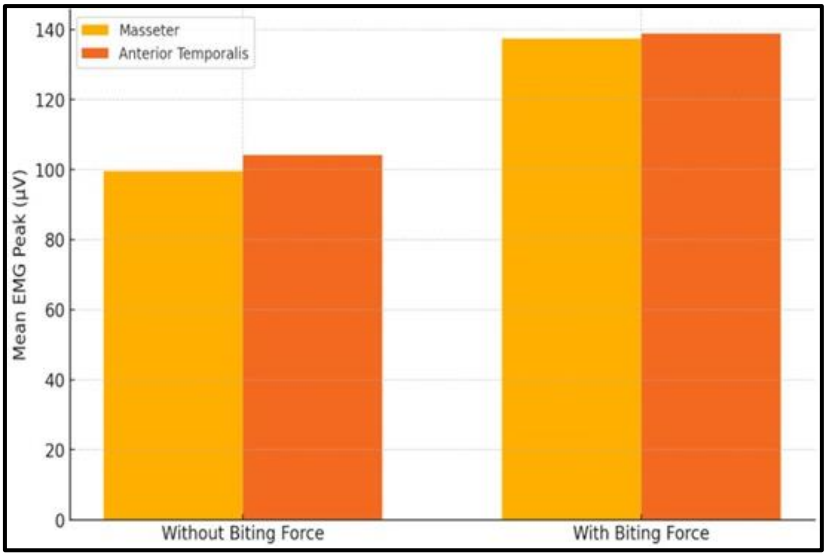
Muscle	Biting Condition	Mean (μV) Without FPD	Mean (μV) With FPD	F-value	p- value	Significance
Masseter	Without biting force	99.51	244.55	106.796	0.000	Significant
	With biting force	137.50	302.70	685.742	0.000	Significant
Anterior Temporalis	Without biting force	104.23	247.23	186.463	0.000	Significant
	With biting force	138.89	297.70	223.720	0.000	Significant

Table 2: Mean Differences – With and Without Biting Force

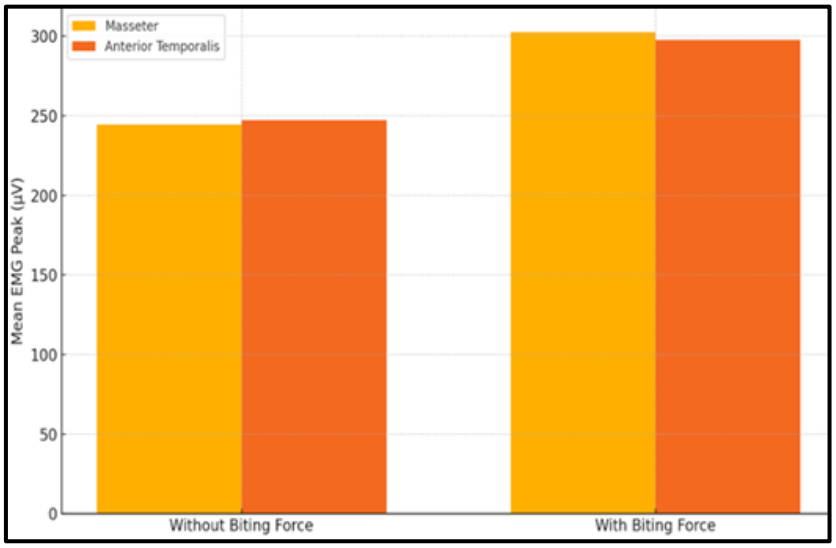
Muscle	Condition	Mean (μV)	Std. Deviation	Std.Error Mean	Mean (μV)	Std. Deviation	Std.Error Mean
Masseter	Without biting force	99.51	8.275	3.701	244.50	30.272	13.538
	With biting force	137.50	8.304	3.713	302.70	11.399	5.097
Anterior Temporalis	Without biting force	104.20	12.526	5.601	247.20	19.785	8.848
	With biting force	138.80	14.136	6.322	297.70	19.074	8.530

Table 3: Intergroup Comparison – With and Without FPD

Muscle	Condition	Mean (μV)	Std. Deviation	Std.Error Mean	Mean (μV)	Std. Deviation	Std.Error Mean
Masseter	Without biting force	99.51	8.275	3.701	244.50	30.272	13.538
	With biting force	137.50	8.304	3.713	302.70	11.399	5.097
Anterior Temporalis	Without biting force	104.20	12.526	5.601	247.20	19.785	8.848
	With biting force	138.80	14.136	6.322	297.70	19.074	8.530



Graph 1: Muscle activity without FPD



Graph 2: Muscle activity with FPD

DISCUSSION

Electromyographic (EMG) analysis plays a crucial role in assessing masticatory muscle function, particularly in understanding how dental prosthetics impact muscle activity during mastication. This study compared the EMG signals of the masseter and anterior temporalis muscles during maximum intercuspation with and without biting force in patients before and after receiving fixed partial dentures (FPDs). The findings revealed a significant increase in muscle activity following rehabilitation with FPDs, emphasizing the complex relationship between dental restoration and masticatory function. The muscle activity was markedly increased under biting force (Graph 2). Before receiving FPDs, patients exhibited varying muscle activity levels due to compromised occlusion, tooth loss, or altered chewing patterns. In the absence of biting force, both muscles showed reduced activity, likely due to decreased masticatory load and diminished coordination, aligning with previous research on non-functional muscle states.[3] Following FPD rehabilitation, there was a marked increase in EMG activity in both muscles during maximum intercuspation. This enhancement can be attributed to improved occlusion, better tooth alignment, and more efficient muscle contractions during mastication. The restored occlusion allows for greater coordination between the masseter and temporalis muscles, leading to increased activity. Additionally, the FPD facilitates stronger bite force generation, requiring muscle adaptation to new functional demands.[4]

The masseter muscle demonstrated higher activation than the anterior temporalis, consistent with its primary role in force generation during biting and chewing. The increase in muscle activity post-rehabilitation may also reflect the central nervous system's adaptation to improved occlusion. The brain enhances its control over the masticatory muscles when provided with stable sensory input, leading to more precise muscle activation. Furthermore, the restoration of proprioceptive feedback through the

FPD allows for more efficient muscle function, contributing to the observed increase in activity.[5]

CONCLUSION

Surface electromyography (EMG) is a non-invasive and effective method for analyzing masticatory muscle function before and after dental treatments. Its applications are widely used in prosthodontics, orthodontics, and oral physiology. The masseter and anterior temporalis muscles are commonly examined due to their accessibility for surface electrode recordings. However, factors such as electrode placement, skin impedance, subcutaneous fat, and muscle depth can affect measurement reliability. Implementing standardized protocols minimizes these variables, ensuring consistent and clinically valuable EMG data.[6] The findings of this study align with previous research, showing that individuals with greater occlusal stability exhibit increased EMG activity during maximum intercuspation. This may be due to a higher number of posterior contacts, which provide stable occlusal support and enhance muscle activation during clenching and chewing. Neuromuscular patterns and EMG activity appear to be influenced by continuous sensory feedback from the dentition, occlusal balance, periodontal ligaments, and temporomandibular joints.[7] A limitation of this study was the small sample size due to strict inclusion criteria. Additionally, EMG recordings were limited to the masseter and anterior temporalis muscles, excluding other masticatory and jaw-closing muscles. There is also no standardized protocol for surface EMG detection in both static and dynamic oral tasks. Future research should explore changes in EMG activity during dynamic tasks, such as chewing, to better understand neuromuscular adaptations following dental rehabilitation. The restoration of dental occlusion likely influences neuromuscular patterns, promoting well-regulated, balanced occlusal contacts.[8]

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