



Prosthodontics

A COMPARISON OF ELECTROMYOGRAPHIC ACTIVITIES OF MASSETER AND ANTERIOR TEMPORALIS MUSCLES IN REST POSITION AND MAXIMUM VOLUNTARY CLENCHING OF EDENTULOUS PATIENTS BEFORE AND AFTER USING THE COMPLETE DENTURE: AN IN-VIVO STUDY.

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ABSTRACT

Introduction: Mastication, an isometric and isotonic rhythmic contraction of the muscles of mastication, is the day-to-day function of stomatognathic system. In edentulous patients, masticatory force and the efficiency and amplitude of masticatory cycle are lower than the dentate subjects. The electromyographic (EMG) variables usually approach to normal after rehabilitation with a denture. **Aim:** To compare the electromyographic activities of masseter and temporalis muscles at rest position and at maximum voluntary clenching in edentulous patients before and after using the complete dentures. **Materials and Method:** This cross-sectional and observational study was carried out on 50 subjects over a period two year (April-2022-March-2024). After siting the patient on dental chair, the clinical examination was done and documented. The EMG recordings were done for each muscle at rest position and maximal voluntary clenching before and after (post 6 months) insertion of the complete denture. **Result:** In this study, maximum study subjects 24(48%) belonged to age group of 56-60 years. At rest position, the mean EMG value of bilateral masseter and temporalis muscles with or without denture was significantly reduced post 6 month after using denture as compared to day 0 (p-value=0.001). At maximum clenching, the mean EMG activity of each muscle with or without denture was significantly higher post 6 month after using the denture as compared to day 0 (p-value=0.001). **Conclusion:** We concluded that the mean EMG activity of all four muscles at rest position was significantly reduced and at maximum clenching position was significantly increased after using the complete denture.

KEYWORDS : Conventional complete denture, masticatory muscle, physiologic rest position, Surface Electromyography

INTRODUCTION:

Mastication is a highly coordinated neuromuscular function involving fast effective movements of the jaw and continuous modulation of force.^[1] It is an alternating rhythm of isotonic and isometric contractions of the masticatory muscles during the everyday function of the stomatognathic system governed by a central pattern generator located in the brainstem.^[2] For edentulous individuals, age, tooth loss, parafunctional habits and even iatrogenic factor may lead to an alteration in the stomatognathic system; therefore, there are significant changes in aesthetics, speech, chewing and deglutition.^[3] Rehabilitation of lost teeth with conventional complete denture (CD) is still widely performed in general clinical setting owing to economic conditions and non-invasiveness of procedure.^[4]

The investigation of the adaptation process to a denture is relevant to understand the control of muscles during maximal voluntary clenching and may provide essential information for the diagnosis of dysfunctions of the masticatory system.^[1] The analysis of EMG activity and kinetics of the movement provides an insight into the motor control system.^[5] This study was undertaken to evaluate the muscle function. The masticatory efficiency of complete denture as compared to natural dentition is just 5%. So, Muscle function is important for the stability of denture thereby increasing the ability to chew fibrous food determinants for patient good health.

MATERIALANDMETHOD:

This cross-sectional and observational study was done in the Department of Prosthodontics and Crown & Bridge, Shree Bankey Bihari Dental College and Research Centre, Masuri Ghaziabad, Uttar Pradesh with in the collaboration into Yashoda superspeciality hospital. Approval for the study was obtained from Institutional Ethical Committee (Reference No. EC/NEW/INST/2022/2820). The study was carried out on 50 subjects (25 male and 25 female) aged between 55-65 years. All patients, who were presented with no teeth,

diminished occlusal vertical dimensions, and all asymptomatic patients who presented without signs and symptoms of Temporomandibular Disorders were studied. Out of which a total 50 patients were selected for this study that fulfill the exclusion and inclusion criteria.

Inclusion Criteria included subjects with age between 55-65 years, good nutritional status, good facial muscle tone, with low well-rounded ridges and all asymptomatic patients who were presented with no signs or symptoms of Temporomandibular Disorders.

Exclusion Criteria included subjects with uncontrolled diabetes, oral lesions, tobacco chewer, neuromuscular disease, rheumatoid arthritis, psychological problems, severe bone resorption (particularly of the mandibular arch) and bruxism

The selected patients were well informed about the treatment plan to be instituted and signed informed consent. After seating the patient on dental chair, the clinical examination & evaluation was done intra-orally and extra-orally and documented. Then the complete denture was made for the patients step by step as

The primary impression of maxillary arch and mandibular arch was recorded with impression compound [Figure-1]
The maxillary and mandibular primary cast was made [Figure-2]
A special tray was fabricated with cold cure acrylic
Border molding or peripheral tracing was done with low fusing compound
Wash impression was made by zinc oxide eugenol [Figure-3]
Then master cast was made by dental stone [Figure-4]
Denture base was fabricated by self-cure acrylic
Occlusal rims were fabricated
Orientation jaw relation was done with face bow
Face bow transfer on Hanau Articulator [Figure-5]

We placed Hight tracer on occlusal rims
 Centric jaw relation was recorded by arrow point tracing
 Centric and protrusive movement was recorded
 Programming of Hanau articulator was done
 Teeth arrangement was done [Figure-6]
 Denture trial was done in patient
 Denture insertion was done (EMG Recording was done before denture insertion and after denture insertion on same day)
 EMG Recording was done after using denture at 6th month

The electrode placement was done by palpation of the muscles and placed at the centre of masseter muscle and middle of both insertions point. For temporalis muscle, the anterior border was detected during the mandibular movement and the electrode was put perpendicular to the sagittal plane immediately behind the frontal process of zygomatic.”

At the time of EMG recording, the patient was kept in sitting position with no head rest aligned in Frankfort horizontal plane and parallel to the floor. The electrodes were connected to an amplifier via cables, and the amplifier connected to a computer with bioresarch (bio-EMG) software, Ultra Neuro Stim NS-2. The electrode signals were recorded and the muscles electrical activities were analyzed. The readings were recorded in the mandibular rest position, and during maximal clenching before (at day-0) and after post 6 months of insertion of complete dentures.

Electromyographic evaluation of the muscles with and without denture was performed under the following clinical conditions:

1. Rest position before using the complete denture (at day-0). [Figure-7,8]
2. At maximal voluntary clenching before using the complete denture (at day-0). [Figure-9,10]
3. Rest position after using the complete denture (at 6th month). [Figure-11,12]
4. At maximal voluntary clenching after using the complete denture (at 6th month). [Figure-13,14]

Cumulative comparisons were made between male and female group at resting position and maximum voluntary clenching readings post 6 months after using the complete denture.

Statistical Analysis: The data of the present study was tabulated in the Microsoft Excel 2007 and analyzed using the SPSS statistical software 23.0 Version. The level of the significance for this study was fixed at 5%. The intergroup comparison was done by using the independent t tests and Paired t test. The Shapiro–Wilk test was used to investigate the distribution of the data and Levene's test to explore the homogeneity of the variables.



[Figure 1]: Showing primary impression.



[Figure 2]: Showing primary maxillary and mandibular cast.



[Figure 3]: Showing secondary mandibular and maxillary impression.



[Figure 4]: Showing maxillary and mandibular master cast.



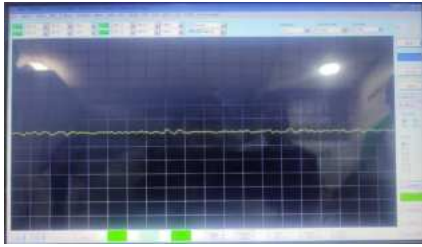
[Figure 5]: Showing face bow transfer on patient.



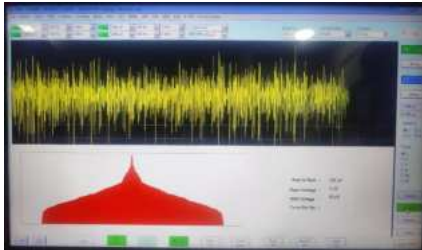
[Figure 6]: Showing Teeth Arrangement on Hanau.



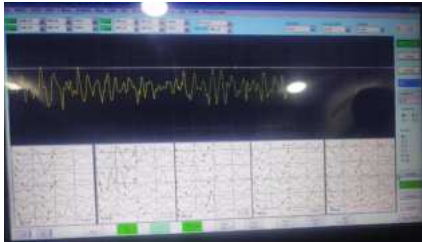
[Figure 7]: Showing EMG activity graph of Right Masseter Muscle at Rest Position before using the complete denture (at day 0).



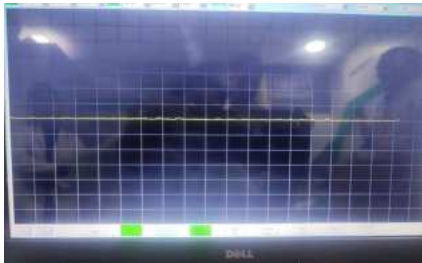
[Figure 8]: Showing EMG activity graph of Right Temporalis Muscle at Resting Position before using the denture (at day 0).



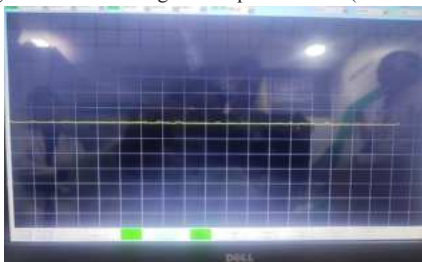
[Figure 9]: Showing EMG activity graph of Left Masseter Muscle at Maximum Clenching before using the denture (at day 0).



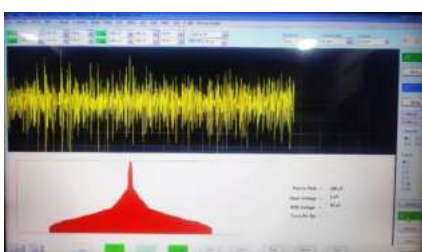
[Figure 10]: Showing EMG activity graph of Left Temporalis Muscle at maximum clenching before using the denture (at day 0).



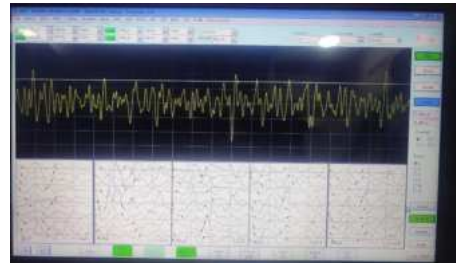
[Figure 11]: Showing EMG activity graph of Right Masseter Muscle at Resting Position after using the complete denture (at 6 month).



[Figure 12]: Showing EMG activity graph of Right Temporalis Muscle at Resting Position after using the complete denture (at 6 months).



[Figure 13]: Showing EMG activity graph of Left Masseter Muscle at Maximum Clenching after using the denture (at 6 month).



[Figure 14]: Showing EMG activity graph of Left Temporalis Muscle at maximum clenching after using the complete denture (at 6 months).

RESULT:

The present study was performed to evaluate the comparison of electromyographic activities of the masseter muscles and anterior temporalis muscles in rest position and maximum voluntary clenching of edentulous patients before (at day-0) and post 6 months of using the complete dentures.

In present study, maximum numbers of study subjects 24(48%) were found in 56-60 years of age group followed by 22(44%) subjects in 61-65 years of age group and 04(8.0%) subjects in 50-55 years of age group. The mean age of the males and females was 58.72 ± 3.07 and 61.32 ± 3.09 years respectively.

In present study, at resting position, the mean EMG activity of the right and left masseter muscle without or with denture was significantly reduced post 6 month after using the complete denture as compared the EMG activity at day-0 with mean difference $21.88 \pm 6.43 \mu V$, $16.32 \pm 4.89 \mu V$, $21.46 \pm 8.14 \mu V$, $20.40 \pm 7.92 \mu V$ and p -value=0.001 respectively.[Table-1]

Table-1: Masseter muscles mean EMG activity (μV) at rest position before (at day zero) and post 6 months after using the complete denture.

	Right Masseter		Left Masseter	
	Without Denture	With Denture	Without Denture	With Denture
At Day 0	74.46 $\pm$ 21.44	85.98 $\pm$ 20.92	87.30 $\pm$ 25.78	101.08 $\pm$ 25.11
After 6 Month	52.88 $\pm$ 27.59	69.36 $\pm$ 27.58	65.84 $\pm$ 32.26	80.68 $\pm$ 32.36
Mean Difference	21.88 $\pm$ 6.43	16.32 $\pm$ 4.89	21.46 $\pm$ 8.14	20.40 $\pm$ 7.92
P-value	0.001*	0.001*	0.001*	0.001*

p value less than 0.001 is highly significant, *=significant

In this study, at resting position, the mean EMG activity of the right and left temporalis muscle without or with denture was significantly reduced post 6 months after using the denture as compared to the EMG activity at day-0 with mean difference $31.90 \pm 3.45 \mu V$, $34.26 \pm 3.47 \mu V$, $30.64 \pm 3.19 \mu V$, $21.76 \pm 3.46 \mu V$ and p -value=0.001 respectively.[Table-2]

Table 2: Temporalis muscles mean EMG activity (μV) at rest position before (at day zero) and post 6 months after using the complete denture.

	Right Temporalis		Left Temporalis	
	Without Denture	With Denture	Without Denture	With Denture
At Day 0	102.90 $\pm$ 35.28	125.46 $\pm$ 34.58	118.04 $\pm$ 36.77	139.64 $\pm$ 36.28
After 6 Month	71.00 $\pm$ 33.07	91.20 $\pm$ 31.63	87.80 $\pm$ 36.88	107.88 $\pm$ 36.45
Mean Difference	31.90 $\pm$ 3.45	34.26 $\pm$ 3.47	30.64 $\pm$ 3.19	21.76 $\pm$ 3.46
P-value	0.001*	0.001*	0.001*	0.001*

p value less than 0.001 is highly significant, *=significant

In this study, at maximum clenching, the mean EMG activity of the right and left masseter muscle without or with denture was significantly increased post 6 months after using the denture as compared to the EMG activity at day-0 with mean difference $102.57 \pm 18.15 \mu V$, $147.78 \pm 31.14 \mu V$, $95.00 \pm 32.13 \mu V$, $150.96 \pm 22.12 \mu V$ and p -value=0.001 respectively.[Table-3]

Table 3: Masseter muscles mean EMG activity (μV) at maximum clenching before (at day zero) and post 6 months after using the complete denture.

	Right Masseter		Left Masseter	
	Without Denture	With Denture	Without Denture	With Denture
At Day 0	252.92 $\pm$ 52.34	290.86 $\pm$ 59.36	297.82 $\pm$ 60.36	328.68 $\pm$ 74.11
After 6 Month	355.12 $\pm$ 34.61	438.64 $\pm$ 92.61	392.82 $\pm$ 92.14	479.64 $\pm$ 93.11
Mean Difference	102.57 $\pm$ 18.15	147.78 $\pm$ 31.14	95.00 $\pm$ 32.13	150.96 $\pm$ 22.12
P-value	0.001*	0.001*	0.001*	0.001*

p value less than 0.001 is highly significant, *=significant

In present study, at maximum clenching, the mean EMG activity of right and left temporalis muscle without or with denture was significantly increased post 6 months after using the denture as compared to the mean EMG activity at day-0 with mean difference 105.68 $\pm$ 21.49 μV , 143.80 $\pm$ 2.47 μV , 104.58 $\pm$ 13.21 μV , 138.32 $\pm$ 1.17 μV and p-value=0.001 respectively.[Table-4]

Table 4: Temporalis muscles mean EMG activity (μV) at maximum clenching before (at day 0) and post 6 months after using the complete denture.

	Right Temporalis		Left Temporalis	
	Without Denture	With Denture	Without Denture	With Denture
At Day 0	301.58 $\pm$ 62.62	358.44 $\pm$ 8.042	314.94 $\pm$ 65.36	373.70 $\pm$ 78.79
After 6 Month	407.26 $\pm$ 83.67	502.24 $\pm$ 8.267	419.52 $\pm$ 83.41	512.02 $\pm$ 78.79
Mean Difference	105.68 $\pm$ 21.49	143.80 $\pm$ 2.47	104.58 $\pm$ 13.21	138.32 $\pm$ 1.17
P-value	0.001*	0.001*	0.001*	0.001*

p value less than 0.001 is highly significant, *=significant

In present study, at rest position without and with denture, we found non-significant difference in mean EMG activities of masseter and temporalis muscle between male and female group after using the complete denture at 6 months.[Table-5,6]

Table 5: Comparison of masseter muscles mean EMG activity (in μV) at rest position between male and female group post 6 month after using the complete denture

	Right Masseter		Left Masseter	
	Without Denture	With Denture	Without Denture	With Denture
Female	56.76 $\pm$ 29.70	74.08 $\pm$ 30.63	71.44 $\pm$ 35.30	86.60 $\pm$ 36.78
Male	49.00 $\pm$ 25.31	64.64 $\pm$ 23.78	60.24 $\pm$ 28.51	74.76 $\pm$ 26.71
Mean Difference	7.76 $\pm$ 4.31	9.64 $\pm$ 5.67	11.20 $\pm$ 6.57	11.84 $\pm$ 9.17
P-value	0.325*	0.238*	0.223*	0.199*

p value more than 0.05 is non-significant, *non-significant

Table 6: Comparison of temporalis muscles mean EMG activity (in μV) at rest position between male and female group post 6 month after using the complete denture.

	Right Temporalis		Left Temporalis	
	Without Denture	With Denture	Without Denture	With Denture
Female	71.84 $\pm$ 28.12	92.08 $\pm$ 26.20	88.60 $\pm$ 39.94	109.16 $\pm$ 38.97
Male	70.16 $\pm$ 37.97	90.32 $\pm$ 36.50	87.00 $\pm$ 34.23	106.60 $\pm$ 34.50
Mean Difference	0.68 $\pm$ 5.12	1.76 $\pm$ 8.98	1.60 $\pm$ 4.67	2.56 $\pm$ 4.57
P-value	0.550*	0.589*	0.684*	0.896*

p value more than 0.05 is non-significant, *non-significant

In present study, at maximum clenching, without and with denture, we found non-significant difference in mean EMG activities of masseter and temporalis muscle between male and female group after using the denture at 6 month.[Table-7,8]

Table 7: Comparison of masseter muscles mean EMG activity (in μV) at maximum clenching between male and female group post 6 month after using the complete denture.

	Right Masseter		Left Masseter	
	Without	With Denture	Without	With Denture

	Denture		Denture	
	Without Denture	With Denture	Without Denture	With Denture
Female	362.04 $\pm$ 74.46	446.52 $\pm$ 92.99	398.20 $\pm$ 87.52	481.40 $\pm$ 89.97
Male	348.20 $\pm$ 87.37	430.76 $\pm$ 92.68	387.44 $\pm$ 98.04	477.88 $\pm$ 98.28
Mean Difference	13.84 $\pm$ 10.17	15.86 $\pm$ 10.12	10.76 $\pm$ 10.54	3.52 $\pm$ 8.12
P-value	0.690*	0.846*	0.830*	0.405*

p value more than 0.05 is non-significant, *non-significant

Table 8: Comparison of temporalis muscles mean EMG activity (in μV) at maximum clenching between male and female group post 6 month after using the complete denture

	Right Temporalis		Left Temporalis	
	Without Denture	With Denture	Without Denture	With Denture
Female	400.64 $\pm$ 87.66	493.96 $\pm$ 83.45	417.68 $\pm$ 87.52	513.48 $\pm$ 84.68
Male	413.88 $\pm$ 80.81	510.52 $\pm$ 82.75	421.36 $\pm$ 80.85	510.56 $\pm$ 74.15
Mean Difference	13.24 $\pm$ 7.13	16.56 $\pm$ 4.57	3.68 $\pm$ 6.45	2.92 $\pm$ 12.45
P-value	0.581*	0.603*	0.678*	0.897*

p value more than 0.05 is non-significant, *non-significant

DISCUSSION:

The Masticatory system is a functional unit made up of teeth, bone, their supporting structures, the jaws, the temporomandibular joints (TMJ), the associated muscles, ligament, vascular and an intricate nervous system to regulate and coordinate all these structural components, and is primarily responsible for chewing, speaking and swallowing.^[6] The basic component of the neuromuscular system is the motor unit, which consist of a number of muscles fibers that are innervated by one motor neuron.^[7]

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.^[8] The masticatory muscles have the capacity to contract during daily use of the stomatognathic system and maintain muscle tone in mandibular rest position.

In edentulous patients, the masticatory cycle amplitude and efficiency, and the masticatory force are smaller in comparison with dentate subjects and directly depend on the size of muscles creating the forces, their position in the mandible, type of chewing, shape of the edentulous alveolar ridge and the degree of intermaxillary separation. Moreover, both the opening and closing velocity of masticatory cycles are reduced, while the occlusal pause is longer.^[1] In edentulous patients, the alveolar bone tends to resorb, the formation of new bone is lost, and the overlying mucosa presents a decreased number of receptors, resulting in the reduction of the afferent inputs, leading to altered sensory feedback.^[9] Due to the change in the influence of peripheral and central neural mechanisms in edentulous patients, several studies have shown that comparable to the subjects with natural teeth the denture wearers are unable to produce levels of muscle activity at maximal voluntary contraction.^[10]

The American College of Prosthodontists (ACP) has developed a classification system for completely edentulous patients based on diagnostic findings.^[11]

1. Class I representing an ideal or minimally compromised
2. Class II representing moderately compromised
3. Class III representing substantially compromised
4. Class IV representing severely compromised

The diagnostic criteria used in the classification system are: 1. Bone height-mandible. 2. Maxillomandibular relationship. 3. Residual ridge morphology-maxilla. 4. Muscle attachments-mandible.

Concepts of Complete Denture Occlusion:^[12]

1. Static concept: "The static relations in occlusion consist of centric occlusion, protrusive occlusion, and bilateral lateral occlusion. Each relation must be balanced with the simultaneous contacts of bilateral all teeth of the arch at their very first contact.

2. Dynamic concept: "The dynamic concept of occlusion is primarily concerned with opening and closing movements involved in mastication. Jaw movements and tooth contacts are made, as the teeth of one jaw glide over the teeth of the opposing jaw."

Occlusal rehabilitation in complete denture fall into four occlusal concepts

- Unbalanced articulation
- Balanced articulation
- Linear or monoplane articulation
- Lingualized articulation.

In complete denture wearers, the bite force is significantly decreased in relation to people with natural teeth and the reduction of masticatory efficacy may be caused by irregular activity of masticatory musculature or is the consequence of irregular flow of energy during mastication.^[13]

In 1949 RE Moyer introduced the technique electromyography, to analyze and quantify the behavior of the masticatory muscles the electromyography is a sensitive tool and widely used for measuring muscle function.^[14]

Electromyography (EMG) is defined as the graphic recording of the electrical potential of muscle.^[15] Electromyography is a device used to evaluate, record and study the fundamental myoelectric properties of skeletal muscle using superficial electrodes (Surface Electromyography) or needle electrodes (Intramuscular Electromyography) which basically determine the muscle is contracting or not.^[16] EMG is widely used in dentistry to study and determine TMJ problems, TMJ dysfunction, dystonia, head and neck muscular illnesses, cranial nerve lesions, seizures and to detect the chewing abilities in denture wearers since years.^[16,17]

The surface EMG has long been the “gold standard” for monitoring muscle activity of masticatory muscle at rest and in function.^[4] Surface electromyography can be an excellent method of measuring masticatory muscular activity, stability and comfort during static and dynamic tasks.^[18] The reasons for evaluating the masseter and temporalis muscles are firstly as these are one of the two muscles of mastication, which are superficial and can be palpated. So, their function can be recorded by the surface electromyography.^[19]

In a previous study by Miralles R et al showed that the integrated EMG activity of both muscles during maximal voluntary clenching was significantly lower in patients with complete dentures than in subjects with natural dentition.^[20]

This cross-sectional study was performed to compare the electromyographic activities of masseter and temporalis muscles at rest position and voluntary clenching in edentulous cases before and after using complete dentures.

In present study, at rest position, the mean EMG value of bilateral masseter muscle without and with denture was significantly reduced after using the complete denture (post 6 months) as compared to before using the complete denture (day-0) that was found statistically significant (p -value=0.001). The mean EMG activity of bilateral temporalis muscles without and with denture was significantly reduced after using the denture (post 6 months) as compared to before using the denture (day-0) that was found statistically significant (p -value=0.001). Nuno Licona A. et al.^[21] found that the EMG amplitude of temporal muscles decreased and masseter muscles elevated. Goiato MC. et al.^[1] revealed statistically no significant differences in mean electrical activity at five months after placement of new dentures. Zuccolotto MCC. et al.^[3] found that temporalis exhibit a significant elevation and masseter exhibits significant reduction in mean EMG activity than the initial values (p -value<0.01).

In present study, at maximum clenching, the mean EMG activity of bilateral masseter muscle without and with denture was significantly higher after using the denture (post 6 month) as compared to before using the denture (day-0) that was found statistically significant (p -value=0.001). The mean EMG activity of bilateral temporalis muscle with and without denture was significantly higher after using the denture (post 6 month) as compared to before using the denture (day-0) that was found statistically significant (p -value=0.001). Goiato MC. et al.^[1] observed a reduction in the mean electrical activity of bilateral temporalis muscle before and after the new dentures were put in place. However, in maximal tooth clenching, the bilateral masseter exhibited no significant difference statistically between pre and post treatment values. Ashraf H.^[6] found a highly significant upgradation in the temporalis muscle activity (p -value=0.003 & p -value=0.002) and

masseter muscle activity (p -value=0.001) with complete denture than subjects without complete denture at maximum voluntary contraction. Sinnurkar S. et al.^[19] revealed increase in muscle efficiency (p -value=0.000*, p -value=0.002*) was significantly high with new denture after 5-months follow than subjects with old denture at maximum voluntary contraction. Najjar RAA. et al.^[22] found every EMG potentials at maximum voluntary clench with reduced OVD were lesser than that with appropriate OVD, with significant differences statistically for each four analyzed muscles (p -value<0.05). Rasheed N et al.^[4] during clenching observed significantly higher mean EMG values at 1-year for bilateral masseter and temporalis muscle than at 2 months (p -value<0.001) and overall mean EMG value of masseter significantly higher than temporalis at 2-months (p -value=0.005) and 1-year (p -value=0.045).

In present study after 6 month of denture insertion, we found non-significant difference in mean EMG activity of all four muscles without or with denture between male and female group.

CONCLUSION:

We concluded that the mean EMG activity of all four muscles at rest position without or with denture was statistically significantly reduced after using the complete denture and at maximum clenching position the EMG activity of all four muscles without or with denture was statistically significantly increased after using the complete denture.

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