Original Article

Masticatory Efficiency of Partially Edentulous Patient's Pre And Post Fixed Prosthodontic Rehabilitation

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ABSTRACT

Background: EMG (electromyography) has been used to determine the masticatory efficiency of the muscles of mastication.
Method: In this study, Temporalis and Masseter muscle activity of patients with unilateral missing mandibular 1st molar were evaluated pre and post rehabilitation with three unit fixed partial denture prosthesis. Six male and four female patients, within the age range of 17–35 years and who had no cranio-mandibular disorder, any obvious malocclusion, or extensive restoration were included. Evaluation of masticatory efficiency was done by EMG analysis of anterior Temporalis and Masseter muscle simultaneously, bilaterally with 8-channel electromyograph. To see the difference, among the groups, pre and post rehabilitation Temporalis and Masseter muscle activity, on experimental side and control side were recorded and analysed*. Paired samples t-test was* applied for statistical data analysis
Result: Pre rehabilitation muscle activity of experimental side Temporalis was 565.36 ± 233.47 which increased to 683.8 ± 211.31 after rehabilitation. Pre rehabilitation muscle activity of experimental side Masseter was 616.54 ± 286.05 which increased to 711.99 ± 245.01after rehabilitation. Maximum change was observed in the muscle activity on experimental side Temporalis. Pre and post rehabilitation values for control side Temporalis were 670.74 ± 232.80 and 709.31 ± 209.73 whereas for Masseter the values were 727.91 ± 296.72 and 855.61 ± 277.53 respectively. Statistically significant changes were observed in Temporalis and Masseter.
Conclusion: Post rehabilitation there was an increase in both the Temporalis and Masseter muscle activity in all the patients. Post rehabilitation, Masseter muscle showed greater increases in muscle activity than that of Temporalis. During rest, Temporalis muscle was at minimum tonic contraction (average Amp. 90µv) whereas no contraction of the Masseter muscles noted bilaterally
Key words – emg (electromyography), fixed partial denture, masticatory efficiency , prosthodontic rehabilitation sensitivity.

INTRODUCTION

One of the most complex and critical neurophysiologic mechanism in human motor functions is mastication. Each tooth is highly specialized in dental arch according to its function. Permanent first molars are the most important units of mastication as they bear the maximum stresses during function. They are considered the "key to occlusion" as they are one of the first to erupt in the oral cavity and help to establish the occlusion.

However, permanent first molars are often lost early, specially the mandibular 1st molars. Mandibular molars erupt at an early age of six years, and therefore are exposed to the oral environment for longer period of time. Also, due to its distal position to the deciduous molars, it is often perceived to be a milk tooth and hence neglected. The result is often extensive caries necessitating its extraction. When a lost single tooth is not replaced,

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occlusal balance is disturbed. The consequences may be supra-occlusion of the opposing tooth or teeth, tilting of the adjacent teeth, defective proximal contacts, leading to dental caries, and injury to the periodontium with resultant derangement of occlusion. Loss of teeth and occlusal disharmony reduces the masticatory efficiency significantly.

For replacing a single tooth, the prosthodontic options available are removable partial denture, fixed partial denture and implant-supported prosthesis. Fixed partial denture is the most widely accepted option for replacement of missing teeth[1], [2] .It is said that changes in the number of natural teeth or replacement with fixed prosthodontic rehabilitation could influence muscle activity and therefore masticatory function[3]. Electromyography has been used to record muscle activity (Masseter and Temporalis muscle) during chewing and maximal biting. Tanaka[4] devised a possible method of measuring masticatory efficiency, where he evaluated masticatory efficiency by using "Inter jaw positional EMG". Observation of the inter jaw positional EMG enabled the understanding of the appearances of each chewing cycle communities**.** He concluded that estimation of masticatory efficiency was possible by using the inter positional EMG.

The maintenance and restoration of masticatory efficiency is an important aspect of dental restorative procedures, yet surprisingly, little information is available regarding the factors influencing this important oral function. There are very few studies in which the masticatory activity and muscle response in partially edentulous patients have been undertaken to measure masticatory efficacy before and after fixed prosthodontic rehabilitation.

MATERIAL AND METHODS

A sample of total 10 patients were selected for this study after informed consent from the patients attending the Prosthodontic Clinic, Department of Prosthodontics, M.B. Kedia dental college, Birganj. The patients were selected irrespective of sex with mean age of 26 years and within the age range of 17 –35 years.

Criteria for selection of patients

Inclusion criteria: Patients who had age range of 17-35 years, Sound periodontal health and good oral hygiene. Intact natural dentition up to 2nd mandibular molar except for missing mandibular 1st molar on one side. Partial edentulousness of 3-6 months duration. Well healed and healthy edentulous ridge, were included in this study.

Exclusion Criteria: Patients who had any carious or unrestored tooth. Any cranio-mandibular disorders. Any Para-functional habits .Any oral manifestations of systemic diseases. Any significant supra eruption of opposing maxillary molar. Mesial and / or distal tilting of abutment teeth anterior and posterior to the edentulous space, were not included in the study.

MATERIALS USED IN THE STUDY

Materials used for electromyography

Surface electrodes (Nicolet Biomedical Madison, WI USA.), Conduction gel (Elefix, Nihon Kohden, Tokyo, Japan), Electromyograph (Medelec, Synergy, UK), Recording paper, Adhesive tape (medical grade adhesive tape, 3M), Skin cleansing agent. Fresh pieces of carrot weighing 20 grams each.

Materials used for Fixed Prosthodontic Rehabilitation

Tooth preparation kit (Shoufu, Japan),Retraction cord (Record), Polyvinyl rubber base Impression material (Reprosil, heavy body and light body, DENTSPLY), Dental stone (Kalabhai, India), Die stone (Kalabhai, India), Ni-Cr alloy (Bego, Germany), Porcelain (Ceramco-2, Ceramco, Berlington, U.K.), Glass ionomer luting cement (Ketac-cem, ESPE, Germany),Porcelain applicator kit (Vita, Germany), Temporary cement (Non-eugenolated, ZnO-luting cement, Rely-x- Temp, 3M, ESPE, Germany), Self cure acrylic resin Porcelain furnace (Compact-100, G.F electronic, France), Burnout furnace (Miditherm, Bego, Germany).

METHODOLOGY

Electromyographic recording was carried out simultaneously during rest position and on chewing from preferred side (unilaterally). The patients were given homogenous pieces of carrot weighing 10gms and recording was performed during rest, and chewing carrots (20strokes) for Anterior Temporalis and Masseter muscle bilaterally. Two minutes interval was given between each recording to prevent muscle fatigue. Three consecutive recording were undertaken for each patient.

Prior to recording, all the patients were carefully instructed about the tests to be performed and were introduced to the EMG apparatus after obtaining their consent. The patients were seated upright in a comfortable position with their head supported, and asked to maintain a natural erect position. The Electromyograph was standardized for each patient with following fixed calibration - Sensitivity - 200μv/div, Sweep speed (Time base) =5 second, Frequency range –20Hz 1 kHz, Electrode impedance checking level -<16kΩ,

Fixed Prosthodontic Rehabilitation (Three unit bridge replacing unilateral missing mandibular first molar)

Irreversible hydrocolloid impression was made to obtain the diagnostic cast, which was poured in dental stone (Type- IV, die stone). The diagnostic cast was transferred to a semi adjustable articulator using face bow transfer and centric relation record. Biomechanical preparation was carried out on mandibular premolar and mandibular second molar employing biomechanical principles of tooth preparation. Standard tooth (abutment) preparation kit was used for abutment preparation. The margin of the preparations was kept at the level of the crest of the marginal gingival (supra gingival). Full veneer porcelain fused to metal (PFM) crown was fabricated for the mesial abutment (second premolar) and full metal crown as a retainer for the distal abutment (second molar).Modified spheroidal type of pontic design was given in porcelain fused to metal for replacement of missing tooth. Glass- ionomer luting cement was used to cement the final three-unit bridge on to the abutment in the mouth.

Evaluation of masticatory efficiency and muscle activity after rehabilitation:

The electromyographic recording were performed for each patient after 3 months of fixed prosthodontic rehabilitation again using the same procedure as described above and was compared with pre-rehabilitation recordings.

STATISTICAL ANALYSIS

The data thus obtained was recorded and master chart was prepared. The data thus obtained was analyzed statistically using descriptive statistics (Mean± SD) for each and every variable. To study the difference among the groups we compared pre rehabilitation with post rehabilitation. Paired sample t-test was applied. Comparison among the canine protection and group function type variables analyzed with Mann Whitney test, P=<0.05 has been considered as statistical significance level.

RESULTS

Comparison of pre and post rehabilitation changes in muscle activity (Table –I).

To see the difference among the group's pre and post rehabilitation Temporalis and Masseter muscle activity on experimental side and control side***, paired samples t-test*** *was* applied. Pre rehabilitation muscle activity of experimental side Temporalis was 565.36 ± 233.47 which increased to 683.8 ± 211.31 after rehabilitation. Pre rehabilitation muscle activity of experimental side Masseter was 616.54 ± 286.05 which increased to 711.99 ± 245.01after rehabilitation. Maximum change was observed in the muscle activity on experimental side Temporalis. Pre and post rehabilitation values for control side Temporalis were 670.74 ± 232.80 and 709.31 ± 209.73 whereas for Masseter the values were 727.91 ± 296.72 and 855.61 ± 277.53 respectively. Statistically significant change was observed in Temporalis and Masseter muscle on experimental side but

the difference on control side was non-significant for both the muscles.

DISCUSSION

Mastication is one of the main functions of the stomatognathic system. Number of posterior tooth contact and the neuromuscular coordination of the masticatory muscles are essential to a harmonious functional relationship in the masticatory system. The number and location of tooth contacts on elevator muscle activity influence masticatory movements, muscle activity and masticatory efficiency of individual.

Activity of the Temporalis and Masseter muscle before and after rehabilitation during rest: In resting position of the mandible, the elevator muscle and their antagonistic depressor muscles were in a resting state of postural contraction, especially the anterior belly of Temporalis was in a minimum tonic contraction as it was observed in this study. In order to evaluate the muscle activity of Temporalis and Masseter at rest, the resting EMG was recorded and analyzed. The result showed that there was minimal tonic contraction on both missing side and the intact dentition side of Temporalis muscle .The height of the burst or mean amplitude was negligible as compared to the muscle activity at the time of chewing (Tracing-1, 3). Masseter muscle showed no muscle activity at rest on both the missing 1st molar side and intact dentition side. Moyers[7] used electromyography for studying the temporomandibular contraction pattern in Angle's class I malocclusion. He found that when the Temporalis muscle was at rest, there was an even state of tonus in all parts of the muscle. In mandibular retroversion, the posterior fibres showed greater activity. The following explanation may account for this observation.

The elevator muscles are all positioned distal to the teeth, so that they elevate the condyle and hold them firmly against the eminence while hinging the jaw. The Masseter, Internal Pterygoid and major part of the Temporalis muscle are responsible for elevation of the mandible. In the normal resting position of the mandible, the elevator muscle and their antagonistic depressor muscles are in a resting state of postural contraction but anterior belly of Temporalis is in minimum tonic contraction which was also observed in this study.

Activity of the Temporalis and Masseter muscle before rehabilitation during chewing test food material (Ten grams of uniform pieces of carrot): Muscle activity of Temporalis and Masseter was tested electromyographically on the missing tooth side and intact dentition side before rehabilitation. It was observed that there was marked decrease in muscle activity of both Temporalis and Masseter muscle as compared to the muscle activity on intact dentition side before rehabilitation (Tracing-3, 4). Hashimoto[8] observed that some subjects with missing teeth had a shorter duration of movement bursts before treatment when compared to persons with natural teeth, but they had the same duration after insertion of dentures. This difference may be due to the fact that the subjects with missing dentition on one side and intact dentition on the other side had the habit of chewing from the side having intact dentition, thereby the number of chewing strokes and the length of the chewing time decreased. Therefore there was better neuromuscular coordination on frequently used side as compared to the missing tooth side, hence increased masticatory efficiency on the intact dentition side,our results confirm to Hashimoto's [8] results. In order to examine individual muscle activity, we recorded Temporalis and Masseter muscle activity on experimental side and intact dentition side before rehabilitation and observed the difference. There was marked reduction in overall muscle activity of Masseter muscle on experimental side (mean difference 111.37μv) as compared to intact dentition side. Relatively less difference was observed between Temporalis muscle activity on experimental side and intact dentition side (mean difference

105.38μv). It means that the muscle activity of Masseter was affected more than that of Temporalis on the experimental side before rehabilitation. Similar finding was observed by Nagasawa and Hiromichi[9] who evaluated the muscle activity of Temporalis and Masseter muscle in subjects with missing mandibular 1st molar and intact natural dentition before rehabilitation and after rehabilitation with removable partial denture followed by fixed partial denture and compared the masticatory efficiency of the subjects before rehabilitation and after insertion of the prosthesis, after one week and after one month of insertion of the prosthesis. Our findings are in agreement with their observation in terms of muscle activity before and after rehabilitation.

Activity of the Temporalis and Masseter muscle after three months of rehabilitation with fixed partial denture: after 3 months of fixed prosthodontic rehabilitation using the same procedure as described above and were compared with pre-rehabilitation recordings. The findings of post rehabilitation muscle activity showed that there was marked change in masticatory muscle activity of both anterior Temporalis and Masseter muscle as compared to pre rehabilitation muscle activity. Reason behind the improved masticatory muscle activity was probably because of the adaptive changes in neuromuscular component of masticatory muscles after replacing mandibular 1st molar. A time period of three months seems to be adequate for the neuromuscular component of masticatory system to adapt. Another major cause for improved masticatory muscle activity could be an increase in number of teeth after replacement of missing mandibular 1stmolar with a three unit bridge which led to increase in total width, surface area of the masticatory table and number of posterior tooth contacts. Previous studies indicate that increase in size and width of the occlusal table tends to increase masticatory muscle activity and thereby improved masticatory efficiency in Toto, as observed by Moller[10] that the fewer the occlusal contacts, the less was the amount of elevator muscle activity. Conversely, a multiplicity of occlusal contact points resulted in higher muscle activity. When the changes in individual muscle activity of anterior Temporalis and Masseter was considered and compared pre and post rehabilitation, it was found that there was statistically highly significant change in Temporalis muscle as well as Masseter muscle activity in the same patients. Our result confirmed to the previous study conducted by Al Quran and Lyons[11] , where they studied the effects of various occlusal splints on masticatory muscle activity and postulated that there was marked change in Masseter muscle activity pre and post occlusal splint therapy as the Masseter muscle is one of the prime muscles during chewing and biting the objects. Increase in Temporalis muscle activity was possibly due to the fact that there were even contacts in posterior teeth after replacement of missing mandibular 1st molar, thereby proper placement and seating of condyle in the articular eminence led to significant increase in muscle activity of Temporalis in terms of level of contraction as well as rhythm of the muscle. Muscle activity of Temporalis and Masseter was assessed in male and female patients. Out of ten patients 6 were male and 4 were female. All the male patients showed higher muscle activity than the female patients of both the muscles studied.

CONCLUSION

The activity of both anterior Temporalis and Masseter muscle were decreased on experimental (missing mandibular 1st molar) side as compared to the control side (intact dentition) before rehabilitation. Post rehabilitation there was an increase in both the Temporalis and Masseter muscle activity in all the patients. Post rehabilitation, Masseter muscle showed greater increases in muscle activity than that of Temporalis. During rest, Temporalis muscle was at minimum tonic contraction (average Amp 90μv) whereas Masseter muscle showed no contraction of the

muscle bilaterally. It is recommended that future studies may be conducted with a larger sample size, longer follow up and in subjects with multiple missing teeth to study the effects of missing teeth on masticatory efficiency and muscle activity. Further, different methods of EMG analysis can be carried out in terms of rhythm, cycle and turns of amplitude of the contracting muscles for selected duration of time for precise evaluation of changes in the neuromuscular behaviour.

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