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"ANALYSIS OF CHANGES IN BILATERAL MASSETER AND ANTERIOR TEMPORALIS MUSCLE EFFICIENCY IN COMPLETE DENTURE WEARERS. -AN EMG STUDY"

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In partial fulfillment of the requirements for the degree of

MASTER OF DENTAL SURGERY
In
PROSTHODONTICS

Under the guidance of

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Dharwad

2010- 2013

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled **"Analysis of changes in bilateral Masseter and Anterior Temporalis muscle efficiency in complete denture wearers. -an EMG study"** is a and genuine research work carried out by me under the guidance of **Dr. Saquib Shaikh, Reader, Department of Prosthodontics, S.D.M. College of Dental Sciences and Hospital, Dharwad.**

Signature of the Candidate

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CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **"Analysis of changes in bilateral Masseter and Anterior Temporalis muscle efficiency in complete denture wearers. -an EMG study"** is a bonafied research work done by **Dr.Shilpa.S**in partial fulfillment of the requirement for the degree of **Master of Dental Surgery in Prosthodontics.**

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ENDORSEMENT BY THE HOD, PRINCIPAL/HEAD OF THE INSTITUTION

This is to certify that the dissertation entitled **"Analysis of changes in bilateral masseter and anterior temporalis muscle efficiency in complete denture wearers. -an EMG study"** is a research work done by **Dr. Shilpa. S** under the guidance of **Dr. Saquibshaikh, Reader Department of Prosthodontics, S.D.M. College of Dental Sciences and Hospital, Dharwad.**

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Place: Dharwad

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'VakratundaMahakaayaSuryakotiSamaprabhaNirvighnamKuruMey Deva SarvaKaaryeshuSarvada

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Signature of the Candidate

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ABSTRACT

Introduction: The loss of natural teeth leads to bone resorption and muscular hypotonicity, which may affect the structures involved in mastication.Atrophy of supporting tissues, poor adaptation, reduced masticatory efficiency, and psychosocial embarrassment are major complaints of edentulous patient wearing old/faulty denture. The need for this study is to examine the effect of old/faulty dentures and a new denture on the bilateral Masseter and anterior Temporalis muscle efficiency, and to evaluate the psychological comfort of a patient. Various techniques are available for examining the stomatognathic system, recording of electromyographic (EMG) activity is a convenient and useful method because it directly measures muscle activity.

Objectives: To assess the changes of bilateral Masseter and anterior Temporalis muscle activity in-patient wearing old/faulty dentures in comparison to the evaluations performed for 5 month following fabrication and insertion of new dentures.

Materials and methods: 15 edentulous patients wearing complete denture prosthesis selected as a subject for the investigation. Individuals presenting with history of neuromuscular and temporomandibular disorders (TMD) are excluded from the study according to exclusionary criteria. Surface electrodes from electromyographic unit (EMG) were placed in the region of right and left anterior Temporalis muscle and Masseter muscle, and the patients will be asked to perform maximum voluntary contraction (MVC). The EMG signals filtered and amplified with a time constant of 10ms. The muscle activity analyzed twice for each patient: (1) with the old/faulty dentures and (2) 5 month following fabrication and insertion of new denture.

Results: The electrical activity during maximum voluntary contraction exhibited statistically significant improved muscle efficiency with new denture when compared to those with old den-

ture wearer in place for 5 months. Highly significant change in muscle activity was seen in right side of the Temporalis muscle as compared to other groups of muscles after having new denture in place for 5 months.

Conclusion: New dentures or improvements in occlusion and vertical dimension produce a positive benefit to the patient by reducing the muscle effort during chewing without affecting masticatory performances. The reduction in muscle effort is likely to cause less tissue and in the end may minimize residual ridge resorption and, a new complete denture allows for neuromuscular reprogramming, which contributes to muscular balance of the masticatory system. A period longer than five months of wearing the new complete dentures is required for adaptation and the acquisition of functional capacity.

Key words: Electromyography, masticatory muscles efficiency, motor units, complete denture, maximum voluntary contraction.

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LIST OF ABBREVIATIONS USED

EMG	Electromyography
IEMG	Intramuscular electromyography
MVC	Maximum voluntary contraction
SEMG	electromyography
TMJ	Temporomandibular joint
TMD	Temporomandibular joint
♣V	Micro volts
SD	Standard deviation
P	Prevalence

INTRODUCTION:

The "stomatognathic system" is complex system that acts as a functional unit of the body characterized by several tissues of different origin and structure that act in consonance to perform different functional tasks. It comprises the joint connection between the mandible and the base of the skull, which in turn has muscle and ligament connections to the neck region. It consists of skeletal components (maxilla and mandible), dental arches, soft tissue (salivary glands, nervous and vascular supplies), temporomandibular joints (TMJ) and muscles. These structures are interconnected and interrelated; when activated, they aim to achieve maximal efficiency with protection of all the participating tissues. The masticatory system is also a part of this complex stomatognathic system

The word "masticatory system" has been defined as the functional unit composed of the teeth, their supporting structures, the jaws, the temporomandibular joints, the vascular and nervous system for these tissues. In dentulous subjects, mastication is highly coordinated neuromuscular function that involves fast effective movements of the jaw and continuous modulation of forces in craniofacial system.[1]Masticatory functions generated by rhythmic contraction of masticatory muscles. These muscles have capacity to contract during daily use of the stomatognathic system and maintain the muscle tone in mandibular rest position. Whereas, in edentulous subjects these mechanism acts with marked differences. The loss of natural teeth leads to bone resorption and muscular hypotonicity, which may affect the structures involved in mastication leading to reduced capacity in various functions of stomatognathic system[1].

When teeth are lost, a change occurs in the mandibular posture, the speech pattern, esthetics, and deglutition as well as in the individual's social, emotional and psychological behavior. Along with this, some age related changes, such as deterioration in the fast and slow-twitch fibers of the striated muscles, results in impaired muscle force. Edentulous persons have reduced capacity to perform various functions of the stomatognathic system such as occlusal forces, tactile thresholds and chewing ability. The loss of teeth and elimination of periodontal afferent innervations flow lead to changes in the neuromuscular patterns causing the reduced chewing efficiency when new complete denture replaces teeth[2].

For the patient who has previously worn dentures, the clinician must determine the OVD based on the clinical presentation. By establishing, an appropriate OVD in the patient who has worn the same dentures for 15 years or longer can be challenging. Excessive wear of the denture teeth in a long-term wearer can cause the patient to function at a reduced OVD, possibly compromising the oral craniofacial system. In addition, older denture wearers may suffer age-related morphologic changes, such as decreased facial height, because of mandibular ridge resorption and a downward and forward rotation of the mandible[1].An increase in the vertical dimension may lead to changes in the oro-facial structures, i.e. jaw elevator muscles and temporomandibular joints. An increase in the vertical dimension may influence the masticatory performance both in a negative way, (hampered chewing cycle) and in a positive way (increased bite force).

Although, various techniques are available for examining the stomatognathic system, the electromyographic recording is one of the convenient and useful methods because it directly measures muscle activity. Electromyographic techniques have permitted more precise assessment of the muscle functions compared to previously possible clinical observation. Technological development has led to the optimization and application of computerized diagnostic systems such as electrognathography[3]. The first effort to apply electromyography in dentistry was made by Robert E. Moyers. It used to corroborate the neuropsychological analysis of the factors linked to prosthetic rehabilitation procedures. Electromyographic data representing muscle activity during movements of the mandible (e.g., chewing) are the result of several variables which are operating simultaneously-i.e., continual variation in muscle length, bite dimension, and temporomandibular joint axis. The study of such data has contributed to our knowledge of the relative function of the masticatory muscles and has certainly indicated the potential value of electromyographic data in dentistry.

The electromyogram can quantify by measuring either the height of the action potentials or the frequency of the individual action potentials. At high levels of activity, when action potential spikes are superimposed, frequency counts become inaccurate. Although electromyography can give useful information on whether a muscle is active and define when the activity begins and ends in the muscle fiber sampled, it is impossible to know how much activity in the muscle being missed. Movement cannot infer from the electromyogram alone, because antagonistic muscles may be working synergistically to control the movement or provide stabilization[4].

However, the usefulness of electromyography depends upon the ability to characterize only quantitatively the "normal" population. At present, data does not permit a characterization based on quality of a muscle activity because of the lack of standardization in recording techniques and the obvious difficulty in expressing the resultant Electromyograms in simple qualitative terms[5]. The two main types of electrodes used for the study of muscle dynamics are surface (or ‘skin’) electrodes and deep electrodes (usually wire or needle). Both these electrode types have their advantages and disadvantages[6].

TheSurface EMG method: most widely and commonly used for recording muscle activity. These are preferred because of their non-invasiveness and reduced risk of infection. In a majority of cases, a technically satisfactory response can be obtained with surface electrodes. They are much more convenient for clinicians, more acceptable for patients and produce less movement; this is a noninvasive and user-friendly method. It is used for superficial muscles. The placement of bipolar surface electrodes on the skin will record the action potential of muscle activity. These electrodes made up of silver/silver chloride halides pick up minute action potential of muscle activity[6].

Surface electromyography has long been the "gold standard" for monitoring muscle activity of masticatory muscle at REST and in FUNCTION. The value of surface EMG best expressed by C.J.DeLuca (Professor of Biomedical Engineering and Research and Professor of Neurology at Boston University), "Surface EMG utilizes sensing electrodes placed on the skin, which allows the clinician to directly and accurately monitor muscle activity.” This is far more accurate procedure than conventional manual palpation or touch, which can provide only gross assessments of muscle activity. The aim of this study was to evaluate the effect of old/faulty dentures and a new denture on the bilateral Masseter and anterior Temporalis muscle efficiency (masticatory performance),and to evaluate the psychological comfort of a patient.

OBJECTIVES OF THE STUDY:

1. To assess the changes of bilateral Masseter and anterior Temporalis muscle activity in patient wearing old/faulty dentures in comparison to the evaluations performed for 5 month following fabrication and insertion of new dentures.

2. To determine the psychological comfort of patient by comparing old/faulty dentures and with new denture following 5 month recall.

Review of literature:

1. Luis Angelone, Joseph a. Clayton (1960)[5]: A study conducted to evaluate the Quantitative Electromyography of the Masseter Muscle and the usefulness of electromyography depends upon the ability to characterize quantitatively the "normal" population. Moreover, it concluded that, the data now do not permit such a characterization, because of the lack of standardization in recording techniques and the obvious difficulty in expressing the resultant electromyogram in simple quantitative terms.

2. Gunne HS, Bergman B, Enbom L, Högström J (1985)[7]: A study was evaluated to asses the masticatory efficiency in complete denture wearers with their old and new dentures. The test chewing material was gelatin hardened by formalin. A standardized preparation of the test chewing material and the sieve-system described. The patients tested on seven different occasions from the period with the old dentures until about 1.5 years after the insertion of the new denture. The test pieces were chewed for ten seconds--a practice test--20 seconds and until ready to be swallowed. The chewed material was strained in a sieve-system and masticatory efficiency indices were calculated. The results revealed no statistical significant differences in masticatory efficiency between any of the seven testing occasions with the me-

thod used. Thus no significant difference was noticed when patients changed from old to new dentures or during the first 18 months after insertion of new denture.

3. Shi CS et al (1991)[8]: compared the mastication between complete denture wearers and dentate subjects. A computer system was used for simultaneously calculating and processing the mandibular movements and myoelectric activities of masticatory muscle and it was found that myoelectrical potentials of mandibular elevator muscle of complete denture wearers tend to increase at opening phase; however, the potentials decreases at the closing phase.

4. Ad P. Slagter et al (1992)[9]: investigated the relationship between the ability of patients with complete dentures to comminute a tough artificial test food, and their answers to questions about chewing experience. It has concluded that the subjective chewing experiences of complete denture wearers were related to ability to comminute test foods and degree of resorption of mandibular ridge was related to comminute test foods.

5. Neal R. Garrert et al (1996)[10]: evaluated the effects of improvements of poorly fitting dentures and new dentures on muscle activity during chewing. Moreover, results revealed that new dentures or stabilization of poorly fitting dentures through the occlusal correction, and restoration on occlusal vertical dimension permits patients to use less muscle effort while chewing and maintaining their initial masticatory performances.

6. K. Yugami, s. Yamashita, m. Ai & j. Takahashi (2000)[11]: a study was conducted to clarify the relationship between the mandibular position with tooth contacts and jaw-closing muscle

activity during sleep using electromyography and newly devised equipment for detecting tooth contacts and confirm the validity of this system. Occurrences of tooth contacts at eccentric mandibular positions in addition to the intercuspal position during sleep system were detected using micro photo sensors and sensor targets prepared for the individuals. Electromyographicactivities (EMG) from right and left masseter and anterior temporalis muscles were also recorded. Results of the polygraphic recordings demonstrated that the mandibular positions during bruxism could be distinguished clearly, whether it is in the right or left position, or has no lateral deviation, and further, that bruxing events could be categorized based on mandibular position pattern.

7. IwaoHayakaw et al (2000)[12] : examined changes in masticatory function of complete denture with soft liner and was shown that applying a soft lining material to the mandibular dentures of 6 edentulous patients improved masticatory function with no adverse effect on the muscular tasks.

8. Seung-Ho Lee, Dong-Wan Kang (2002)[13]: A study conducted to quantify the relative muscle activity of the masseter and temporal muscles in relation to different intermaxillary relations recorded by intra-oral tracer during maximal clenching and to decide the optimal mandibular position. EMG activity recorded for masseter and temporal muscle and the results found that a) in comparison with maximum intercuspation, the chewing position was the most similar followed by tapping position, myocentric position and posterior border position. b) in comparison of bilateral symmetry of masseter muscle, tapping position was the most symmetrical followed by chewing position and maximum intercuspation. c) in comparison of bilateral symmetry of anterior temporal muscle, chewing position was the most symmetrical followed by posterior border position, maximum intercuspation, myocentric position and tapping position. d)in comparison of proportionality of anterior temporal muscle to masseter muscle activity on left side, posterior border position was the greatest followed by myocentric position, tapping position, chewing position and maximum intercuspation. And the proportionality of posterior border position was greater than that of maximum intercuspation. e)in comparison of proportionality of anterior temporal muscle to masseter muscle activity on right side, myocentric position was the greatest followed by posterior border position, tapping position, maximum intercuspation and chewing position. However, the differences were not statistically significant.

9. Iva AlajbegMelita, ValentiE-PeruzoviE and Ivan Alajbeg (2003)[14]: A study investigated through Electromyographic Evaluation of Masticatory Muscle Activity in Patients with Temporomandibular Dysfunction. Results of this investigation showed the presence of altered masticatory muscle activity in TMD patients and confirmed the use of electromyography in TMD diagnosis

10. A. L. Roark, a. G. Glaros& a. M. O'mahony (2003)[15]: study conducted to evaluate the flat plane interocclusal appliance affects the electromyographic (EMG) activity of the temporalis and masseter muscles in pain-free individuals. Maxillary splints were fabricated for individuals who reported no history, signs or symptoms of myofacial pain or arthralgia as determined by two trained, independent examiners. Subjects were instructed to establish light tooth contact, maximum clenching, and moderate clenching with ⁄ without the splint in place (as determined by random assignment) while EMG data from the left and right temporalis and masseter muscles were recorded. The effectiveness of interocclusal appliances may be due to mechanisms other than redistribution of adverse loading.

11. TadasuHaketa et al (2003)[16]: conducted a study to test the utility and validity of a newly developed EMG-based bruxism recording system. This system allowed high-resolution digital recordings of the masseter EMG in the patient’s home environment and, systematic discrimination of artifact signals with the aid of semiautomated software. Simulated bruxism and nonbruxism signals were recorded in two subjects. Two independent scorers were shown these signals and asked to Differentiate bruxism from nonbruxism signals. And it was concluded that the EMG-based bruxism recording system has high utility and reasonable accuracy and precision.

12. F. Ferrario, g. M. Tartaglia, a. Galletta, g. P. Grassi (2006)[17]: Study conducted to examine the electromyographic (EMG) characteristics of masseter, temporalis and sternocleidomastoid (SCM) muscles during maximum voluntary teeth clench. In conclusion, the presence of a complete or partial Angle occlusal Class I did not seem to influence the standardized contractile activities of masseter, temporalis and SCM muscles during a maximum voluntary clench. Subjects with a ‘complete’ Angle Class I were somewhat a more homogenous group than subjects with ‘partial’ Angle Class I.

13. Giuliana Zanatta, WilkensAurélioBuarque Silva, Frederico Andrade Silvato(2006)[18]. Assessed the evolution of painful symptomology in patients with completely edentulous maxilla and partly edentulous mandible, with Class I or Class II Kennedy prosthetic spaces. They were treated with flat occlusal appliances, before, during and after 150 of starting treatment.

These revealed statistically significant differences between the values obtained at each assessment made. it was concluded that the therapy used was effective and that the experimental scale was efficient for registering the evolution of the symptoms initially detected.

14. Marcelo Coelho Goiato, AlícioRosalino Garcia, Daniela Micheline dos Santos (2007)[1]: A study investigated to assess the electrical activity of the masseter and anterior temporal muscles in patients with severe bone resorption, with complete dentures worn for over ten years, and five months after having new dentures put in place. The RDC questionnaires applied to twelve asymptomatic patients, before and five months after new dentures put in place. The electrical activity recordings made in the mandibular position at rest, and during maximum tooth clenching. The result reveals that the electrical activity of the masseter and anterior temporal muscles in the position at rest presented no statistically significant difference after five months of wearing the new complete dentures. Electrical activity during tooth clenching exhibited a statistically significant reduction only in the right temporal muscle. A period longer than five months of wearing the new complete dentures is required for adaptation and the acquisition of functional capacity.

15. Rodrigo Galo, Mathias Vitti1, Maria da Glo´ riaChiarelloMattos and Simone Cecı´lioHallakRegalo (2007)[19]: Investigated the levels of muscular activation of elderly individuals, during chewing, and to compare with young individuals were performed using a MyoSystem-Br1 electromyography with differential active electrodes. The test was recorded during functional conditions, and the muscles assessed were the temporalis and masseter. Data were normalized by maximum voluntary contraction (MVC), Results of this study showed that normalized electromyographic data obtained. Comparing the normalized values obtained for MVC, the mean values for the masseter and temporalis muscles of elderly group were statistically lower than control group for harder foods, but there were no significant differences for food with the lowest consistency. Hence it can be concluded that elderly individuals show slight hypoactivity of their masticatory musculature during chewing when compared to young individuals.

16. Henrique Casselli, AlexandreBraitLandulpho (2007)[20]: Study investigated, through computerized electrognathographic evaluations the mandibular movement pattern of patients rehabilitated with complete dentures presenting no symptoms of stomatognathic functional alterations. The patients were instructed to wear an intra-oral appliance for occlusal plane coverage over their usual superior denture and were then rehabilitated with new dentures preserving a free -way space of 3 mm. After sixty days, the occlusal vertical dimension was increased and the modified inferior dentures were used for another 60 days. It was concluded that the presence of a free-way space at the end of the treatment confirms the importance of its existence for maintaining the balance of the masticatory system, assuming the occurrence of a postural repositioning.

17. Maria Cristina Candelas et al (2007)[21]: A study was investigating electromyographic (EMG) activity of the anterior temporalis and masseter muscles in edentulous individuals with temporomandibular disorder (TMD). This study was carried out before and after using sliding plates on complete dentures in the mandibular rest position, EMG recordings were made before the insertion of the dentures (0 months), also after using the sliding plates at the fourth month, 9th month and 12th month, using computerised electromyography K6-I/ EMG Light Channel Surface. EMG evaluations of the muscles were performed under clinical conditions like rest position with dentures (R1), rest position without dentures (R2), rest position with dentures post-activity (chewing) (R3), rest position without dentures post-activity (chewing) (R4). The results obtained from the study showed remission of muscular fatigue and reduced pain in stomatognathic system structures. Temporalis muscle showed significant increase in EMG activity compared with initial values. Masseter muscles showed significantly lower mean values compared with initial values. Hence it's concluded that the sliding plates allowed the process of neuromuscular deprogramming, contributing to muscular balance of the masticatory system, and are therefore indicated to be used before the fabrication of definitive complete dentures in patients with TMD.

18. Maria Teresa Botti Rodrigues dos Santos,FabíolaGrammaticoCarmagnani, and César F Amorim,(2008)[22]: Evaluated the electromyographic activity of right and left anterior temporalis and masseter muscles in the physiological rest position of the mandible in patients with cerebral palsy in a dental chair, before and after postural stabilization. Result of this study reveals that the right and left anterior temporalis muscles showed a statistically significant reduction in electrical activity after postural stabilization, and the same was observed for the right and left masseter. Hence, it has concluded that postural stabilization influences not only the activity of masticatory muscles but also inhibits pathological postural reflexes, facilitating dental treatment of individuals with cerebral palsy.

19. Francesca Trovato, Bruno Orlando, Mario Bosco (2009)[23]: study conducted review of electromyographic studies, in order to asses the relationship between various occlusal features and masticatory muscles activity. The results obtained seem to suggest that occlusal features can affect the electrical signals recordings of masticatory muscles.

20. Mei-qing wang1, Jian-jun He1, Kelun Wang & Peter Svensson (2009)[24]: Study examined to test whether changes in occlusal support differentially modulate masseter and anterior temporalis muscle electromyographic (EMG) activity during controlled maximal voluntary clenching. EMG activity decreased in both muscles when occlusal support was moved from the molar to the premolar region. When occlusal support was moved from bilateral to unilateral contacts, EMG activity in the balancing-side anterior temporalis muscle and in bilateral masseter muscles decreased. Unilateral clenching on the molars, but not on the premolars, was associated with lower EMG activity in the balancing-side masseter and always associated with lower EMG activity in the balancing-side anterior temporalis compared to the working side. Masseter and anterior temporalis muscles respond differently to changes in occlusal support, which may have implications for stability of the mandible during intense clenching.

21. Marcelo Coelho Goiato et al (2010)[2]: assessed masticatory efficiency and duration of the masticatory cycle in patients with complete denture wearer for 10 years. A sieved system used to assess the masticatory efficiency with artificial foods. The recording made before 5 months and, after 1 year, new dentures insertion. It found that an improvent in masticatory efficiency and reduction in mastication time observed with new dentures after 1 year.

22. Ignacio Ardizone, Alicia Celemin Fernando Aneiros(2010)[25]: A comparison was made between the electromyographic patterns specific to patient with temporomandibular disorders and that of normal healthy patients. The results showed significant differences among patients with a different degree of clinical dysfunction. These differences were more important during maximum effort clenching and mastication.

23. A. Van der bilt, j. Mojet, f. A. Tekamp& j. H. Abbink (2010)[26]: A study was conducted to compare comminution of an artificial test food and mixing of a two-coloured chewing gum. The degree of mixing of the colours of the chewing gum was quantified with an optical method.However, the comminution test was better in discriminating the masticatory performance of the two groups. The mixing ability test with the two-coloured chewing gum proofed to be a good method to determine masticatory function in subjects with a compromised masticatory performance (elderly subjects). However, the method appeared to be less suitable for subjects with a good masticatory performance (young subjects).

24. P. A. PRO¨ SCHEL & T. R. MORNEBURG (2010)[27]: examined bilateral surface electromyograms of masseter and anterior temporalis muscles and incisor movements were recorded during unilateral chewing Working side ⁄ Balancing side -ratios of masseter and temporalis activities and temporalis ⁄ masseter-ratios on both sides were calculated. The ratios were related to MIDs of consecutive chewing cycles. Three of the four ratios were associated with masticatory MID in the same manner as with jaw gape in isometric biting. The increase in asymmetry was attributed to a stronger decrease in masseter activity on the BS than on the working side. Hence, it’s concluded that relative jaw muscle activation is associated with interocclusal distance in a similar way in isometric biting and in chewing. This analogy supports the idea of a common jaw gape related neuromuscular strategy facilitated by afferent signaling of interocclusal distance.

MATERIALS AND METHODS:

Sample selection: Fifteen edentulous patients (eight men and seven women aged between 40 and 80 years) with complete, old maxillary and mandibular dentures, worn for over 10 years were selected for the present study. The patients were selected from the out patient department of SDM college of Dental sciences Dharwad.All patients presented diminished occlusal vertical dimension (OVD), with deficient dental occlusion, and severe bone resorption, particularly of the mandibular arch. They were all asymptomatic and presented no signs or symptoms of neuromuscular and temporomandibular disorders (TMD).The selected patients were informed about the treatment to be instituted and signed a term of consent in accordance with the recommendations of the Human Research Ethics Committee in Dharawad- Karnataka. At private clinic- Brain and nerve center in Hubli- Karnataka the EMG recordings were carried out.

Screening examination

The computerized system was used for recording the EMG data. The components of this system comprises of a display monitor, a cathode ray tube and electrodes (surface and hypodermic needle). The monitor helps in screening and it display the amplitude of muscle activity by special **RMS EMG software**. The cathode ray tube (CRT) transmits the activity of muscle from electrode to the monitor, and the electrode, which filters the muscle activity and it, transmits to the CRT for amplification. The two main types of electrodes used for the study of muscle dynamics are surface (or 'skin') electrodes and inserted electrodes (usually wire or needle). Both these electrode types have their advantages and disadvantages. Surface EMG utilizes sensing electrodes placed on the skin, which allows the clinician to directly and accurately monitor muscle activity. This is far more accurate procedure than conventional manual palpation or touch, which can provide only gross assessments of muscle activity.

Preparation of the patients:

On the day of EMG recording for old denture and with the new denture after 5-months follow up, any needed adjustment to the intaglio, cameo and occlusal surfaces of the complete dentures were made. During the electromyographic recording, the patient was asked to seat in nonconductive a chair, which reduces the interferences in an upright but relaxed position. The head was kept unsupported, and aligned according to Frankfort horizontal plane, parallel to the floor. Patient was informed about the test so he could offer the maximum cooperation. The conductivity of the electrode-skin interface was increased using conductive gel after thorough cleaning of the skin with 99.5% alcohol swabs and skin preparation gel to enable an easy transport of electrical potentials. The electrode must be firmly attached to the skin, with adhesive tape, to avoid bias due to movements. The application of conductive gel reduces the impedance below 20kV. The recordings were performed 5 minutes later, which allowed the conductive paste to adequately moisten the surface. The EMG signals were filtered (0.003-1.0) and amplified with a time constant of 10mili second, and displayed on the cathod ray tube (CRT) monitor for on line monitoring.

Experimental protocol*:* The wires were connected. The appliance is equipped with a trial test, which is necessary to verify the correct state of the electrodes and connections. The anatomical locations for area of interest were recognized and palpated. Each EMG recording lasted 10 s and a computer calculated the rootmean- square (RMS) value of the EMG activity. The subjects were allowed to practice prior to the start of the experiment. They were instructed when to start and stop and continuously encouraged to obtain the maximal clenching level. Once the patient and instruments were prepared for the collection of data, the procedure for recording muscle activity by EMG was carried out.The electrical signals were captured and the electrical activity of the muscles was analyzed. Each EMG recording was repeated at about a 1-min interval to avoid muscle fatigue. For EMG recording the patient was asked to clench his/her teeth, and keep them clenched for two seconds. Next the patient was asked to relax the muscles, slightly separating the teeth for another two seconds. The operator controlled all the times. The electrical activity was recorded manually for 5sec. and rested for 15sec. and repeated the clenching cycle 5 times. To record maximum tooth clenching, the patient maintained tooth contact for two seconds, and electrical activity was recorded. The averages RMS-EMG of the two repeated recordings were used for the statistical analysis.

Data collection:

EMG recording for bilateral anterior temporalis muscle:

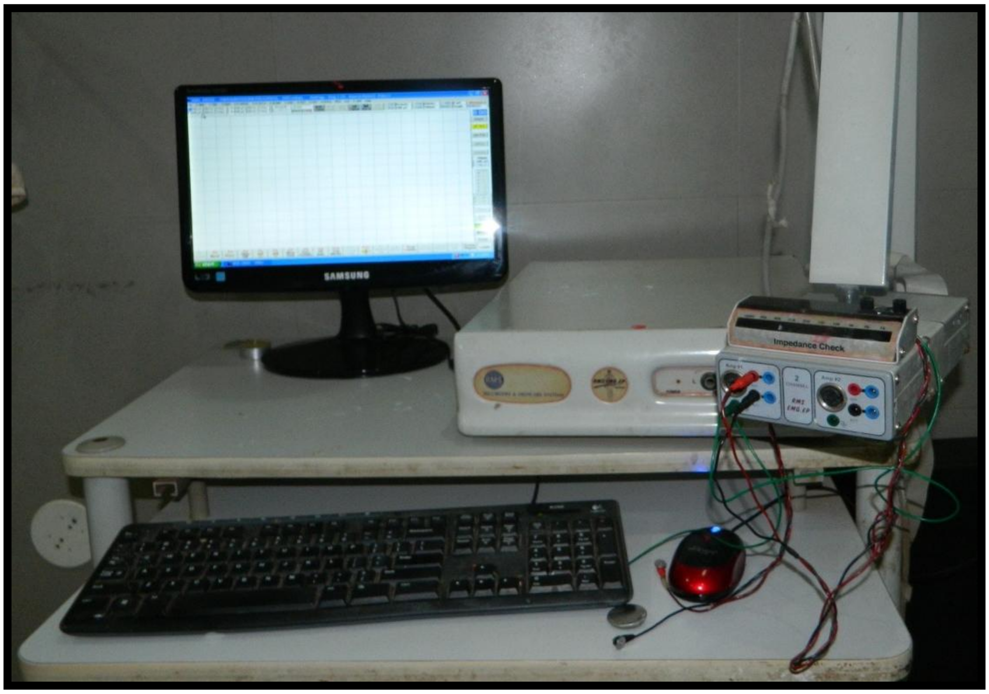
For recording EMG activity of anterior temporalis muscle, two pair of miniature surface bipolar Ag/AgCl electrodes were placed over the anterior temporalis muscle 1-inch posterior and 1-inch superior to the outer canthus of the eye with adhesive tape. These electrodes were placed parallel to the muscle fibers, with a centre-to-centre distance of 30mm to avoid the endplate region and thus to obtain stable recordings. They were positioned at the motor point, on each portion of the anterior temporalis muscles, so that their electrical activity could be assessed. The placement of the electrode was determined by manual palpation of the muscles bilaterally. The muscle activity is checked by asking the patient to gently clench the mouth in maximal intercuspal position following the longitudinal alignment, parallel with the direction of the muscle fibres. The ground electrodes were placed over the center of forehead in order to eliminate possible external interferences. The subjects clenched manually for 5sec and rested for 15sec and repeat the clenching cycle 5 times. The highest EMG activity was considered the maximum clenching.

EMG recording for bilateral masseter muscle:

The EMG activity of masseter muscle was carried out by placing two pair of miniature surface bipolar Ag/AgCl electrodes over superficial fibres of masseter muscle. The superficial fibres of masseter muscle originate at dorsal surface of zygomatic bone and inserted to the ramus of the mandible. A band of superficial masseter muscle was palpated by manual method from the prominence of zygoma till the gonial angle of the mandible. The activity this muscle was assessed by forcing the teeth for clenching. These electrodes were placed 2cm above the lower margins of the mandible halfway between the mandibular angle and anterior borders of muscles. These electrodes were placed parallel to the masseter muscle fibers, with a centre-to-centre distance of 30mm to avoid the endplate region and thus to obtain stable recordings. They were positioned at the motor point, on each portion of the muscles, so that their electrical activity could be assessed. The ground electrodes were placed over the center of forehead in order to eliminate possible external interferences. The subjects clenched manually for 5sec and rested for 15sec and repeat the clenching cycle 5 times. The highest EMG activity was considered the maximum clenching.

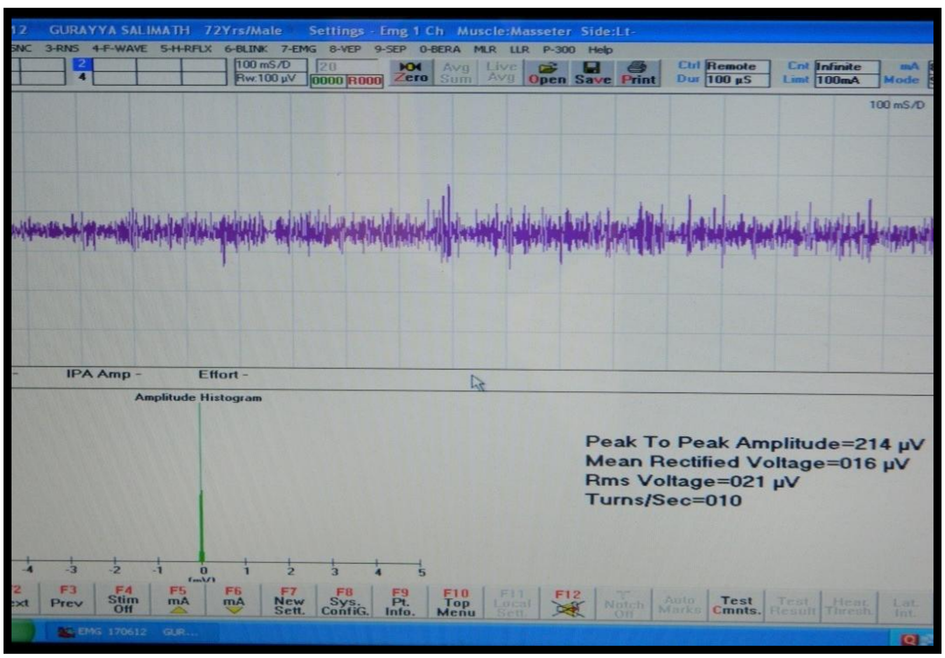
In all the procedures, the capture and analyses of EMG signals were carried out as recommended by the International Society of Electrophysiology and Kinesiology (Willians, 1987). Recordings and analysis of the muscles electrical activity were obtained with the mandible in the maximum voluntary clenching.The EMG signals were stored and analyzed as root mean-square (**RMS**) values expressed in microvolts (μV) in the maximum intercuspation position. Finally, a new set of complete dentures with corrected occlusal vertical dimensions, an appreciable occlusal anatomy and well-polished cameo surface were delivered to all old denture wearers. The same procedure were performed after 5-months with new set of complete dentures.The statistical analyses were performed using paired t-test. A significance level of 0.05 was adopted for all tests.

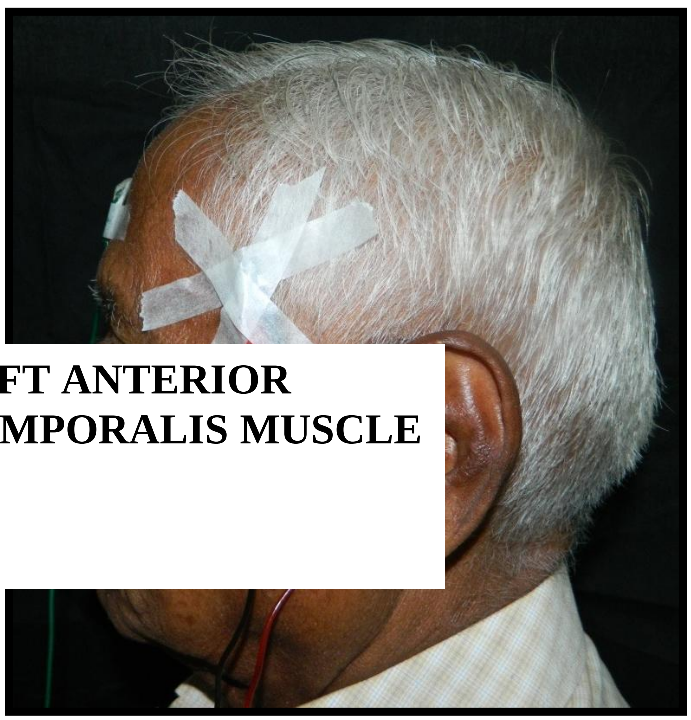
ELECTROMYOGRAM



ELECTRODES, CONDUCTIVE GEL & ADHESIVE TAPE.

ELECTROMYOGRAPHIC RECORDING





LEFT ANTERIOR TEMPORALIS MUSCLE

RIGHT MASSETER MUSCLE

LEFT MASSETER MUSCLE

Table-1: Statistical analysis showing comparison between the activity of **Anterior Temporalis** Muscle with old denture and new denture after 5-months follow up during maximum voluntary contraction

Anterior Temporalis Muscle	With old denture (♣V)		With new denture (♣V)		Difference		P Value
	Mean	SD	Mean	SD	Mean	SD	
Right	242.4	38.13	168	32.34	74.4	42.3	0.000*
Left	237.67	43.26	166.07	44.15	71.6	39.9	0.000*

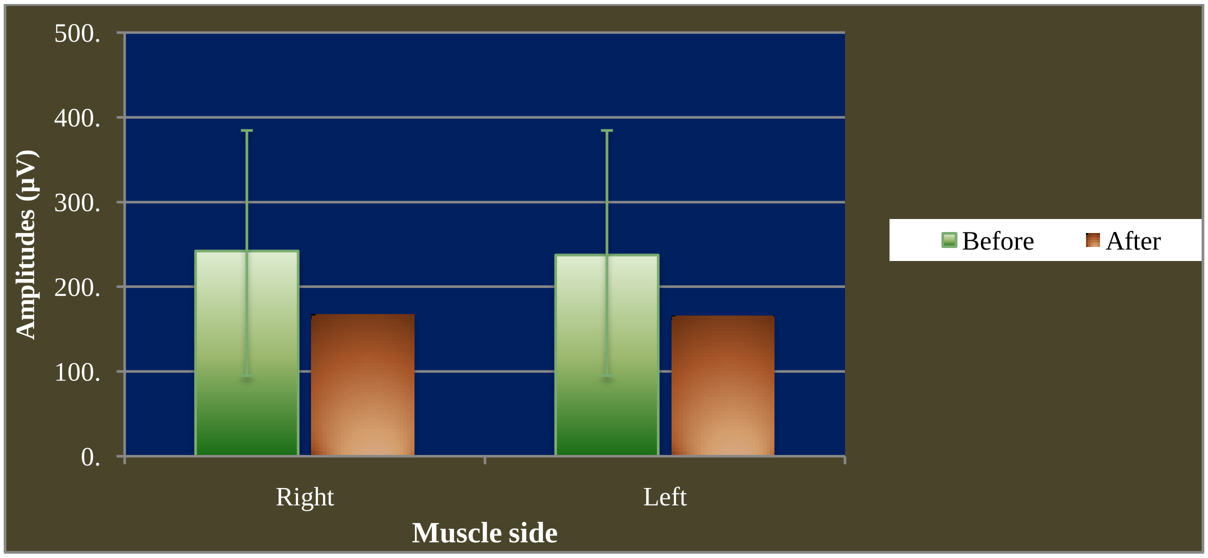
***Significant at p ≤ 0.05**

Table -2: Statistical analysis showing comparison between the activity of **Masseter Muscle** with old denture and new denture after 5-months follow up during maximum voluntary contraction

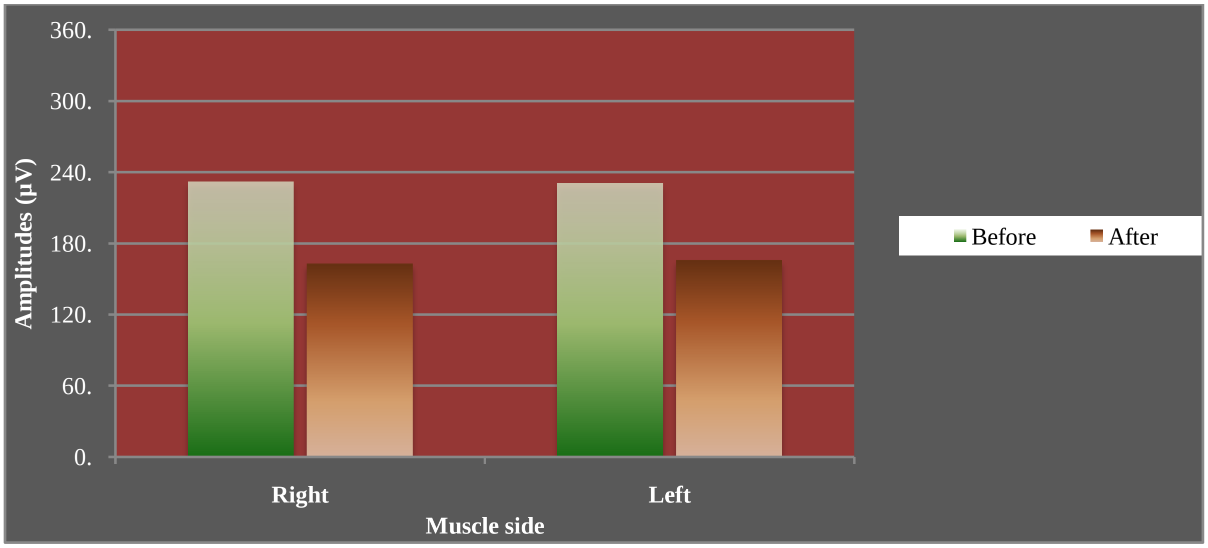
Muscle side	With old denture (♣V)		With new denture (♣V)		Difference		P value
	Mean	SD	Mean	SD	Mean	SD	
Right	231.93	59.12	163.13	42.73	68.8	40	0.000*
Left	230.60	46.87	171.73	75.30	58.8	61.4	0.002*

***Significant at p ≤ 0.05**

Graph-1: Evaluation of EMG recording for right and left **Anterior Temporalis Muscle** with standard deviation.



Graph-2: Evaluation of EMG recording for right and left **Masseter Muscle** with standard deviation.



The data engraved from this study were subjected to statistical analyses by using paired t-test. A significance level of 0.05 was adopted for all tests. The data of the study was analysed and the results are presented in the table 1 and 2. These tables represents the mean values of electro-myographic activity of masseter and anterior temporalis muscles with old and new denture after 5-months of follow up during maximal voluntary contraction(MVC) in the intercuspal position.

Table-1

Statistical analysis to compare the activity of Anterior temporalis muscle with old and new denture after 5 months follow up.

This data showed during maximum voluntary contraction of Anterior Temporalis Muscle. The Mean activity of 242.4♣V on right side and 237.67♣V on left side with old denture and, 168♣V on right side and 166.07♣V on left side with new denture after 5-months follow up. The paired difference between the old denture and new denture, the activity of Anterior temporalis muscle for right side is 74.4and on left side 71.6, thus from these values it infers that right side of Anterior Temporalis muscle is more efficient than the left side of the muscle. Statistical analysis reveals highly significant increase in muscle efficiency (p=0.000*, p=0.000*) with new denture after 5-months follow up when compared to subjects with old denture during maximum voluntary contraction.

Table-2

Statistical analyses to compare the activity of Masseter muscle with old and new denture after 5 months follow up

This data showed during maximum voluntary contraction of MasseterMuscle. The mean activity of 231.93♣V on right side and 230.60♣V on left side with old dentures and, 163.13♣V on right side and 171.73♣V on left side with new denture after 5-months follow up. paired difference between the old denture and new denture, activity of Masseter muscle for right side is 68.8and on left side 58.8, thus from these values it infers that right side of Masseter muscle is more efficient than the left side of the muscle. Statistical analysis reveals highly significant increase in muscle efficiency (p=0.000*, p=0.002*) with new denture after 5-months follow up when compared to subjects with old denture during maximum voluntary contraction.

Discussion:

The word "masticatory system" has been defined as the functional unit composed of the teeth, their supporting structures, the jaws, the temporomandibular joints, the vascular and nervous system for these tissues. In dentulous subjects, mastication is highly coordinated neuromuscular function that involves fast effective movements of the jaw and continuous modulation of forces in craniofacial system[1]. These muscles have capacity to contract during daily use of the stomatognathic system and maintain the muscle tone in mandibular rest position. Whereas, in edentulous subjects these mechanism acts with marked difference. The loss of natural teeth leads to bone resorption and muscular hypotonicity, which may affect the structures involved in mastication leading to reduced capacity in various functions of stomatognathic system[1]. Masticatory function occurs because of the interrelation between organs of the stomatognathic system, proprioception, brain centers, and occlusal function. Any change in the occlusal characteristics, temporomandibular joint or masticatory muscles may affect the pattern of the masticatory movements and, consequently, their effectiveness

When teeth are lost, a change occurs in the mandibular posture, the speech pattern, esthetics, and deglutition as well as in the individual's social, emotional and psychological behavior. Along with this, some age related changes, such as deterioration in the fast and slow-twitch fibers of the striated muscles, results in impaired muscle force[6]. Edentulous persons have reduced capacity to perform various functions of the stomatognathic system such as occlusal forces, tactile thresholds and chewing ability[3]. The loss of teeth and elimination of periodontal afferent innervations flow lead to changes in the neuromuscular patterns causing the reduced chewing efficiency when new complete denture replaces teeth. Other factors can affect chewing ability in complete denture wearer such as age, gender, personality type, denture experience, denture quality and occlusal schemes. Ellsworth K reported that age did not affect masticatory performance except the patient who is lower than 35 years old and upper than 75 years old. Yamashita S showed that the maximum in masticatory performance found in natural dentition, lower in removable partial denture and the lowest in complete denture wearer[11].

Age and muscular fatigue affect the function of the masticatory system and this is frequently accompanied by tooth loss, prosthetic rehabilitation, and, also by the development of local and systemic circumstances that may greatly influence this physiological process and reduce the masticatory ability of elderly individuals. Because of ageing in the oral cavity, there is a reduction in food intake, as well as opting for softer foods, which leads to an imbalance in nutritional intake. This fact leads to metabolic alterations, which can cause general ageing of tissues of the body[7]. With regard to the masticatory process, there is a motor adaptation to the textural characteristics of food, leading to changes in the amplitude and duration of electromyographical activity of the masticatory cycle, which, in turn, change the duration and form of specific phases of the cycle. The occlusion of natural teeth is one of the factors that guarantee the quality of life, in as much as the stomatognathic function influences the health of individuals. As age advances, the swallowing capability of the individual decreases with time spent in preparing the bolus and swallowing larger quantity of food than might be appropriate[19]. Peyron et al. found a progressive muscular loss as age advances, ranging around 40% when individuals were 75 years old, and, also a decrease in masticatory performance.

The Effect of gender on masticatory performance did not differ in complete denture wearer. On the contrary, gender affected masticatory performance in natural dentition. However, the improvement in denture quality significantly affected masticatory performance in complete denture wearer[24]. The major complaints of edentulous patient wearing old/faulty denture are atrophy of supporting tissues, poor adaptation, reduced masticatory efficiency, and psychosocial embarrassment[9]. Changes in the occlusal vertical dimension are a common procedure in prosthodontic treatment. An increase in the vertical dimension may lead to changes in the oro-facial structures, i.e. jaw elevator muscles and temporomandibular joints. Furthermore, an increase in the vertical dimension will lead to a decreased activity of the jaw elevator muscles in postural position. Restorative procedures, in which the vertical dimension is increased, may alter the length of the main jaw elevator muscles as well as the position of the mandibular head in the fossa temporalis[24]. For the patient who has previously worn dentures, the clinician must determine the OVD based on the clinical presentation. By establishing, an appropriate OVD in the patient who has worn the same dentures for 10 years or longer can be challenging. Excessive wear of the denture teeth in a long-term wearer can cause the patient to function at a reduced OVD, possibly compromising the oral craniofacial system. In addition, older denture wearers may suffer age-related morphologic changes, such as decreased facial height, because of mandibular ridge resorption and a downward and forward rotation of the mandible. These morphologic changes, manifested primarily in the mandibular arch, result in a progressive forward posturing of the mandibular denture that can lead to a reduced horizontal overlap[17].

Restorative procedures, in which the vertical dimension is increased, may influence the mechanisms of chewing cycle. Furthermore, changes in masticatory muscle length resulting from vertical opening may influence the length–tension relationship. An optimum musclular force measured under static conditions occurred at a jaw openings varying between 5 and 10 mm were measured at the first molar region. Hence, increasing the vertical dimension of occlusion may increase bite force during mastication. Thus, an increase in the vertical dimension may influence the masticatory performance both in a negative way, (hampered chewing cycle) and in a positive way (increased bite force and thus better breakage of food particles)[13].

Although, various techniques are available for examining the stomatognathic system, the electromyographic recording is one of the convenient and useful methods because it directly measures muscle activity. Electromyographic techniques have permitted more precise assessment of the muscle functions compared to previously possible clinical observation. Technological development has led to an optimized application of computerized diagnostic systems such as electrognathography[3]. The first documented experiments dealing with EMG started with Francesco Redi's works in 1966. Redi discovered a highly specialized muscle of electric ray fish generated electricity. Marey made the first actual recording of this electrical activity in 1890, who also introduced the term EMG. In 1922, Gasser and Erlanger used an oscilloscope to show the electrical signals from muscles. Clinical use of SURFACE EMG [SEMG] for the treatment of more specific disorders began in 1960's and was used by Hardyek The first effort to apply electromyography in dentistry was made by Robert E. Moyers. It used to corroborate the neuropsychological analysis of the factors linked to prosthetic rehabilitation procedures[4].

Electromyography can be used in many clinical and biomedical applications. It acts as a diagnostic tool for identifying neuromuscular diseases, disorders of motor control and, used as a control signal for prosthetic devices such as prosthetic hands, and lower limbs. Electromyographic data representing muscle activity during movements of the mandible (e.g., chewing) are the result of several variables which are operating simultaneously-i.e., continual variation in muscle length, bite dimension, and temporomandibular joint axis. The study of such data has contributed to our knowledge of the relative function of the masticatory muscles and has certainly indicated the potential value of electromyographic data in dentistry.

Various applications of EMG in dentistry:

- It provides an objective means by monitoring changes in muscle activity.

- To study action potentials in actively contracting lingual and masticatory muscles

- It is used in the treatment of Myofacial Pain Dysfunction where the procedure is called a Auditory or Visual electromyographic feedback, It supplies information to the patient concerning to the muscle activity.

- To study biomechanics of jaw and facial muscle functions.

- EMG is useful for identifying asymmetry of muscle action and particularly for judging the results of the therapy.

- Used for monitoring of nocturnal bruxism and jaw muscle tracking

- Used as one part of a full assessment protocol to determine if a patient has significant muscle asymmetries possible postural disturbances and significant muscle fatigue.

Anatomical and physiological basis for surface electromyogram: During the normal twitch of a muscle fiber, a minute electrical potential is generates, which dissipates into the surrounding tissue. The duration of the action potential associated with this twitch is about 1–2mili seconds, or even 4mili seconds. Since all the muscle fiber of a motor unit do not contract at exactly the same time, the electrical potential developed by the single twitch of all fibers in the motor unit is prolonged. (A motor unit is a single α-motor neuron and all of the corresponding muscle fibers it innervates; all of these fibers will be of the same type either fast twitch or slow twitched). A majority of these motor-unit potentials have amplitude of around 0.5 mV. When displayed on a cathode-ray oscilloscope, the result is a sharp spike that is most often biphasic. Einthoven discovered that a muscle contraction gives off an idio-muscular current (a semi permanent contraction of a muscle, produced by a mechanical irritant). This refers to as an action current or an action potential. The current generated is so small that it must amplify many thousand times to record. By means of an electromyogram, one can get a relatively accurate picture of muscular activity under diverse functional conditions.

Peterson and Kugelberg showed that the electrode types affect the recorded duration and amplitude of the action potentials. They demonstrated characteristic variation, e.g. the smallness of potentials in facial muscles as compared with those in muscles of the extremity. Under normal conditions, the smaller potentials appear first with a slight contraction. As the force is increased, larger and larger potential recruited, this being the normal pattern of recruitment. The electromyogram can quantify by measuring either the height of the action potentials or the frequency of the individual action potentials. At high levels of activity, when action potential spikes are superimposed, frequency counts become inaccurate. Movement cannot infer from the electromyogram alone, because antagonistic muscles may be working synergistically to control the movement or provide stabilization[4].

However, the usefulness of electromyography depends upon the ability to characterize only quantitatively the "normal" population. At present, data does not permit a characterization based on quality of a muscle activity because of the lack of standardization in recording techniques and the obvious difficulty in expressing the resultant Electromyograms in simple qualitative terms. The two main types of electrodes used for the study of muscle dynamics are surface (or 'skin') electrodes and deep electrodes (usually wire or needle). Both these electrode types have their advantages and disadvantages[28].

Deep electrodes: the electrodes inserted within the muscle by using two thin-coated wire filaments, which introduced by means of a hypodermal needle.They are superior to surface electrodes, as the quality of the electromyogram is better. There are lesser technical artifacts, because distance between the muscle and the electrode remains more constant. There is a risk of infection associated with the use of needle electrodes. They may also be painful. After insertion of the needle, it is always important to confirm that the needle correctly placed by asking the patient to contract the muscle being tested. The most important guideline for adequate needle insertion is to observe and palpate the muscle in contraction, while the test maneuver is being performed. This rule is applicable to almost all superficial muscles. If the needle is correctly positioned this maneuver should easily produce crisp action potentials[6].

The Surface EMG method: most widely and commonly used for recording muscle activity. Surface EMG has been advocated as a "modern scientific approach" because the output from such devices is presumed to be both "quantitative" and "objective". Surface EMG employs surface electrodes, which are non-invasive, painless and reduced risk of infection. These SEMG record the broad range of activity of entire muscle. Using a surface electrode always presents the possibility of loosening of the electrodes during nerve stimulation. Surface electrodes also give rise to errors when the distance between the electrodes and the muscle changes during muscle contraction. In a majority of cases, a technically satisfactory response can be obtained with surface electrodes. They are much more convenient for clinicians, more acceptable for patients and produce less movement; this is a noninvasive and user-friendly method. Surface electromyogram (EMG) analysis in studies of muscle function has attained increasing attention during recent years and has been applied to assess muscle endurance capacity, anaerobic and lactate thresholds, muscle biomechanics, motor learning, neuromuscular relaxation, muscle soreness, neuromuscular diseases, motor unit activities, and skeletal muscle fatigue[6].

The placement of bipolar surface electrodes on the skin will record the action potential of muscle activity. These electrodes made up of silver/silver chloride halides pick up minute action potential of muscle activity. Electrodes can also be categorized as: a) Monopolar: An electrode is placed on a muscle bundle of interest and another electrode is placed at a point non-affected by the activity of that muscular bundle; then, the difference in potential is measured between those two points. b) Bipolar: two electrodes on the region of study and a third electrode – called grounding electrode – is placed somewhere not affected by the activity of the region of interest. Then, the difference of electric potential is measured between both electrodes on the region of interest, taking the grounding electrode as reference.

Various factors exist including electrode position, sweat during testing, subcutaneous fat tissue, movement of the muscle under the skin to name a few which affect the EMG signal and make it difficult to reproduce the same signal twice. Some of the associated problems can be controlled, such as electrode position, though according to Basamajan and De Luca (1985) when wire electrodes are implemented a diversion of only 1 00♣V can decrease the peak to peak amplitude of the output signal by 75%. Komi and Buskirk (1970) who investigated both surface and inserted wire electrodes have performed repeatability studies in the past. They reported that repeatability of IEMG was better between recordings made during the same testing session than when the SEMG[9].

Efficacy of Surface Electromyography in Dentistry: A broad body of literature, which supports the physiologic basis for using surface EMG, as an aid in assessment of muscle function/ dysfunction. (38 + studies support this ending with Lynn et al, 1992). There is substantial evidence based upon controlled studies that confirm that surface EMG is reliable and reproducible. (18 studies ending with Dean et al., 1992). 87, studies verifying the use, safety, and efficacy of EMG to monitor masticatory muscle function/ dysfunction[9]. In 1988, W.D.McCall also states, "there is general agreement among both clinicians and investigators that masticatory muscle activity is increased in symptomatic patients as compared with normal subjects. Electromyography is the principal tool used to investigate such differences." Many investigators have confirmed the safety, efficacy and value of surface electromyography for assessing RESTING and FUNCTIONAL status of muscle. There is evidence, based on controlled studies that used extensive statistical tests, that surface electromyography is reliable and reproducible (Goldensohn, 1966; Lloyd, 1971; Hermens et al., 1986; Burdette and Gale, 1987).

According to F. Felici, G. Filligoi, F. Laterza, R. Merletti, (1998) proposed Frequency domain analysis of surface electromyograms (SEMG) obtained during voluntary and electrically elicited contractions in humans is a well experimented technique. It provides information regarding the rate of spectral compression over time during an isometric contraction at a preset percentage of Maximal Voluntary Contraction (MVC) as well as during stimulated contractions at a given stimulation rate. It has also been proposed that from the time evolution of those SEMG power spectrum parameters able to describe the phenomenon of the known localized muscular fatigue, such as the median frequency (MDF) of the power density spectrum, the modalities of motor unit recruitment can be inferred. Studies shows that there is an association between EMG and underlying muscle forces is the basis for many applications of EMG, allowing inferences regarding various aspects of muscle physiology. However, it is not possible to measure muscle force directly using EMG. Since 1952 there have been studies that show some cases where there is a linear relationship between force and EMG (Lippold, 1952), however this relationship is not always simple and linear[4].

Electromyographic examination of masticatory muscles may have confirming value for clinical diagnosis of myospasm (Spasmodic contraction of a muscle), which characteristically shows a marked increase in EMG activity. Surface EMG of muscles of mastication used routinely as a part of diagnosis and treatment of TMD. The duration of temporary pause in ongoing EMG activity of jaw closing muscles during maximal clench has been found to be longer, on average in a group of TMD patients. Several studies have quantitatively investigated the EMG during postural activity of the mandible and during maximal bite in the intercuspal position. The EMG values for the temporal and masseter muscles have been quantitatively investigated in these studies for control subjects without functional disorders and for patients with functional disorders.

The purposed usefulness of surface electromyography: A clinical use of SEMG has been proposed for the diagnosis and treatment of TMD. It’s based on the assumption that various pathological or dysfunctional conditions can be discerned from SEMG recordings of masticatory muscle activity. The muscle activity including postural hyperactivity, abnormal occlusal positions, functional hyperactivity and hypoactivity, muscle spasms, fatigue and muscle imbalance. SEMG activity has been suggested to be useful in documenting changes in muscle function before and after therapeutic interventions as evidence of successful treatment. SEMG also has been used in biofeedback concerning the awareness and control of nocturnal and diurnal para-functional habits.[29]

Factors that influence use of surface electromyography: Several biological and technical factors influence the reliability, validity, sensitivity and specificity for the use of SEMG as a diagnostic and treatment procedure. Biological factors:The biological factors that influence information provided by SEMG are physiological variability, age, sex, skeletal morphology, psychological factors, and skin thickness and weight. Each of these factors discussed below.

a) ***Physiological variability:***Physiological variability exists in all humans. In general, population samples researchers have found that normal subjects have a certain degree of physiological variability in terms of muscle activity asymmetry, postural position, and silent period after chin taps and spectral analysis, resulting in confusion between symptomatic and asymptomatic groups. The presence of variability between people, in addition to the existence of considerable overlap among these so-called "normal" and "abnormal" groups, makes it difficult to ascertain any diagnostic conclusions in any specific patient.

b) ***Age:***In a healthy population, electromyographic (EMG) activity recorded during isometric contraction decreases with increasing age, probably because of gradual muscle atrophy and increased fatty infiltration. It also was found, in populations with and without TMD, that EMG amplitudes and frequency levels of the temporal muscle and, to a lesser degree, the frontal muscle decreased with increasing age. This may be due to a decrease in the number of motor units activated during this voluntary contraction. (A motor unit is a single α-motor neuron and all of the corresponding muscle fibers it innervates; all of these fibers will be of the same type (either fast twitch or slow twitch). When a motor unit is activated, all of its fibers contract. Groups of motor units often work together to coordinate the contractions of a single muscle; all of the motor units that subserve a single muscle are considered a *motor unit pool*. Larger motor units have stronger twitch tensions) A further explanation for this decrease in EMG activity in the temporal muscles with increasing age may be a combination of impaired chewing ability and, decreased muscle force. It also has been reported that with increasing age, the latency of the masseteric jaw jerk reflex is increased while the amplitude is decreased.

c) ***Sex:***Differences in SEMG recordings have been attributed to differences between males and females. It has been reported that female subjects generate higher EMG amplitudes during the exercise of lifting the same weight and displayed significantly and consistently higher fatigue and recovery ratios during experimentally induced loading compared with male subjects. It also has been reported that in a general population sample, male subjects showed higher masticatory EMG levels than did female subjects during maximal voluntary contractions. Sex also influences the masseter jaw jerk reflex in a healthy population. The hypotheses for these findings may be explained by differences in the diameter and number of muscle fibers, differences in distribution of fiber type within the muscles, and differences in head and body size between males and females. Therefore, the usefulness of any diagnostic test using SEMG must define and adjust for the difference in parameters between males and females.

d) ***Skeletal morphology:*** Differences in skeletal facial types also influence SEMG measurements. Ueda and colleagues found a longer duration of masseter and digastric muscle activities in people with a decreased vertical skeletal facial type. Other researchers found the amount of postural activity for both masseter and anterior temporal muscles to be higher in Class III subjects than in Class I and Class II subjects. Therefore, to be useful, any diagnostic test employing SEMG must define and adjust for skeletal facial type.

e) ***Psychological factors:***Psychological factors can influence SEMG recordings significantly. In a healthy population, experimental stressors induce an increase in masticatory EMG muscle activity, with different masticatory muscles demonstrating different patterns of increase. Ruf and colleagues found that in healthy dental students, a nonexperimental emotional stress increased EMG activity during both rest and functional muscle activity. However, not all subjects followed this pattern. A few people in this study actually displayed a decrease in EMG activity. This difference may be explained by inter-individual variance in the manner in which different people or different muscles of certain people respond to specific stimuli. Cecere and colleagues compared bilateral SEMG recording from the masseter and anterior temporalis muscles of healthy people after performing functional activities at three times during the same day (before work activities in the morning and one hour and seven hours after the initial recordings). Their results indicated that there was a statistically significant difference in SEMG recordings between the initial recordings and the recordings made seven hours later. They reasoned that this discrepancy was related to the interval between the sessions due to changes of the psychological conditions resulting in physiological variations of muscular activity or skin impedance within the subjects. Therefore, to be useful, any diagnostic test employing SEMG must define and adjust for these psychological factors.

f) *Skin thickness and weight:*SEMG activity is greatly influenced by the thickness of the soft tissues overlying the muscles that are being measured. De la Barrera and Milner and Lobbezoo and colleagues described the mechanism of this phenomenon as being the process whereby electrical signals are low-pass–filtered and attenuated as they pass through media such as muscle tissue and subcutaneous fat. They stated that the greater the conduction distance, the greater the filtering and attenuation. Additional filtering occurs owing to the anisotropy of electrical conductivity in muscle tissue and as a result of refraction and redirection of electrical signals at tissue boundaries, such as those between muscle and subcutaneous fat. They concluded that SEMG signals cannot be interpreted in the same manner for all subjects and that selectivity of SEMG measurements increases as the thickness of the layer of subcutaneous fat interposed between the skin and the muscle surfaces decreases. It also has been reported that female skin fold was found to be significantly thicker than that of male subjects, thus resulting in more attenuation of the EMG signal for females, as well as yielding the finding that the thickness of certain muscles (including different areas within the same muscle) varies. A lower-amplitude signal in obese people could be interpreted inaccurately as evidence of reduced muscle activity, because there is a reduced uptake of the signal (adipose tissue contains fewer muscle fibers) and the fibers are further away from the electrode than they are in people with lesser skin thickness. Therefore, any diagnostic test using SEMG must define and, adjust for the thickness of the soft tissues overlying the muscles that are being measured.[29]

Masticatory forces in complete edentulous mouth directly depends on- a) the size of muscle creating the forces, b)their position in the mandible, c)type of chewing, d)shape of edentulous alveolar ridges and e)the degree of intermaxillary separation. Bite forces in complete denture wearers are significantly decreased in relation to person with natural teeth. There is fundamental difference in the distribution of functional energy in the complete denture wearer and subjects with intact teeth. Reduction of masticatory efficiency in denture wearers may be caused by irregular activity of masticatory musculature or is the consequences of irregular flow of energy during mastication[3]. In previous studies, Miralles R et al showed that the integrated EMG activity of both the muscles during maximum voluntary contraction was significantly lower in complete denture wearers than in subjects with natural dentition. Numerous studies have compared the muscle activity in complete denture wearer and, showed that new dentures with improvement in occlusion vertical dimension produces better chewing efficiency and superior masticatory performances. Several authors have investigated the relationship between the masticatory performance and subjects own assessments of their chewing ability, denture quality, and oral conditions. Millars et al showed that low muscle activity in patients with complete denture might be a consequence of change in the peripheral or central neural mechanism, since in edentulous patients the periodontal receptors are missing, and mucosal mechanoreceptors play a role in replacing them. NunoLicnoa A, Angles Medina F in 1990 showed that elevator muscle activity in patients before and after complete denture suggest that the use of new complete denture with increase in vertical dimension provokes electromyographic changes.[3]

Clinical evaluations revealed the following conditions: severe decrease in lower face height yielding poor facial esthetics, inadequate fit of complete dentures, worn denture teeth, clinically perceptible deficiency in OVD, acquired protrusive maxillomandibular relationships secondary to resorption, or angular cheilitis. The new complete dentures were made according to the procedure recommended by Zarbet al.[30]

Although numerous studies have described comparison of different parameters in edentulous subjects and natural dentition, little comparative information has been regarding the complete denture patients. The data engraved from this study (Table-1) showed significant increase in muscle efficiency of right Anterior Temporalis muscle (74.4) when compared to left Anterior Temporalis muscle (71.6). The mean difference between the values of electrical activity of muscles analysed in maximum voluntary contraction were higher for old denture wearers in comparison with those patients with new complete denture wearers following 5-months follow up. This study showed highly significant increase in muscle efficiency of right Anterior Temporalis muscle as compared to left side of Anterior Temporalis muscle. In a study by Verkindere et al (1988) showed that the electrical activity of temporalis muscle were slightly affected by the absence and replacement of teeth, whereas the electrical activity of Masseter muscle was markedly altered. Rustia et al (1996) suggested that long edentulous period is visible in not only the functioning of masticatory muscle, in terms of decreased EMG activity, but also as decreased density of the muscle, which implies muscle atrophy after certain period. According to Tellgren et al (1986) and Gervais (1989) showed electrical activity of the temporalis muscle was lower than that of Masseter muscle after 5 of having the new complete denture. The reduction in the electrical activity of Anterior Temporalis muscle in maximum tooth clenching after prosthetic treatment may be an adaptation that occurs after OVD (occlusal vertical dimension) and the occlusal surface has been reestablished, causing the anterior temporalis muscle to return to its main role of postural muscle of the mandible, associated with the enhanced occlusal stability.

The data obtained from this study (Table-2) showed significant increase in muscle efficiency of right Masseter muscle (68.8) when compared to left Masseter muscle (58.8). The mean difference between the values of electrical activity of muscles analysed in maximum voluntary contraction were higher for old denture wearers in comparison with those patients with new complete denture wearers following 5-months follow up. This study showed highly significant increase in muscle efficiency of right Masseter muscle as compared to left side of Masseter muscle. This finding is in keeping with the fact that the Masseter muscle is more active in raising the mandible, especially during the masticatory function. According to **Lippold (1952)** the mean electrical activity recorded at the surface of the Masseter muscle increase with force of muscle contraction. The reduction in electrical activity during maximum voluntary contraction with new complete denture is in disagreement with the results of **Licona et al (1990) and Lindauer ET al(1993)**, who found that after 30 days of using new dentures in place, the electrical activities were significantly greater. This increase electrical activity occurred as a result of reestablishing occlusal vertical dimension. Visser A et al stated that the mean Masseter EMG amplitude was not influenced by the immediate change in the vertical and protrusive inter maxillary relationship. This is in agreement with the finding by Christensen, Kawzoe et al. Several author Pincino et al (2005), Gunne HS et al (1982), Slagter AP et al (1993) states that the main cause of reduction in muscle activity may be related to patient’s lack of musculature capacity and ability to adapt new dentures.

According to **Seung-Ho Lee Dang-Wan Kang (2002)** showed during maximum intercuspation, chewing position, the proportionality of anterior temporalis muscle to masseter muscle activity was lower than other positions, and Naeije Shi found similar results. He also concluded that the temporalis muscle activity is especially sensitive to immediate changes in lateral positioning and that the masseter activity remains unchanged when conditions of stable bilateral occlusal contacts are present. Clinically, the use of new complete denture will allow new occlusal contacts to be reestablished, functionally benefiting the masticatory system by allowing a return to normal parameters. Zuccolotto et al (2007) showed patients who have been edentulous for over 10 years and have adapted to their unsatisfactory prosthesis may need extra time to reestablish their musculature after changing the prosthesis and it may be necessary to consider new parameter for these patients. The above-mentioned observations indicate that the subjects with old denture wearers show greater muscle activity and hence improved muscle efficiency. The new dentures showed improved facial esthetics, adequate fit, correct maxillomandibular relationships, and anatomical teeth with cuspal morphology.[29]

Having new denture after 5-months follow up for adaptability of dentures to the musculature infers minimal muscle activity and greater muscle efficiency. Due to the poor condition of dentures, these edentulous patients follow a diet based on soft foods. For that reason, it was assumed that the musculature would show hypotonicity. By suppressing proprioceptive mechanisms corresponding to the preservation of hypoactive muscle activities and eliminating possible interference from the occlusal relationship of the old dentures, new denture with improved occlusal surface and vertical dimension could promote musculature reconditioning. This fact probably occurred and allowed hypoactive muscles to optimize their electric activity. The increase in mean temporalis muscle values is clear evidence of its role in mandibular positioning to establish a new horizontal maxillomandibular relationship. Factors such as OVD, occlusal plane conditioning, integrity and adaptation of old dentures, and the possibility of muscle hypoactivity before treatment, could cause functional imbalances. After being corrected and using new set of complete denture, these were probably characterized by an increase in muscle efficiency. In this study, patients who were evaluated during the whole period of the study, reported that they felt greater comfort and that they were pleased with the aesthetics. Seventy per cent reported that they could chew better when wearing the new set of complete dentures than they did with the old dentures. From these results, it could be concluded that new set of complete dentures allow for neuromuscular reprogramming, which contributes to muscular balance of the masticatory system.

As might be expected the data suggest that there are differences in the levels of muscular activation in elderly individuals during masticatory function. However, there is a need for further long-term studies concerning elderly individuals, with the purpose of elucidating if these results are important for dynamic, specific or non-specific functional activities. By use of new complete denture with established occlusal contacts and vertical dimension, that functionally benefits the masticatory system by allowing a return to normal parameters. Thus, the musculature's EMG activity (anterior temporalis) may be reduced, allowing muscles to work more efficiently during 'tooth' contact. Other authors have affirmed that patients with new dentures increased masticatory efficiency, even with poor muscular adaptation and reduced electrical activity in the masticatory muscles.

In edentulous patients, the correct vertical dimension allows muscle relaxation. This is possibly due to length reprogramming and muscular tonus, mainly owing to the mechanoreceptor references of the periodontium. It is possible that for edentulous patients, the receptors of the oral mucosa are responsible for the modulation of motor activities, despite being less sensitive than those of the periodontium. This small increase may be related to reestablishment of OVD and presence of cusps; however, this increase was not statistically significant perhaps due to lack of muscular capacity and ability, as well as the complex neuromuscular skills required to overcome the limitations of dentures. These characteristics make occlusal adjustment of dentures difficult; perhaps permitting premature occlusal contacts that may destabilize the dentures and complicate mastication. This increased masticatory efficiency may have developed from muscular adaptation, reestablishment of OVD and occlusal surfaces. The new dentures with correctly positioned cusps facilitated intercuspation and perhaps required a lower amount of force to chew the food. This could lead to greater chewing of food and a better quality diet.

In the present study, the reduction in the number of cycles occurred mainly at the end of mastication. By electromyography, we can also see muscular changes in patients requiring prosthetic rehabilitation; therefore, we can state that rehabilitation need interferes on muscle harmony thus improvent in the efficiency of muscle activity. It is essential to explain to complete denture users, the importance of attending periodical visits in order to evaluate their dentures and oral conditions. These factors are factors intimately linked to aesthetics and functionality.

Limitations of the study:-

- The principal limitation of the present study is the number of analysed subjects, which was under the proper sample size to avoid type II errors.

- In this study, 5 months was not enough time to observe increased efficiency with the new complete dentures.

- The complex neuromuscular skills required to overcome the limitations of dentures. Adaptation of neuromuscular system takes an extended time and may be a determinant factor in influencing the EMG activity and this aspect can change the results.

- Reestablishment of the artificial tooth cusps with anatomic teeth and conventional balanced occlusionpositive outcomes can be expected.

- Patients who have been edentulous for over 3-5 years and have adapted to their old (unsatisfactory) prosthesis may need extra time to re-establish their musculature after changing the prosthesis and it may be necessary to consider new parameters for these patients

- The patients investigated in the present study were healthy physiologically and psychologically and, results may be different in psychologically distressed patients.

- Electrodiagnostic resources are still far from a concrete professional reality due to the lack of knowledge about the technique along with high-cost equipment.

Further scope of the study:

- A complementary approach in TMD diagnosis by EMG with other methods is sufficient if applied

- Improved masticatory efficiency would be explained by enhanced bilateral balanced occlusion obtained with the new dentures.

- The behavior of the dynamics masticatory muscle activity, like chewing swallowing and in rest postural position underlines the importance of an integrated analysis of both kinematics and EMG activity in the follow up of patients with new dentures.

- The studies should clarify the association among masticatory efficiency and alterations in anatomical occlusal form.

- Further investigations are needed to explore the relationship between occlusal features and muscular activity, designed following specific criteria (randomization, inclusion and exclusion criteria, similarity between groups at baseline, detailed description of the protocols to facilitate replication, blinding methods) in order to establish if a causal association between these variables really exist, thus avoiding spurious associations.

- Longitudinal studies with the purpose to appraise the long-lasting effects of occlusal disturbance on the activity of masticatory muscles.

- Finally, a greater accuracy of the electromyography would be desirable to confer to the results obtained an absolute reliability

CONCLUSION.

The results of the study showed that-

- During maximum voluntary contraction of Anterior Temporalis Muscle, the Mean activity of 242.4♣V on right side and 237.67♣V on left side with old denture and, 168♣V on right side and 166.07♣V on left side with new denture after 5-months follow up. Statistical analysis reveals highly significant increase in muscle efficiency (p=0.000*, p=0.000*) with new denture after 5-months follow up when compared to subjects with old denture during maximum voluntary contraction.

- This data showed during maximum voluntary contraction of MasseterMuscle. The mean activity of 231.93♣V on right side and 230.60♣V on left side with old dentures and, 163.13♣V on right side and 171.73♣V on left side with new denture after 5-months follow up. Statistical analysis reveals highly significant increase in muscle efficiency (p=0.000*, p=0.002*) with new denture after 5-months follow up when compared to subjects with old denture during maximum voluntary contraction.

According to the methodology used and according to the results obtained it may be concluded that the electrical activity of Anterior Temporalis muscle and Masseter muscle during maximum voluntary contraction was reduced; hence, muscle efficiency has been improved after 5 months with the new complete denture in place. The difference was statically significant.

The results show that new dentures or improvements in occlusion and vertical dimension produce a positive benefit to the patient by reducing the muscle effort during chewing without affecting masticatory performances. And it also indicate that in edentulous subjects with an old denture used for several years, after the delivery of a new denture 5 months of followup , the EMG activity of right side of the anterior temporalis muscle decreases hence the muscle efficiency is improved as compared to other group of muscles examined. The reduction in muscle effort is likely to cause less tissue trauma and in the end may minimize residual ridge resorption.

A new complete denture allows for neuromuscular reprogramming, which contributes to muscular balance of the masticatory system. With wear of old complete dentures over a period (more than 5-6 years), lead to the compromise in esthetic and function with reduced masticatory efficiency. Thus, recognition of these expected gains to the patient is important for the dentist to make treatment recommendations about making new dentures for every three years. Moreover, improvement in occlusal surface (anatomic cusp), reestablishment of new vertical dimensions significantly improves the esthetic, function and increased masticatory efficiency. However, further improvement in muscle efficiency in edentulous patient leading to better nutrition and digestion. All these factors considered for physical and psychological benefit to the patient’s health, condition and well-being.

Summary:

The loss of natural teeth leads to bone resorption and muscular hypotonicity, which may affect the structures involved in mastication.Atrophy of supporting tissues, poor adaptation, reduced masticatory efficiency, and psychosocial embarrassment are major complaints of edentulous patient wearing old/faulty denture. Mastication being a complex biologic function utilizing various components such as muscles, dentition and neural control; requires these various controlling components to be in harmony and optimal health. When one of these components loses their function, the masticatory efficiency of the individual hampered. The restoring of the lost or affected components to some extent, bring back the patients efficiency. This study was conducted to assess the changes of bilateral Masseter and anterior Temporalis muscle activity in-patient wearing old/faulty dentures in comparison to the evaluations performed for 5 month following fabrication and insertion of new dentures.

For purpose of the study 15 patients wearing complete denture prosthesis between the ages of 40-70 years were selected as a subject for the investigation. Individuals presenting with history of neuromuscular and temporomandibular disorders (TMD) were excluded from the study according to exclusionary criteria. Although various techniques are available for examining the stomatognathic system, recording of electromyographic (EMG) activity is a convenient and useful method because it directly measures muscle activity. Surface electrodes from electromyographic unit (EMG) were placed in the region of right and left anterior Temporalis muscle and Masseter muscle, and the patients will be asked to perform maximum voluntary contraction

(MVC). The EMG signals filtered and amplified with a time constant of 10ms. The muscle activity analyzed twice for each patient: (1) with the old/faulty dentures and (2) 5 month following fabrication and insertion of new denture.

The electrical activity during maximum voluntary contraction exhibited statistically significant improved muscle efficiency with new denture when compared to those with old denture wearer in place for 5 months. Highly significant change in muscle activity was seen in right side of the Temporalis muscle as compared to other groups of muscles after having new denture in place for 5 months.

New dentures or improvements in occlusion and vertical dimension produce a positive benefit to the patient by reducing the muscle effort during chewing without affecting masticatory performances. The reduction in muscle effort is likely to cause less tissue and in the end may minimize residual ridge resorption and, a new complete denture allows for neuromuscular reprogramming, which contributes to muscular balance of the masticatory system. A period longer than five months of wearing the new complete dentures is required for adaptation and the acquisition of functional capacity.

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ANNEXURE

Electromyographic activity of right Anterior Temporalis muscle expressed in microvolt (♣V)

Right Anterior temporalis muscle

With old denture (♣V)	With new denture (♣V)
273	203
287	119
246	183
292	162
197	120
193	161
265	220
256	203
168	131
209	169
220	172
226	201
269	148
254	136
281	192

Electromyographic activity of left Anterior Temporalis muscle expressed in micro-volt (♣V)

Left Anterior temporalis muscle

With old denture (♣V)	With new denture (♣V)
287	239
287	217
216	192
228	144
290	125
282	223
201	182
173	105
231	162
170	142
185	112
258	219
257	132
218	124
282	173

Electromyographic activity of right Masseter muscle expressed in microvolt (♣V)

Right Masseter muscle

With old denture (♣V)	With new denture (♣V)
229	214
220	176
190	133
310	198
209	136
218	197
307	179
144	95
207	206
170	125
210	124
153	84
307	196
296	186
309	198

Electromyographic activity of left Masseter muscle expressed in microvolt (♣V)

Left Masseter muscle

With old denture (♣V)	With new denture (♣V)
223	116
287	181
183	141
310	202
217	208
268	378
176	194
181	73
262	196
253	232
169	93
214	134
216	122
198	102
302	204