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Role of Electromyography in Dental Research: A Review

Santosh R Patil [1], Bharati R Doni [2], Chaitra Patil[3], Shaikh Nawab [4], Mohammad Khursheed Alam [5]

[1] Department of Oral Medicine and Radiology, New Horizon Dental College and Research Institute, Bilaspur, Chhattisgarh, India
[2] Department of Dentistry, Koppal Institute of Medical Sciences, Koppal, Karnataka, India
[3] Department of Oral and Maxillofacial Surgery, Krishnadevaraya College of Dental Sciences and Hospital, Bangalore, India
[4] Department of Orthodontics and Dentofacial Orthopedics, SVS Institute of Dental Sciences, Mahbubnagar, India
[5] Department of Orthodontics, College of Dentistry, Jouf University, Kingdom of Saudi Arabia

Corresponding author:
Santosh R Patil, Department of Oral Medicine and Radiology, New Horizon Dental College and Research Institute, Bilaspur, Chhattisgarh, India

drpsantosh@gmail.com

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Abstract

Background and Aim: The purpose of this review was to provide an overview of the use of electromyography (EMG) in dentistry over the past several years, as well as related research. EMG is a sophisticated technique used to detect and analyze muscle activity. EMG was primarily utilized in medical sciences in the past, but it is now widely utilized in both the medical and dental fields.

Materials and Methods: Electronic search was conducted in EMBASE, PubMed, Scopus, Web of Science, and Google Scholar to find all clinical studies regarding applications of EMG in dentistry.

Results: This review included 31 papers in all. According to the results, neuromuscular activity may be recorded using EMG for both diagnostic and therapeutic purposes. It could be used in dentistry to evaluate parafunctional habits such as clenching and bruxism as well as muscle activation during actions like chewing and biting. In recent years, the use of EMG in treatment of temporomandibular joint (TMJ) and myofascial pain disorders has significantly increased.

Conclusion: EMG has a variety of applications in dentistry for monitoring, diagnostic, and therapeutic purposes.

Key Words: Dentistry; Facial Muscles; Masticatory Muscles; Electromyography

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Introduction

Electromyography (EMG) evaluates and records myoelectric signals produced by skeletal muscles. The electrical potential produced by the muscle cells when they are electrically or neurologically active can be measured by EMG. By analyzing the signals, problems with the body and mouth may be found. The EMG's structural core is the motor unit [1]. The motor unit action potential is the sum of extracellular potential of muscle fiber action potentials of a motor unit. A muscle's motor unit is its most basic functioning unit. It is composed of a motor neuron and all muscle fibers that are innervated by the axonal branches of the motor neuron. The motor unit action potential is the electrical signal produced when the muscle fibers of a motor unit are activated, which is measured by an electrode. The motor unit action potential is the basic unit of the EMG signal [2].

The muscle fiber excitability through brain control is a fundamental element in muscle physiology. A semi-permeable membrane model can explain this behavior. An ionic equilibrium creates a resting potential at the muscle fiber membrane between the inner and outer spaces of a muscle cell (approximately -80 to -90 mV when not contracted). The ionic pump maintains this potential difference, resulting in creation of a negative charge in the internal surface of the cell as opposed to the positively charged outside surface. Activation of an alpha-motor anterior horn cell results in transmission of excitement along the motor nerve (induced by the central nervous system). After the release of neurotransmitter at the motor end plates, an end plate potential is produced. The diffusion characteristics of the muscle fiber membrane are altered, and a flow of Na+ ions within the surface occurs. It causes membrane depolarization, which is followed by a process of repolarization, in which ions are exchanged backwards in the active ionic pump [1,2].

EMG is often used in both clinical and research settings. EMG is widely used in dentistry for temporomandibular joint (TMJ) problems, TMJ dysfunction, dystonia, head and neck muscular illnesses, cranial nerve lesions, and seizures. EMG is also used to identify illnesses like as amyotrophic lateral sclerosis and myasthenia gravis, which are related to degeneration of muscle tissue and nerves [3]. In addition, EMG is useful for assessment of facial muscles during orthodontic treatment, particularly in light of the neuromuscular approach and the discomfort that functional facial appliances may produce. Surface EMG and intramuscular EMG are the two techniques used for capturing EMG. Using a pair of electrodes, surface EMG quantifies muscle function by recording muscle activity at the skin surface. Surface EMG allows the noninvasive study of the bioelectrical phenomena of muscle contraction. The EMG technology allows for the examination of numerous important muscles involved in eating, swallowing, and head position (typically masseter, temporalis, anterior and posterior digastric, and sternocleidomastoid). For intramuscular EMG; however, a variety of recording electrodes may be used. Monopolar electrodes are the most basic type of needle electrodes. Electrical stimulation of the neurons of a muscle induces electrical activity in the muscle, which may be recorded to detect the type and location of motor unit injury [4]. The purpose of this review was to provide an overview of the use of EMG in dentistry over the past several years, as well as related research.

Materials and Methods

This study used a variety of electronic databases, including Google Scholar, EMBASE, PubMed, Scopus, and Web of Science, as its primary search tool. EMG, dental, dentistry, orthodontics, and temporomandibular joint were a few of the keyword combinations that were utilized to conduct a thorough search of the literature up to (including) March 2022 (Figure 1).

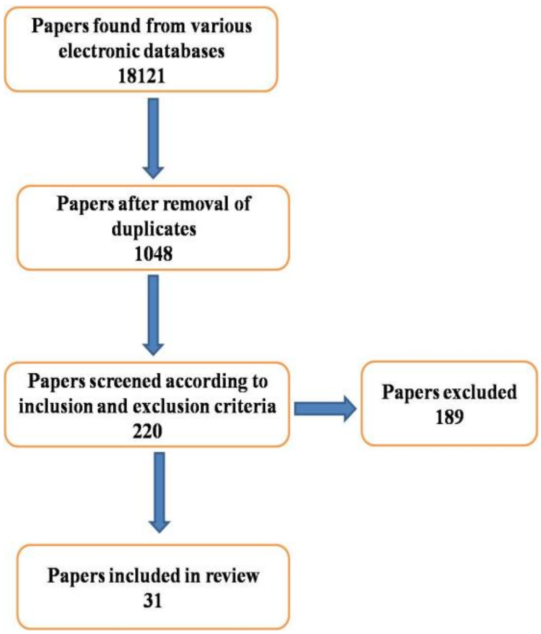

Figure 1. Flowchart of search strategy according to PRISMA guidelines

Finding out how EMG is used in dentistry was the major goal of this study. For this review, all of the data that were accessible in the literature were gathered. The inclusion criteria were studies employing EMG in dental specialty, using EMG in the head and neck area, and mentioning the importance of EMG in dental practice. However, studies that used EMG for purposes other than dental applications or had nothing to do with dental specialty were disqualified from the evaluation. Studies that were not conducted on humans and publications written in languages other than English were also excluded. The total number of publications was established using a computerized database search, and the authors then chose the number of papers based on the inclusion and exclusion criteria.

Results and Discussion

From a total 18,121 hits, duplicate articles were excluded, and 220 studies were selected after screening. A total of 31 full-text papers were taken into consideration for this review on the basis of the inclusion and exclusion criteria (Figure 1).

EMG is the study and recording of muscle electric potentials. Man has always had a curiosity for who he is and what is around him. This sparked the development of a number of revolutionary inventions that improved human lives. The development of today's electrodiagnostic techniques is the result of extensive research and documentation in the field of bioelectricity. There are advantages in using EMG as a diagnostic tool in medicine. It significantly influences a number of areas of clinical medicine and dentistry. Consequently, this literature review was conducted to familiarize readers with the applications of EMG in various dental disciplines.

Moyers attempted to use EMG in dentistry for the first time. He observed that the appropriate relationship of teeth was determined by the balance of muscles within the same jaw as well as those in the opposing jaw. In orthodontics, the temporalis muscle, masseter muscle, lateral pterygoid, and medial pterygoid are all important mandibular elevator muscles. The genioglossus muscle is also essential in determining the facial shape [5]. Hamada et al. conducted an EMG research of the masseter and anterior temporalis muscle in bruxism patients with muscular discomfort, tiredness, and soreness to find the best course of therapy for such individuals. Due to the increased activity, the results suggested that the masticatory muscles were fatigued [6]. Kishimoto reported that canine teeth most commonly showed pathological occlusal wear due to grinding, and observed increased EMG activity of anterior temporalis muscle [7].

Li et al. compared healthy subjects with surgically treated unilateral cleft lip and palate individuals with anterior cross bite to evaluate the characteristics of masticatory muscle activity. On both sides, the masseter and temporalis muscles' EMG activity was recorded. The masseter and temporalis muscles' potential functions were lower and their levels of resting activation were higher in individuals with unilateral cleft lip and palate. The masticatory muscle activity was found to be inharmonious during border movements of the mandible [8].

During EMG responses to changes in tooth contact on an occlusal splint during maximal biting, Wood and Tobias examined the myofunctional activity in the left and right masseter, left and right sides of the posterior temporalis, and left and right sides of the anterior temporalis. When the contacts became more unilateral, the authors wanted to see how the EMG muscle activity changed between occlusal splint clenching and intercuspal clenching.

Comparisons were made between the muscle activity that occurred during maximal clenching in various conditions, and the authors discovered that the result was not statistically significant [9]. Christensen examined the impact of an occlusal splint on experimental participants' integrated EMG of the masseter muscular clenching. He came to the conclusion that the splint's potential mechanism of action in lowering muscle activity was stretching [10]. Sherman utilized EMG to characterize activity in the masseteric regions of individuals with pain emanating from the TMJ region as their chief complaint. The patients were divided into four groups based on whether the patients had obvious TMJ problems with or without physical evidence, as well as a history of clenching or bruxism. The findings revealed that although the mixed issue group substantially differed from the normal group, 16 individuals with obvious TMJ problems who had no history of clenching or bruxism were neither statistically nor clinically different. Therefore, the degree of muscle contraction is undetectable when TMJ is paired with clenching and bruxism, proving that the presence of TMJ issues alone does not cause a rise in the degree of muscle contraction [11]. EMG activity and masticatory muscle discomfort were measured before and during treatment with orthopedic protraction headgear by Ngan et al. In general, 800 g of orthopedic force was utilized to protract the maxilla, with the temporomandibular region receiving 75% of this force. The findings showed that orthopedic therapy with maxillary protraction headgear did not result in a substantial increase in muscular discomfort or masticatory muscle activity [12].

Burdette and Gale employed bipolar surface electrodes to obtain stimulant postural EMG data from the masseteric and anterior temporalis areas of individuals with temporomandibular disorders (TMDs) for an intensive treatment program that included splinting and psychophysiological therapy. The findings showed that myofascial pain dysfunction syndrome (MPDS) patients may have higher tonic masticatory muscle activity [13]. Goldreich et al. investigated how discomfort from orthodontic arch wire adjustments affected masseter activity. The electromyographic level dropped considerably after therapy. The findings indicated that orthodontic tooth discomfort decreased muscular activation during function [14].

Burdette and Gale looked at the reliability of surface EMG in the masseteric and anterior temporalis areas. A total of 37 patients with MPDS were examined. The correlation coefficients' statistical significance for the masseteric and temporalis muscles suggested that these muscles were tonically activated [15]. Compared to healthy controls, patients with MPDS, TMDs, and back pain had significantly higher left masseter EMG levels during neutral and stressful conditions than did patients with chronic back pain and healthy controls. The right side's reaction was greater, and the findings of Katz et al. regarding higher EMG values in the right temporalis muscle helped to explain it [16]. Ingervall and Egermark-Eriksson surveyed how patients with multiple bites use their masseter and temporalis muscles (an occlusion with an abnormally long anteroposterior difference between the retruded and intercuspal position of the mandible). The low postural activity of the temporalis muscle was found in dual bite individuals, presumably indicating a protruded posture of the jaw. While the masseter activity was low during biting in the retruded position, the posterior temporalis muscle activity was low at maximum biting in the intercuspal position. During peak biting, none of the two mandibular sites under study resulted in balanced activation of all three muscles [17]. Patients with chronic temporomandibular pain participated in a research by Flor et al. to identify 33 stress-related electromyographic responses; MPDS patients reported higher levels of life stress and averseness throughout the trial [18]. In normal, healthy, pain-free men, Lobbezoo et al. discovered that occlusal appliances changed the pattern of muscle activity. Splints decreased the electromyographic activity of the anterior temporalis muscle while increasing the activity of the masseter [19]. The mean potentials of men and women were found to be equal in a research by Ferrario et al.; however, in clenching, men had greater electromyographic levels and contact during centric occlusion. Ferrario et al. examined the electromyograms of children with class II division 1 malocclusion and discovered that the temporalis muscle was deficient in both habitual and resting occlusion (increased activity in the posterior part of the temporalis muscle). He discovered that this impairment may make the post-normal occlusion worse [3]. Wieselmann-Penkner et al. examined the effects of transcutaneous electrical neuromuscular stimulation and EMG-biofeedback on individuals with bruxism in order to induce muscle relaxation. As a result, after the treatment period, MPDS patients' skin conductance and EMG activity of the masticatory muscles showed reduced mean values in both groups, with greater EMG values in the myomonitor group [20]. Iyer and Valiathan assessed various uses of EMG. The authors elaborated the motor unit potential and EMG procedure where surface electrodes are preferable compared to needle electrodes [4].

To assess the effects of interocclusal appliances, Roark et al. employed EMG during parafunctional tooth contact. Without the splint in place, individuals were told to make mild tooth contact, complete clenching, and sufficient clenching, while EMG data from the left and right temporalis and masseter muscles were recorded. EMG activity demonstrated a significant difference between the two conditions [21].

Ahlgren et al. recorded electromyographic activity of 10 patients with normal occlusion using intramuscular electrodes from the front, middle, and posterior sections of the temporalis muscle while the jaw was at rest and during effort. The posterior section of the temporalis was found to be responsible for mandibular position. Individual differences in EMG were found in three muscle divisions. EMG activity increased proportionately in all areas of the muscle when the biting force increased. The temporalis EMG activity was linked to the shape and location of the jaw [22].

Ferrario et al. conducted a research to determine the repeatability of submaxilla electromyographic force connections done simultaneously and symmetrically on both sides of the mouth in order to measure the maximal biting force. The experiment led to the discovery of meaningful linear correlations between biting force and EMG potentials [23]. High-density surface EMG was studied by Drost et al. as a diagnostic tool for motor neuron diseases, neuropathy, and myopathy [24]. In normal occlusion, Ahlgren looked at the EMG pattern of the temporalis muscle. In isometric contraction, he discovered that the posterior section of the temporalis muscle was active during posture, but there was no significant difference in EMG activity of the three divisions of the temporalis muscle [25].

Castroflorio et al. conducted a review of surface EMG in the jaw elevator muscles to describe the recording method, contributing variables, and clinical applications (identifying the etiology of TMD) [26]. They discovered that surface EMG recording can increase the sensitivity and reliability of this procedure. Harper et al. investigated the role of the lateral pterygoid muscle in mandibular retrognathism and the effects of surgery on mandibular advancement. They discovered previously unknown aberrant pterygoid muscle activity patterns and their adaptive response to orthognathic surgery [27].

According to De Felicio et al., who conducted a research to assess the relationship between surface EMG of muscles of mastication, orofacial myofunctional status, and TMD severity score [28], TMD patients had more discrepancies between the right and left muscles, increased unstable contractile activity of the contralateral muscles, worse myofunctional status, and enhanced TMD severity scores than healthy individuals. Miralles et al. monitored the electromyographic activity of the anterior temporalis and masseter muscles in 15 children with Class II Division 1 malocclusion who were undergoing activator treatment. They found that while the activator was in the mouth, the activity was much higher when swallowing, confirming the claim that the activator is worn throughout the day [29]. The dysfunction of the face (masseter) and head (temporalis) muscles during tooth brushing, which may result in a dynamic effect on the face and head muscles, was examined by Alam et al. using surface EMG. While brushing the teeth, the shoulder joint and the temporalis and master muscles on both sides of the force were constantly in motion [30]. Iwasaki et al. conducted a study to evaluate the differences in masticatory muscle usage across TMJ dysfunction diagnostic groups. According to the authors [31], it was shown that the temporalis muscle was much more active than the masseter muscle. Mousa et al. examined how varying cusp angles affected masticatory efficiency and muscle activity in people who had a bilateral distal mandibular partial removable dental prosthesis. The authors discovered that partial removable dental prosthesis with anatomic teeth had the lowest EMG activity; whereas, non-anatomical teeth had the highest activity [32].

The muscular changes brought on by oral contraceptive usage throughout the menstrual cycle were evaluated by Turcio et al, using EMG during the quiet period of the menstrual cycle [33]. Alam et al. assessed patient satisfaction with posterior implants based on clinical success criteria and the results of the surface EMG of the masseter and temporalis muscles. They discovered a link between the clinical success criteria and the EMG results and the high levels of satisfaction implant patients expressed [34]. Kant et al. evaluated the electromyographic activity of oral submucous fibrosis patients. The amplitude and duration of activity of the masseter, anterior temporalis, and orbicularis oris muscles were assessed in both relaxed and contracted states on both the right and left sides. The authors discovered that in patients with extensive oral submucous fibrosis, the masseter muscle activity was significantly reduced [35]. Sinha et al. compared pre- and posttreatment activity in patients with oral submucous fibrosis with healthy controls. They also looked at the electromyographic activity of the masseter and orbicularis oris muscles in patients with oral submucous fibrosis. The researchers discovered that the electromyographic activity of both muscles in the control group was significantly lower than that of individuals with oral submucous fibrosis. There was a statistically significant decrease in activity in those with oral submucous fibrosis between pretreatment and posttreatment. According to the authors [36], electromyography may be used to assess the involvement of the mastication and facial expression muscles in patients with oral submucous fibrosis as well as the impact of treatment on muscular activity. Based on the included studies in the present review, the followings are some of the applications of EMG in dentistry:

EMG enables the study of action potentials in actively contracting lingual and masticatory muscles. It is used in treatment of MPDS, and its process is known as auditory or visual electromyographic feedback. It provides information about muscle activation. It enables the study of biomechanics of the jaw and facial muscle functioning. EMG is important to assess the outcome of treatment and asymmetry of muscle activation. It enables tracking of nocturnal bruxism and jaw muscle activity. By identifying uncontrolled muscular activity, it is extremely useful in treatment of bruxism patients. It also helps determine whether there is any muscular imbalance or probable postural abnormalities, as well as substantial muscle exhaustion. In both active and resting situations, the EMG record can indicate a masticatory muscle response.

Conclusion

EMG is the most objective and trustworthy method to assess the muscle electrical potential. This technique identifies the electrical potentials of the muscles. The peripheral nervous system, the equipment used to collect the signal, and the anatomical and physiological characteristics of the muscles all affect EMG signals. Understanding fundamental muscle function is important to efficiently record EMG signals. In general dentistry, EMG has a wide range of applications, including monitoring, diagnosis, and treatment.

References

1. Raez MB, Hussain MS, Mohd-Yasin F. Techniques of EMG signal analysis: detection, processing, classification and applications. Biol Proced Online. 2006;8:11-35.

2. De Luca CJ. Encyclopedia of Medical Devices and Instrumentation. Webster JG ed. USA: John Wiley Publisher; 2006. p.98-109.

3. Ferrario VF, Sforza C, Miani A Jr, D'Addona A, Barbini E. Electromyographic activity of human masticatory muscles in normal young people. Statistical evaluation of reference values for clinical applications. J Oral Rehabil. 1993 May; 20 (3):271-80.

4. Iyer M, Valiathan A. Electromyography and its application in orthodontics. Curr Sci (Bangalore) 2001;80(4):503–7.

5. Moyers RE. Temporomandibular muscle contraction patterns in Angle Class II, division 1 malocclusions; an electromyographic analysis. Am J Orthod. 1949 Nov;35(11): 837-57.

6. Hamada T, Kotani H, Kawazoe Y, Yamada S. Effect of occlusal splints on the EMG activity of masseter and temporal muscles in bruxism with clinical symptoms. J Oral Rehabil. 1982 Mar;9(2):119-23.

7. Kishimoto T. Studies on bruxism. Journal of Japan Orthodontic Society. 1957;16:26.

8. Li W, Lin J, Fu M. Electromyographic investigation of masticatory muscles in unilateral cleft lip and palate patients with anterior crossbite. Cleft Palate Craniofac J. 1998.Sep; 35(5):415-8.

9. Wood WW, Tobias DL. EMG response to alteration of tooth contacts on occlusal splints during maximal clenching. J Prosthet Dent. 1984 Mar;51(3):394-6.

10. Christensen LV. Effects of an occlusal splint on integrated electromyography of masseter muscle in experimental tooth clenching in man. J Oral Rehabil. 1980 Jul;7(4):281-8.

11. Sherman RA. Relationships between jaw pain and jaw muscle contraction level: underlying factors and treatment effectiveness. J Prosthet Dent. 1985 Jul;54(1):114-8.

12. Ngan PW, Yiu C, Hagg U, Wei SH, Bowley J. Masticatory muscle pain before, during, and after treatment with orthopedic protraction headgear: a pilot study. Angle Orthod. 1997;67(6):433-7.

13. Burdette BH, Gale EN. The effects of treatment on masticatory muscle activity and mandibular posture in

myofascial pain-dysfunction patients. J Dent Res. 1988 Aug; 67(8):1126-30.

14. Goldreich H, Gazit E, Lieberman MA, Rugh JD. The effect of pain from orthodontic arch wire adjustment on masseter muscle electromyographic activity. Am J Orthod Dentofacial Orthop. 1994 Oct;106(4):365-70.

15. Burdette BH, Gale EN. Reliability of surface electromyography of the masseteric and anterior temporal areas. Arch Oral Biol. 1990;35(9):747-51.

16. Katz JO, Rugh JD, Hatch JP, Langlais RP, Terezhalmy GT, Borcherding SH. Effect of experimental stress on masseter and temporalis muscle activity in human subjects with temporomandibular disorders. Arch Oral Biol. 1989; 34(6): 393-8.

17. Ingervall B, Egermark-Eriksson I. Function of temporal and masseter muscles in individuals with dual bite. Angle Orthod. 1979 Apr;49(2):131-40.

18. Flor H, Birbaumer N, Schulte W, Roos R. Stress-related electromyographic responses in patients with chronic temporomandibular pain. Pain. 1991 Aug;46(2):145-52.

19. Lobbezoo F, van der Glas HW, van Kampen FM, Bosman F. The effect of an occlusal stabilization splint and the mode of visual feedback on the activity balance between jaw-elevator muscles during isometric contraction. J Dent Res. 1993 May;72(5):876-82.

20. Wieselmann-Penkner K, Janda M, Lorenzoni M, Polansky R. A comparison of the muscular relaxation effect of TENS and EMG-biofeedback in patients with bruxism. J Oral Rehabil. 2001 Sep;28(9):849-53.

21. Roark AL, Glaros AG, O'Mahony AM. Effects of interocclusal appliances on EMG activity during parafunctional tooth contact. J Oral Rehabil. 2003 Jun;30(6): 573-7.

22. Ahlgren J, Sonesson B, Blitz M. An electromyographic analysis of the temporalis function of normal occlusion. Am J Orthod. 1985 Mar;87(3):230-9.

23. Ferrario VF, Sforza C, Zanotti G, Tartaglia GM. Maximal bite forces in healthy young adults as predicted by surface electromyography. J Dent. 2004 Aug;32(6):451-7.

24. Drost G, Stegeman DF, van Engelen BG, Zwarts MJ. Clinical applications of high-density surface EMG: a systematic review. J Electromyogr Kinesiol. 2006 Dec; 16 (6):586-602.

25. Ahlgren J. EMG pattern of temporalis in normal occlusion. Eur J Orthod. 1986 Aug;8(3):185-91.

26. Castroflorio T, Bracco P, Farina D. Surface electromyography in the assessment of jaw elevator muscles. J Oral Rehabil. 2008 Aug;35(8):638-45.

27. Harper RP, de Bruin H, Burcea I. Lateral pterygoid muscle activity in mandibular retrognathism and response to mandibular advancement surgery. Am J Orthod Dentofacial Orthop. 1987 Jan;91(1):70-6.

28. De Felício CM, Ferreira CL, Medeiros AP, Rodrigues Da Silva MA, Tartaglia GM, Sforza C. Electromyographic indices, orofacial myofunctional status and temporomandibular disorders severity: A correlation study. J Electromyogr Kinesiol. 2012 Apr;22(2):266-72.

29. Miralles R, Berger B, Bull R, Manns A, Carvajal R. Influence of the activator on electromyographic activity of mandibular elevator muscles. Am J Orthod Dentofacial Orthop. 1988 Aug;94(2):97-103.

30. *Alam MK, Basri* R, Reza MF. Myofunctional Benefit of Tooth Brushing with Miswak: Electromyography and Magnetoencephalography Assessment. Int Med J. 1994; 20 (2):247–9.

31. Iwasaki LR, Gonzalez YM, Liu H, Marx DB, Gallo LM, Nickel JC. A pilot study of ambulatory masticatory muscle activities in temporomandibular joint disorders diagnostic groups. Orthod Craniofac Res. 2015 Apr;18 Suppl 1(01): 146-55.

32. Mousa MA, Patil S, Lynch E. Masticatory efficiency and muscular activity in removable partial dental prostheses with different cusp angles. J Prosthet Dent. 2017 Jan; 117 (1):55-60.

33. Turcio KHL, Garcia AR, Zuim PRJ, Moreno A, Goiato MC, Guiotti AM, Dos Santos DM. Evaluation of silent period on masticatory cycles of different muscles in dentate oral contraceptives users and nonusers. Eur J Dent. 2015 Apr-Jun;9(2):171-5.

34. Alam MK, Rahman SA, Basri R, Sing Yi TT, Si-Jie JW, Saha S. Dental Implants - Perceiving Patients' Satisfaction in Relation to Clinical and Electromyography Study on Implant Patients. PLoS One. 2015 Oct 14;10(10):e0140438.

35. Kant P, Bhowate RR, Sharda N. Assessment of cross-sectional thickness and activity of masseter, anterior temporalis and orbicularis oris muscles in oral submucous fibrosis patients and healthy controls: an ultrasonography and electromyography study. Dentomaxillofac Radiol. 2014; 43(3):20130016.

36. Sinha G, Sharma ML, Ram C. An electromyographic evaluation of orbicularis oris and masseter muscle in pretreatment and posttreatment patients of oral submucous fibrosis: A prospective study. J Indian Acad Oral Med Radiol. 2018;30:210-5.