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ELECTROMYOGRAPHY AND ITS APPLICATIONS IN PROSTHODONTICS

Prosthodontics

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ABSTRACT

There are various modalities for diagnosing temporomandibular disorders and assessing their prognosis. Electromyography is one of the gadget used frequently. It is an advanced technique to record and assess skeletal muscle activity. Earlier electromyography was used only in medical field, but now it has been playing an important role in diagnosis and treatment planning in dentistry also. It has been used in dentistry frequently for diagnosis and treatment of bruxism and myofascial pain dysfunction syndrome. Its other applications in prosthodontics have remained somewhat unexplored. So the aim of this review article is to describe electromyography and its applications in prosthodontics.

KEYWORDS

electromyography, temporomandibular disorders,dentistry,bruxism,myofascial pain dysfunction syndrome.

INTRODUCTION

Temporomandibular disorders are defined as conditions producing abnormal,incomplete,or impaired function of the temporomandibular joint(s)and/or the muscles of mastication[1]Köhler and colleagues[2] reported that approximately 50 percent of individuals in general population may have at least one sign of temporomandibular disorder , and almost upto 5 to 9 percent have clinically significant more severe temporomandibular disorder symptoms. Temporomandibular disorder may result in chronic orofacial pain that may hamper day to day activities, and may present along with other symptoms affecting the orofacial region.[3] Temporomandibular disorder pain typically is worsened by jaw function and may be accompanied by a limitation in jaw movement, as well as by tenderness of joints , joint noises and soreness of masticatory muscles.[4]Noninvasive, conservative treatments generally improve or relieve symptoms and are therefore advised in the initial management of temporomandibular disorders.[5]Conservative approach in patients with temporomandibular disorders can be discouraging; however, the use of electromyography (EMG) as an adjunct to and in conjunction with other therapy interventions may be beneficial.[6]

Electromyography (EMG) is well-defined as the recording and study of the fundamental electrical properties of skeletal muscle using superficial or needle electrodes which help us in determining the muscle is in contraction or not. Electromyography is abundantly used both for clinical and research purposes . In dentistry, electromyography is more commonly used for diagnosing and treating temporomandibular joint (TMJ) disorder, temporomandibular joint dysfunction, dystonia, muscle disease of head and neck, cranial nerve lesion, and also seizure disorders. Electromyography is also used in detecting diseases which are associated with damage of muscle tissue and nerve such as the one performed for the tongue muscle due to amyotrophic lateral sclerosis and facial muscle due to myasthenia gravis. Moreover, electromyography plays a significant role in diagnosing abnormalities of facial muscle during orthodontic treatment related to neuromuscular approach and facial pain associated with the use of functional appliance.[7]

BRIEF HISTORY

In 1849, Emil du Bois-Reymond discovered that it was also possible to record electrical activity during a voluntary muscle contraction. The first actual recording of this activity was made by Marey in 1890, who also introduced the term electromyography.[8] Research began at the Mayo Clinic in Rochester, Minnesota under the guidance of Dr Edward H. Lambert, in the early 1950s. Dr Lambert, "Known as the "Father of electromyography."with the assistance of his Research Technician, Ervin L Schmidt, a self taught electrical engineer, developed a machine that could be moved from the electromyography Lab, and was relatively easy to use.[9]

METHOD-

Electromyography has evolved from the now well-established techniques of electrocardiography and electroencephalography. The equipment required are :

(1) The electrodes-which pick up the minute electrical activity.
(2) An amplifying system to magnify these signals.
(3) A means of recording the amplified signals.

1] The electrodes:

Commonly two types of electrode are used

(a) The surface electrode that comprises of small metal disc attached to the skin
over the muscle by a suitable conducting material such as celloidin.

(b) The needle electrode that comprise of a small bore hypodermic needle, containing an insulated wire.

The latter is the bipolar or coaxial type, but there are monopolar needle electrodes also available and used in conjunction with recordings from a relatively neutral part of the patient's body, e.g., the lobe of the ear. The implant electrodes, have been used in animal experiments by Turlington *et al.*[10]

Surface electrodes are limited to monitor muscles situated superficially. Due to the presence of other deeper and adjacent structures, their reception is not restricted to the muscle that is to be observed. Several factors might lead to faulty readings such as the conductivity of skin or electrode placement. Surface electrodes are for this reason suitable for the studying integrated activity of the muscle mass just beneath skin.By proper symmetrical placement of these electrodes bilaterally over paired muscles, their relative activity may be studied at resting state and during various movements.[11]This type of electromyography adequately permits the examination of some of the muscles significantly involved in mastication, deglutition, and posture of the head (typically masseter, temporalis anterior and posterior digastric,anterior sternocleidomastoid).[12]The most important advantage of surface electromyography is that it is non-invasive .[11]It is a painless and innocuous method for recording muscle function that may conceivably be used in the temporomandibular identification.[13,14]

On the other hand needle electrodes have an area of pick-up limited to a few motor units in their immediate approximity. Insertion of a needle into the muscle itself causes trauma and gives rise to the so-called “insertion potential”.[15]

2]the amplifying system

It is usually some modification of an electroencephalograph. The number of channels differ and is a measure of the number of simultaneous recordings of which the machine is capable.

***3]Recording apparatus* :**

Several techniques have been employed for recording . They are the crystographic inkwriter, with a synchronous controlled-speed paper feed, cathode ray oscilloscope coupled with a movie camera; and a sound amplifier recording on a magnetic tape. The inkwriter has a shortcoming of inertia and hence not accurate at frequencies over 100 cycles per second.[16]

Limitations of electromyography

Before considering the implications of electromyographic analysis, some of the chief limitations of this technique will be mentioned.

(1) No machine is completely free of "amplifier noise". Hence absolute electrical silence, which is synonymous with inactivity in muscle, cannot be recorded. This effect can be kept to minimum by using audio-recording,

calibrating the amplifier noise as zero.

(2) Unless simultaneous recordings are made from all the muscles associated with certain activity (i.e., from the agonists, antagonists, and synergists which stabilize the part), no accurate function can be ascribed to any one muscle. It is not valid to infer an abnormality of action of a single muscle or a group based on analysis of only a few of the muscles involved in that activity

(3) when surface electrodes are used, there is no way we can isolate the action potentials of a single group from those muscle fibres adjacent or deep, to it.

(4) when needle electrodes are used, they interfere with the normal activity of the muscle being studied.[11]

(5) According to Jarabak[17] small changes in electrical activity due to slow movements to either side of the rest position, cannot be accurately monitored electromyographically.

(6) Correlation between muscular forces, i.e., tension developed, and electrical activity, is limited to certain physiological conditions. Changes in muscle length, rate of change, and muscle fatigue, which occur in the oral muscles,make such correlations impossible.[18]

(7) Variations in the patient's performance may be beyond the operator's control.[11]

Applications Of Electromyography In Prosthodontics

1] In Bruxism

a)Masticatory Muscle Electromyographic Recording

The Electromyographic recording has been commonly used to measure actual sleep bruxism activity directly. The principal advantage is, that the occurrence of bruxism can be assessed without intra-oral devices, which may change natural bruxism activity.

b)Portable electromyographic Recording Device

Starting in the 1970s, sleep bruxism episodes were measured over an extended period in patients homes with the use of battery-operated Electromyographic recording devices[19]. Its easy for subjects to use and can measure masticatory muscle activity more minutely, i.e. the number, duration and magnitude of bruxism events can be evaluated with fair accuracy. Criteria for the detection of sleep bruxism with the portable Electromyographic recording system have been suggested[20] but their validity in a large population has not yet been confirmed. The detection power of sleep bruxism is generally considered inferior to that in a sleep laboratory because other confounding oro-facial activities (e.g. sight, coughing and talking) cannot be discriminated from sleep bruxism. Also, other sleep disorders cannot be ruled out or other physiological changes related to sleep bruxism (e.g. microarousal, tachycardia and sleep-stage shift) cannot be monitored[21-23]. Also, a surface Electromyographic electrode with a built-in buffer-amplifier and a cordless type of electromyographic measurement system was developed to improve the reliability of recordings [24].

c) Miniature Self-Contained Electromyographic Detector–Analyser

A miniature self-contained Electromyographic detector–analyser (Bite-Strip) was developed as a screening test for moderate to high level bruxers [25]. It displays outcome in the morning, a light emitting diode and a lithium battery records the number of masseter muscle activities above a preset threshold. The special feature of this device is that the number of bruxism events can be objectively estimated by simply attaching it to the skin over the masseter muscle. Minakuchi and Clark[25]examined the sensitivity and specificity of the BiteStrip recording versus masseter electromyographic recordings during a polysomnogram in five suspected bruxers. Overall, there was good specificity for all subjects but fair sensitivity for subjects that exhibit moderate to high levels of Electromyographic determined bruxism. The device might be a cost-effective tool for screening moderate- to high level bruxism subjects.More recently, a miniature self-contained electromyographic detector– analyser with a biofeedback function (Grindcare) was developed as a detector and biofeedback device for sleep bruxism[26]It enables the online recording of Electromyographic activity of the anterior temporalis muscle, online processing of electromyographic signals to detect tooth grinding and clenching and also biofeedback stimulation for reducing sleep bruxism activities. Although scientific confirmation is needed for a large population, it is considered as one of the potent devices for detecting and also for managing sleep bruxism.

2]IN CONVENTIONAL COMPLETE DENTURES

Fernanda P. de Caxias[27] et al studied Effects of mouth rehabilitation with removable complete dentures on stimulus perception and the electromyographic activity of the orbicularis oris muscle and concluded that

a. The oral discomfort sensation was reduced 100 days after insertion of the new prostheses.
b. Electromographic activity decreased in the upper fascicle of the orbicularis oris muscle during rest.
c. Electromyographic activity in the upper fascicle increased at 30 days, followed by a decrease at 100 days and a decrease in the upper fascicle during suction at 100 days.
d. Electromyographic activity in the inferior fascicle decreased during the phonetic tests at 30 days, except for during pronunciation of the /pah/ syllable. In addition, the lower fascicle was more active than the upper fascicle during rest and most functional activities.

Effect of soft denture liners' on the masticatory function in patients wearing complete dentures has also been studied using electromyography in a systematic review[28] and concluded that soft denture liners provided denture wearers with increased masticatory function compared to conventional denture base materials as shown by electromyography and other methods . Specifically, the use of long-term silicone liners significantly improved the mastication parameters.

Researchers[29] have also studied the influence of occlusion on masticatory performance and satisfaction in complete denture wearers and concluded that Complete dentures with lingualised occlusion showed increased masticatory performance, maximum voluntary contraction and patient satisfaction and decreased chewing time.

3]in Myofascial Pain Dysfunction Sydrome

A systematic review[30] aimed to check the effectiveness of exercise, manual therapy, electrotherapy, relaxation training and biofeedback in the management of temporomandibular disorders was done.one of the conclusions was that Programs involving relaxation techniques and biofeedback, EMG training, proprioceptive reeducation may be more effective than placebo treatment or occlusal splints in decreasing pain and increasing Total vertical opening in people with acute or chronic myofascial or muscular temporomandibular disorder in the short term and the long term.

A pilot study[31]aimed to test the hypothesis that strengthening masticatory muscles using a controlled chewing exercise protocol improves muscle function, as evaluated quantitatively by electromyogram, and reduces pain at rest and during function and they told in their study that the electromyographic showed that the masticatory muscle exercise did produce objective physiologic results. In the exercise group, a significant increase was found in the electric muscle activity of the masseters during maximal voluntary clench . The exercise group showed significant reduction in pain during rest,

pain during the chewing test, and a disability score.

Immediate complete anterior guidance development[32] (ICAGD) is an excursively focused coronoplasty performed from the maximum intercuspal position (MIP) without mandibular manipulation to centric relation in patients with myofascial pain dysfunction syndrome as a therapeutic measure . It is a measurement driven, computer-guided occlusal adjustment procedure that shortens prolonged excursive movement occlusal surface contact frictional durations. The main objective of this therapy is to shorten the posterior disclusion time to ≤0.5 s per excursion because 0.41 was the first studied, physiologic mean disclusion time. It is always performed today with the T-Scan synchronized to the BioEMG III Electromyography system. The patient wears electromyography electrodes upon the masseter and temporalis muscles throughout the entire occlusal adjustment process to ensure that changes in muscle hyperactivity can be properly observed post treatment.

4]in Implant Supported Overdentures

A systematic review and meta-analysis[33] aimed to evaluate how muscular activity, measured by electromyography (EMG), differs among edentulous patients treated with a complete denture (CD), removable implant overdentures (IO), implant-retained fixed dental prostheses (IFDP), and dentates was done.They concluded that in general, edentulous patients with complete dentures can achieve a greater degree of muscular activity after rehabilitation with Implant overdentures during clenching and chewing. During clenching, patients with implant retained fixed dental proshtesis achieved higher values than those with dentates. The muscular activity increases with the hardness of the food.

A study[34] aimed to investigate the outcomes of the installation of two implant-supported overdentures until such treatment is complete. The results for Electromyography found a decrease in muscle activity during rest, the mastication of raisins, and lateral movements when the overdentures were installed.

CONCLUSION-

Electromyography is of great help in the treatment of bruxism patients by detecting uncontrolled muscle activity.It is also diagnostically useful in identifying patients with pain-related temporomandibular disorder.further research is required to find out its other applications in prosthodontics and also to reduce few of its flaws.

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