Review Article

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ELECTROMIOGRAPHY AND ITS ORTHODONTIC APPLICATION

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ABSTRACT

Electromyography is one of the usefull techniques for evaluating muscle function and efficiency by detecting their electrical potentials. It helps in determine the muscle activity. It helps in recording the electrical activity evoked in a muscle by electrical stimulation of its nerve. This article outlines some of the uses in orthodontics.

Key Words: Electromyography, Muscle function, Orthodontics

INTRODUCTION

The Electromyographic technique consists of various types of electrodes. The two main types of electrodes are surface electrodes and needle electrodes. The introduction of electromyography in orthodontics determined the beginning of some studies about neuromuscolar system's response to physiological and pathological oral alterations and the effect of masticatory muscles on facial morphology.[1] Experimental studies demonstrated that a real change in muscolar function causes morphology alterations.[1] Several studies in literature, from Watt e Williams, who studied in 1951 the effect of masticatory bolus on mouse maxillary and mandibular development, to Avis who in 1961 showed how muscolar function was important for gonial region development, connect morpholgy and function.[2]

Electromyographic analysis of the masticatory muscles constitutes an important complementary instrument in orthodontic diagnosis, as a careful evaluation of muscle activity before and during treatment guides the professional in selecting suitable therapy, as well as in the choice of more individualized retainers, minimizing relapses.[3]

In what it refers to diagnosis tools to evaluate the mandibular kinesiology, the surface of electromyography that studies the kinesiology of the muscular groups, it represents a useful diagnosis technique for dentists, physiotherapists, phonoaudiologists therapeutic occupation, neurologists, otorhinolaryngologists, orthopedic specialists and of professionals of other areas that need objective parameters for clinical evaluation of the muscular activity, as well as to evaluate the therapeutic results. The electromyography also investigates general muscular alterations, it determines the beginning of muscular activation and it evaluates the coordination or unbalance of the different muscles involved in the kinesiology of the muscles.[4]

ELECTROMYOGRAPHY IN ORTHODONTICS

The first effort to apply electromyography to dentistry was made by Robert E. Moyers.[4] He observed that the normal relations of teeth to each other in the same jaw and with those of the opposite jaw were influenced by muscular balance. With relevance to orthodontics, the muscles of importance are the mandibular elevators, namely: masseter muscle, temporalis muscle, and the medial pterygoid muscle; and the mandibular depressor, i.e. the lateral pterygoid muscle. The genioglossus muscle also plays an important role in determining facial morphology. This muscle is responsible for the protrac-

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tion of the tongue. Mentalis muscle and orbicularis oris muscle are also important.

Allen Brodie said that, 'If we could learn to control the musculature through the critical period of growth, we might be able to expect that, in at least a proportion of the patients, there would be spontaneous unfolding of development, that we thought previously must be managed with orthodontic force'.[5] Graber points out that in contract to Class I malocclusion where the muscle function is usually normal (except for open bite cases), most Class II division 1 malocclusions involve abnormal muscle activity. In Class II division 2 malocclusion, there is compensatory muscle activity, with dominance of posterior fibers of both the temporalis and masseter muscles. Graber also added that in Class III and Class II division 1 malocclusions, the problem is that of dominant bone dysplasia with adaptive muscle function and tooth irregularity reflecting a severe basal dysplasia.[6]

Pancherz analysed the electromyographic activity in the masticatory muscles of patients with Class II division 1 malocclusion and normal occlusion. Recordings were made during maximal biting in centric occlusion and during chewing. The results revealed: During maximal biting in intercuspal position, the Class II exhibited less electromyographic activity in the masseter and temporal muscles than the controls. The reduction in electromyographic activity in the study group was most apparent for the masseter muscle. During chewing the Class II subjects showed less electromyographic activity in the masseter muscle than in the normals. For the temporal muscle, no differences were found between the two groups. High positive correlations were found between the electromyographic activity during maximal biting and chewing for both muscles of the two groups. The impaired muscle activity found in the Class II cases may be attributed to a diverging dentofacial morphology and unstable occlusal contact conditions.[7] Moyers investigated electromyograms of children with Class II division 1 malocclusion and found dysfunction of the temporal muscle in habitual occlusion and at rest (increased activity in the posterior part of the temporal muscle). He asserted that this dysfunction might be an etiologic factor of postnormal occlusion.[4]

The study by Lacouture *et. al.* on the action of 3 types of functional appliances on the activity of the masticatory muscles. The appliances used were – Herbst, Frankel and simulated Twin block. The authors found that the use of these appliances in non-human primates was associated with a statistically significant decrease in functional activity of the jaw muscles. This study was used to test the 'lateral pterygoid hypothesis', which states that postural and functional activity of the superior, and inferior heads of the lateral pterygoid muscle increases after the insertion of a functional appliance.[8] This increased activity, especially in the superior head of the lateral pterygoid muscle then acts to stimulate increased condylar growth. The electromyographic activity of the masseter, digastric, superior and inferior heads of the lateral pterygoid muscles were monitored and were found to decrease with functional appliance treatment. This study did not support the lateral pterygoid muscle hypothesis.[8,9]

The study of temporal muscle activity during the first year of Class II division 1 malocclusion treatment with activator. They found no evidence of decrease in the postural activity of the posterior temporal muscle, although such a decrease has been described as a sign of forward displacement of the mandible during treatment with a functional appliance.[10]

The study done on Class III subjects showed that the correction of the anterior crossbite in Class III patients increases the electromyographic activities of the masseter and anterior temporal muscles, or improves coordination of the bilateral masseter and anterior temporal muscles.

A study by Deguchi and Iwahara tested this hypothesis. They used chin cup therapy for Class III patients and found a decrease in masseter muscle activity on both the working (chewing) and balancing sides, with no improvement in the coordination of bilateral masseter and anterior temporal muscles. It has been reported that the integrated electromyographic activity of the masseter and temporal muscles in Class III cases is less than in normal occlusion subjects. Electromyographic activity during swallowing The electromyographic activity of the facial muscles shows characteristic differences during normal and abnormal swallowing. In the normal mature swallow, the mandible rises as the teeth are brought together during the swallow, and the lips touch lightly. The facial muscles do not show marked contractions. The temporal muscle contracts as the mandible is elevated. During the teeth-apart swallow, no contraction of the temporal muscle is seen. Here mentalis muscle and lip contractions are needed for mandibular stabilization.[11]

Winders studied the forces exerted on the dentition by perioral and lingual musculature during swallowing. He concluded that the buccal and labial musculatures do not contract during swallowing unless there is an anterior open bite with accompanying antero–posterior skeletal dysplasia. All the muscles of the body are continually being remodelled to match the functions that are required of them. Any muscle that is used more than optimal level hypertrophies, and thus its total mass increases. Atrophy occurs when the muscle is not used causing a decrease in muscle mass. In tongue thrust swallowing, the tongue activity is increased. The tongue has to come more forward than normal to produce an oral seal to help initiate the swallowing procedure. Therefore, the tongue muscle, especially the genioglossus muscle (which is responsible for protrusion of the tongue), hypertrophies. Virtually all muscle hypertrophy results from increase in the number of actin and myosin filaments in each muscle fiber, thus causing enlargement of the individual muscle fiber1. This is called fiber hypertrophy. This usually occurs in response to contraction of a muscle at maximal or almost maximal force. Another type of hypertrophy occurs when muscles are stretched to a greater-than-normal length. This causes new sarcomeres to be added at the ends of the muscle fibers where they attach to the tendons. Whenever a muscle hypertrophies, its electromyographic activity increases relative to the normal. This is because of increased motor units being activated during muscle contraction. This applies to the tongue muscle as well. When the tongue is retrained and the tongue habit is corrected, the muscle remains shortened continually to less than its normal length. Thus sarcomeres at the ends of the muscle fibers disappear, and the amount of actin and myosin decreases. Therefore, there is a relative atrophy of the muscle fibers. The electromyographic activity after habit correction returns to normal levels. It is by this process that muscles are continually remodelled to have an appropriate length for proper muscle contraction. [12]

Pain has been shown to have an effect on muscle activity even when it does not originate in the muscle itself or in the related joint. The effect of pain from archwire adjustment on jaw muscle activity is unclear. Goldreich et al. evaluated the effect of orthodontic archwire adjustment pain on masseter electromyographic activity. The electromyographic levels during function decreased significantly after treatment started. The results suggest that orthodontic pain on teeth tend to reduce muscle activity during function.[13] Ngan et al. assessed masticatory muscle pain and electromyographic activity before, during, and after treatment with orthopaedic protraction headgear. In general, 800 g of orthopaedic force is used to protract the maxilla and 75% of this force is transmitted to the temporomandibular area via the mandible. The results of the study demonstrate no significant increase in masticatory muscle activity or muscle pain associated with orthopaedic treatment using maxillary protraction headgear. [14]

The study of lips showed different electromyographic activity occurred between youngsters with Class II, Division 1 and those with normal occlusion, This activity was shown to be greater in youngsters with Class II, Division 1, thus, suggesting decreased lip competence in this group.[15]

A higher activation level of masseter and temporalis muscles in rest position. Lower potential function of masseter and temporalis muscles. Inharmonious activity of the masticatory muscles during mandibular border movements. Higher asymmetry index of masseter and temporalis muscles.[16] Electromyographic study on occlusal stability in cleft lip and palate patients. The occlusal stability index and the masseter muscle activity in the child constricted arch group were lower than those of normal child group and child non-constricted arch group. Also, the child constricted arch group showed higher value of asymmetry index than other groups.[17]

CONCLUSION

The role of muscles is one of the factor in causing malocclusion. As electromyographic studies have shown, the muscle will be active in rest position also. Compensatory activity can also be seen in Class II and Class III malocclusions. After orthodontic therapy, adaptations to the new morphologic relationship are clearly seen. Electromyographic studies may help in giving a clue to solving many malocclusion problems.

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