

## INFLUENCE OF OCCLUSAL STABILIZATION SPLINTS AND SOFT OCCLUSAL SPLINTS ON THE ELECTROMYOGRAPHIC PATTERN, IN BASAL STATE AND AT THE END OF SIX WEEKS TREATMENT IN PATIENTS WITH BRUXISM

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### ABSTRACT

The aim of this study is to assess the electrical activity generated in temporal and masseter muscles during voluntary muscular contraction of patients with bruxism, as a result of the use of two types of occlusal splints (occlusal stabilization splint and soft occlusal splint) in which 2 groups of 8 patients were evaluated -12 women and four men aged 19 to 40 years, who used a single type of occlusal splint for 46 to 60 days. The splints were made from sheets of rigid acetate plus heat-cured acrylic (occlusal stabilization splint, control group) and sheets of flexible acetate (soft occlusal splint, experimental group). Two electromyographic tests (EMG) were performed on each patient; one before placing the splint and another at the end of the treatment. The statistical analysis used was computerized variance ANOVA analysis with F distribution ( $P \leq 0.025$ ).

In the control group, muscle electrical activity increased significantly in 5 patients and decreased slightly in 3. In the experimental group, there was considerable reduction of such activity in 6 patients and a slight increase in 2. There is a statistically significant difference ( $P \leq 0.025$ ) between the muscle electrical activity generated in the control group and in the experimental group. The increase in muscle electrical activity in the control group may have been due to a neuromuscular recovery process; while the decrease in the experimental group might have been due to a negative or decremental process of muscular organization to prevent the recruitment of new motor units. Occlusal stabilization splints are therefore considered better than soft occlusal splints.

Key words: bruxism, occlusal splints, electromyography, mechanoreceptors.

## INFLUENCIA DE LAS FÉRULAS OCLUSALES DE ESTABILIZACIÓN Y FÉRULAS OCLUSALES BLANDAS EN EL PATRÓN ELECTROMIOGRÁFICO, EN ESTADO BASAL Y AL TÉRMINO DE SEIS SEMANAS DE TRATAMIENTO, EN PACIENTES CON BRUXISMO

### RESUMEN

El presente estudio tiene como objetivo valorar la actividad eléctrica generada en los músculos temporales y maseteros, durante la contracción muscular voluntaria de pacientes con bruxismo, resultante del uso de dos tipos de férulas oclusales (férula oclusal de estabilización y férula oclusal blanda). Se evaluaron 2 grupos de 8 pacientes cada uno, 12 mujeres y 4 hombres con edades entre 19 y 40 años, recibiendo un solo tipo de férula oclusal, durante 46 días como mínimo y 60 como máximo. Las férulas oclusales se elaboraron con láminas de acetato rígido y acrílico transparente autopolimerizable (de estabilización, grupo control) y de láminas de acetato flexible (blandas, grupo experimental). Se realizaron dos pruebas electromiográficas (EMG) a cada paciente, la primera antes de colocar la férula y la segunda al finalizar el tratamiento. El análisis estadístico utilizado fue el análisis de varianza ANOVA computarizado con distribución F ( $P \leq 0.025$ ).

En el grupo control 5 pacientes aumentaron notablemente su actividad eléctrica muscular y 3 disminuyeron débilmente. En el grupo experimental 6 pacientes mostraron una reducción considerable de dicha actividad y 2 aumentaron levemente, encontrándose diferencia estadística significativa entre ambos grupos ( $P \leq 0.025$ ). El aumento de la actividad eléctrica muscular en el grupo control podría ser por un proceso de recuperación neuromuscular; y la disminución en el grupo experimental se debería a un proceso de organización muscular negativo o decremental que impide el reclutamiento de nuevas unidades motoras, por lo que se consideran a las férulas oclusales de estabilización más beneficiosas, con respecto a la férulas oclusales blandas.

Palabras clave: bruxismo, electromiografía, férulas oclusales, mecanoreceptores.

## INTRODUCTION

The parafunctional habit of bruxism leads to an increase in masticatory muscular tone, especially in the masseter and temporal muscles, through the loss of adaptation capacity of the muscular system produced by the mechanisms of oral reflexes in charge of inhibiting harmful muscular activity<sup>1</sup>.

The problems of the temporomandibular joint (TMJ) and bruxism have been studied for many years, and devices called occlusal stabilization splints have been developed. There are no data on the effects of occlusal stabilization splints and soft occlusal splints on the voluntary contraction of the masseter and temporal muscles, therefore the aim of this study was to determine, through an electromyographic device (EMG), the voluntary muscular electrical activity produced by the use of occlusal stabilization splints and soft occlusal splints in the masseter and temporal muscles of patients with bruxism.

There are mechanisms that protect the masticatory system which are able to inhibit or alter muscular activity when its adaptive capacity is exceeded; called oral reflex mechanisms<sup>1</sup>.

Other studies have shown that the Ruffini nerve endings (periodontal mechanoreceptors) are able to modulate muscular activity through two mechanisms or functions: excitation and inhibition, which are activated by the pressure on the teeth at the time of clenching<sup>2-5</sup>, for example during mastication. The mechanoreceptors send the information of the force required to crush or chew the food (facilitatory or excitatory function), but if the compression is excessive or harmful to the masticatory system, the second mechanism is activated (inhibitory function)<sup>4</sup>.

These functions are driven to the fusimotor system throughout the reflex arch trigeminal<sup>6</sup>.

In the masticatory cycle and in parafunctional habits like bruxism, the slopes of the cusps of the posterior teeth make contact, causing the forces not to be received in the direction of the longitudinal axis of the teeth.

The forces are therefore not transmitted appropriately to the bone, because some fibers of the periodontal ligament compress and others lengthen or tighten<sup>7-8</sup>.

In lateral movements, the contact with posterior teeth causes an increase in muscular activity, specifically from the temporal and masseter muscles<sup>7,9,10</sup>. When the intercuspal position is active, the maxi-

mum muscular contraction takes the condyles to the ligament position, different to the most stable muscle-skeletal position<sup>7</sup>.

Occlusal stabilization splints have been proposed as treatment for muscular hyperactivity appearing during periods of stress, with the purpose of reducing or improving the symptomatology by relaxing the masticatory muscles, eliminating occlusal interferences that damage the temporomandibular joint (TMJ) and taking it to an appropriate orthopedic relation<sup>1,7, 11-15</sup>.

Their effectiveness has been also evaluated by electromyographic tests (EMG) indicating a reduction in the electrical activity of the temporal and masseter muscles during the night<sup>2, 16-22</sup>.

According to Kawazoe et al<sup>2</sup>, muscular relaxation is given by a reduction of the sensorial information that comes from the periodontal receptors during night clenching or creaking, due to the elimination of the occlusal interferences by the use of the occlusal stabilization splint.

Later on, the reflex control of periodontal mechanoreceptors was demonstrated in the pattern of muscular contraction during clenching in humans<sup>3</sup>. In addition to reducing muscular electrical activity, occlusal stabilization splints improve the patient's symptomatology<sup>13,23-26</sup>.

Ferrairo V. F. et al.<sup>25</sup> reported that the decrease in sharp pain responds to a smaller bite force as well as to a smaller load on the TMJ, based on the biomechanical pattern.

There are also studies evaluating the effectiveness of occlusal stabilization splints and soft occlusal splints in the reduction of the symptoms of patients with temporomandibular disorder. One of these, performed by Gallego et al.<sup>27</sup>, concluded that there was no significant difference between the two kinds of occlusal splints, through palpation of the temporal and masseter muscles and measurement of mouth opening. Craig A. Pettengill et al.<sup>24</sup> found a similar result through the palpation of the following muscles: temporal, masseter, medial pterygoid, sternocleidomastoid, suboccipital, scalenes, deep posterior cervical, and trapezius.

Okeson, et al.<sup>13</sup> evaluated the following muscles: lateral and medial pterygoid, temporal, masseter, sternocleidomastoid, posterior of the neck and the TMJs, observing a decrease in the values of pain, and an increase in the maximal mandible opening. Naikmasur V. et al.<sup>28</sup> evaluated the effectiveness of

occlusal therapy (soft occlusal splints), comparing it with pharmacotherapy, concluding that occlusal splints represent a safer, cheaper and more effective therapy, measured through a visual analog scale (VAS) of 100 mm.

It is important to note that all the parameters used in these studies<sup>13, 24, 25, 27, 28</sup> are subjective because they are based on the information that the patient shows on the evolution of the symptomatology.

## MATERIALS AND METHODS

The study was not focused on the involuntary pathological muscular activity of bruxism, therefore, the degree of hypertonicity or muscular relaxation was not taken into account. Our research evaluated the effect that two types of occlusal splints (stabilization and soft occlusal splints) have on voluntary muscular activity in patients with bruxism. The study included a sample of 12 women and 4 men (n=16) aged 19 to 40 years, diagnosed as bruxers by the research team, taking into account the following inclusion criteria: bruxers, molar relationship Angle's Class I and II, not having received previous treatment with analgesic and/or muscular relaxing at least six (6) months before beginning the study, and with natural teeth until the upper and lower second molar. To determine the diagnosis of bruxism, clinical evaluations were developed investigating the presence of the following signs and symptoms described in the literature:

- a) Dental attrition of the incisal and occlusal surfaces<sup>1, 29</sup>.
- b) Gingival erosion (abfraction) or non-decay cervical lesions<sup>1, 29</sup>.
- c) Wear from the canine on the side of work (pathognomonic sign)<sup>1</sup>.
- d) Muscular spasm (external pterygoid and masseter)<sup>1</sup>.
- e) Pain and sensitivity in the region of the masticatory muscles<sup>30</sup>.
- f) Absence of noise can also occur during night bruxism<sup>1</sup>.
- g) Tinnitus<sup>31</sup>.
- h) Sounds during condylar movements<sup>30</sup>.
- i) The patient may or may not present TMJ damage<sup>1</sup>.
- j) Sounds during condylar movements<sup>30</sup>.

Okeson<sup>7</sup> mentions that fulcrum or premature contact would not be a cause of bruxism but of painful muscle symptoms.

Patients were randomly divided into 2 groups, one of which was treated with an occlusal stabilization splint made of rigid acetate sheets plus heat-cured acrylic (control group), while the other group received the soft occlusal splint made of flexible acetate sheets (experimental group).

The patients received only one kind of treatment for 46 to 60 days. They were instructed to wear the occlusal splints 24 hours a day, except when they ate, based on the methodology of previous research<sup>23, 32</sup>. The patients made 2 visits to the Neuroscience Institute of El Salvador, the first appointment before the treatment and the second on concluding it. At each appointment, two EMG evaluations were performed to obtain an average value, with a rest period of 30 seconds between each EMG test in order to avoid muscular fatigue.

## Protocol for electromyographic evaluations

In this study, a Cadwell electromyography machine was used with the software Sierra Wave version 6.0.33. The tests were blind, since the medical neurophysiologist did not know which type of occlusal splint each patient received. The skin was prepared by cleaning with 90° alcohol at the electrode placement points, Nuprep tm EEG toothpaste was applied, the Grass Telefactor electrodes F-E5GH-48 were placed and then the electrode was held to the skin with tape (3M surgical type) of 2 inches.

Four active surface electrodes were placed: one in the superficial masseter right muscle; the second in the superficial masseter left muscle; the third in the temporal right muscle and the fourth in the temporal left muscle. Four reference electrodes were also placed, one at each external angle of the eyes and the other two 1 cm above each eyebrow; in addition to a common electrode pole to earth located in the region of the right arm.

Analysis of the voluntary muscular contraction: Each patient placed a buccal bite pressure transducer in his/her mouth by his/her own means. This pressure was measured by a sphygmomanometer modified and adapted to the patient's mouth. The sphygmomanometer was modified as follows: the nylon cuff was eliminated in which the rubber band was exposed, 4 folds were made and tape was used to secure it in that position. It was also wrapped

with gauze to prevent damage during clenching and adhesive plastic was placed over it, as a biosafety measure, which was eliminated at the end of the procedure in each patient.

Patients were instructed to contract the muscles, biting the buccal transducer until it reached 40 mm Hg for 6 seconds continuously, while they observed the mm Hg value of their contraction.

However, if the 40 mm Hg pressure applied was not enough for recording to begin, they were instructed to increase bite pressure to 50, 60 or more mm Hg, until the computer recorded the activity of motor units from the software Sierra Wave version 6.0.33.

Once the pressure required of each patient was obtained, the test began. Each patient underwent two EMG tests. At each appointment, recording began with a baseline of 100 milliseconds (msec) with the muscles at rest. Immediately, the patient was instructed to bite the transducer until it reached the pressure in mm Hg as previously established. At this time, the on-line analysis began by recording the activity of the motor units on the screen for 6 seconds. Then the patient was told to return to the state of rest, concluding with another baseline of 100 msec (isoelectric).

It is important to mention that the buccal transducer of bite pressure had an initial pressure of 20 mm of Hg. It was decided to make the tests without the occlusal splint in the mouth because it was considered the best way to determine the real state of the muscles before and after the treatment.

During muscular contraction, the signs that come from the examined muscles were shown in real time in sequences of 100 msec resolution per screen; the amplitude was enough to observe a complete motor unit.

The sample was 4 points per microsecond.

The high frequency filter was 100 KHz.

The low frequency filter was 20 KHz.

The adhesion of the static filter depended on the resolution of the line.

The acquired motor units were studied analogically and converted digitally using a well-known on-line process, Interference Pattern Analysis (IPA)<sup>33-36</sup>, which consists of 3 types of statistical studies that the electromyographic device performs on the muscles analyzed (right and left masseter and right and left temporal) of each patient during 6 seconds:

- 1) Turns/sec analysis: turns are the product of the electrical activity generated by the phenomenon of contraction of the muscle that lies under the active electrode, measured in microvolts per second ( $\mu\text{V}/\text{sec}$ ), equivalent to the number of active motor units during a contraction, which represents the quantity of muscle working.
- 2) Amplitude/turns analysis: this calculation is derived from the average of the amplitude of the turns in the unit of time from the 4 channels; this is equivalent to the size of the motor unit measured in  $\mu\text{V}$ , which represents the force of the muscle.
- 3) Analysis of envelope vs. activity: where activity stands for the quantity of motor units that pulse in the time unit (muscular contraction), being specific in each central generator and that causes an interference pattern of motor units (phases or turns) that saturate the screen or time of resolution of the electromyography screen, and the envelope is the numeric expression that corresponds to the value on 1% of the pattern of maximum interference of this "activity", measured in  $\mu\text{v}$ . This means that it is a statistical analysis of 1% of the larger active motor units during the muscular contraction; it represents the quality of muscle contraction.

Therefore if the value of the IPA in the second test is higher than the first one, it is related to an increase of the voluntary global muscular electrical activity, and on the contrary, if the value IPA in the second test is lower, it will be understood as a decrease in the voluntary global muscular electrical activity.

In order to perform the statistical analysis of the study, we used the difference, by subtracting the average of the results of the first EMG tests (appointment 1) from the one obtained in the tests performed at the second appointment. This was considered to be the most precise value for determining whether or not there had been improvement in the voluntary muscular compression.

## RESULTS

The results obtained from the first EMG tests were compared to the results of the second tests. It was found that in the group with occlusal stabilization splints (control group), in 5 of 8 patients the difference of the averages of the quantity of Turns/Seconds between the first and second appointment increased; and in the experimental group this difference decreased in 6 of the 8 patients evaluated (Table 1).

Regarding the difference of the average values of the Amplitude/Turns between the first and second appointment, in the control group it increased in 6 of 8 patients; contrary to what was observed in the experimental group where it decreased in 7 of 8 patients (Table 2).

Regarding muscular electrical activity or IPA measured through the difference of the averages of Envelope/Activity between the first and second appointment, in the control group it increased in 6 of 8 patients, while in the experimental group it decreased in 6 of 8 patients. (Table 3).

**Table 1: The difference of the averages of Turns/Seconds between the first and second test EMG ( $\mu\text{v}/\text{seg}$ ).**

Occlusal stabilization splints				Soft occlusal splints			
Patients	First Test	Second Test	Difference	Patients	First Test	Second Test	Difference
1	95	181,4	86,4	1	234,5	46,9	-187,6
2	175,6	193,8	18,2	2	299,7	190,4	-109,3
3	37,7	58,5	20,8	3	223,2	31,1	-192,1
4	70	95	25	4	188,2	48,4	-137,8
5	248,6	257,7	9,1	5	69,9	35,8	-34,1
6	291,2	288,9	-2,3	6	88,5	78,4	-10,1
7	25,1	24,4	-0,7	7	38,9	64,8	25,9
8	49,3	33,5	-15,8	8	122,2	128,5	6,3

Fo = 9.10; p = 0.009 (ANOVA test)

**Table 2: The difference of the averages of the Amplitude/Turns between the first and second test EMG ( $\mu\text{v}$ ).**

Occlusal stabilization splints				Soft occlusal splints			
Patients	First Test	Second Test	Difference	Patients	First Test	Second Test	Difference
1	124,5	152,5	28	1	169,8	128,1	-41,7
2	143,7	155,1	11,4	2	313,3	241,7	-71,6
3	126	127,3	1,3	3	171,1	123,5	-47,6
4	134,6	138,2	3,6	4	134,6	127,9	-6,7
5	236,1	269,6	33,5	5	155,3	148,4	-6,9
6	178,8	198,5	19,7	6	140,8	134,9	-5,9
7	134,7	129,1	-5,6	7	147	132,8	-14,2
8	133,5	125,3	-8,2	8	129,5	149,4	19,9

Fo = 7,58; p = 0,016

**Table 3: The difference of the averages of Envelope/Activity between the first and second test EMG ( $\mu\text{v}$ ).**

Occlusal stabilization splints				Soft occlusal splints			
Patients	First Test	Second Test	Difference	Patients	First Test	Second Test	Difference
1	178,1	249,9	71,8	1	249,3	144,2	-155,1
2	195,1	254,7	59,6	2	516,7	388,8	-127,9
3	143,4	166,5	23,1	3	301	138,3	-162,7
4	174,6	205,7	31,1	4	245,2	161,6	-83,6
5	461	531,9	70,9	5	189,6	154,1	-35,5
6	315,9	340,5	24,6	6	216	200,8	-15,2
7	155	154,4	-0,6	7	147,1	228,6	78,5
8	187,4	143,5	-43,9	8	244,2	252,6	8,4

Fo = 7,51; p = 0,016



## DISCUSSION

No study has been found evaluating the muscular voluntary contraction of the masseter and temporal muscles in patients with bruxism. This means that there is a lack of information showing the recovery from the neuromuscular dysfunction after the use of occlusal splints and how it affects the masticatory function. The IPA used in this research allows recognition of the quantity of muscle working, its force and the quality of the contraction produced.

Therefore our study evaluated the effect of two types of occlusal splints (stabilization and soft occlusal splint) on the voluntary muscular activity in bruxers and did not focus on the involuntary pathological muscular activity of bruxism during night, as other studies have done<sup>20, 21</sup>.

To understand this phase of the study, it should be noted that the motor unit is defined as the basic unit of the neuromuscular mechanism constituted by one or more muscular fibers and a motoneuron.

This motor unit is in charge of transmitting the afferent and efferent information of the muscles involved<sup>1</sup>.

Our research found that the use of the occlusal stabilization splint notably increased muscular electrical activity in the IPA in 5 of 8 patients and decreased it slightly in the 3 remaining patients. It could be interpreted that: 1) an increase in the turns/sec values in the second EMG evaluation is equivalent to a higher number of active motor units during the voluntary contraction of the four muscles analyzed, during the 6 seconds of EMG records, therefore there is more muscle working; 2) more amplitude/turns in the post-treatment test could mean that the active motor units are larger, and as a result, the force of the muscle is greater; 3) a larger envelope/activity value would mean that the quantity of large active motor units is higher, which means that the contraction is better.

The values of the IPA after the treatment may suggest a phenomenon of "muscular recovery"<sup>6</sup>.

On the contrary, using the soft occlusal splint considerably diminished the IPA values in 6 of 8 patients, increasing it slightly in the 2 remaining patients. It could therefore be considered as a negative or decremental process of muscular organization, since there is less quantity of muscle working (turns/sec), the muscles have less force (amplitude/turns) and the contraction of those muscles is weak (envelope/ activity). It is difficult to classify motor units as glucose or oxidative units by means of the computer analysis. As

it is not a histopathology analysis, biochemical characteristics cannot be identified from the IPA graph.

The findings of this study might be explained based on the following:

**1. Occlusal stabilization splints produce muscular relaxation by achieving the most stable muscle-skeletal position<sup>7</sup>.**

The design of this type of occlusal stabilization splint allows occlusal contact between all the existing teeth with the same intensity of force in the direction of the longitudinal axis of each tooth and consequently, better dissipation towards the periodontal tissue. It also facilitates posterior disocclusion and achieves the most stable muscle-skeletal position<sup>7</sup>.

**2. Occlusal stabilization splints produce muscular relaxation through the rehabilitation of damaged mechanoreceptors<sup>3, 4</sup>.**

Previous studies report reduction in EMG values when occlusal stabilization splints are used<sup>2, 18-21</sup>, because they may reduce the sensorial information of the periodontal mechanoreceptors on the contraction of the closing muscles from the jaw when eliminating the occlusal interferences<sup>2</sup>. The pattern of muscular masticatory contraction is controlled by the periodontal mechanoreceptors, according to Klopogge and Griethuysen<sup>3</sup>.

This is reconsidered by Türker et al.<sup>4</sup>, who report that the pressure on the teeth during clenching or mandible compression stimulates the periodontal mechanoreceptors, acting in different ways: facilitation and inhibition of the motor function of the mandible during the masticatory acts. For example, if the consistency of the food is hard, the periodontal mechanoreceptors send information so that the contraction force increases (facilitation), but if the consistency is soft and the compression level is excessive, the periodontal mechanoreceptors order a decrease in the force, avoiding bone lesions or fracture of the teeth (inhibition)<sup>4</sup>. Both functions (facilitation and inhibition) are driven to the fusimotor system throughout the reflex arch trigeminal<sup>6</sup>.

**3. Relationship between pain and the oral motor function<sup>37</sup>.**

It has been reported that signs and symptoms such as limitation of mandibular movements, decrease in the force of contraction and irregular masticatory cycles are characteristic of patients with myofascial pain and temporomandibular disorders.

Capra N. F. et al.<sup>37</sup> concluded that when changing the amplitude of the opening of the mandible, 21 Trigeminal Mesencephalic Nucleus showed a reduced or increased Firing Rate (Fr-TMN) of 27 evaluated TMN, indicating that the pain caused modulates the response of the afferent spindles mediated by muscular afferents of small diameter and it depends on the continuous nociceptive information from the caudalis trigeminal sub-nucleus on the trigeminal gamma- motoneurons<sup>37</sup>. The abovementioned points allow us to present 3 hypotheses about how occlusal stabilization splints and soft occlusal splints act on the function of the muscles analyzed:

*1. Occlusal stabilization splints improve contractile capacity.*

The programming in central occlusion of occlusal stabilization splints allows the most stable muscle-skeletal position, the flat and rigid occlusal surface makes the occlusal forces that were formerly horizontal become vertical: in the same way, it enables all the teeth in the mouth to receive the same intensity of force, allowing the inhibitory and facilitator functions to rehabilitate in the periodontal mechanoreceptors. Another characteristic is the posterior disocclusion provided by the canine guide. All this benefits the masseter and temporal muscles, which reduce their non-functional contraction, beginning the recovery of their contractile capacity.

Soft occlusal splints generate a vicious cycle of non-muscular recovery. Some studies evaluating activity in bruxism report that the non-functional activity of the masseter and temporal muscles increases. Due to the absence of the characteristics of the occlusal stabilization splints, the horizontal occlusal forces continue during the eccentric movements, therefore the functions (inhibitory and excitatory) of the periodontal mechanoreceptors remain altered; when there is no canine guide, the occlusal interferences continue, and additionally, the jaw is not taken to the most stable muscle-skeletal position.

The abovementioned points result an increase of the non-functional muscular activity, preventing the recovery of its contractile capacity.

*2. Occlusal stabilization splints rehabilitate the periodontal mechanoreceptors (neurogenous process).*

The typical pressure of bruxism appears to increase the excitatory function and reduce the inhibitory function of the periodontal mechanoreceptor. When

occlusal stabilization splints are used, the physiological thresholds of facilitation and inhibition are recovered, stimulating the stabilization of both the inhibitory proprioceptive input and motor information output, reducing the non-functional activity of the masseter and temporal muscles and recovering their contractile capacity.

Soft occlusal splints do not seem to allow the recovery of the physiological thresholds of the periodontal mechanoreceptors, promoting the non-functional activity of the muscles analyzed, hindering the recovery of contractile capacity.

*3. Occlusal stabilization splints stimulate the recovery of the muscular spindle (myogenous process).*

Recent evidence indicates that a denervated muscle could re-establish the strength of normal or nearly normal contraction as long as the neuron is intact. Acts of daily exercise or physiological repetitive contractions like walking in elongated muscle damage or disease can raise the capacity to generate tension<sup>38</sup>. Muscular pain affects the afferent transmission of the muscular spindles, producing an increase in the afferent discharge on the mesencephalic nucleus causing a reduction in the Fr-TMN. There is information about the relationship between Fr-TMN and the quality of the muscular contraction, with the resolution of the pain for the use of the occlusal stabilization splints the activity of the motoneurons that were previously diminished, increase the Fr-TMN and cause better contractile function, through the recruitment of motor units<sup>39-41</sup>, which is a form of "muscular recovery"<sup>6</sup>. This allows us to hypothesize that patients with bruxism will experience pain reduction, condyles reposition and at the same time their muscle fibers will increase the contraction up to normal levels with the occlusal stabilization splint treatment. Although there are no data in human bruxers, the results of our study illustrate this phenomenon numerically in a non-invasive and indirect way.

Although our study did not evaluate symptomatology, our results show symptomatic improvement with the use of both types of occlusal splints, in agreement with data obtained in previous research<sup>15, 23, 24, 27</sup>, but the recovery of the contractile capacity is not observed from the four analyzed muscles after the use of the soft occlusal splints, so that it could be assumed that the Fr-TMN continues in decrement. (Tables 1-3), because:

1) IPA values show a smaller quantity of turns/sec this means that the number of active motor units is smaller, in other words, there is less muscle working;

- 2) Decrease in the amplitude/turns values, meaning that the size of the active motor units is smaller, which is translated as a weak muscle;
- 3) Lower envelope/activity value means that the quantity of larger motor units working has diminished, which could be understood as a weak contraction. These 3 IPA values suggest a negative or decremental process of muscular organization, which agrees with research with non-favorable results with this type of occlusal splints, because they increase the pathological contraction pattern<sup>20, 21</sup>, therefore, the dysfunction of the periodontal mechanoreceptors continues, affecting the recovery of the muscular spindle and with it the activity of Fr-TMN<sup>37</sup>. These data could demonstrate in a non-invasive way the cascade of negative events on voluntary muscular contraction, supporting the idea that the symptomatic improvement of pain is not always linked to motor function improvement<sup>42-46</sup>.

The discoveries of this study should be interpreted as a guide for further research with a multidisciplinary focus and greater detail and depth; and at the same time to research the role of pain in the functions of the TMN in patients who are bruxers; the symptomatic improvement related to an adaptation

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of the periodontal ligament and/or masticatory muscles, to the change in position of the condyles with the use of soft occlusal splints; the behavior of the fibers of the periodontal ligament during the parafunctional movements of bruxism and their influence in the functions of the periodontal mechanoreceptors; the possible process of reinnervation of the masticatory muscles with the use of the occlusal stabilization splints that may allow the recruitment of new motor units, and others.

#### CONCLUSIONS

The use of the occlusal stabilization splints allows the increase of electromyographic voluntary activity measured through IPA, which may mean the beginning of a process of neuromuscular recovery. The decrease of voluntary electromyographic activity, measured through IPA produced by the use of soft occlusal splints prevents the recruitment of new motor units.

The parafunctional habit of bruxism could involve muscular and/or neurological pathological processes of origin, which affect the contractile capacity, and when occlusal stabilization splints are used, these processes are eliminated or diminished, recovering the voluntary muscular compression of the masseter and temporal muscles during the bite.

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