

## ORIGINAL ARTICLE

# Electromyographic evaluation of superficial masseter and anterior temporal muscles after using cyclobenzaprine during extraction of impacted third molars

Avaliação eletromiográfica dos músculos masseter superficial e temporal anterior após uso de ciclobenzaprina na extração de terceiros molares inclusos

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## ABSTRACT

**Objective:** The influence of cyclobenzaprine hydrochloride (Miosan®, 10mg/orally/single dose), taken prior to the extraction of impacted mandibular third molars on the electrical activity of superficial masseter and anterior temporal muscles was evaluated through electromyographic recordings aiming at contributing to the discussion of the diagnosis of stomatognathic dysfunctions in relation to long lasting operative procedures. **Material and Methods:** Twenty patients referred for the extraction of impacted and embedded mandibular third molars at the Discipline of Oral and maxillofacial Surgery and Traumatology (Institute of Science and Technology of São José dos Campos/Unesp), without systemic disease and allergic reactions to the drugs used, both sexes were selected. An electromyographer model EMG-800C (EMG System do Brasil Ltd.), with four input channels, previously calibrated with active electrodes and 20-fold amplification gain was used together with a channel linked to the system to record the mouth opening (mandibular goniometer). The following conditions were assessed: rest, maximum voluntary isometric contraction, and maximum mouth opening, at the following periods: pre-surgical, surgical, and post-surgical (7, 15, and 30 days). **Results:** The electrical activity of the studied muscles was reduced at the beginning of the surgical procedure, but it did not significantly alter by the administration of the drug at all evaluated periods. The masseter muscle, after the drug administration, reestablished its activity just after the post-operative period, unlikely the control group, which reestablished the activity after 7 days. A significant

## RESUMO

**Objective:** Avaliamos a influência do cloridrato de ciclobenzaprina (Miosan®, 10mg/via oral/dose única), administrado previamente à extração de terceiros molares inferiores inclusos na atividade elétrica dos músculos masseter superficial e temporal anterior, por meio de registros eletromiográficos, na condição de repouso, contração isométrica voluntária máxima e abertura máxima da boca, nos períodos: pré cirúrgico, cirúrgico, e pós cirúrgico (7, 15 e 30 dias), e assim contribuir com a discussão do diagnóstico de disfunções do sistema estomatognático frente aos procedimentos operatórios de longa duração. **Material e Métodos** Foram selecionados 20 pacientes, com indicação de extração de terceiro molar inferior incluso e impactado, sem comprometimento sistêmico, com ausência de reações alérgicas aos fármacos utilizados, de ambos os sexos, provenientes da Disciplina de Cirurgia e Traumatologia Bucomaxilofacial do Instituto de Ciência e Tecnologia de São José dos Campos da Unesp. Utilizamos o eletromiógrafo modelo EMG-800C da EMG System do Brasil Ltda de quatro canais de entrada, previamente calibrado, com eletrodos ativos e ganho de amplificação de 20 vezes. Além disso, foi utilizado um canal acoplado ao sistema para registro de abertura bucal (goniômetro mandibular). **Resultados:** Observamos que a atividade elétrica dos músculos estudados é reduzida na fase inicial do procedimento cirúrgico, embora não se altere significativamente pela presença do fármaco, durante todos os períodos avaliados. O músculo masseter, na presença do fármaco, restabelece sua atividade logo após o período pós-operatório ao contrário do grupo controle que ocorre após 7 dias. Observamos um aumento significativo

mouth opening was seen for the comparison between control and experimental groups ( $p < 0.001$ ). **Conclusion:** Thus, based on these results, we suggest that the single-dose myorelaxant taken prior to the surgical procedure interferes on the motor activity of the studied muscles. This approach can be useful as adjuvant therapy in patients exhibiting stomatognathic system dysfunctions causing damage to the masticatory system due to the presence of embedded mandibular third molar.

## KEYWORDS

Myorelaxants; Third molars; Electromyography; Cyclobenzaprine; Surgery, oral.

da abertura bucal comparando-se o Grupo Controle e o Grupo experimental ( $p < 0,001$ ). **Conclusão:** Assim, nossos resultados, em conjunto, sugerem que o relaxante muscular, em dose única e previamente ao procedimento cirúrgico, interfere na atividade motora dos músculos estudados, e pode ser útil como adjuvante terapêutico nas condições de disfunção do sistema estomatognático que acarretam prejuízo ao processo mastigatório devido à presença de terceiro molar inferior incluso.

## PALAVRAS-CHAVE

Miorrelaxantes; Terceiros molares; Eletromiografia; Ciclobenzaprina; Cirurgia bucal.

## INTRODUCTION

One of the most performed procedures in the specialty of Oral and Maxillofacial Surgery and Traumatology, namely the extraction of impacted and embedded third molars, is frequently associated to either transitory or permanent postoperative morbidity. Among the most common accidents after impacted/embedded third molar extraction are: hemorrhages, alveolitis, pain, edema, alteration in muscle activity, injury to the inferior alveolar nerve, infections in the facial spaces, and injuries to adjacent teeth. Of all complications, the alteration in the masticatory muscles expressed by the increased muscle tonus, clinically called trismus, which is related to the difficulty in mandibular opening and closing. The local inflammatory process resulting from the surgical trauma causes trismus, whose intensity ranges from mild to moderate, circumscribed to the surgical area; or trismus might disseminate and involve other muscle groups. About 56% of the individuals submitted to third molar extraction might have this symptomatology at postoperative period. Trismus duration depends on several factors, such as: individual features, presence of other morbidities, duration and length of surgical procedure, pain, behavioral factors, and even the clinical therapeutics used. A mean

period ranging from 10 to 14 days is expected to one recovers the full capacity of mouth opening after surgery [1-3]. Other complication from the extraction of impacted/embedded third molar is marked facial edema that is one of the reaction responses of the body to the surgical procedure. Marked facial edema both slows the repair and accounts for postoperative pain [4].

Total trismus and/or the failure in opening the mouth might occur at preoperative period due to traumatic arthritis of the temporomandibular joints; at the postoperative period, the muscle spasm due to hematoma, inflammation of soft tissues, or reflex muscle spasm due to inflammation accounts for trismus after the extraction of mandibular third molars [5]. Moreover, the surgery complexity, i.e., the requirement of performing osteotomy and odontosection lead to higher chances of postoperative complications such as trismus.

The trismus treatment comprises physiotherapy, heat application and administration of myorelaxants. Central myorelaxants are drugs that selectively depress part of the central nervous system controlling muscle tonus and are indicated to promote muscle relaxation during musculoskeletal spasms; useful as adjuvants of rest, psychotherapy, and other appropriate measures to treat the discomfort caused by the painful located musculoskeletal

spasm [6]. The cyclobenzaprine hydrochloride is a central myorelaxant drug, synthesized in 1960, and initially used as antidepressant. At daily doses of 75 to 150 mg, it was efficient to treat depression but without advantages over other antidepressant drugs [7]. After the limited success during the treatment of schizophrenia, anxiety, chronic migraine, and rigidity caused by Parkinson's disease, the cyclobenzaprine hydrochloride has been used as adjuvant for relieving the muscle spasm associated to acute musculoskeletal pain [8,9].

Currently, cyclobenzaprine hydrochloride (Miosan®) has been employed as myorelaxant, and although its mechanism of action is not fully understood, it is known that cyclobenzaprine hydrochloride does not act directly on the musculoskeletal relaxation, does not depress the neural conduction and the neuromuscular transmission. The cyclobenzaprine hydrochloride acts particularly on the pain associated with musculoskeletal hyperactivity and sleep disturbs associated with fibromyalgia [10-12].

Surface electromyography was used aiming to observe cyclobenzaprine hydrochloride action on the jaw elevator muscles (masseter and temporal) because this electromyography type detects the action potentials produced by the motor units and captured by the presence of active microelectrodes on the skin over the studied muscle [13,14]. Because surface electromyography is an ease-handling, non-invasive, high-sensible method, it is gain space in monitoring the electrical activity from muscles, such as the motor behavior of the jaw elevator muscles during maximum masticatory effort [15]; assessments of intraoral devices [16]; analysis of the masticatory force [8], speech and swallowing disturbs [17], pain evaluation during surgical procedures [18], muscle spasm [19], among others.

## OBJECTIVE

This study aimed to evaluate the effect of cyclobenzaprine hydrochloride administration

(Miosan®, 10 mg/orally/single dose) on the electrical activity of the jaw elevator muscles – superficial masseter and anterior temporal, through electromyographic analysis at pre-surgical, surgical, and post-surgical (7, 15, and 30 days). Additionally, the degree of mouth opening was verified during the extraction of impacted and embedded mandibular third molars.

## MATERIAL AND METHODS

This study was submitted and approved by the Institutional Review Board and all participants read and signed a free and clarified consent form. Twenty patients referred for the extraction of impacted/embedded mandibular third molars at the Discipline of Oral Maxillofacial Surgery and Traumatology, Institute of Science and Technology (UNESP) were selected. All participants were classified according to the guidelines of the American Society of Anesthesiology (ASA 1) as healthy, without systemic alterations, without continue use of drugs. Exclusion criteria comprised patients with any systemic alteration; allergic reactions to the drug use or any drug; surgical time longer than one hour; and those not returning for postoperative following-up appointments.

To determine the sample size, a difference of 30% between groups was set for the primary variable (electrical activity of the masseter). With study power of 80%,  $\alpha = 0.05$  and an expected standard deviation of 10%, sample size was calculated in 12 individuals per group. The sample of 20 individuals gives the study a power close to 80% to detect a difference of 30% in the electromyographic measures between the devices.

All participants underwent routine preoperative examinations: physical (measurement of blood pressure and heart rate); laboratorial (bleeding and clotting time; blood sugar); and imaging (panoramic x-ray).

The participants were randomly allocated in two groups: Group 1 (control; n

= 10): no preoperative medication; Group 2 (experimental; n = 10): use of cyclobenzaprine hydrochloride (Miosan® 10 mg – single dose, orally, 1 (one) hour before surgery). One single surgeon performed all elective surgeries at morning, always after abstention of at least 48 h of alcohol and 8 h of tobacco.

### ***Surgical procedures***

After extra- and intraoral asepsis with 0.12% chlorhexidine digluconate, local anesthesia by inferior alveolar nerve block with 2% mepivacaine 1/100,000 epinephrine was administered. Next, with the aid of size 15 scalpel blade slightly moved towards the buccal surface, a straight incision was made from retromolar area to the central sulcus of the occlusal surface of the second molar, measuring approximately 1.0 cm, followed by an intrasulcular incision on the interdental papilla between the first and second molars. With the aid of Molt elevators, a total flap was raised to enable an adequate surgical field followed by osteotomy. Odontosection was executed with the aid of handpiece at high speed and size 4 HL round carbide burs, under copious irrigation of 0.9% sodium chloride. With the aid of straight and angled Seldin elevators or Potts elevators the tooth was extracted, followed by the removal of the pericorony capsule, cleaning of the alveolus, and replacement of the flap, and suture with 4.0 silk thread (Ethicon - Johnson & Johnson).

### ***Electromyographic evaluation***

During all experimental periods (pre-surgical, surgical, and post-surgical), the patients were evaluated by means of electromyography. To record the electromyographic sign of the anterior part of right (rT) and left (lT) temporal and the superficial part of right (rM) and left (lM), we used an electromyographer model EMG-800C (EMG System do Brasil Ltd.) with eight channels, previously calibrated with 20-fold total amplification gain, common mode rejection > 100 dB, analog-to-digital

converter board (A/D) with 16bit dynamic range resolution, linked to a computer by 10 Mbit network adapter (Ethernet) and connector RJ45 (10BASE T) through TCP/IP protocol; two pole low pass (500 Hz) and high pass (20 Hz) Butterworth analogic filter; imaging software for acquisition and analysis of electromyographic signs (Windows Vista /XP) allowing simultaneously view of the signs from many channels and sign treatment (RMS value, mean, minimum, maximum, and standard deviation, FFT (on line) with software programmable acquisition rate (sampling) of up to 2,000 samples/second per channel. Five input channels were used, of which four were coupled to active electrodes with 20-fold amplification gain to collect the electromyographic sign for further analysis of the studied muscles. The fifth channel was used to determine the degree of mouth opening through mandibular goniometer (EMG System do Brasil Ltd.) linked to the system.

To capture the action potentials of the evaluated muscles, we used double surface electromyographic Ag-AgCl electrodes (Meditrace® Kendall-LTP, model Chicopee MA01) (diameter of 10 mm) placed 10 mm between each other, coupled to a polyethylene foam with disposable hypoallergenic tape and adhering solid gel on the individual's skin. These electrodes captured the electrical activity of many units simultaneously, providing a general approach of the muscle dynamics. To characterize a differential circuit, the electrodes were coupled to a preamplifier with 20-fold gain. A reference electrode (earth) was placed on the frontal area of the individual's skull to reduce the undesirable electrical noises. During the mouth opening, a mandibular goniometer was coupled to the electromyographer providing an electrical sign corresponding to the angular movement together with the electromyographic signs. This enabled the reading from 0 to 255 degrees, that is, from 0 to 80 mm with the sign recording of the real measurement unit.

At the moment of the electromyographic assessments, all participants were seated with the eyes opening, at natural posture, and the head guided by Frankfurt horizontal plane, without visualizing the recordings on the computer's screen. Prior to the assessments, the participant's skin was cleaned with 70% alcohol solution and the electrodes were placed following the direction of the muscle fibers to reduce the skin's impedance [20,21]. For the studied muscles, the passive electrodes were inserted at the mean point of the venters [22,23].

The baseline electromyographic records comprised: postural assessment (basal) followed by the maximum voluntary contraction (isometry) and simultaneously measurement of the interocclusal distance of the central incisors through the mandibular goniometer (to evaluate the mouth opening degree). The collection lasted 10 s, at three successive times after 1 min interval. One single previously calibrated performed the assessment by monitoring and recording the electromyographic recordings at real time. The assessment was repeated if any undesirable interference occurred, for example, an unsolicited movement. The sign recordings were stored on the computer. The electromyographic amplitude values were quantified through two measurements (response variables): Root Mean Square (RMS). RMS is the electronic mean (square root of the mean of the square roots of the electromyographic sign voltage) recommended to express the electromyographic amplitude of non-dynamic contractions, e.g. isometric contractions [6, 24-27].

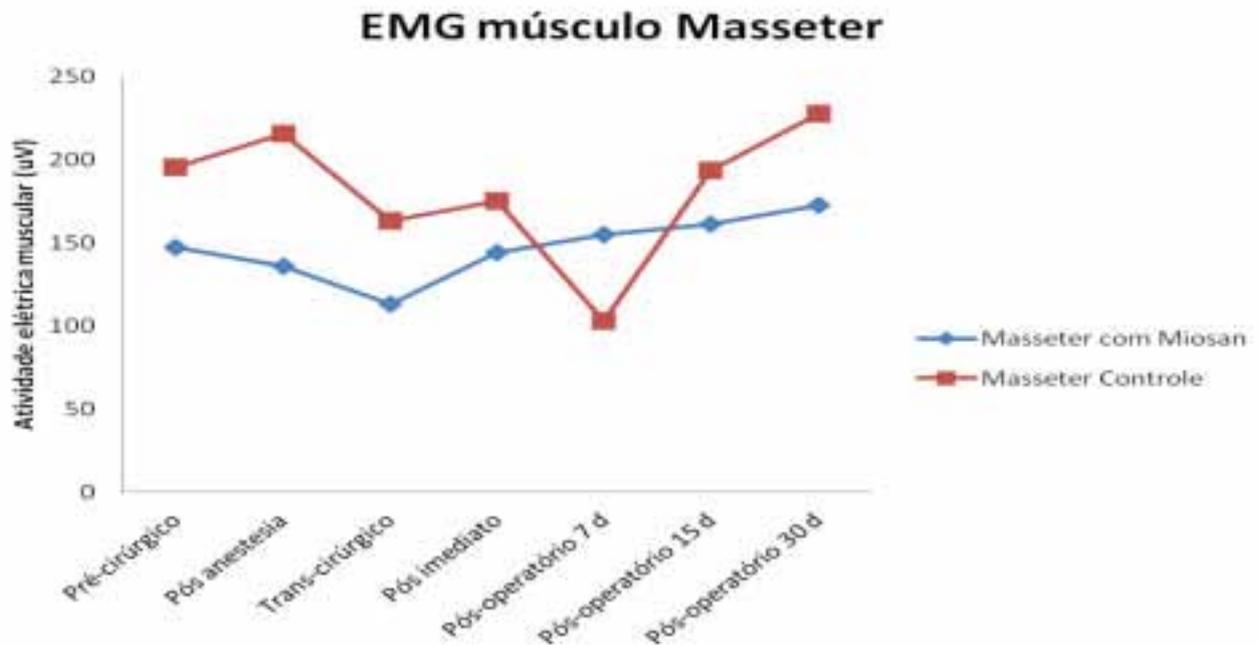
## RESULTS

Table I showed the means of the electrical activity values of the studied muscles for the comparison between control (no drug) and experimental group (Miosan®, 10 mg/orally/single dose) of the maximum voluntary contraction on the side of the extraction. During the initial electromyographic recordings (pre-

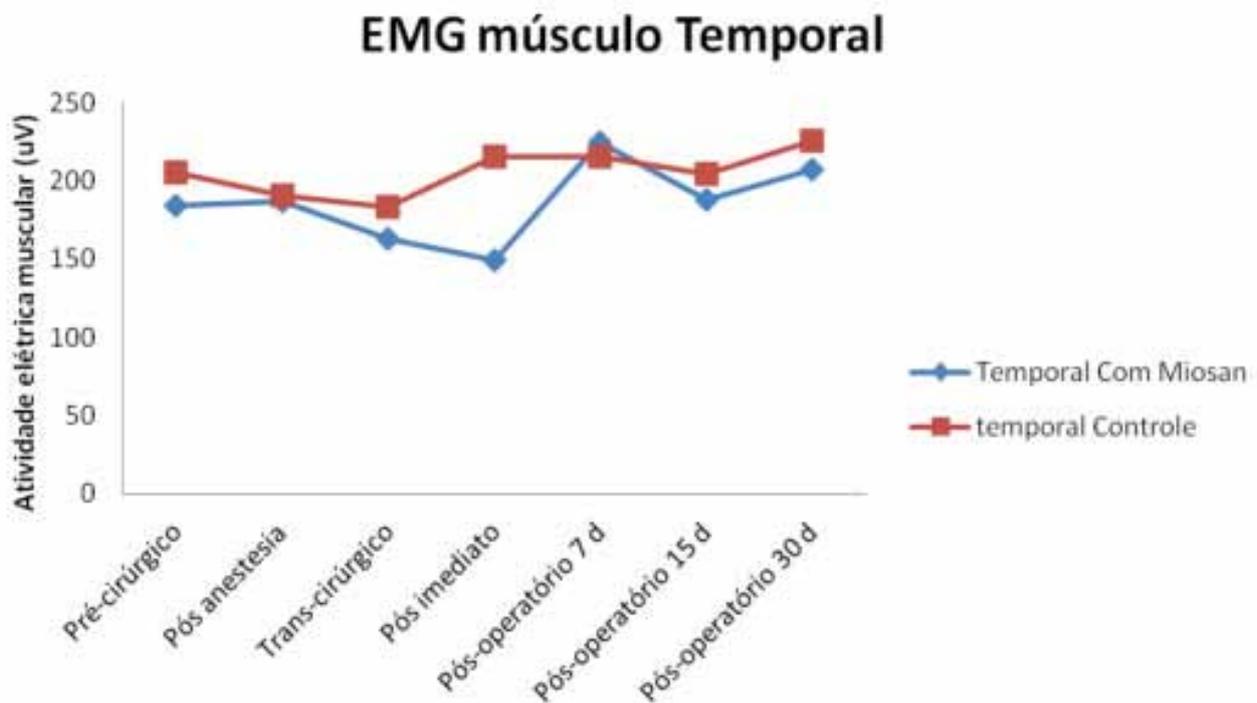
surgical, after anesthesia, and during surgery), the electrical activity of the masseter decreased in the experimental group, which returned at the immediate post-operative period by progressive increasing at the following periods, signaling the increasing of new motor units and the prompt recovery of the oral motor function of these participants (graph 1). On the other hand, control group did not follow the same electromyographic profile because the electrical activity of masseter reduce for 7 days after the surgical procedure, returning to baseline values only at the following periods with consequent reestablishing of motor function. The rationale behind this fact might be the local inflammatory process due to trauma or releasing of chemical mediators which could have increased the muscle tonus (graph 1) and decreased the development of new active fibers, similarly to which other authors have described for trismus related to third molar extractions.

Although the electromyographic recordings of temporal muscle indicated a mild reduction on the presence of the myorelaxant, at the initial surgical procedures (pre-operative, after anesthesia, during surgery and immediate post-surgical), the motor behavior was similar to that of the control group, without statistically significant differences at any evaluated period (graph 2).

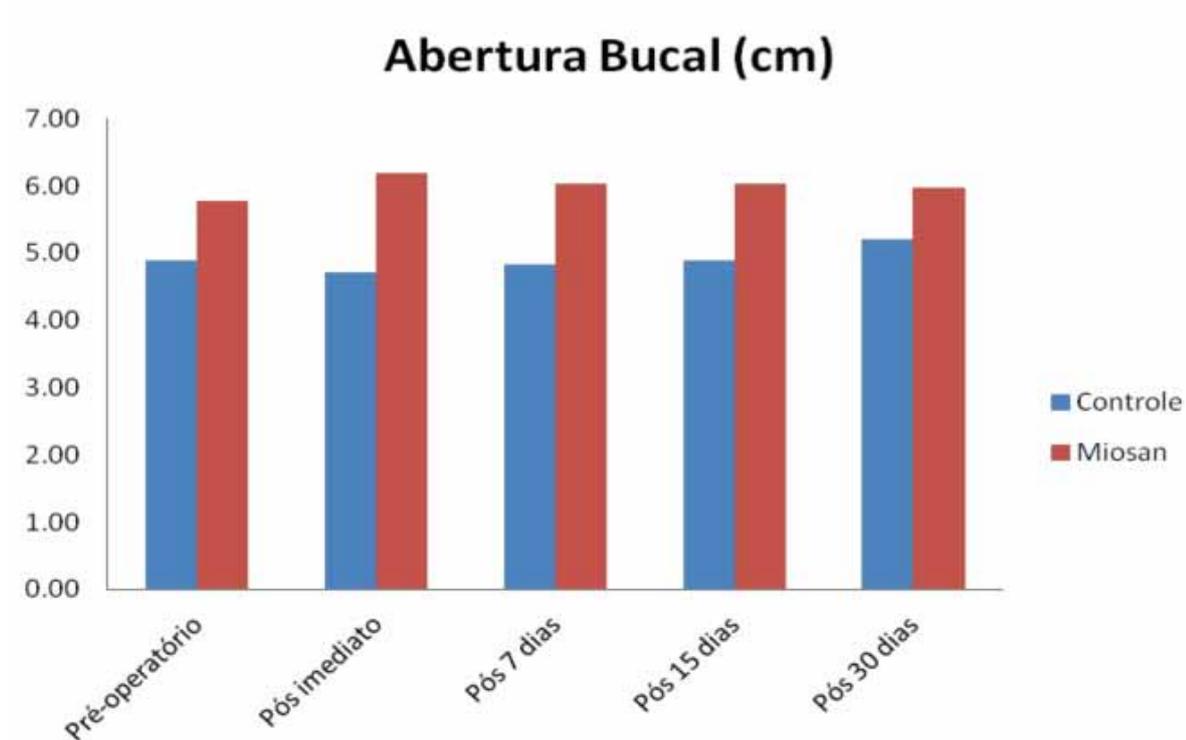
The degree of mouth opening has been used to detect the tonus alteration of the jaw elevators muscles, which reduces in cases of trismus during elevation and hampers the food swallowing, causing pain and negatively impacting on the quality of life of patients submitted to long-lasting surgeries. The maximum mouth opening in the presence of cyclobenzaprine significantly increased at the pre-operative period (control group = 4.89 cm Vs experimental group = 5.77 cm) and at the other studied periods ( $p < 0.001$ ), with mean increasing values of approximately 10 mm.



**Graph 1** - Comparison of the electrical activity (uV) of masseter muscle (extraction side) with or without the use of cyclobenzaprine hydrochloride (Miosan®;10 mg/orally/single dose) for the maximum voluntary contraction – isometry. EIXO Y – muscle electrical activity, EIXO X – pre-surgical/after, anesthesia/during, surgery/immediate, post-surgical/ 7d, 15d, 30d.



**Graph 2** - Comparison of the electrical activity (uV) of temporal muscle (extraction side) with or without the use of cyclobenzaprine hydrochloride (Miosan®;10 mg/orally/single dose) for the maximum voluntary contraction – isometry. EIXO Y – Muscle Electrical activity, EIXO X – pre-surgical/after, anesthesia/during, surgery/immediate, post-surgical/7 d, 15 d, 30 d.



**Graph 3** - Comparison of the mean mouth opening values of control and experimental groups at the studied periods ( $p < 0.001$ ). Pre-surgical/immediate, post-surgical/ 7d,15d, 30d.

**Table 1** - Mean and standard deviation of the electromyographic measurements of patients submitted to the extraction of impact/ embedded third molars of control and experimental groups.

Observation periods	Side			
	Masseter (uV)		Temporal (uV)	
	Control (10)	Miosan (10)	Control (10)	Miosan (10)
Pre-surgical	195.34±208.85	147.5± 51.06	205.57±153.99	184.18±73.29
After anesthesia	215.71±224.84	135.62±41.79	191.07±83.20	186.67±70.52
During surgery	162.84±125.92	112.93±29.95	183.25±98.23	162.83±74.06
Immediate post-surgical	175.28±97.70	144.41±51.42	215.21±123.99	149.64±74.77
7 day post-surgical	103.12±64.70	155.15±55.32	215.65±87.66	225.11±82.03
15 day post-surgical	193.30±132.34	161.49±62.21	204.65±64.58	188.38±54.40
30 day post-surgical	227.53±111.24	172.35±70.99	225.93±83.62	207.26±48.16

Values correspond to mean ± standard deviation; (N) number of participants; (uV) microvolt

## DISCUSSION

The extraction of third molars is one of the most common surgical procedures performed by the Specialty of Oral Maxillofacial Surgery and Traumatology. Third molar extraction might result in complications in about 56% of the individuals such as muscle limitation which impairs mandible movements due to damage to the capacity of the muscle fibers to contract Ahlgren, 1985; Albornoz et al., 2009; Merletti., 1999 [13,23,10].

Myorelaxants as Miosan are largely employed in Dentistry mainly in treatments causing postoperative pain and discomfort (Amorim et al., 2008) [28]. Acting very selective, the myorelaxant depressed the nervous system part controlling muscle tonus. Some studies report trismus relieving in patients taking this drug at postoperative period after dental surgeries (Achan et al.2012). This drug has been also employed in the treatment of fibromyalgia, temporomandibular joint disorder, and trigeminal neuralgia [27,29,30].

Notwithstanding, de Santana et al. [31] reported that cyclobenzaprine was ineffective in reducing pain, swelling, and trismus after third molar extraction. Thus, cyclobenzaprine use in long-lasting procedures is controversial thus justifying this study.

This study found that both the activity of masseter and temporal muscles reduced after the myorelaxant use at the initial periods of the surgical procedure. Although without statistically significant differences, our data suggested that cyclobenzaprine can be useful to control the muscle activity aiming at decreasing the risk of trismus after surgical procedures.

At the evaluated periods, the electromyographic activity of the masseter muscle of the extraction side varied after the use of Miosan. At the initial measurements, the muscle activity reduced which can be partly explained by the drug action in inhibiting the upper centers regulating the motricity.

The early recovery (immediate postoperative period) suggested that cyclobenzaprine attenuates the effect of surgical trauma on the motor activity of masseter thus reducing the likelihood of spasmodic events. The variability of electromyographic records were significantly smaller than those of control group indicating more homogenous electrical activities and suggesting a better stomatognathic system balance.

The electrical activity of temporal muscle slightly reduced at the initial periods of the surgical procedure after administration of Miosan, followed by a marked recover at the subsequent periods, but the muscle behavior was similar to that of control group. This was expected because the temporal muscles act as mandible positioner, not participating in the maximum voluntary contraction. The variability of the records of temporal muscles was also more homogenous than that of control group, corroborating the more evident muscle balance in the presence of the drug.

The capacity of mandible opening is one of the most important parameters to evaluate TMJ, the mastication muscles [32] and the applied therapeutic progress [33]. The degree of mouth opening indicates the local inflammatory process [23] and the increasing in muscle tonus (e.g., trismus) significantly reduces the mouth opening values. Our results are in agreement with those of the study of Reicheneder et al. [34], who reported a maximum mouth opening of 69.8 mm, with mean value of 56.9 mm in adult individuals.

No case of oral motor dysfunction was seen with the use of the myorelaxant. Unlikely, the mouth opening increased 4 mm between the initial and final periods. Such findings are in agreement with the study of Mertelli, who found that 15 to 30 days [22] after the extraction, the patient normally exerted the masticatory functions with normal electrical activity. According to Benediksdóttir et al. [35], the surgeon's experience may also influence

on the increasing of maximum mouth opening after extractions.

Generally, the muscle activity after administering the myorelaxant was smaller than that of control group for both muscles. However, further randomized clinical trials are necessary following CONSORT-STATEMENT guidelines and with larger sample size. The small sample size increases the data variability and reduces statistically differences (study power). Especially in this study, where high standard deviations were seen, a larger sample size is advisable.

## CONCLUSION

The myorelaxant administration prior to the extraction of impacted/embedded mandibular third molars might interfere with the muscle electrical activity by reducing the likelihood of trismus during postoperative period and promoting a better biomechanical balance of the stomatognathic system.

Other factors may help in decreasing the trismus likelihood after surgical procedures, such as the surgeons' experience in applying the surgical techniques. We strongly recommend further studies with larger sample sizes to improve this area.

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