Acta Scientiarum
http://periodicos.uem.br/ojs/acta
ISSN on-line: 1807-8648
Doi: 10.4025/actascihealthsci.v46i1.65698

Does acupuncture treatment reduce temporomandibular dysfunction symptoms?

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ABSTRACT. To analyze the pain, the muscle profile of some muscles actively and passively involved in the stomatognathic system, and stress traits. A clinical, randomized and double-blind study (n = 35) was performed analyzed by the Research Diagnostic Criteria/Temporomandibular Dysfunction (RDC/TMD), with subjects allocated in experimental group (EG) which received acupuncture at the meridian points according to Traditional Chinese Medicine, and another placebo group (PG) which received acupuncture at random points. The degree of discomfort was evaluated by the Visual Analog Scale (VAS), tissue sensitivity, somatic and psychic anxiety level, salivary cortisol levels, electrical activity of the masseter, anterior temporal, sternocleidomastoid (SCM) and trapezoid muscles before and after the proposed treatment. The Wilcoxon test, Chi-squared test, Signal test, Mann-Whitney U-test, paired and independent Student's t-test, Pearson's correlation test and the symmetry index of the muscles were used for statistical analysis, considering a significance level equal to 0.05. There was a reduction of physical non-specific TMD symptoms, and the degree of discomfort decreased by fifty percent in the EG, with a trend curve pointing to an evolution in the repair process. Tissue sensitivity decreased in the EG and increased in the PG. The treated group presented a reduction of physical and psychological manifestations in the anxiety situation, while the reduction was only for physical manifestations in the PG. Salivary cortisol levels did not change. The masticatory musculature presented an increase in the temporal activity and a decrease in the masseter/temporal ratio in the PG. The EG showed a better relationship between the trapezium and sternocleidomastoid muscles. Therefore, acupuncture treatment was efficient for reducing the pain symptoms and the physical and mental conditions of anxiety in people with TMD, as well as to improve the relationship of postural muscles.

Keywords: acupuncture; temporomandibular joint dysfunction syndrome; pain; anxiety; electromyography.

Received on November3, 2022.
Accepted on May24, 2023.

Introduction

Temporomandibular dysfunction (TMD) comprises changes in functional organization involving the temporomandibular joint (TMJ) and mastication muscles. Based on the clinical presentation, this dysfunction is divided into articular, muscular and bone pathologies (Poveda-Roda, Bagan, Fernández, Bazán, & Soriano, 2007; Anderson et al., 2010). The most common is that of muscular origin which occurs between 20 and 45 years of life, known as myogenic TMD; the main factor from 40 years of age is joint degeneration which characterizes arthrogenic TMD (Biasotto-Gonzalez et al., 2008; Winocur, Steinkeller-Dekel, Reiter, & Eli, 2009). The most common signs and symptoms are: pain in the face and/or in the muscles of chewing, sensitivity in the TMJ which may be unilateral or bilateral, limitation of mandibular movements, pain in the preauricular region, cervicalgia, headaches and otologic manifestations such as tinnitus and auricular fullness (Browne, Clark, Yang, & Nakano, 1993; Visscher et al., 2000; Tingey, Buschang, & Throckmorton, 2001; Chaves, Turci, Pinheiro, Sousa, & Grossi, 2014; Bevilaqua-Grossi, Chaves, Oliveira, & Monteiro-Pedro, 2006; Bevilaqua-Grossi & Chaves, Oliveira, 2007; Ohmure et al., 2008; Klasser & Greene, 2009; Carrara, Conti, & Barbosa, 2010;Weber et al., 2021; Siqueira, Teixeira, & Siqueira, 2013). They may also present otologic manifestations such tinnitus, sensation of hearing loss, aural fullness and dizziness (Carrara et al., 2010; Leeuw, 2010; Oliveira, 2019). Several factors have been considered in the development of TMD such as

traumas, depression, stress, anxiety, genetic factors and neuroendocrine dysfunctions (Maixner et al., 2011; Siqueira et al., 2013; Harper, Schrepf, & Clauw, 2016; Slade et al., 2016).

Electrical activity of the involved muscles has been observed in individuals with this type of disorder so that the therapeutic approaches are compared. In addition, the muscular pattern in adverse conditions such as the case of chronic pain and stress can be analyzed (Carlson, Okeson, Falace, Nitz, & Lindroth, 1993; Tsai, Chou, Gale, & Mccall, 2002; Grillo et al., 2015), because the hyperactivity of muscles elevating the jaw may increase the intra-articular pressure, in turn causing biomechanical changes in TMD with typical symptoms of these dysfunctions (Carlson et al., 1993; Sato & Kawamura, 2005; Sato, Kawamura, Yamaguchi, & Kasai, 2005). The pain caused by masticatory muscles and the cervical region palpating can be considered proportional to the severity of TMD, being reported as one of the classic signs of this dysfunction (Pedroni, De Oliveira, & Guaratini, 2003; Siqueira et al., 2013).

It is expected that there will be greater activation of the hypothalamus-pituitary-adrenal (HPA) axis in a chronic pain condition (Chinthakanan et al., 2018; Nadendla, Meduri, Paramkusam, & Pachava, 2014), resulting in an increased contraction state (Carlson et al., 1993; Tsai et al., 2002). It was recorded that the release of salivary cortisol in stress situations occurred concomitantly with increased EMG activity and the severity degree of TMD (Tosato et al., 2015), when seeking a correlation between masseter and anterior temporal electromyographic (EMG) activity and the hormone index. However, this relationship between TMD and anxiety is not a consensus in the literature of TMD (Giannakopoulos, Keller, Rammelsberg, Kronmüller, &Schmitter, 2010; Tosato et al., 2015).

The treatment of musculoskeletal conditions by acupuncture has been investigated in the scientific world, and there are expressive results for TMD both through the exclusive use of the technique (Cho & Whang, 2010; Borin, Corrêa, Silva, & Milanesi, 2012) and in proposals of combined therapeutic approaches (Wong, Cheng, 2003). Positive results have been evidenced by this technique to resolve pain and have contributed to the search for this alternative treatment. The first study of the analgesic effect of acupuncture was published in the 1970's by activating the opioid system (Han, 2003; Zhao, 2008) although other endogenous substances have been studied (Zhao, 2008; Cheng, 2014) such as serotonin (Kim et al., 2005) and melatonin (Spence et al., 2004). In recent decades, the endocannabinoid system has been identified with antinociceptive effects (Hu, Bai, Xiong, & Wang, 2017).

In addition to the investigations of the antalgic systems, acupuncture produces a series of biological effects which induce homeostasis (Kim et al., 2005; Cheng, 2014) and among these studies have shown its role in mood and anxiety disorders, changing the framework to conditions which result in improved quality of life (Spence et al., 2004; Vázquez, González-Macías, Berlanga, & Aedo, 2011; Hek et al., 2013). However, there are still gaps regarding the effect of acupuncture treatment and the relationship of the pain symptomatology, the electrical aspects of the musculature and the anxiety conditions in individuals with TMD. Therefore, we investigated the efficacy of acupuncture treatment on pain, stress traits and electrical activity of the masseter, anterior temporal, trapezius and sternocleidomastoid muscles in individuals with TMD.

Materials and methods

The sample calculation counted an "n" equal to 19 based on research which evaluated salivary cortisol variation in acupuncture-treated patients (Vázquez et al., 2011; Hek et al., 2013), including a 25% sample loss. This study is a randomized, double-blind clinical trial with 35 individuals diagnosed by the Fonseca Anamnestic Index as having TMD. This western diagnosis allows to homogenize the groups for statistical analysis afterwards, considering that the assessment by the five elements does not meet a fixed treatment protocol (Zhang & Zhang, 2021). These individuals were included in the study after losses due to inadequacy of the inclusion criteria or to impracticability on the part of the volunteers. The study was approved by the Ethics and Research Committee of the Federal University of Pernambuco under protocol: 81287917.9.0000.5208. The volunteers signed the Informed Consent Form and were allocated into the experimental groups in order of adherence to the research to preserve the neutrality in the therapeutic approach. The randomization scheme was presented by the virtual tool: http://www.radomization.com which generated the code 12033, and the composed groups were the experimental (EG): treated with acupuncture; and placebo (PG): who received needles at points not found in the ordinary meridians of Traditional Chinese Medicine (TCM). The evaluators were blinded to the randomization process and the intervention groups in which the patients were allocated.

We included people between 18 and 45 years old without gender restriction who presented signs and/or symptoms of TMD. The exclusion criteria were considered as individuals: treated with another type of treatment for TMD; treated with viscosuplementation in TMJ(s) less than a year ago or with BOTOX in the face less than six months ago; who presented a tumour in the body; diagnosed with Cushing's or Adison's syndrome; with facial paralysis or acute structural problems in the cervical region; night workers; who have had Jet Lag in the last two weeks; who have recently been victims of accidents or direct trauma to the face and/or neck; with metal allergy; with mental illness or who have undergone TMJ surgery.

The individuals attended six appointments (the first was evaluation followed by intervention, the next four were for intervention only, and the sixth was for reassessment) with flexible schedules. A collection tube provided by a clinical analysis laboratory containing salivary sample (collected at awakening) was delivered in the first and last appointments. The patients were evaluated on these two days by the Research Diagnostic Criteria for Temporomandibular Dysfunction (RDC/TMD), the Hamilton Anxiety Questionnaire, Visual Analog Scale (VAS), and an electronic algometer. In addition, electrical activity (surface EMG - Miotec®/Miotool 400, 8 channels, 14 Bits) of the superficial masseter muscles, anterior temporal muscles, upper portion of the trapezius and sternocleidomastoid were recorded. Before the examination, the patients were asked to perform a maximum voluntary contraction (MVC), supported by isometry of five seconds for the masseter, anterior temporal, sternocleidomastoid, and trapezoid muscles in order to normalize the data. They were subsequently interpreted using the MATLAB program. The amplitude of the electric potential in microvolts (μV) expressed by the root mean square (RMS) was considered in analysing the results.

The intervention sessions were five in total in an interval of 30 to 45 days (trying to keep to one session per week whenever possible). Patients were asked to lay down on a stretcher in the dorsal decubitus position with their legs and arms exposed in acclimatized room at a pleasant temperature for the patient and without direct lights. The areas where disposable needles (DUX of 0.25 X 15mm) touched the skin were disinfected with 70% alcohol, which remained inserted for 20 minutes. The patient and therapist remain in silence. Then the needles were removed and disposed off in a specific box for sharps. The sessions lasted about 30 minutes and were always carried out by the same therapist (blinded to randomization process and assessment results) in the same room, avoiding any type of interaction. The VAS was applied to assess the patient well-being before and after each intervention. The volunteers didn't have to change their routine or received new instructions on daily matter.

The points selected for the EG were based on the local and distal pointsof TCM principles, with a balanced combination of points involving the Yin and Yang principle (upper and lower; right and left of body) and use of the same energy level channels and paired with coverage in the studied region. The chosen points were: LI4 (Large Intestine 4) on one side and L3 (Liver 3) on the other, followed by PC6 (Pericardium 6) on the opposite side and GB43 (Gallbladder 43) contralateral to it. Points on the skull: GB20, GB8, SI19 (Small Intestine 19), TH17 (Triple Heater 17), ST6 (Stomach 6) and ST7 (Stomach 7). The distal point and last to be punctured was KI3 (Kidney 3). The first point (LI4) was placed in the following sequence: in women, $LI4^{R}$, $L3^{L}$, $PC6^{L}$, $GB43^{R}$, GB20, GB8, TH17, SI19, ST6, ST7 and KI3; in men, $LI4^{L}$, $L3^{R}$, $PC6^{R}$, $GB43^{L}$, GB20, GB8, TH17, SI19, ST6, ST7 and KI3.

A control group was established so we could evaluate the effectiveness of the proposed acupuncture protocol for TMD. The acupuncture for this group was performed at points not found in the ordinary TCM meridians and its sites were: a point on the back of the hand, vestibular to the 5^{th} metacarpal, located between the metacarpophalangeal joint and the dorsal fold of the wrist; another point located at the intersection of the horizontal point passing through the gallbladder point 04 (located on the lateral face of the skull on the frontoparietal suture) and the perpendicular point passing in front of the ear tragus; and a third point on the dorsolateral face of the foot in the depression between the heads of the 3^{rd} and 4^{th} metatarsals at the junction of the red and white skin. The use of the non-specific approach was only declared in the sixth consultation for this group. It was offered effective treatment for five more sessions (as a reward for participating in the study), which were not included in the research data analysis.

Statistical analysis

A significance level of 0.05 was considered for statistical analysis, and the Student's T, Wilcoxon and Chi-squared tests were used for RDC data; the Wilcoxon's test was used to evaluate the algometry and VAS data; the Signals test for the Hamilton Anxiety Questionnaire; and the Mann-Whitney U-test was performed for all

of them in the analysis between the groups. We used paired and independent Student's t-test, Pearson's correlation test and calculated the symmetry index of the muscles for the EMG activity.

Results

A total of 35 people were evaluated and distributed into two randomized groups (EG: 17 women and one man; PG: 17 women). They presented a homogeneous distribution relative to functional clinicals aspects, except in left laterality which showed a difference between the groups in the condition prior to treatment (Table 1).

Table 1. Distribution and qualification of the characteristics of subjects' TMD.

Groups		Total	Experimental group (EG) N = 18	Placebo group (PG) N = 17	P
Age[a] (mean ± SD)		32 ± 8.90	30 ± 9.60	34 ± 7.90	0.33
Grade of chronic pain (n)[#♦]	GI	14	8	6	0.57
	GII	9	6	3	0.80
	GIII	8	4	4	1.00
	GIV	2	0	2	-
Depression degree[b#]			1.28	1.14	0.26
Passive opening without pain[a#]			33.06	30.35	0.99
Right laterality[a#]			7.78	7.88	0.69
Left laterality[a#]			6.50	8.12	0.01
Physical symptoms except pain[b#]			0.83	0.77	0.46
Physical symptoms including pain[b#]			0.98	0.85	0.90
Cortisol[a]			0.32 ± 0.16	0.30 ± 0.17	0.99

Results expressed according to the analyses performed using the $\chi 2$ test for frequency of chronic pain degrees, Student's t-test for age, passive openness without pain, right laterality, left laterality and cortisol, and Mann Whitney test for analysis of the depression degree and physical symptoms excluding and including pain. GI = low intensity; GII = hight intensity; GIII = Moderately limiting regardless of Characteristic Pain Intensity and GIV = Severely limiting regardless of Characteristic Pain Intensity. For all tests, it was considered $\alpha \leq 0.05$. a: Student t test; b: U Mann-Whitney; c- $\chi 2$. # = Research Diagnostic Criteria for Temporomandibular Dysfunction (RDC/TMD). ♦ = Two individuals in the control group did not have chronic pain and therefore were not considered in the grade of chronic pain aspect.

RDC/TMD analysis

In the RDC/TMD analyses before and after acupuncture treatment, differences were only observed for the EG. Acupuncture reduced the intensity of TMD pain, depression degree, promoted benefits in mandibular movement (passive openness and lateralities) and reduction of the specific and non-specific physical symptoms (somatization). This difference was noted in the aspect of physical symptoms in which the pain condition wasn't analysed (before treatment: 0.83 ± 0.68 vs. after treatment: 0.65 ± 0.68, n = 18; Wilcoxon test, P = 0.008). There were no significant results in the analysis between the groups (p > 0.05) (Figure 1).

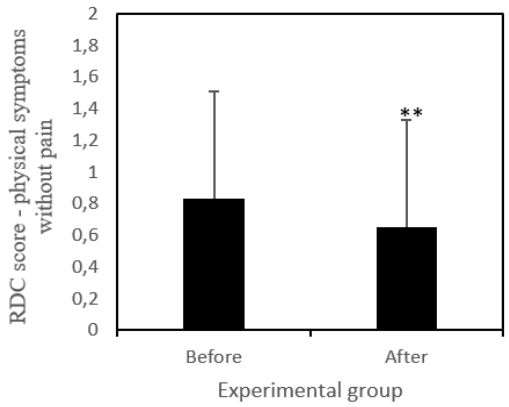


Figure 1. Analysis of physical symptoms, excluding pain, in the treated group (GE) using the Research Diagnostic Criteria/Temporomandibular Dysfunction (RDC/TMD). Wilcoxon Test (p = 0.008).

Pain discomfort subjectivity

In the subjective analysis of data representing pain discomfort, the percentage of change with treatment was a 50.53% reduction for the EG and 27.57% for the PG. Although improvement percentages were found in both groups in the VAS signalling analysis in each of the consultations, the results tend to produce a declining trend curve only for the treated group.

The subjective pain sensitivity did not present a significant difference in the comparison between the groups (p > 0.05) (Figure 2).

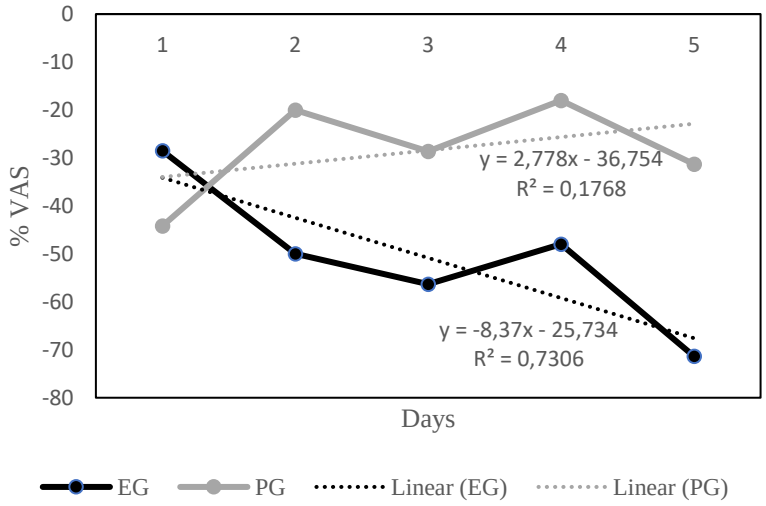


Figure 2. Evolution percentage of the discomfort analyzes evaluated by Visual Analog Scale (VAS) in the five evaluation days in both the experimental group (EG) and the placebo group (PG) after treatment by acupuncture and trend line.

Tissue sensitivity to pain

There was a small reduction in pain sensitivity (7.23%) recorded by the algometer considering all the muscles evaluated in the EG. However, there was an increase in pain sensitivity in the PG in this same analysis (-21%). The treated group showed no difference when the comparison was performed before and after acupuncture treatment (p > 0.05); however, this data showed a higher tissue sensitivity (α 0.05) in the placebo group for the right medial temporal (Z = -2.06; p = 0.04) left medial temporal (Z= -2.79; p = 0.005) and left trapezoid (Z= -2.9; p = 0.003). There were no statistical differences in the comparative analysis between the groups (p > 0.05) (Figure 3).

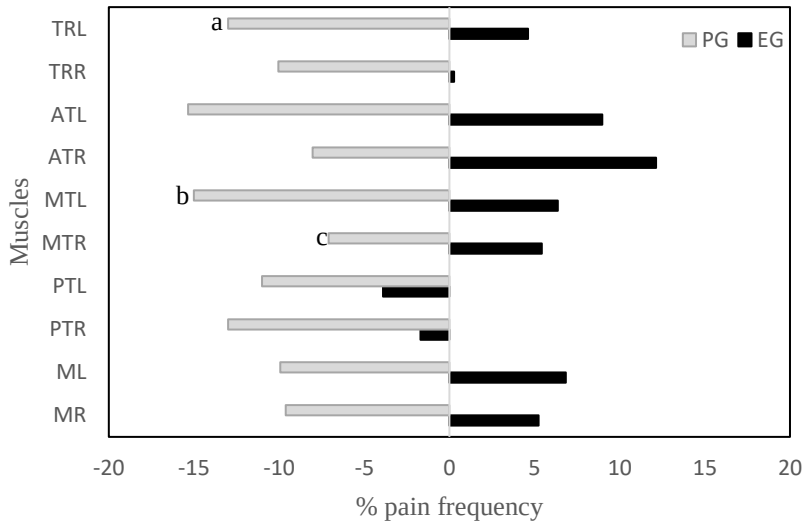


Figure 3. Pain frequency distribution percentage in the algometry of the masseter muscles (M), posterior temporal (PT), medial temporal (MT), anterior temporal (AT) and trapezius (RT) on both sides (Right - R and Left - L) from the experimental (EG) and placebo (PG) groups. Wilcoxon test, (a) p = 0.003; (b) p = 0.005 and (c) p = 0.04.

Anxiety analysis - Hamilton test

We found significant results in both the EG and PG in analysing the psychological and somatic manifestations of anxiety which are scored in the Hamilton Anxiety Questionnaire. Physical symptoms of anxiety were significantly reduced in both groups (EG: 2.9 ± 3.36; n = 17, P = 0.003 vs. PG: 3.06 ± 3.0, n = 18;

Sign Test, p = 0.000). However, psychological manifestations were only lower in the treated group (EG: 2.39 ± 4.34; n = 17; Sign Tests and p = 0.003 /PG: 1.5 ± 3.45 n = 18; Sign Test and p = 0.32). There were no significant differences in the comparative analysis between the groups (p > 0.05, Mann-Whitney U-test) (Figure 4).

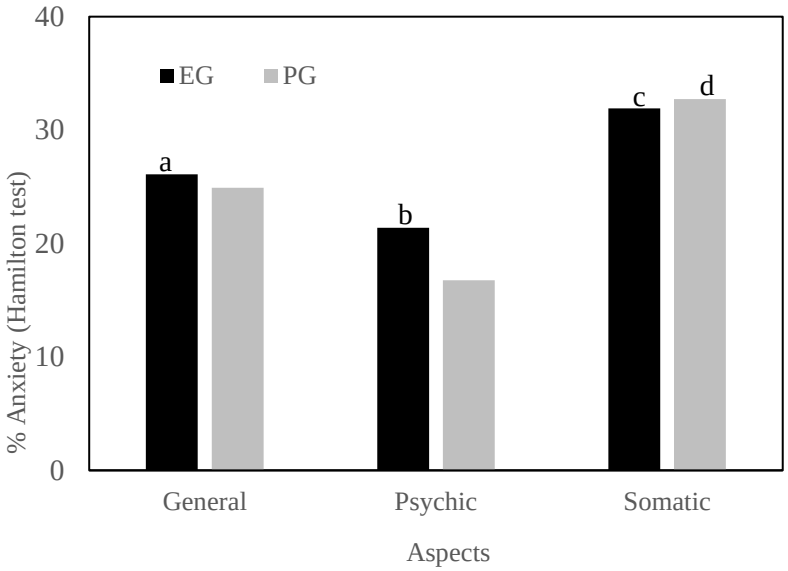


Figure 4. Percentage of anxiety levels assessed with the Hamilton Anxiety Questionnaire in general, psychic and somatic aspects. Significant Signal Test results, (a) p = 0.05; (b) p = 0.003; (c) p = 0.003 and (d) p = 0.000.

Indirect stress analysis - salivary cortisol

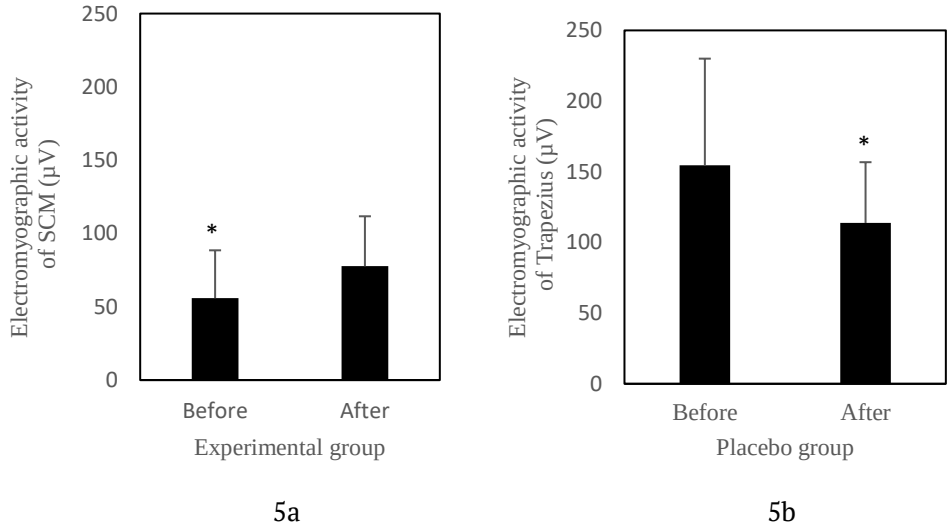
Cortisol levels were not significantly different in the conditions before and after treatment (GE: before 0.39 ± 0.17; after 0.32 ± 0.16; GP: before 0.39 ± 0.26; after 0.30 ± 0.17; p > 0.05: paired Student's t-test).

Electromyographic activities of postural and masticatory muscles

Presentation of the electrical activity of postural muscles at rest

When the masticatory muscles were resting it was observed that only the right SCM in the EG presented significant alteration with increase of myoelectric activity (t = 2.12; p = 0.049, Student's t-test), in the intra-group comparison analysis (Figure 5a).

In the chewing condition, there was a reduction in the activity in the right trapezius of the PG (t = -2.39; p = 0.03) (Figure 5b).



5a 5b

Figure 5. (a) Presentation of the increased myoelectric activity of the right SCM, at rest, after acupuncture treatment, in the experimental group (EG). t test, p = 0.049 and; (b) Presentation of the decreased myoelectric activity of the right trapezius, in chewing condition, after treatment with acupuncture, in the placebo group (GP). Student's t-test, p = 0.032.

Symmetry of homonymous muscles

The results of the symmetry tests of homonymous muscles showed no significant differences in an intragroup analysis.

Relationship between masticatory muscles at rest - comparison between groups.

The condition of the masseter and temporal muscles in the resting state was evaluated, showing that there were no significant statistical changes in the EG. However, there was an increase of left temporal activity which presented a significantly worse relationship between the masticatory muscles analysed in the PG ($t = 2.20$; $p = 0.05$, Student's t-test) (Figure 6).

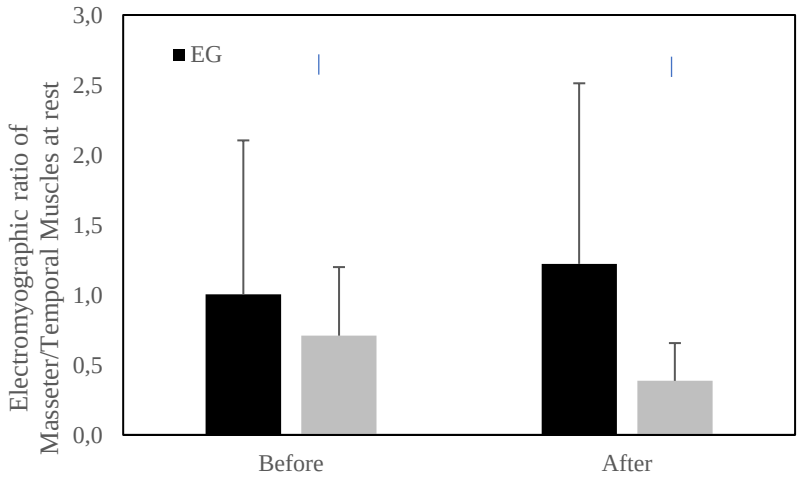


Figure 6. Electromyographic ratio of Masseter and Temporal muscles on the left side of the experimental (EG) and placebo (PG) groups at rest, Student's t-test *p = 0.05.

Relationship between masticatory muscles in chewing between groups

None of the groups presented significant changes ($p > 0.05$) when considering the relationship between the masseter and temporal muscles during the mastication period.

Analysis of postural muscles at rest during chewing

In the analysis of postural muscles at rest during chewing, the two groups showed a tendency to equal myoelectric activation of the trapezius and SCM muscles after treatment. However, these changes happened for the EG on the right side and the PG, on the left side, Figure 7.

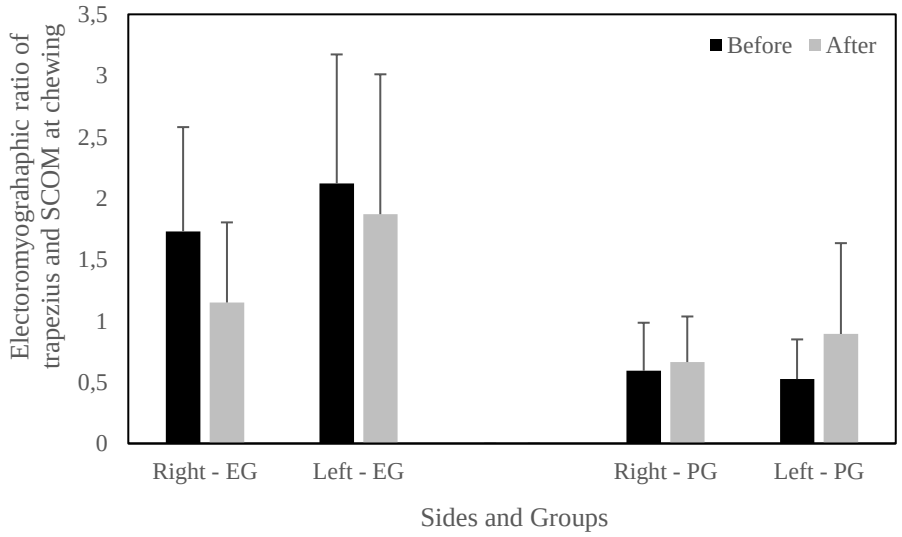


Figure 7. Electromyographic ratio of trapezius and sternocleidomastoid muscles (SCM) before and after acupuncture treatment on the Right and Left sides in the chewing period of the experimental (EG) and placebo (PG) groups.

Discussion

Within the blind study, it can be observed that the presentation of the groups by the RDC records was similar, which configures common characteristics in chronic patients of orofacial pain, as already pointed out in the literature (Winocur et al., 2009; Siqueira et al., 2013). The present study showed that signs and symptoms reported in patients with TMD may have a significant reduction when treated by acupuncture. Although laboratory records do not translate with statistical significance several of these improvements, the perception of discomfort and behaviour before the causal agent was evidenced.

TMD pain and the severity reductions of acupuncture therapy has been pointed out in the literature (Cho & Whang, 2010; Borin et al., 2012; Grillo et al., 2015). In the present study, a reduction in discomfort was observed in both groups the treated one (50.53%) and the placebo (27.57%) but the trend curve only decreased in the treated group. This decline curve could be the reason of the cumulative effect of acupuncture and the production of homeostasis by autonomic reflexes since the acupuncture activated the neurotransmitters and hormones providing homeostatic regulation, physical and psychological well-being (Menezes, Moreira, & Brandão, 2010; Cheng, 2014). In the placebo group, the trend curve showed to be ascending, but over time may result in a nullity of well-being due to the lack of effective treatment, which leads us to consider the effectiveness of studies which record results after a single treatment session.

There were no statistically significant differences between the groups in the aspect of tissue sensitivity to pain, although was noticed an increase in the treated group. The placebo group had a reduction of the pain threshold with increased sensitivity. Our data acknowledge acupuncture and sham acupuncture research where an increase in the potential threshold accompanied by improvement of symptoms and greater tolerance to pressure were only registered in the groups that received effective acupuncture (Kam, Eslick, Campbell, 2002; Smith, Mosscrop, Davies, Sloan, & Al-Ani, 2007; Shen, Younger, Goddard, & Mackey, 2009).

The findings on anxiety and the possible marker of chronic stress in this research showed differences between the groups. In clinical aspects, both groups showed a reduction in the physical manifestations of anxiety. While the symptoms of anxious mood were only reduced in the treated group. The reduction of psychiatric symptoms was only significant in the experimental group, as seen in the literature regarding depression and distress symptoms (Vázquez et al., 2011; Şen et al., 2020). However, no change in salivary cortisol levels was observed, which corroborates with some data in the literature (Jasim, Louca, Christidis, & Ernberg, 2014; Jo et al., 2016). Although these findings were inconclusive, the results may indicate a downregulation of the HPA axis in individuals with chronic anxiety (Hek et al., 2013). Some research shown positive correlations between TMD and an increase salivary cortisol. The pain and high contract activity of skeletal muscles could be co-related to the high level of this hormone and the severity of disfunction (Tosato et al., 2015; Kobayashi et al., 2017; Chinthakanan et al., 2018).

This study showed an increase (which was not significant) of the temporal electrical activity in the PG in resting condition, mainly on the left side, which resulted in a decrease of the masseter/temporal ratio. The hyperactivity of the temporal muscle in relation to the masseter corresponds to an altered pattern of the musculature in individuals with TMD (Visser, Naeije, & Son, 1995; Ries & Bérzin, 2008; Tosato et al., 2015), which may be reflecting the increased sensitivity of this muscle found in this research after stimulation with acupuncture needles. The results differ from other studies found in the literature (Rancan et al., 2009; Borin et al., 2012), maybe because of the amount of therapeutics sessions and/or the bilateral prescriptions of distal point LI4. This is considered a face command point (Kong et al., 2015; Fernandes et al., 2017).

Many studies report a high incidence of associated cervical spine disorders in individuals with TMD (Visscher, Lobbezoo, Boer, Zaag, & Naeije, 2001; Bevilaqua-Grossi et al., 2007). The signs and symptoms of TMD tend to follow the severity of TMD, but the inverse relation is not a consensus (Bevilaqua-Grossi et al., 2007). An increase in the electrical activity of the right ECM was found in the treated group, which, in following analysis of the symmetry of postural muscles in active period of masticatory muscles, reflected a harmonious relationship with the trapezius, mainly in this same side. This symmetry may be associated with the recovery of cervical movements which act stabilizing the head and improve TMD symptoms (Ries & Bérzin, 2008).

The right trapezius in the placebo group presented a reduction of contractile activity at the isotonic contraction moment of the masticatory muscles. In fact, both groups tended to show similar electrical activation of postural muscles during chewing, but the reduction of trapezius activity in the PG may be related to the increase in sensitivity recorded in algometer in the left trapezius and the VAS trend curve may be increasing.

The laterality presented in the tension behaviours by EMG can be associated with the presence of alpha waves in areas of emotional regulation. The social anxiety is related to the predominance of this waves in the left hemisphere registered in electroencephalogram (Duarte, Bandeira, & Lopez, 2022). Suggestions for future research will be to detect the increase of alpha waves on the frontal right lobe. That can reflect negative aversive emotions as an external symptom tension on the opposite side. In the same way the increase of the alpha waves on the left lobe can reflect positive emotions and muscle comfort.

As limitations of the present study, factors such as gender discrepancy, test time, age and patients' daily practice may have contributed to the high standard deviation value. Despite that, the obtained results generally bring significant data. A sample size survey using the standard deviations and differences found in this study was performed for each data set, considering a statistical power of 80% with a significance level of 5% (to algometer 342; VAS 26; Hamilton Anxiety Questionnaire 112; Salivary cortisol 171; EMG to masticatory muscles 202 and EMG to postural muscles 90 individuals. Do not included sample loss).

Finally, our results showed that acupuncture is an important strategy for TMD treatments, providing well-being to treated patients with a reduction in pain and anxiety added to a change in muscle profile, but further studies should be conducted to understand the mechanisms involved in this therapeutic approach.

Conclusion

Acupuncture treatment was effective to reduce the pain symptoms and reduce the physical and mental conditions of anxiety in people with TMD, in addition to producing a change in the muscle profile with increased electrical activity of the right sternocleidomastoid that reflected a harmonious relationship with the trapezius.

Acknowledgments

The authors are grateful to Phonoaudiology Department of the Federal University of Pernambuco and Marcelo Magalhães Clinical Analysis Laboratory for performing the salivary cortisol tests.

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