Treatment of Masticatory Muscle Pain with Acupuncture: Is It Necessary to Associate with Occlusal Splints?

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Background: Temporomandibular disorders (TMDs) are treated by different modalities including splints, physiotherapy, and acupuncture. Although all of these offer evidence-based benefits to the patients, avoiding overtreatment is of paramount importance.

Objectives: To assess the effectiveness of muscle pain treatment with acupuncture combined with or without occlusal splints.

Methods: Recruited patients were allocated to G1 (acupuncture) and G2 (acupuncture and occlusal splint) groups and treated in four consecutive weekly sessions (P1, P2, P3, and P4). The reported pain (RP) and the pressure pain threshold (PPT) of the masseter and temporalis muscles were assessed before and after each session.

Results: RP decreased after each session in G1, except at P4. In G2, the RP decreased only after the first session, and the PPT did not vary.

Conclusion: The assessed treatments did not influence the PPT levels of the masseter and anterior temporalis muscles in patients with temporomandibular disorders. Our findings suggest that occlusal splints may not be mandatory along with the acupuncture treatment.

Keywords: Acupuncture, Facial pain, Occlusal splint, Pressure pain threshold, Pain perception, Temporomandibular joint disorder

INTRODUCTION

Temporomandibular disorders (TMDs) are defined as a group of disorders involving the masticatory muscles, the temporomandibular joint (TMJ), and associated structures, and the most common symptoms include pain in the face, TMJ, masticatory muscles, and the head and the ear [1].

Approximately 100 million people were diagnosed with TMDs in the United States, and 3 million occlusal splints were prepared every year in the 1990s [2]. Splints are mainly used to decrease muscle overload and stimulate cognitive awareness [3]. However, the indication of occlusal splints is debatable [4] since other treatments also seem to offer similar recovery rates and comparable quality of life [5].

Chinese traditional medicine has reported the importance of needling at diverse points [6]. Western medicine research has shown that electroacupuncture triggers the release of substance P and calcitonin gene-related peptide in mice [7]. The analgesic effect of acupuncture may be mediated via adenosine A1 [8]. Endogenous pain modulation seems to be activated via acupuncture [9] and has been considered

imperative to address acute cases without side effects [10]. Since clinicians often combine different treatment modalities to treat chronic pain, offering scientific and evidence-based benefits to patients, but avoiding overtreatment is of paramount importance. This study aimed to assess the effect of combining occlusal splints with acupuncture in reducing muscle pain in TMD patients. The hypothesis was that the use of occlusal splint would lead to a greater reduction of the reported pain (RP) and significantly increase the pressure pain threshold (PPT) of muscles.

MATERIALS AND METHODS

1. Trial design

This study was performed in accordance with the Declaration of Helsinki and approved by the Human Research Ethics Committee (81422417.4.0000.5420).

2. Participants

The participants were recruited from the Center of Diagnosis and Treatment of TMDs from FOA-UNESP. They were

selected according to the Research Diagnostic Criteria (DC-TMD) [11]. All participants signed an informed consent form.

The inclusion criteria were: (1) age ≥ 18 years; and (2) masseter and temporalis muscles pain as the primary cause of discomfort (minimum of 3 months); (3) reported bruxism. The exclusion criteria were: (1) use of recreational drugs; (2) severe systemic diseases (trigeminal neuralgia, tumor, neurologic diseases, psychiatric problems, and narcolepsy); (3) complete dentures; (4) history of TMJ surgery; (5) degenerative diseases, neuropathic pain; (6) continuous antidepressant, anxiolytic, or opioid intake; (7) pregnancy; and (8) pain in TMJs as the main and/or exclusive complaint, without muscle pain.

Forty TMD patients (regardless of the presence or absence of joint pain) were selected. They were randomly allocated (by raffle) into two groups: G1, acupuncture only ($n = 20$); and G2, acupuncture plus occlusal splint ($n = 20$). All patients reported probable sleep bruxism on the questionnaire described by Paesani et al. (2013) [12]. In case of a positive answer to one of the questions, the patient was included. They were scheduled for pain evaluation and treatment initiation and were treated in four weekly sessions (periods P1, P2, P3, and P4).

3. RP and PPT

RP was assessed before and after each session by pain response on the visual analog scale from the question “*how would you rate your facial pain on a 0 to 10 scale at the present time, that is right now?*”

PPT was assessed by algometry (Wagner Instruments, Model FDI, Greenwich CT, USA) on the masseter and anterior temporalis muscles. On the anterior temporalis, an algometric analysis was performed on the fossa infra-temporalis above the zygomatic process [11] right behind the eyebrows. On the masseter, pressure was applied at medium distance from the zygomatic arch and the mandible angle on the muscle belly [13]. Measures were obtained in triplicates on each spot with a 3-minute interval between each reading, and the average value was calculated for each muscle. The PPT assessment was randomized among the muscles and was not prolonged to avoid trauma to the tissues [14] and hyperexcitation of nerve fibers.

The pain assessments were performed twice in each session, before and after the acupuncture session. Therefore, RP and PPT were evaluated before and after each session and at P1, P2, P3, and P4 timepoints.

4. Acupuncture

Distal and local acupuncture spots were selected (LI4, LI11, ST36, LR3, TE21, LR2, TE17, LU19, and ST6) according to the patient characteristics, clinical disposition, and indications

of classical spots. The local spots were selected on the painful side of the face, whereas the distal spots were randomly selected; furthermore, ST36 was contralateral to LI4, LI11, and LR3 [15]. The sessions were held weekly for four weeks.

5. Splints

Patients wore the splints (heat-polymerized acrylic resin; Artigos Odontológicos Clássico Ltd., Sao Paulo, Brazil) every night, during sleep. Occlusal splints fully covered the maxillary dental arch and were approximately 2 mm thick in the molar regions [16].

6. Statistical analysis

The sample size was determined based on a pilot study. The test was based on a mean outcome of 5.8 in the control group, a mean outcome of 2.8 in the experimental group, and a standard deviation of the outcome of 2.5 with 95% confidence level, 80% power, and medium effect size. The results of the calculation showed that 11 individuals per group were required in the study.

The Statistical Package for the Social Sciences 22.0 software was used for data analysis. Data were submitted to normality testing using the Kolmogorov-Smirnov test. Two-way analysis of variance with repeated measures and Tukey's test were used to assess RP and PPT between the different treatments ($p < 0.05$). The t-test was used to compare the RP and PPT before and after each session ($p < 0.05$).

RESULTS

Twenty-nine patients completed the study, of which 17 were in G1 (men = 2; women = 15) and 12 were in G2 (men = 2; women = 10; age 20-65 years).

Data were normally distributed according to the Kolmogorov-Smirnov test, for both G1 ($P1 - p = 0.200$; $P2 - p = 0.200$; $P3 - p = 0.109$; $P4 - p = 0.060$) and G2 ($P1 - p = 0.200$; $P2 - p = 0.085$; $P3 - p = 0.059$; $P4 - p = 0.715$). “Period” influenced RP levels (Table 1).

Table 1. Analysis of variance with repeated measures with two factors of level of reported pain (RP) according to the treatment: acupuncture (G1, $n = 17$) and acupuncture and splint (G2, $n = 12$)

	SS	df	MS	F	p
Treatment	4.450	1	4.450	0.237	0.630
Inter samples	507.123	27	18.782		
Period	170.897	3	56.966	14.494	< 0.001*
Treatment $\times$ period	16.458	3	5.486	1.396	0.250
Intra samples	318.348	81	3.930		

* $p < 0.05$ is statistically significant.

1. RP assessment

RP decreased after each acupuncture session in G1, except at P4. In G2, there was an immediate decrease in pain levels after the first acupuncture session, with a significant difference between P1 and P2 (Tables 2 and 3).

2. PPT assessment

PPT values of the masseter and temporalis did not vary before and after each acupuncture session in both groups (Tables 4 and 5), except that of the right masseter at P3 ($p = 0.042$). There were no variations in the PPT values between G1 and G2.

Table 2. Mean values (M) and standard deviation (SD) of level of reported pain (RP) of patients according to the treatment: acupuncture (G1, $n = 17$), and acupuncture and splint (G2, $n = 12$), in the different periods (P1, P2, P3, P4) before each session and after each session

Session		Before each session	After each session	p
		M (SD)	M (SD)	
G1	P1	4.71 (3.02)	2.29 (2.26)	0.013*
	P2	3.59 (2.85)	1.47 (1.97)	0.017*
	P3	2.50 (2.63)	0.76 (1.30)	0.022*
	P4	1.82 (2.40)	0.85 (1.74)	0.188
G2	P1	6.04 (2.45)	2.50 (2.39)	0.002*
	P2	2.80 (2.9)	1.33 (2.06)	0.174
	P3	3.04 (1.45)	1.45 (1.80)	0.177
	P4	2.33 (2.23)	1.04 (1.17)	0.094

* $p < 0.05$ indicates statistical significance, paired T-test.

DISCUSSION

This study assessed the effect of occlusal splints along with acupuncture for four weeks in alleviating muscle pain in patients with TMDs. The overall hypothesis was rejected since treatment with occlusal splints significantly decreased only RP and not PPT; moreover, the difference was significant only in the second session, and both groups, with and without occlusal splints, presented a similar reduction in pain at the end of the assessment period.

Despite the small number of controlled studies regarding the use of acupuncture to treat TMDs [17,18], several studies have demonstrated the effectiveness of acupuncture in treating acute and chronic pain (91% and 71%, respectively) [9]. In the present study, comparing the pain before and after each session of acupuncture, regardless of whether splints were used, the RP level significantly reduced immediately after each session at P1, P2, and P3 in G1 and at P1 in G2. A significant decrease in RP was only demonstrated at P1 in G2, even after installing the splint; furthermore, the RP

Table 3. Mean values (M) and standard deviation (SD) of level of reported pain (RP) of patients, according to the type of treatment

Treatment	Session			
	P1 M (SD)	P2 M (SD)	P3 M (SD)	P4 M (SD)
G1	4.71 (3.02) Aa	3.59 (2.85) Aab	2.50 (2.63) Abc	1.82 (2.40) Ac
G2	6.04 (2.45) Aa	2.80 (2.9) Ab	3.04 (1.45) Ab	2.33 (2.23) Ab

Means followed by different uppercase letters in the column and lowercase letters in the row differ. 5% significance by Tukey test.

Table 4. Mean (M) and standard deviation (SD) of pressure pain threshold (PPT) of right masseter (RM) and left masseter (LM) muscles according to the treatment [acupuncture (G1, $n = 17$) and acupuncture and splint (G2, $n = 12$)] at different periods (P1, P2, P3, P4) before (A) and after (B) each session

Session		PPT - RM			PPT - LM		
		A	B	p	A	B	p
		M (SD)	M (SD)		M (SD)	M (SD)	
G1	P1	1.47 (0.51) Aab	1.66 (0.45)	0.262	1.48 (0.50) Aab	1.66 (0.48)	0.291
	P2	1.42 (0.38) Ab	1.67 (0.37)	0.060	1.39 (0.50) Ab	1.67 (0.43)	0.086
	P3	1.56 (0.54) Aab	1.80 (0.52)	0.210	1.55 (0.52) Aab	1.74 (0.67)	0.364
	P4	1.65 (0.55) Aa	1.74 (0.63)	0.689	1.68 (0.64) Aa	1.73 (0.45)	0.788
G2	P1	1.66 (0.78) Aa	1.80 (0.38)	0.610	1.43 (0.62) Aa	1.67 (0.57)	0.320
	P2	1.62 (0.68) Aa	1.73 (0.59)	0.676	1.62 (0.57) Aa	1.78 (0.49)	0.477
	P3	1.57 (0.42) Aa	2.09 (0.69)	0.042*	1.60 (0.59) Aa	1.82 (0.72)	0.427
	P4	1.75 (0.62) Aa	1.82 (0.61)	0.793	1.68 (0.67) Aa	1.75 (0.65)	0.789

* $p < 0.05$ indicates statistical significance, paired T-test.

In the column Before each session (A), means followed by same uppercase indicate that there is no statistical difference in the comparison between groups, for each period separately, and means followed by same lowercase indicate that there is no statistical difference in the comparison between periods (P1, P2, P3, and P4), for each group separately. 5% significance by Tukey test.

Table 5. Mean (M) and standard deviation (SD) of PPT of right temporalis (RT) and left temporalis (LT) muscles according to the treatment [acupuncture (G1, n = 17), and acupuncture and splint (G2, n = 12)] at different periods (P1, P2, P3, P4) before (A) and after (B) each session

Treatment		PPT- RT			PPT- LT		
		A	B	<i>p</i>	A	B	<i>p</i>
		M (SD)	M (SD)		M (SD)	M (SD)	
G1	P1	2.35 (0.87) Aab	2.46 (0.70)	0.713	2.45 (0.83) Aab	2.59 (0.83)	0.603
	P2	2.10 (0.52) Ab	2.34 (0.55)	0.202	2.27 (0.77) Ab	2.65 (0.59)	0.116
	P3	2.42 (0.75) Aa	2.56 (0.69)	0.583	2.38 (0.80) Ab	2.57 (0.78)	0.480
	P4	2.73 (0.77) Aa	2.96 (0.96)	0.431	2.69 (0.78) Aa	2.84 (0.84)	0.602
G2	P1	2.29 (0.92) Aa	2.49 (0.72)	0.556	2.31 (0.88) Aab	2.48 (0.77)	0.633
	P2	2.49 (0.82) Aa	2.59 (0.77)	0.758	2.49 (0.96) Ab	2.61 (0.70)	0.711
	P3	2.55 (0.94) Aa	2.94 (0.92)	0.322	2.82 (1.02) Aa	2.85 (0.81)	0.930
	P4	2.54 (0.75) Aa	2.61 (0.79)	0.828	2.50 (0.81) Aab	2.67 (0.96)	0.633

* $p < 0.05$ indicates statistical significance, paired T-test.

In the column Before each session (A), means followed by same uppercase indicate that there is no statistical difference in the comparison between groups, for each period separately, and means followed by same lowercase indicate that there is no statistical difference in the comparison between periods (P1, P2, P3, and P4), for each group separately. 5% significance by Tukey test.

level remained low following this period. Acupuncture reduces pain by several neurological mechanisms [19-23]. The immediate decrease in pain may be influenced by the placebo effect of pain treatments [24].

A significant decrease in pain levels was noted one week after using the splint and undergoing regular acupuncture sessions; furthermore, it remained at a low level. However, in G1, there was a remarkable and simultaneous decrease in RP levels, and this change was significant in all sessions. Although acupuncture alone was able to reduce RP levels, the use of a splint accelerated the decrease in RP levels, and the short-term efficiency of occlusal splints has already been confirmed [25]. Combined treatment with acupuncture and occlusal splints can have a placebo effect on the patient's pain [17]. Occlusal splints are widely used to treat TMDs [26]; however, its application as a primary treatment modality is questioned [27].

Inter-period comparison of the decrease in pain levels demonstrated that the RP levels in the acupuncture-only group decreased at each assessment period and subsequently decreased significantly at the fourth week. The decrease in RP levels attributed to acupuncture treatment that was noted in the present study corroborates with the finding of a systematic review published by Lam et al. (2013) [28] that acupuncture has a beneficial effect on pain and functional limitation and ensures favorable treatment outcomes regarding pain reduction.

The maintenance of low RP levels in G1 during the four weeks suggested that acupuncture can significantly influence pain perception by activating the descending pain pathway by releasing endogenous opioids in the central nervous system in response to the long-term activation of ascending sensory

fibers [9,19,29]. It is possible that the immediate analgesic effect of acupuncture influenced the RP levels in G2, in which the patients also used splints. Therefore, it is not possible to differentiate the biological mechanisms involved in pain reduction; it is particularly difficult to identify the treatment that showed greater efficacy or the underlying mechanism. Another important factor associated with the decrease in RP levels in G2 during the first week is that the patients treated in the study were individuals who considered being treated at a dental school. This might indicate that they were relatively more confident about the treatment involving occlusal splints, and this may have increased the chances of a positive outcome.

Although this study demonstrated a decrease in the pain reported by the patients, the results must be carefully evaluated, since the study presents some limitations, such as a short assessment period and lack of information about the mechanism of pain reduction.

The patients did not present a significant increase in PPT after being treated, except for the PPT of the right masseter ($p = 0.042$) in G2 at P3. Our results corroborate those reported by Baeumler et al. (2015) [30]. They reported an increase in the PPT after electroacupuncture but not manual acupuncture and suggested that the increase in the threshold of their volunteers was due to segmental inhibition after electroacupuncture in the tested region. The present study was conducted in patients with facial chronic pain who presented a pain threshold of both the masseter and anterior temporalis muscles below that of healthy individuals as reported by Andersen et al. (2015) [31].

Despite several limitations of the study, such as the absence of blinding, it is imperative to consider that acupuncture is

a safe treatment modality that has few side effects when well applied, and none were reported in this study. In addition, the patients who received the splints presented a faster recovery. The application of different treatment strategies is not only useful in identifying associations between the treatments but also for addressing cases in which drugs cannot be used [32] or the patients are unable to adapt themselves to the occlusal splint [33]. Furthermore, the fabrication of a large number of occlusal splints, more than two decades ago [2], can be considered to cause environmental problems due to garbage accumulation since the occlusal splints are not recycled.

CONCLUSIONS

The findings of this study indicate that improvement in the RP is influenced by the “period” of treatment. The use of occlusal splints with acupuncture decreased the RP after one week of treatment, whereas the pain significantly subsided only after two weeks in patients treated with acupuncture alone. The assessed treatments did not influence the PPT levels of the masseter and anterior temporalis muscles in TMD patients. Thus, the addition of occlusal splints to acupuncture treatment is not mandatory.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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