Effects of Orofacial Myofunctional Therapy on Temporomandibular Disorders

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ABSTRACT: The objectives of the current study were to analyze the effects of orofacial myofunctional therapy (OMT) on the treatment of subjects with associated articular and muscular temporomandibular disorders (TMD). Thirty subjects with associated articular and muscular TMD, according to the Research Diagnostic Criteria (RDC/TMD), were randomly divided into groups: 10 were treated with OMT (T group), 10 with an occlusal splint (OS group), and 10 untreated control group with TMD (SC). Ten subjects without TMD represented the asymptomatic group (AC). All subjects had a clinical examination and were interviewed to determine Helkimo's Indexes (Di and Ai), the frequency and severity of signs and symptoms, and orofacial myofunctional evaluation. During the diagnostic phase, there were significant differences between groups T and AC. There were no significant differences between group T and OC and SC groups. During the final phase, groups T and OS presented significant improvement, however, the group T presented better results and differed significantly from group OS regarding the number of subjects classified as AiI; the severity of muscular pain and TMJ pain; the frequency of headache and the muscles and stomatognathic functions. The group T differed significantly from the SC group but no longer differed significantly from the AC group. OMT favored a significant reduction of pain sensitivity to palpation of all muscles studied but not for the TMJs; an increased measure of mandibular range of motion; reduced Helkimo's Di and Ai scores; reduced frequency and severity of signs and symptoms; and increased scores for orofacial myofunctional conditions.

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Dr. Cláudia Maria de Felício *received an undergraduate degree in speech and language pathology and audiology from the Campinas Catholic University, Brazil in 1983. She received a master in education from Federal University of São Carlos in 1992 and in 1996, she received a Ph.D. in science (psychobiology) from the Faculty of Philosophy, Science and Letters, University of São Paulo. Currently, she is a professor at the Faculty of Medicine of Ribeirão Preto, University of São Paulo, Brazil.*

The stomatognathic functions—mastication, deglutition, respiration and speech—possess vital and social aims. Alterations/dysfunctions of the appearance, posture and/or mobility of the lips, tongue, mandible and cheeks and of the stomatognathic functions are defined as orofacial myofunctional disorders (OMD).[1]

OMD may disequilibrate the function of the temporomandibular joints (TMJ),[2] or may be a consequence of temporomandibular disorders (TMD), since the nociceptive stimuli originating from occlusion and/or the TMJ may generate compensatory muscle behaviors.[3-5] The presence of long-standing TMJ pain is associated with marked functional impairment.[6]

The treatment most frequently employed for TMD has been the occlusal splint or oral appliance.[7-10] Its mechanism of action is attributed to the temporary interruption of the nociceptive information, inducing muscular equilibrium with a mandibular positioning more favorable to the TMJ.[11] Recently, the available scientific evidence regarding oral appliances has been discussed.[10]

Exercise and manual therapies are commonly used to manage TMD in combination with other therapeutic

modalities, such as an occlusal splint, or alone,[12] as a strategy for the control of the physiological functions associated with pain.[13]

Orofacial myofunctional therapy (OMT), a modality of exercise therapy, has also been suggested for the management of TMD[14-16] in order to equilibrate the orofacial muscles and to favor the execution of stomatognathic functions.[5]

Although positive results of exercise-based therapy have been reported,[12] there is discussion about the fact that evidence is weak,[17] and few studies have specifically analyzed the effects of OMT on TMD. Thus, many professionals are not aware of the objectives of this therapy and question its effectiveness.

The objectives of the present study were to analyze the effects of OMT on the treatment of subjects with chronic associated articular and muscular TMD using clinical protocols in order to determine whether OMT promotes: (a) remission and/or reduction of pain in the musculature and TMJ; (b) increased mandibular range of motion; (c) modification of Helkimo's dysfunction and anamnestic index; (d) remission and/or reduction of the frequency and severity of signs and symptoms; and (e) of orofacial myofunctional disorders. The results were compared to those obtained for a group treated with an occlusal splint and for two control groups, one with TMD and the other asymptomatic.

Materials and Methods

The project was approved by the Human Research Ethics Committee of the Institution and all subjects gave written informed consent to participate.

Subjects

Thirty (30) subjects with long-lasting TMD and 10 subjects with no signs or symptoms of TMD participated in the study. The TMD subjects were selected from a group of 100 patients on the university waiting list for orofacial pain and TMD treatment in the following semester, and the asymptomatic subjects from a group of 20 volunteers invited to participate in the study. All subjects were female.

The inclusion criterion for TMD groups was to present long-lasting associated articular and muscular TMD based on the Research Diagnostic Criteria for TMD (RDC/TMD),[18] and for the control group it was absence of TMD based on the same criteria.

The exclusion criteria were: associated neurological or cognitive deficit, previous or current tumors or traumas in the head and neck region, and orthodontic treatment.

The subjects, whose mean duration of TMD was 74.4 months (range: six to 300 months), were randomly assigned to three groups using the GraphPad software (Graphpad Software, Inc., La Jolla, CA). Ten of the subjects were put into the OMT (group T) (mean age: 31 years, range: 13 to 43 years), 10 into treatment with an occlusal splint (mean age: 29 years, range: 17 to 64 years) (group OS), and 10 participated as symptomatic controls (group SC) (mean age: 34 years, range: 14 to 63 years) and were treated after four months. Ten subjects were assigned to the asymptomatic control group (group AC) (mean age: 27 years, range: 18 to 68 years).

Clinical Examination

Subjects were examined while sitting on a dental chair in a room with appropriate lighting. The RDC/TMD, axis I was used for the diagnosis of TMD.[18]

To determine Helkimo's Di[19] the subjects were given a clinical examination, consisting of measures of mandibular range of motion and of TMJ function, of muscle and TMJ tenderness to palpation, and of the presence of pain during movements. As recommended by the author, each item evaluated was scored, and the sum of scores of the five items was used to define the group and the description of clinical severity. Helkimo's Anamnestic Dysfunction Index (Ai) was also applied in order to classify dysfunction according to patient perception.

Subject perception regarding the disorder was also investigated using the ProTMDMulti protocol.[20] The subjects responded to the first part of the ProTMDMulti, which required a positive or negative reply. In the second part, they were asked to indicate the severity of the signs and symptoms presented according to the situation, i.e., when waking up, during mastication, when speaking, and at rest, using a printed 11 point numerical scale (zero = absence of the symptom and 10 = highest possible severity). The severity score consisted of the sum of the scores attributed to each sign and symptom in the four situations questioned.

Orofacial myofunctional evaluation was performed, according to a protocol of orofacial myofunctional evaluation with scores (OMES Protocol). The components of the stomatognathic system, i.e., lips, tongue, jaw, and cheeks, were evaluated in terms of appearance/posture, mobility and performance during deglutition—liquid and solid—and mastication functions.[1]

All subjects were evaluated in the diagnostic phase (phase D) and in the final phase (phase F) by the same experienced examiner, a specialist in TMD and orofacial pain accredited by the Federal Council of Dentistry for the application of the RDC/TMD and Helkimo's Di. The ProTMDMulti and OMES Protocol were applied by two examiners, both speech pathologists, trained (Kappa =

0.90) specialists in OMT accredited by the Federal Council of Speech Pathology and Therapy.

The reliability and validity of these measures were demonstrated previously.[1,18,21-24]

Treatment Procedures

Orofacial myofunctional therapy (OMT): OMT for the T group was planned by the speech pathologists on the basis of the following main objectives: favoring pain relief, mandibular posture and mobility without deviations, symmetry between muscle pairs, coordination of the muscles of the stomatognathic system, as well as equilibration of the stomatognathic functions in a manner compatible with occlusion. All patients were treated by the same speech pathologist. According to the treatment protocol, the patients participated of the OMT sessions, lasting 45 minutes each, with a weekly frequency during the first 30 days and every two weeks after this period, with no other additional therapeutic conducts[5] (treatment duration = 120 days). A home exercise program was prescribed during each session. The specific goals and the therapeutic conducts, including number and duration of the exercises, used to achieve them were defined in each case based on the results of clinical examination and on previous proposals.[5,15,25] The basic program is presented in the Appendix.

Occlusal Splint: For the OS group the occlusal splint was prepared according to the Michigan principles.[11] Continuous use of the occlusal splint was recommended during the first 15 days, except during eating and dental hygienization, followed by only night-time use after this period,[20] for a total of 45 days of treatment.

After treatments the groups T and OS were re-evaluated. SC and AC were only evaluated but received no treatment. The AC and SC were reevaluated 120 days, in mean, of the diagnostic phase.

Statistical Analysis

All subjects with TMD and AC subjects selected were considered for analysis. The binomial and Fisher tests were used for categorical data. The Wilcoxon test for paired data (intra-group) and the Mann-Whitney test for unpaired data (inter-groups) were used for data expressed at the interval level and the Student *t*-tests for paired and unpaired data were applied for intra-group and inter-group analysis, respectively, for data expressed at the ratio level. The confidence intervals were calculated. The calculations were made using the Statistica data analysis software, with the level of significance set at 0.05. The effect Size Cohen's *d* (ES) was calculated using the Effects Size Calculators (*http://web.uccs.edu/lbecker/Psy590/escalc3.htm*).

Results

The classification of the subjects according to the RDC/TMD is presented in **Table 1**.

Group Comparison

During phase D (baseline) there were no significant differences between group T and groups OS and SC ($p>0.05$) regarding Helkimo's index or ProTMDmulti parts I and II. The only difference observed concerned posture/appearance of the tongue (OMES Protocol), with a worse result for group T compared to group OS ($p<0.05$). There were significant differences between groups T and AC regarding Helkimo's indices, and the sub-index of mandibular mobility (Mi), ProTMDmulti - part I, and part II and the OMES Protocol ($p<0.05$), with worse results for group T. The effect size indicates the magnitude of the difference. Specifically regarding masticatory function, 80% of AC subjects presented alternate bilateral chewing, while 33% of the patients in the TMD groups considered as a whole presented this pattern.

During phase F, group T presented better results and differed significantly from group OS regarding the number of subjects classified as AiII; severity of signs and symptoms (ProTMDmulti-part II) of muscular pain and TMJ pain; the frequency of headache; mandibular posture and tongue appearance/position, tongue, lip and mandible mobility; deglutition and mastication ($p<0.05$).

Group T differed significantly from group SC regarding Di and AiII; severity of muscular pain, TMJ pain, cervical pain, fullness and TMJ noise; frequency of muscle pain and tinnitus; mandibular posture and tongue appear-

Table 1
Groups Distribution According to the RDC/TMD Classification

RDC/TMD Classification	T	OS	SC	AC
Ia + IIa	0	0	1	0
Ia + III	1	2	1	0
Ib + IIa	1	0	0	0
Ib + III	1	4	4	0
Ia + IIa + III	2	1	2	0
Ib + IIa + III	3	3	2	0
Ib +IIb + III	2	1	0	0

Ia: myofascial pain; **Ib**: myofascial pain with limited opening; **IIa**: disk displacement with reduction; **IIb**: disk displacement without reduction with limited opening; **III**: arthralgia, osteoarthritis of the TMJ; **T**: orofacial myofunctional therapy group; **OS**: occlusal splint group; **SC**: symptomatic control group; **AC**: asymptomatic group

ance/position, tongue mobility, mastication, mandible mobility and deglutition ($p<0.05$). The effect size was large in all measures showing significant differences (Cohen's $d>0.94$).

Groups T and AC continued to differ in Di despite the increased measures of mandibular range in group T, and in the ProTMDmulti-part I only regarding the frequency of TMJ noise ($p<0.05$). Group T no longer differed significantly from group AC regarding severity of otalgia, tinnitus, tooth sensitivity, fullness, difficulty to swallow and the results of the OMES protocol ($p>0.05$).

Intra-Group Comparison

Group T: The differences between the D and F phases were significant for Di and its sub-index of mandibular mobility (Mi) and for Ai, indicating improvement of TMD signs and symptoms. There was a significant decrease from phase D to phase F regarding the ProTMDmulti - frequency and severity. There were significant differences in orofacial myofunctional conditions, with the OMES scores indicating a positive course for all of these items, ($p<0.05$).

Group OS: The differences between the D and F phases were significant for Di, ProTMDMulti (part II), severity of TMJ pain, TMJ noise, tooth sensitivity and appearance of the cheeks ($p<0.05$).

Groups SC and AC: The patients and subjects in these groups did not show any significant difference between the D and F phases. One SC patient presented worsening of TMD and was immediately treated.

The results of inter- and intra-group comparisons are listed in **Tables 2**, **3**, **4** and **5**.

Discussion

Exercise therapy in the management of TMD usually consists of passive and active movement of the mandible, correction of body posture,[26] and relaxation techniques, as well as patient education.[13,25-28] The OMT protocol is intended to relieve pain and also to favor the execution of stomatognathic functions[14,15] in a manner compatible with the occlusal condition and the TMJ.[5] However, few reports on the analysis of the effectiveness of OMT are available, especially in comparison with other groups.

The present study design, whereby OMT was performed with no association with any other therapeutic modality, was chosen in order to clarify the extent of the effects of the procedure and its limitations in the management of long-lasting associated articular and muscular TMD.

Previous studies have suggested that the lack of standardization of the evaluation and classification of different populations with TMD prevents a consensus about the diagnosis and the choice of treatment method.[18] In addition, it has been recommended to use appropriate measures of clinical outcome in each study,[12] considering that high rates of success have been reported for a variety of treatments for TMD.[23]

In the present study, the subjects were selected on the basis of the RDC/TMD, adopted as a method for classification[18,21,29,30] and complemented with measurements of severity,[19,20] to determine the degree of dysfunction in the two phases of the present investigation and the results of the treatments proposed for groups T and OS, as well as possible variations over time for groups SC and AC. To analyze the SC group was important because changes in TMD signs and symptoms could reflect the fluctuation or the natural course of the condition.

The results of phase D (baseline) demonstrated differences between groups T and AC and similarities between group T and groups OS and SC, confirming an appropriate group composition according to the RDC/TMD. The frequencies of signs and symptoms observed for the groups with TMD agreed with literature data, as also observed for group AC.[4,20,30,31]

During the F phase, there was improvement of TMD signs and symptoms in both treated groups, with some advantages for group T in relation to group OS. Obviously, OS patients were not expected to improve in items essentially dependent on the strategies used in OMT, but the occlusal splint also had a positive effect on the appearance of the cheeks which seemed to be related to the increased vertical dimension of occlusion simulated by the splint, reflecting on the resting condition during evaluation.

The groups SC and AC did not show significant changes between phases. To analyze the SC group was important because changes in TMD signs and symptoms could reflect the fluctuation or the natural course of the condition,[6,10] but this did not occur. Thus, the results suggest that TMD patients do not improve without treatment.

Group T presented better results than groups SC regarding Ai, Di, orofacial myofunctional conditions and the frequency and severity of symptoms verified with the ProTMDmulti.

Thus, there was a clinical distance between groups T and SC, whereas the differences between groups T and AC decreased. The lack of total remission of TMD signs and symptoms after treatments as assessed by Helkimo's index has also been observed in other studies.[9,25]

The occlusal splint Michigan model, or stabilization splint,[11] was chosen for comparison with group T since it is the most commonly used type of intraoral appliance, and when properly fabricated it has the least potential for

Table 2
Comparison of the Measures of Mandibular Range of Motion Among Group T and Other Groups in Phases D and F and Intra-Group Comparison (PD x PF): Means, Standard Deviation (SD), Confidence Level (CI) and Effect Size Cohen's *d*(*d*)

Phase D		MMO	RLE	LLE	Pt
T	Mean±SD	42.55±10.93	5.64±1.71	7.70±3.01	5.02±1.85
	95% CI	34.7-50.4	4.4-6.9	5.5-9.8	3.7-6.3
OS	Mean±SD	42.33±8.53	6.26±2.91	7.33±3.27	5.08±3.47
	95% CI	36.2-48.4	4.2-8.3	5.0-9.7	2.6-7.6
	d: T and OS	0.0	0.3	0.1	0.0
SC	Mean±SD	47.18±5.05	5.70±2.94	5.93±3.40	7.33±3.48
	95% CI	43.6-50.8	3.6-7.8	3.5-8.4	4.8-9.8
	d: T and SC	0.5	0.3	0.1	0.0
AC	Mean±SD	53.33**±5.89	8.03**±1.54	7.06±1.71	7.36**±1.48
	95% CI	49.1-57.54	6.9-9.1	5.8-8.3	6.3-8.4
	d: T and AC	1.2	1.1	1.5	1.4
Phase F					
T	Mean±SD	45.37±9.48	7.97†±2.34	8.41±2.71	7.58†±2.15
	95% CI	36.6-52.2	6.4-9.6	6.5-10.3	6.0-9.1
OS	Mean±SD	43.96±8.56	6.84±1.72	8.55±2.86	6.99±2.29
	95% CI	37.8-50.1	5.61-8.10	6.5-10.6	5.3-8.6
	d: T and OS	0.2	0.5	0.0	0.3
SC	Mean±SD	46.25±6.77	6.15±2.94	6.31±3.4	7.37±3.48
	95% CI	41.4-51.1	3.9-8.4	4.0-8.6	5.5-9.2
	d: T and SC	0.1	0.7	0.7	0.1
AC	Mean±SD	53.26*±5.54	8.10±1.52	8.54±1.83	7.57±1.34
	95% CI	49.3-57.2	7.0-9.2	7.2-9.8	6.6-8.5
	d: T and AC	1.0	0.1	0.1	0.0

MMO: maximal mandibular opening; RLE: right lateral excursion; LLE: left lateral excursion; Pt: Protrusion (↑ = better).
T: orofacial myofunctional therapy group; OS: occlusal splint group; SC: symptomatic control group; AC: asymptomatic subjects; effect size Cohen's *d*(*d*)
*0.05, **0.01 level of inter-group significance; Student *t*-test for unpaired data,
†0.05 level of intra-group significance Student *t*-test for paired data

adverse effects to the oral structures. Currently, oral appliances are still regarded as useful adjuncts for treating certain kinds of TMD patients, but the emphasis is entirely on their conservative application.[10]

The time of indication of the use of the splint varies among investigators. The reduction of TMD severity in OS group observed here agrees with previous study,[20] in which the splint was used for 50 days; however, in the present study, more favorable results might perhaps have been obtained if the time of splint use had been longer.

In a study comparing the effects of therapy based on exercises and on the use of the occlusal splint for the treatment of TMD of muscular origin, there was no difference between the two treatment modalities after six months regarding Di and Ai, but the group treated with exercises tended to show better clinical results.[25]

Regarding the orofacial myofunctional condition, group AC presented the mean values closest to expected scores among the groups evaluated. The evaluation of mandible mobility demonstrated that this was the structure that presented a greater occurrence of alteration in group T compared to group AC. Mandibular deviations during mouth opening and asymmetries between right and left lateral excursion, are common in the presence of

Table 3
Comparison of the Severity of Signs/Symptoms Among Group T and Other Groups in Phases D and F, and Intra-Group Comparison (PD x PF): Means, Standard Deviation (SD), Confidence Interval (CI), and Effect Size Cohen's *d*(*d*)

Phase D		MP	TMJP	CP	O	T	F	TS	TMJN	DSw	DS
T	Mean±SD	21.40 ±10.96	19.90 ±10.83	15.20 ±13.08	13.40 ±9.57	8.80 ±8.02	13.50 ±9.05	13.00 ±11.41	15.90 ±10.10	7.30 ±8.38	11.80 ±11.10
	95% CI	13.6-29.2	12.2-27.6	5.8-24.6	6.6-20.2	3.1-14.5	7.0-20.0	4.8-21.2	8.7-23.1	1.3-13.3	3.9-19.7
OS	Mean±SD	18.89 ±11.90	17.56 ±11.05	12.22 ±12.40	10.11 ±12.45	10.67 ±10.14	11.11 ±12.05	15.11 ±11.73	15.67 ±9.34	8.78 ±10.15	11.00 ±10.81
	95% CI	9.7-28.0	9.1-26.0	2.7-21.8	0.5-19.7	2.9-18.5	1.9-20.4	6.1-24.1	8.5-22.8	1.0-16.6	2.7-19.3
	d: T and OS	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.0	0.2	0.1
SC	Mean±SD	15.40 ±9.13	13.30 ±10.59	12.30 ±9.38	5.30 ±8.96	3.80 ±6.60	9.80 ±10.20	10.10 ±9.22	16.40 ±8.06	5.60 ±8.80	12.40 ±8.54
	95% CI	8.9-21.9	5.7-20.9	5.6-19.0	-1.1-11.7	-0.9-8.5	2.5-17.1	3.5-16.7	10.6-22.2	-0.7-11.9	6.3-18.5
	d: T and SC	0.6	0.6	0.2	0.9	0.7	0.4	0.3	0.0	0.2	0.1
AC	Mean±SD	0.5*** ±1.08	0.1*** ±0.32	1.8** ±2.10	0.00*** ±0.00	0.5** ±1.66	0.1*** ±0.32	2.8* ±4.16	0.00*** ±0.00	0.00** ±0.00	0.00** ±0.00
	95% CI	-0.2-1.3	-0.1-0.3	-0.3-3.3	----	-0.6-1.6	-0.1-0.3	-0.2-5.7	----	----	----
	d: T and AC	2.7	2.6	1.4	2.20	1.4	2.1	1.2	2.2	1.2	1.5
Phase F											
T	Mean±SD	3.10†† ±2.42	4.10†† ±4.38	4.70† ±4.92	0.50† ±1.58†	2.30 ±4.16	1.40†† ±3.44	2.10† ±3.54	4.30†† ±4.47	2.60 ±5.97	3.80 ±6.94
	95% CI	1.4-4.8	1.0-7.2	1.2-8.2	-0.6-1.6	-0.7-5.3	-1.1-3.9	-0.4-4.6	1.1-7.5	-1.7-6.9	-1.2-8.8

MP: muscular pain; TMJP: TMJ pain; CP: cervical pain; O: otalgia; T: tinnitus; F: fullness; TS: tooth sensitivity; TMJN: TMJ noise; DSw: difficulty swallowing; DS: difficulty speaking; (↓ = better); Effect size Cohen's *d*(*d*).
**0.01 level of inter-group significance; *0.05 level of inter-group significance; Mann-Whitney test for unpaired data; †0.05 level of intra-group significance Wilcoxon test for paired data.

Table 3 continued on next page

Table 3
Comparison of the Severity of Signs/Symptoms Among Group T and Other Groups in Phases D and F, and Intra-Group Comparison (PD x PF): Means, Standard Deviation (SD), Confidence Interval (CI), and Effect Size Cohen's *d(d)*

Phase F (cont)		MP	TMJP	CP	O	T	F	TS	TMJN	DSw	DS
OS	Mean±SD	14.56** ±8.14	10.78†* ±9.04	14.33 ±12.58	1.78 ±2.54	6.89 ±7.49	5.56 ±6.44	10.33† ±10.40	10.22† ±8.11	9.56 ±13.27	9.11 ±9.93
	95% CI	8.3-20.8	3.8-17.7	4.7-24.0	-0.2-3.7	1.1-12.6	0.6-10.5	2.3-18.3	4.0-16.5	-0.6-19.8	1.5-16.7
	d: T and OS	1.9	0.9	1.0	0.6	0.8	0.8	1.1	0.9	0.7	0.6
SC	Mean±SD	13.60** ±9.49	12.10* ±7.96	13.40* ±8.49	2.10 ±3.75	6.50 ±7.35	10.50* ±9.82	7.80 ±8.20	10.80* ±6.68	1.10 ±2.33	7.50 ±8.66
	95% CI	6.8-20.4	6.4-17.8	7.3-19.5	-0.6-4.8	1.2-11.8	3.5-17.5	1.9-13.7	6.0-15.6	-0.6-2.8	1.3-13.7
	d: T and SC	1.5	1.2	1.2	0.6	0.7	1.2	0.9	1.1	0.3	0.5
AC	Mean±SD	0.3** ±0.67	0.00** ±0.0	0.6** ±1.26	0.00 ±0.0	0.1 ±0.32	0.1 ±0.32	1.6 ±3.77	0.3** ±0.67	0.00 ±0.0	0.00* ±0.0
	95% CI	-0.1-0.8	----	-0.3-1.5	----	-0.1-0.3	-0.1-0.3	-1.1-4.3	-0.2-0.8	----	----
	d: T and AC	1.6	1.3	1.1	0.45	0.7	0.5	0.1	1.25	0.61	0.8

MP: muscular pain; TMJP: TMJ pain; CP: cervical pain; O: otalgia; T: tinnitus; F: fullness; TS: tooth sensitivity; TMJN: TMJ noise; DSw: difficulty swallowing; DS: difficulty speaking; (↓ = better); Effect size Cohen's *d(d)*.
**0.01 level of inter-group significance; *0.05 level of inter-group significance; Mann-Whitney test for unpaired data; †0.05 level of intra-group significance Wilcoxon test for paired data.

TMD,[5] as well as reduction in the values of maximum mandibular opening and mandibular opening and closing speed during speech.[4]

As was the case in the present study, other investigations have demonstrated that subjects with TMD frequently have a disorder of the oral phase of deglutition.[2,3,15] In an attempt to avoid nociceptive stimuli, the tongue acts in a compensatory manner, interposing itself between the dental arches.

Several studies have also detected a prevalence of unilateral mastication among subjects with TMD, which involves a greater risk of pain and more signs and symptoms of TMD.[32] In addition, it has been observed in other chewing impairments[6] that if the demands of functional adaptation exceed the structural and functional tolerance of TMJ, a TMD may be triggered, resulting in alterations of mandibular movements and consequent disorders of stomatognathic function.[4]

The findings for group T indicate the positive effects of OMT. In studies of TMD and its treatment it should be considered that muscles functioning under less than ideal conditions commonly result in compensating muscle activity, which needs to be corrected. Otherwise, deterioration can progress to a self-perpetuating chronic condition with increasing dysfunction and pain.[33] A major focus of current research is trying to prevent acute pain conditions developing into chronic ones.[34]

The recovery of the functionality of the stomatognathic system which, among other things, reestablishes the possibility to chew, to swallow and to speak without pain and without aggravating the problem, is an objective of OMT.[5]

Some factors may have contributed to the better results obtained for group T than for group OS, i.e., OMT acts directly on the musculature, OMT aims at equilibrium of the functions according to the occlusal condition

Table 4
Comparison of the Appearance/Posture (AMIOFE) Among Group T and Other Groups in Phases D and F, and Intra-Group Comparison (PD x PF): Means, Standard Deviation (SD), Confidence Interval (CI) and Effect Size Cohen's *d*(*d*)

		Lips	Jaw	Cheeks	Facial Symmetry	Tongue	Palate
Phase D	Expected scores	3	3	6	3	3	3
T	Mean ±SD	2.40±0.52	2.10±0.32	4.30±0.95	2.10±0.57	2.60±0.52	2.70±0.67
	95% CI	2.00-2.80	1.90-2.30	3.60-5.00	1.07-2.50	2.20-3.00	2.20-3.20
OS	Mean±SD	2.30±0.48	2.00±0.47	3.60±1.58	1.80±0.42	2.10*±0.32	2.90±0.32
	95% CI	2.00-2.60	1.70-2.30	2.50-4.70	1.50-2.10	1.90-2.30	2.70-3.10
	d: T and OS	0.2	0.2	0.5	0.6	1.2	0.4
SC	Mean±SD	2.40±0.52	2.10±0.74	5.20±1.03	2.00±0.0	2.10±0.57	2.90±0.32
	95% CI	2.03-2.76	1.60-2.62	4.46-6.00	----	1.70-2.50	2.70-3.12
	d: T and SC	0.0	0.0	0.9	0.2	0.9	0.4
AC	Mean±SD	2.50±0.53	2.80**±0.42	5.50±1.08*	2.70*±0.48	2.80±0.42	2.6±0.52
	95% CI	2.1-2.9	2.5-3.1	4.7-6.3	2.4-3.00	2.5-3.1	2.2-3.0
	d: T and AC	0.2	1.9	1.2	1.1	0.4	0.2
Phase F							
T	Mean±SD	2.60±0.52	2.80†±0.42	5.60†±0.84	2.30±0.48	2.80±0.42	2.80±0.63
	95% CI	2.20-3.00	2.50-3.10	5.00-6.20	2.00-2.60	2.50-3.10	2.30-3.30
OS	Mean±SD	2.10±0.57	1.90**±0.32	5.50††±1.08	2.10±0.32	2.20**±0.42	3.00±0.0
	95% CI	1.70-2.50	1.70-2.10	4.70-6.30	1.90-2.30	1.90-2.50	0.00
	d: T and OS	0.9	2.4	0.1	0.5	1.4	0.4
SC	Mean±SD	2.20±0.42	1.80**±0.42	4.70±1.16	2.00±0.0	1.90**±0.32	2.70±0.48
	95% CI	1.90-2.50	1.50-2.10	3.90-5.53	----	1.67-2.12	2.35-3.04
	d: T and SC	0.8	2.4	0.9	0.9	2.4	0.2
AC	Mean±SD	2.50±0.53	3.00±0.0	5.40±1.35	2.70±0.48	2.80±0.42	2.50±0.53
	95% CI	2.1-2.9	----	4.4-6.4	2.4-3.0	2.5-3.1	2.1-2.9
	d: T and AC	0.2	0.7	0.2	0.8	0.0	0.5

T: orofacial myofunctional therapy group; OS: occlusal splint group; SC: symptomatic control group; AC: asymptomatic subjects; Effect size Cohen's d(d).
*0.05 level of inter-group significance - Mann Whitney test for unpaired data;
††0.01 level of intra-group significance; †0.05 level of intra-group significance - Wilcoxon test for paired samples (↑ = better).

and to the condition of the TMJs themselves, and the subjects who follow the therapy program learn to control their movements and to avoid joint clicking and pain without negative compensations and start to recognize the factors triggering the symptoms and to avoid and/or control them as all the procedures regarding the objectives related to TMD and the way to carry them out are explained to them during therapy.

Carefully structured interventions with emphasis on self-care of the TMD may provide real benefits to a significant number of patients exceeding those of conventional treatment, among them the occlusal splint.[29] However, it should be pointed out that patient compliance is of fundamental importance. In this respect, the occlusion splint treatment is much less demanding on the patients and some of them prefer this modality.

The principal limitations of the study are the number of analyzed subjects and the treatment duration with the occlusal splint. The inclusion/exclusion criterion, led to the exclusion of many subjects, but these were necessary for the rigorous sample definition. However, the results are actually related to patients presenting long-lasting associated articular and muscular TMD based on the RDC/TMD, not to any TMD.

Table 5
Comparison of the Mobility and Functions (AMIOFE) Among Group T and Other Groups in Phases D and F, and Intra-Group Comparison (PD x PF): Means, Standard Deviation (SD), Confidence Interval (CI), and Effect Size Cohen's *d*(*d*)

Phase D	Expected score	Lips	Tongue	Jaw	Cheeks	Breathing	Deglutition	Mastication
		8	12	10	8	2	10	9
T	Mean±SD	7.20±1.03	7.80±2.40	5.90±1.20	7.40±0.70	1.90±0.32	7.30±2.00	5.80±1.62
	95% CI	6.50-8.00	6.10-9.50	5.00-6.80	7.00-8.00	1.70-2.10	6.00-8.70	4.60-7.00
OS	Mean±SD	7.00±1.56	8.30±2.50	6.50±1.72	7.10±1.00	1.70±0.48	6.80±2.25	6.00±1.50
	95% CI	6.00-8.10	6.50-10.10	5.30-7.70	6.40-7.80	1.40-2.00	5.20-8.40	5.00-7.10
	d: T and OS	0.1	0.2	0.4	0.3	0.5	0.2	0.1
SC	Mean±SD	7.00±1.50	8.50±2.51	6.00±1.90	7.70±0.67	1.90±0.32	6.90±1.37	6.80±2.10
	95% CI	6.20-7.80	6.70-10.30	4.70-7.30	7.20-8.20	1.70-2.10	6.00-8.00	5.30-8.30
	d: T and SC	0.2	0.3	0.1	0.4	0.0	0.2	0.5
AC	Mean±SD	7.9±0.32*	9.90*±1.85	8.9**±0.74	7.80±0.42	1.9±0.32	9.40**±0.84	8.10**±0.99
	95% CI	7.67-8.13	8.57-11.23	8.37-9.43	7.50-8.10	1.67-2.13	8.80-10.0	7.39-8.81
	d: T and AC	0.9	1.0	3.0	0.7	0.0	1.4	1.7
Phase F								
T	Mean±SD	7.90±0.32	10.90†±1.85	8.40††±1.17	8.00†±0.00	2.00±0.00	9.10†±1.20	7.80††±0.42
	95% CI	7.70-8.10	9.60-12.20	7.60-9.20	----	----	8.20-10.00	7.50-8.10
OS	Mean±SD	6.60*±1.43	7.90**±1.85	6.70**±1.06	7.70±0.48	2.00±0.00	6.80**±1.55	6.80*±1.03
	95% CI	5.60-7.60	6.60-9.20	6.00-7.50	7.40-8.00	----	5.70-8.00	6.10-7.50
	d: T and OS	1.2	1.6	1.5	0.9	0.0	1.7	1.8
SC	Mean±SD	7.40±0.84	8.00**±2.16	6.60*±1.58	7.70±0.48	1.80±0.42	6.60**±1.80	6.20*±2.04
	95% CI	6.80-8.00	6.50-8.00	5.50-7.70	7.40-8.00	1.50-2.10	5.30-8.00	4.70-7.70
	d: T and SC	0.8	1.4	1.3	0.9	0.7	1.6	1.4
AC	Mean±SD	7.70±0.48	10.10±1.60	9.10±0.88	8.00±0.00	1.90±0.32	9.50±0.85	8.20±0.79
	95% CI	7.35--8.05	8.96-11.24	8.47-9.73	----	1.67-2.13	8.89-10.11	7.64-8.76
	d: T and AC	0.5	0.5	0.7	0.0	0.5	0.4	0.6

T: orofacial myofunctional therapy group; OS: occlusal splint group; SC: symptomatic control group; AC: asymptomatic subjects; Effect size Cohen's *d*(*d*).
*0.05 level of inter-group significance - Mann-Whitney test for unpaired data; ††0.01 level of intra-group significance; †0.05 level of intra-group significance - Wilcoxon test for unpaired samples (↑ = better).

Conclusions

OMT had the following positive effects in treated patients: (a) a significant reduction of pain sensitivity to palpation of all muscles studied but not for the TMJs; (b) increased measures of mandibular range of motion; (c) reduced Helkimo's Di and Ai scores, (d) reduced frequency and severity of signs and symptoms; and (e) increased scores for orofacial myofunctional conditions.

Analysis of the OS group also revealed significant improvement, with some advantages for group T. Groups SC and AC did not differ over time. Groups T and SC differed significantly after treatment, whereas the differences between groups T and AC decreased.

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Appendix

Therapy Protocol

1. To instruct the patient about the TMD and orofacial myofunction therapy goals.

Provide information on:

1.1. TMJ etiology, symptoms, treatments;

1.2. Stomatognathic functions and myofunctional disorders;

1.3. Result of clinical examination and the probable connection between symptoms and disturbed function of the masticatory system;[25]

1.4. Care needed to avoid stomatognathic system overloading (avoid opening the mouth widely and biting large/thick pieces of food, parafunctions);

2. Pain relief and relaxation of the jaw muscles, shoulders and neck and adequate mandibular rest posture:

2.1. To apply thermotherapy with hot and moist compresses to the jaw, shoulder and neck muscles, for at least 20 minutes, every day;

2.2. To perform circular massage applied to the same muscle groups for 5-10 min;

2.3. To perform relaxation of the shoulders and neck muscles;[15]

2.4. To perform diaphragmatic breathing;[15]

2.5. To normalize mandibular vertical rest posture, i.e. dental freeway space:

2.5.1 Provide information about the normal mandibular vertical rest posture;

2.5.2. To pass the anterior and upper portion of the tongue along the region of palatine rugosity and of the alveolar papilla in a back-and-forth movement (relaxation of the elevator muscles) for five min, several times a day;

3. TMJ lubrication and controlled and symmetrical mandibular mobility:

3.1. To apply passive exercises of mandibular mobility: the patient is instructed to keep the jaw elevator muscles relaxed and manual mobilization is performed by the therapist, leading the patient to perform slow and controlled opening and closing movements;

3.2. To perform active exercises of mandibular mobility;

3.2.1. exercises of mouth opening and closing, executed in a slow and controlled manner for 30 sec. several times a day. The tip of the tongue should remain touching the alveolar papilla or, if possible, should remain coupled to the palate in order to establish a limit of the opening movement;

3.2.2. if there is deviation in the opening and/or in the closing path, the exercise could be performed with the tip of the tongue positioned in a compensatory manner in order to prevent deviation. The best position of the tip of the tongue should be defined after attempts under the supervision of the therapist.

3.2. 3. exercises of mandibular mobility, lateral movements to the right without exceeding the occlusal guide and then to the left;

3.2.4. exercises of differentiated muscle contraction when asymmetry is present between sides.

4. Preparatory exercises to improve the coordination of the muscles and the stomatognathic functions.

4.1. To apply massage to the muscle groups in order to distend and elongate them, to reduce flaccidity and to activate the musculature according to patient needs;

4.2. To perform mobility exercises separately for the tongue, lips and cheeks;

4.3. To perform isometric exercises separately of the tongue, lips and cheeks;

4.4. To perform exercises of coordinated movements of the structures;

5. Mastication

5.1. If the patient presents unilateral mastication, he should first be instructed to masticate simultaneously on both sides to divide the masticatory load and to avoid condylar translation;

5.2 To optimize the function: training for alternate bilateral mastication should be initiated after the patient develops better muscle function movements and when there is no dental occlusion leading to functional overloading.

6. Deglutition

6.1. The patient should be instructed to increase chewing time to improve particle reduction and lubrication of foods;

6.2. The exercises of contraction, mobility and coordination of tongue, lips and cheeks will favor the execution of the function.

It is important to point out that the exercises and functions should be performed without pain, TMJ noise or other symptoms. If pain occurs, the conduct must be corrected or modified.