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Article *in* Cranio: the journal of craniomandibular practice · April 2008

DOI: 10.1179/crn.2008.016 · Source: PubMed

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Otologic Symptoms of Temporomandibular Disorder and Effect of Orofacial Myofunctional Therapy

Cláudia Maria de Felício, Ph.D.; Melissa de Oliveira Melchior, M.S.;
Clãudia Lúcia Pimenta Ferreira, M.S.; Marco Antonio M. Rodrigues Da Silva, Ph.D.

0886-9634/2602-000$05.00/0, THE JOURNAL OF CRANIOMANDIBULAR PRACTICE,

Manuscript received May 1, 2007; revised manuscript received October 25, 2007; accepted December 11, 2007

Address for correspondence:
Dr. Cláudia M. de Felício
Faculty of Medicine of Ribeirão Preto
University of São Paulo
Dept. of Otorrinolaringologia, Oftalmologia e Cirurgia de Cabeça e Pescoço
Av. Dos Bandeirantes – 3900
Ribeirão Preto CEP – 14049-900
Brazil
E-mail: cfelicio@fmrp.usp.br

ABSTRACT: The aim of this study was to investigate the frequency of otologic symptoms and their relationship to orofacial signs and symptoms of temporomandibular disorder (TMD), and the effect of orofacial myofunctional therapy. The study was conducted on eight asymptomatic subjects (Group C) and 20 subjects with articular TMD, randomly distributed over two groups: one treated using orofacial myofunctional therapy (OMT Group) and a control group with TMD (Group CTMD). Patient selection was based upon the Research Diagnostic Criteria for TMD (RDC/TMD). All subjects submitted to a clinical examination with self-reporting of symptom severity, and to orofacial myofunctional and electromyographic evaluation at diagnosis and again, at the end of the study. Correlations were calculated using the Pearson test and inter- and intragroup comparisons were made ($p<0.05$). In the diagnosis phase, subjects with TMD reported earache (65%), tinnitus (60%), ear fullness (90%), and 25% of the asymptomatic subjects reported tinnitus. The otologic symptoms were correlated with tenderness to palpation of the temporomandibular muscles and joints and with orofacial symptoms. Only the OMT group showed a reduction of otologic and orofacial symptoms, of tenderness to palpation and of the asymmetric index between muscles. OMT may help with muscle coordination and a remission of TMD symptoms.

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 masters in education from the Federal University of São Carlos in 1992 and in 1996, and her 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.*

Temporomandibular disorder (TMD) can involve dysfunction in the delicate interrelationship of the skull, mandible, cervical vertebrae, and neuromuscular apparatus.[1] Otologic symptoms are frequent in patients with TMD,[2-4] but not in asymptomatic control subjects.[5,6]

It has been hypothesized that symptoms such as earache, ear fullness, and tinnitus in patients with TMD are due to the anatomical and functional relationship between the temporomandibular joint (TMJ), the muscles innervated by the trigeminus, and the structures of the ear.[7-9] However, a study based on electromyographic (EMG) analysis failed to confirm that spasms of the mandibular muscles affect the physiology of the tensor veli palatini muscle or the function of the auditory tube.[10] With regard to the audiologic findings, reduction of aerial tonal threshold at certain frequencies has been reported by some authors,[9,11] but not by others.[2,12]

Significant relationships have been detected between otologic symptoms and other signs and symptoms of TMD,[4,5,13] and the results of a recent study support the

concept of neuromuscular and functional relationships between tinnitus and the stomatognathic system.[14] However, in a significant number of patients seeking treatment for ear pain, physicians find no dysfunction in the ear, but in the TMJ and in the masseter muscle.[15]

Dental treatments such as occlusal splints and mandibular orthopedic appliances are reported to be efficient in reducing the otologic symptoms of patients with TMD.[1,6,12]

Orofacial myofunctional therapy (OMT), a modality of exercise therapy in which the objectives include the promotion of proprioception, tonicity, and mobility, working with the facial and cervical musculature, as well as with stomatognathic functions of respiration, mastication, deglutition, and speech, is also suggested for patients with TMD.[16,18,19] However, studies on the analysis of the effect of OMT on the otological symptoms of TMD are not available.

The objectives of the present study, carried out on subjects with TMD and asymptomatic subjects were to investigate (a) the frequency of otologic symptoms, (b) the relationship between otologic symptoms and the main orofacial signs and symptoms in TMD, and (c) the effect of OMT on the frequency and severity of these symptoms.

Materials and Methods

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

Twenty (20) subjects with articular TMD participated in the study. Of these, ten were treated with OMT (group OMT) and ten, who were on a waiting list for treatment, were designated as controls (group CTMD). Eight subjects with no signs or symptoms of TMD represented the asymptomatic control group (group C). The twenty (20) TMD subjects were selected from a group of 70 patients on the university waiting list for orofacial pain and TMD treatment.

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

The inclusion criterion for TMD was to present with articular TMD, based on the Research Diagnostic Criteria for TMD (RDC/TMD).[20] The patients with articular TMD, were randomly distributed into two groups: Ten patients for treatment with orofacial myofunctional therapy (OMT Group) and ten controls with TMD (Group CTMD).

Subjects with no signs or symptoms of TMD were invited to participate in the study. The inclusion criterion for the control group was absence of TMD based on the same RDC/TMD criteria. There were eight subjects in the asymptomatic control group (group C).

Mean age in the groups was 31.46 years. All subjects were female due to a much greater proportion of the female gender on the waiting list for treatment.

Subjects were examined while sitting on a dental chair in a room with appropriate lighting, by the same examiner. The data considered in the present study referred to tenderness to palpation in the masseter, temporal, and supra-hyoid muscles and in the TMJ. The patients were asked to grade their pain on a VAS scale from zero (absence of pain) to ten points (greatest possible pain). The TMJ region was also palpated during the mandibular movements for the identification of joint noises, which were confirmed by auscultation.

The patients responded to the first part of the questions in a protocol,[21] which required a positive or negative reply. In the second part of the questionnaire, 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 in which zero was considered to be complete absence of the symptom and ten was considered to be the highest possible severity. The severity score consisted of the sum of the scores attributed to each sign and symptom in the four situations.

Orofacial Myofunctional Evaluation

Orofacial myofunctional evaluation was performed by visual inspection during the sessions and confirmed with later analysis of images recorded on a videocassette. A movie camera, model Panasonic M9000 S-VHS NV-M9000, was installed on a tripod and filming was performed at the same distance from the each subject. The components of the stomatognathic system were evaluated in terms of aspect/posture, mobility, and performance during the deglutition (liquid and solid) and mastication functions.[22]

Electromyographic (EMG) Data Collection

The subject's skin was cleaned with alcohol to eliminate natural oils and pollution residue. The room was dimly lit, and the patient was seated on a comfortable office-type chair with no headrest with feet resting on the floor and arms resting in the lap. The head was positioned upright and the Frankfort posture/plan was used as a positioning parameter.

The EMG was recorded using an eight-channel computerized surface electromyograph (Lynx Tecnologia Eletrônica -EMG1000) connected to a microcomputer, with simultaneous acquisition, amplitude range (-10V to

+10V), and sampling frequency per channel of one KHz. The Aqdados software was used for signal visualization and the AqAnalisys software for processing (Lynx Tecnologia Eletrônica). Myoelectrical signals were captured via active differential surface electrodes (silver bars ten mm apart, ten mm long, two mm wide, 20 times of gain, input impedance of 10 GW and 130 dB CMRR at 60 Hz). A reference electrode was placed on the patient's arm in order to reduce the effect of electromagnetic interference and other acquisition noises.

The electrodes were positioned centrally and parallel to the direction of the fiber bundles of each masseter and temporal muscle. The electrodes were fixed with bands of adhesive tape, allowing total contact between the electrode uptake bars and the skin.

The clinical conditions investigated were: (a) resting before the exercises; (b) maximum voluntary dental clench: the subject was asked to clench as strongly as possible for five seconds; (c) maximum voluntary dental clench on cotton rolls: after a five min rest, two ten mm thick cotton rolls (Roeko Luna), were positioned bilaterally in the region of the second premolar and first molar, and one maximum voluntary contraction was recorded for five seconds. The procedures were explained to the participants prior their participation and each movement explained in advance of the testing by the examiner. For each clinical condition, the subjects made two attempts in each phase and the mean activity for each muscle evaluated was calculated.

The EMG signals were recorded and later calculated as muscle activity evaluated as root mean square (rms) of amplitude (μV) with the aid of the AqAnalysis software. The data were stored for later statistical analysis.

The asymmetry index between muscle pairs was calculated as described in the literature,[23,24] as follows: the activity of each subject in maximum dental clench with cotton rolls was normalized by maximum habitual intercuspation (MHI) and the asymmetry index (AI) was calculated (AI=(MR–ML)/(MR+ML); where MR is the activity of the muscle on the right and ML the activity on the left.

All subjects submitted to the evaluation described in the diagnostic phase (phase D) and the final phase (phase F) of the study and came to the laboratory on two separate days to complete the evaluation in each phase.

Treatment Procedures

OMT was planned on the basis of the following main objectives: favoring increased local blood circulation and pain relief, mandibular posture and mobility without deviations, coordination of the muscles of the stomatognathic system (symmetry between muscle pairs), as well as equilibration of the stomatognathic functions in a manner compatible with occlusion.

The specific goals and the therapies used to achieve the goals were defined in each case, based on the results of clinical examination, myofunctional evaluation, and EMG, and on previous proposals.[19,22] According to the treatment protocol of the clinic, during treatment the patients participated in a minimum of nine and a maximum of 13 sessions of OMT (mean=11.8 sessions), 45 minutes each, with a weekly frequency during the first 30 days and every two weeks after this period, with no other additional therapeutic conduct.

During the study, the CTMD and asymptomatic groups (group C) were submitted to evaluations only.

Outcome Measures

The outcome measures comprised clinical examination (tenderness to palpation, identification of joint noises), self-assessment of TMD severity signs and symptoms, and asymmetry index between muscle pairs based on EMG analyses. After a mean of 135 days of the diagnostic phase, all patients and subjects were submitted to the re-evaluation, according to the OMT protocol used (minimum of nine and a maximum of 13 sessions of OMT).

Statistical Analysis

All subjects selected were considered for analysis. Data analysis was carried out according to a pre-established analysis plan. Correlations were calculated using the Pearson product-moment test. For data expressed on interval levels, inter-group data were analyzed using the Mann-Whitney test for unpaired data, and intra-group (between phases) data were analyzed using the Wilcoxon test for pairs. The EMG data were analyzed using parametric statistics. The asymmetry indices of the temporal and masseter muscles were calculated separately and intragroup phase comparison was performed using a students t-test for paired data. Analysis of variance (ANOVA) (three groups x two muscles) was applied for inter-group analysis, followed by the Tukey post-test. All calculations were made using the Statistica software (StatSoft Power Solutions), with a level of significance set at 0.05.

Results

Correlations of Otologic Symptoms with Tenderness to Palpation and Orofacial Symptoms

In the diagnostic phase (D), considering the sample as a whole, there were positive correlations between otologic symptoms and tenderness to palpation of the muscles and of the TMJ. There were also significant correlations between the severity of otologic and orofacial symptoms.

The Pearson correlation coefficients (r) and the levels of significance (p level) are presented in **Table 1**.

Frequency of Signs and Symptoms in the Groups in Each Phase

In phase D, the frequency of the otologic symptoms was 65% for earache, 60% for tinnitus and 90% for ear fullness in subjects with TMD. In group C, 25% of the subjects reported tinnitus. In the OMT group these symptoms occurred in the D and final (F) phases at the following respective frequencies: 70% and 20% for earache, 60% and 20% for tinnitus, and 90% and 30% for ear fullness. The respective frequencies were 60% and 50%, 60% and 80% and 90% and 80% for the CMTD group and 0% and 12.5%, 25% and 12.5% and 0% and 12.5% for group C.

Group Comparison: Tenderness to Palpation

In phase D, there was no difference between the OMT group and the CTMD group, except for tenderness to palpation in the left suprahyoid muscle (p=0.02), mean value was higher in the OMT group. The OMT group presented significant differences from group C in all comparisons (p<0.005).

In phase F, the OMT and CTMD groups differed in tenderness to palpation of the masseter (p<0.05) and temporal muscles, and of the TMJs (p<0.02), both on the right and the left, with higher mean values for group CTMD. Groups OMT and C maintained differences only regarding tenderness in the TMJs (p<0.02). The mean values for the groups in each phase are shown in **Table 2**.

Table 1
Pearson Correlation Coefficient of Otologic Symptoms with Tenderness to Palpation an Orofacial Signs and Symptoms

N=28	Earache	Tinnitus	Fullness
Tenderness to palpation			
RM	0.53*	0.48*	0.60*
LM	0.36	0.33	0.45**
RT	0.42**	0.36	0.37**
LT	0.42**	0.42**	0.60*
RTMJ	0.58*	0.47**	0.68*
LTMJ	0.37**	0.39**	0.55**
Orofacial symptoms			
Muscular pain	0.67*	0.61*	0.46**
TMJ pain	0.71*	0.65*	0.65*
Joint noise	0.46**	0.41**	0.39**

M: Masseter muscle; T: temporal muscle;
TMJ: temporomandibular joint; R: right; L: left
*0.01 significance level; **0.05 significance level

Group comparison: Severity of Signs and Symptoms

In phase D, there were no significant differences between groups OMT and CTMD, but there were significant differences between OMT and C (p<0.05). In phase F, the OMT group presented lower means compared to the CTMD group in all items analyzed, with a significant difference regarding the severity of tinnitus (p<0.05). Compared to group C, group OMT no longer presented differences in earache or tinnitus (p>0.05). The mean values for the groups in each phase are shown in **Table 3**.

Group Comparison Relative to Asymmetry Index (AI)

Analysis of variance for AI data showed no significant differences in phase D between groups (F=1.20, p=0.32), between muscles (F=0.41, p=0.53), or an interaction effect (F = 0.84, p=0.44). In phase F there was a tendency to a significant difference between groups (F=3.00, p= 0.07), but not between muscles (F=0.0, p=0.98), or an interaction effect (F=0.52, p= 0.60). The Tukey post-test revealed that the probability of equality decreased between groups OMT and CTMD and increased between groups OMT and C from phase D to phase F (**Table 4**).

Comparison Between Phases: Group OMT

Tenderness to palpation: The differences between phases D and F were significant for all muscles. The scores of tenderness to palpation in the TMJs decreased but not significantly so. **Table 2** presents the mean values and the results of the comparisons.

Severity of signs and symptoms: There was a significant reduction of signs and symptoms from phase D to phase F and a tendency to significance for tinnitus (p=0.052) (**Table 3**).

Comparison of AI between phases: There was an decrease in AI between phases for both muscles, with a significant difference for the masseters (p< 0.05), but not for the temporal muscles (p>0.05) (**Table 4**).

Comparison between phases: Group CTMD

Tenderness to palpation: There was no difference in tenderness to muscle palpation between phases. Only the mean intensity of pain in the right TMJ was greater in phase F and differed significantly from phase D due to the worsening of signs and symptoms in one subject (**Table 2**).

Severity of signs and symptoms: There was no significant difference between phases (**Table 3**).

Comparison of AI between phases: There was no significant difference in AI between phases for the masseter (p>0.65) and temporal muscles (p>0.79).

Table 2
Mean Scores for Tenderness to Palpation and Level of Significance of Phase Comparison in Each Group

	Pain upon palpation					
	OMT		CTMD		C	
Sites	DP	FP	DP	FP	DP	FP
RM	6.30	2.40*	4.7	5.3	0.75	0.38
LM	5.80	2.50**	4.9	5.1	0.63	0.50
RT	4.00	0.70**	2.5	4.4	0.25	0.63
LT	4.50	1.00**	3.1	3.9	0.25	0.50
RSUPRA	3.70	0.70**	2.1	3.3	0.25	0.00
LSUPRA	5.50	0.30**	2.2	2.3	0.00	0.00
RTMJ	6.50	3.90	5.7	8.1**	0.13	0.38
LTMJ	5.80	3.50	5.2	6.9	0.50	0.38

M: Masseter muscle; T: temporal muscle; SUPRA: supra-hyoid; TMJ: temporomandibular joint; DP: Diagnostic phase; FP: Final phase; R: right; L: left
*0.01 significance level; **0.05 significance level

Comparison Between Phases: Group C

Tenderness to palpation: There was no significant difference between phases D and F (**Table 2**).

Severity of signs and symptoms: In group C, because of the various mean values equal to zero, the statistical difference between phases was not calculated (**Table 3**).

Comparison of AI between phases: There was no significant difference in AI between phases for the masseter or temporal muscles ($p > 0.05$).

Discussion

The most frequent complaints reported by subjects with TMD are pain in the masticatory muscles and in the TMJ, which are related to other complaints such as difficulty in opening the mouth wide, mastication, and speech.[19-22,25,27] During anamnesis, spontaneous reports of otologic symptoms are less common because the subjects often do not relate those symptoms and TMD.

Table 3
Mean Severity Scores for Signs and Symptoms and Level of Significance of Phase Comparison in Each Group

	Severity of signs and symptoms					
	OMT		CTMD		C	
	DP	FP	DP	FP	DP	FP
Otologic symptoms						
Earache	13.40	1.00**	5.3	2.1	0.63	0.13
Tinnitus	8.80	4.50	3.8	6.5	0.00	0.00
Ear fullness	13.50	3.10*	9.8	10.5	1.75	0.38
Orofacial symptoms						
Muscular pain	21.40	9.80*	15.4	13.6	0.38	0.00
TMJ pain	19.90	8.60*	13.3	12.1	0.13	0.00
Joint noise	15.90	6.80*	15.9	10.8	0.00	0.00

TMJ: temporomandibular joint; DP: Diagnostic phase; FP: Final phase
*0.01 significance level; **0.05 significance level

Table 4
Asymmetry Index and Probability of Group Equality During D and F Phases According to the Tukey Post Test

N=28	Asymmetry indices and probability of group equality					
	DP			FP		
		OMT	CTMD		OMT	CTMD
Groups	AI			AI		
OMT	0.14			0.06		
CTMD	0.12	0.89		0.16	0.16	
C	0.06	0.34	0.57	0.04	0.90	0.10

AI: Asymmetry index; DP: Diagnostic phase; FP: Final phase; OMT: Orofacial myofunctional therapy group; CTMD: Controls with TMD; C: Asymptomatic subjects

Several investigators have tried to clarify the possible origin of otologic symptoms in TMD.[7,9,10] Some studies have focused on the relationship between orofacial and otologic symptoms[4,5,13] and on the effect of dental treatment on the latter.[1,12,16] However, the possibility of using a therapy directed at the musculature and at the stomatognathic functions has not been investigated.

The prevalence of otologic symptoms observed in the present study agrees with the literature,[2-6] with a greater occurrence of ear fullness compared to earache in subjects with TMD[4] and of tinnitus, although other studies have reported a greater occurrence of earache.[12] In contrast, in individuals without TMD the prevalence of otologic symptoms is low.[5,6]

Earache, tinnitus, and ear fullness were significantly correlated with tenderness to palpation of the masticatory muscles,[4,14] TMJ[5] and with the severity of TMJ noise and of pain in the mandible elevator muscles and in the TMJ.[3,6]

Individuals with TMD and otologic symptoms have a greater probability of feeling pain when opening the mouth.[5] This movement is present in mastication and speech, both situations considered by the subjects to indicate the severity of their signs and symptoms, according to the protocol used of self-assessment of severity.[21]

The sensorimotor innervation of the face involves several cranial nerve pairs, which do not occur in a shared manner. In individuals with TMD, rather than a harmonic functioning between face, mouth, and pharynx, there is a gradual modification of the movements performed by the joints during mastication, deglutition, and speech due to the process of muscular and articular degeneration of the disease.[4] Thus, disharmony of the stomatognathic system manifesting as orofacial pain and difficulty in functional behaviors seem to be associated with otologic symptoms in TMD cases.

In phase D, as expected, the OMT group presented significant differences in tenderness to palpation and severity of signs and symptoms only compared to group C. As previously observed, asymmetry in the EMG activity of muscle pairs was present both in control subjects and in subjects with TMD, although the latter presented greater disequilibrium.[25] The change in muscle recruitment may be a compensatory mechanism for pain relief, or asymmetrical muscle recruitment may precede the muscle pain symptoms in TMD cases.[26]

The nociceptive stimuli originating from occlusion and/or TMJ can lead to frequent disorders of stomatognathic functions.[17-19,27] For this reason, OMT has been long indicated[17,18] and applied to TMD patients[19,22] in order to equilibrate the orofacial muscles, with the development of adequate mobility of the lips and tongue and of symmetry and control of mandibular movements, in addition to favoring the execution of stomatognathic functions in a manner compatible with the occlusal condition.

The results of the present study indicate positive effects of OMT since in phase F the OMT group presented lower mean values than the CTMD group regarding both tenderness to palpation and severity of signs and symptoms, and did not differ from group C regarding tenderness to muscle palpation or severity of earache and tinnitus.

Also, comparison of phases F and D showed that reduction of tenderness to muscle palpation, of the scores of muscle pain severity, of TMJ pain, of earache, ear fullness, and articular noise occurred only in the OMT group,

with a tendency to a significant reduction in the severity of tinnitus and a reduction of the AI of EMG activity, whereas no important changes in these parameters occurred in the CTMD or C groups.

Muscle coordination is considered to be necessary for successful treatment of TMD.[28] In the F phase, the OMT group became closer to group C, asymptomatic, and moved away from group CTMD, which received no treatment, seen by the probability of equality between groups, demonstrating that OMT achieves the objective of favoring the equilibrium of mandible levator muscles.

The recovery of the functionality of the stomatognathic system which, among other things, reestablished the possibility to chew, to swallow, and to speak without pain and without aggravating the problem, was an objective of OMT which, based on the results, contributed to a reduction of the symptoms of TMD, including otologic symptoms.

Conclusion

On the basis of the current study results, it may be concluded that (a) in the groups with TMD, in contrast to the asymptomatic group, there was a high incidence of otologic symptoms, with ear fullness predominating over earache and tinnitus; (b) the otologic symptoms were significantly correlated with tenderness to palpation and with the severity of orofacial signs and symptoms; (c) the group with TMD that received OMT presented a reduction of tenderness to palpation and of the severity of signs and symptoms of TMD, among them the otologic ones and the index of muscle asymmetry; (d) the group with TMD that did not receive treatment and the asymptomatic group did not present significant changes; and (e) OMT had positive effects on orofacial and otologic symptoms.

Acknowledgments

This study was supported by Fundação de Amparo à Pesquisa do Estado de São Paulo - FAPESP, Process N. 2004/08478-8.

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Melissa de Oliveira Melchior *received a M.S. degree in speech and language pathology and audiology from the Faculty of Dentistry of Bauru, University of São Paulo in 1998. Currently, she is a postgraduate student, Department of Otorhinolaryngology, Ophthalmology, and Head and Neck Surgery, Faculty of Medicine of Ribeirão Preto, University of*

São Paulo and a speech pathologist at the Dental School of Ribeirão Preto, University of São Paulo.

Cláudia Lúcia Pimenta Ferreira *received a M.S. degree in speech and language pathology and audiology from University of Ribeirão Preto in 2003. Currently, she is a postgraduate student, Department of Otorhinolaryngology, Ophthalmology and Head and Neck Surgery, Faculty of Medicine of Ribeirão Preto, University of São Paulo.*

Marco Antônio M. Rorrigues Da Silva *received his D.D.S. degree in 1974 and his Ph.D. in 1991 from the Faculty of Dentistry of Ribeirão Preto, University of São Paulo, Brazil. He is a professor at the Faculty of Dentistry of Ribeirão Preto, University of São Paulo and is involved in research in articular disorders.*