Experimental Chewing in Myofascial Pain Patients

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Aims: *To evaluate the potential capacity of a chewing exercise to differentiate chronic myofascial pain (MFP) patients from healthy controls and to test whether there are distinct pain response differences among MFP patients.* **Methods:** *Eighty-nine subjects participated in the study; 49 were diagnosed as belonging to the MFP subgroup of temporomandibular disorders (TMD) and had suffered from MFP for at least 6 months, and 40 healthy age- and gender-matched subjects comprised the control group. After completion of a clinical examination, all subjects performed a chewing exercise. Subjects chewed on half a leaf of green casting wax for 9 minutes and then held their jaw at rest for another 9 minutes. They indicated the intensity of the pain experience on a visual analog scale (VAS) every 3 minutes from the beginning (P0) to the end (P18) of the chewing exercise. Only changes in pain report of more than 5 mm on the VAS were considered. Analysis of covariance with repeated measures was used to analyze fluctuations in pain levels during the test, with the pain level at baseline (P0) as a covariant.* **Results:** *Statistical analysis revealed a significant main effect for group (MFP versus control); a significant main effect for activity (chewing versus rest); an interaction between activity and time; and an interaction between activity, time, and group. The latter revealed the significant effect of the chewing activity on pain levels in both groups along the axis of time and its recovery at rest. In the MFP patients, pain had increased by 32 mm at P9 in 84% of the patients and recovered to almost the initial pain levels by P18; 6% reported a decrease in pain sensation and 10% reported no change in pain. In the controls, pain had increased 4.9 mm by P9, a value within the recording error range of the scale.* **Conclusion:** *(1) A strenuous chewing exercise is a potentially beneficial tool in the diagnostic process of myofascial pain patients and, if validated, could be incorporated into clinical examinations. (2) The increase in pain intensity following the chewing exercise is typical of most of the MFP group. (3) The phenomenon of pain decrease in a small percentage of MFP patients should be further investigated.*

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Masticatory muscle disorders are not a single condition but several related and often overlapping ones, with pain as the main symptom.[1] In a retrospective study, Scholte et al[2] found that in 36% of patients with temporomandibular disorders (TMD), pain originated in the neck and/or shoulder area and radiated to the facial area. It was concluded that, occasionally, differential diagnosis with pain from a masticatory muscle source could be confusing and difficult.

Myofascial pain (MFP) is defined as a regional, dull, aching pain accompanied by the presence of localized trigger points in the muscles that produces a characteristic pattern of regional referred pain on provocation.[3] Stohler and Lund[4] found that neither pain radiation nor pain referral occurs in every patient.

The multipennate structure of the human masseter muscle, with fiber lengths of 15 mm, raises the question of whether the diagnosis of "taut bands" would be possible.[5] In the Research Diagnostic Criteria for TMD (RDC/TMD),[6] trigger points are not discriminative criteria for MFP.

Patients suffering from masticatory muscle pain often complain of aggravation of pain during chewing.[7,8] Clark et al[9] found these patients to have a lower maximum voluntary bite force level and a shorter endurance time compared to normal subjects. Dao et al[8] found that a 3-minute chewing test increased pain in most MFP patients, particularly in those with low pain scores at rest. Surprisingly, the exercise decreased pain in those whose resting pain levels were higher and had no effect on asymptomatic subjects. It was speculated that there exist 2 subgroups of MFP patients with opposite reactions to exercise. They recommended that the experiment be repeated with a lengthened chewing test.

Functional exercise tests are commonly used in orthopedic and physiotherapy treatment as a way to evaluate the improvement achieved by a specific treatment or as a diagnostic tool. To the best of our knowledge, there is no data in the literature to verify the exacerbation of pain during chewing among MFP patients reported by Dao et al.[8]

The purpose of this article was twofold: *(1)* to describe and perform a quantitative functional chewing exercise and to test its potential capacity to differentiate chronic MFP patients from healthy controls; *(2)* to test whether there are distinct pain response differences among MFP patients.

Materials and Methods

Subjects

The MFP group consisted of 49 patients referred for treatment at the Clinic for Craniomandibular Disorders, School of Dental Medicine, Tel Aviv University (Table 1). Criteria for inclusion were facial pain for at least 6 months, full natural dentition or fixed dental rehabilitation, no history of facial or cervical injury, no pain or limitation of movement at the cervical area, no active periodontal disease or caries, and no history of general neurologic disturbances, hormonal diseases, neoplasm, or psychiatric diseases. Patients who suffered from temporomandibular joint (TMJ) disorders according to the RDC/TMD and panoramic radiographs were excluded from the study. All patients were diagnosed by a single expert clinician as belonging to the MFP subgroup of TMD, according to the RDC/TMD[6] (Ia or Ib diagnostic group).

Table 1 Study Population Characteristics

	MFP group	Control group
No. of subjects	49	40
Age range	16–45	16–45
Mean age (± SD)	29.2 ± 7.8	27.9 ± 7.4
Female/male ratio	36/13	28/12

The control group included 40 age- and gender-matched subjects recruited among dental students and general dental patients. None of the subjects complained of facial pain or sought treatment 6 months prior to the experiment. Their report was verified by the same clinician who examined the MFP group. With the exception of pain, the inclusion criteria for the control group were identical to those for the MFP group.

All participants granted their informed consent to participate in the study.

Experimental Design

All participants filled out the RDC/TMD questionnaire and were clinically examined by 1 of the authors. The arithmetic mean value was also calculated for sensitivity to finger palpation of approximately 1 kg (21 lb) at 8 sites of the superficial muscles of mastication (origin and insertion of the right and left masseter muscles and the right and left anterior and middle portion of the temporalis muscle).

Following the clinical examination and completion of the relevant questionnaires, participants were requested to perform an experimental chewing exercise modified from Dao et al.[8] Initially, participants were asked to indicate their rest pain intensity (P0) on a visual analog scale (VAS) ranging from 0 to 100 mm. They were then requested to chew on half a leaf of green casting wax (28-gauge, Kerr) for 9 minutes and to indicate the

Table 2 Participant Characteristics According to RDC/TMD Axis II

	MFP group		Control group		
Characteristic	Mean	SD	Mean	SD	*P* value
Pain intensity	55.98	25.48	1.45	6.40	< .001
Disability score	30.12	29.29	0	0	—
Depression score	0.804	1.016	0.461	0.586	.061
Somatization score	0.715	0.584	0.367	0.434	.001
Somatization score without pain items	0.567	0.601	0.278	0.476	.013

Table 3 Signs and Symptoms at Initial Examination According to RDC/TMD Axis I

	MFP group		Control group		
Signs/symptoms	Mean	SD	Mean	SD	*P* value*
Symptoms					
Present pain (VAS)	46.59	29.46	0.27	1.74	< .001
Maximal pain (VAS)	70.02	27.71	3.12	13.93	< .001
Signs					
Active mouth opening (mm)	45.63	8.40	50.15	5.74	.005
Passive mouth opening (mm)	50.27	6.95	52.03	5.87	.206
Difference (passive – active)	4.63	3.57	1.88	1.11	< .001
Mean muscle sensitivity (points)	1.765	0.492	0	0	

*According to Student *t* test.

intensity of the pain on the VAS after 3, 6, and 9 minutes of chewing. The variables were marked as P0, P3, and P9, respectively. The chewing exercise was terminated after 9 minutes, and participants were instructed to hold their jaw at rest for an additional 9 minutes. During the rest period, participants were instructed to indicate the intensity of their pain on the VAS every 3 minutes (ie, 12, 15, and 18 minutes from the beginning of the experiment). Variables were marked as P12, P15, and P18, respectively. The use of wax as a chewing material has the advantages of being harder than commercial chewing gum and a constant consistency throughout the chewing period.

Each VAS was provided on a separate page to avoid possible bias by former recordings. Only changes in pain report of more than 5 mm on the VAS, calculated by subtracting P0 from P9, were considered.

Statistical Analysis

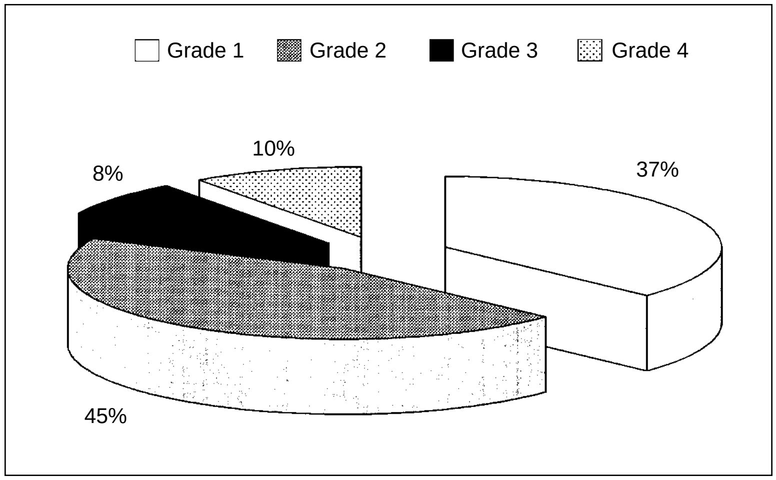
The Student *t* test was used to analyze differences between study groups (MFP versus control) regarding their signs and symptoms and participants' characteristics according to the RDC/TMD. Analysis of covariance (ANCOVA) with repeated measures was applied to analyze the effects of group (MFP versus control), activity (chewing versus resting phase), and time on the intensity of pain. The level of pain at baseline (P0) was introduced as a covariant. Statistical significance was set at $P < .05$.

Results

Patient evaluations and clinical examinations according to RDC/TMD prior to the experiment are presented in Tables 2 and 3. As expected, the most prominent finding was the difference in the mean present pain between the MFP and control groups at the time of initial examination (46.59 ± 29.46 mm vs. 0.27 ± 1.74 mm; $P < .001$) and for the maximal pain reported by each group (70.02 ± 27.71 mm vs. 3.12 ± 13.93 mm).

The active and passive range of mouth opening in both groups (MFP patients and controls) was normal (Table 3); nevertheless active mouth opening was significantly smaller in the MFP group

Fig 1 Chronic pain grade in the MFP patients.



compared to the control group ($P < .005$). Limitation of mouth opening was observed in 8 out of the 49 MFP patients. They were diagnosed as group Ib according to the RDC/TMD. The difference between passive and active opening was significantly larger in the MFP group compared to the controls ($P < .001$). The superficial muscles of mastication were sensitive to palpation in the MFP group (mean 1.76), while no such sensitivity was observed in the control group.

There were significant differences between the groups with respect to disability, somatization, and somatization without pain scores according to the RDC/TMD.[6] A tendency toward significance ($P = .06$) was found between the groups concerning depression (Table 2).

The chronic pain grade, calculated according to the RDC/TMD[6] among the MFP group, is presented in Fig 1; 82% of the patients were found to be at levels 1 or 2 (low disability level) and 18% were in levels 3 or 4 (high disability level). The impact of pain intensity on the daily activity of the MFP subjects was obvious. Among the control group, the very low levels of pain had no effect on the subjects' daily life.

Chewing Test

Data concerning pain levels and their fluctuations over time of both groups at the different measurement points are presented in Tables 4 and 5 and Fig 2. After 3 minutes of chewing (P3), 28 patients in the MFP group (57%) presented pain increase, 5 patients (10%) reported pain decrease, and 16 (33%) felt no change in their pain level. After 9 minutes (P9), only 3 subjects indicated pain decrease (6%), and 5 reported no pain change (10%). This means that at P9, 41 (84%) of the patients reported a pain increase. In the control group at P3, 35 subjects (87.5%) reported no change, and 5 subjects (12.5%) reported pain increase. By P9, 30 subjects (75%) had no pain increase and 10 subjects (25%) experienced a degree of pain increase.

Analysis of covariance of pain levels during the chewing experiments yielded the following: a significant main effect for group (MFP vs. control, $P < .001$); a significant main effect for activity (chewing vs. rest, $P = .0047$); an interaction between activity and time ($P < .001$); and an interaction between activity, time, and group ($P < .001$). These findings reveal the significant effect of the chewing activity on the pain level in both groups along the axis of time and a recovery at rest (Table 4, Fig 2). In the MFP group, the pain increased by 32 mm by P9 and recovered to almost baseline pain levels by P18. In the controls, mean pain increase was 4.9 mm at P9.

Discussion

The most important finding in this clinical experiment was the differences in pain during chewing in the 2 groups. The increase in pain in the MFP patients following the chewing exercise was significantly larger compared to the healthy controls ($P < .001$). This was statistically significant as well as clinically important, since it has been suggested[10] that the smallest detectable difference on a VAS (serving as a cutoff point for clinical significance) is 28 mm (the MFP group showed a 32-mm increase). In the controls, the average increase of 4.9 mm was clinically meaningless, since a value of

Table 4 Mean Pain Levels (± SD) During Chewing Test

Time point	MFP group	Control group
P0	25.06 ± 26.42	0
P3	37.55 ± 30.50	1.675 ± 3.68
P6	49.63 ± 33.82	3.175 ± 6.82
P9	57.01 ± 36.38	4.925 ± 9.14
P12	46.59 ± 30.81	1.575 ± 4.63
P15	37.96 ± 30.56	1.475 ± 5.41
P18	31.51 ± 28.77	0.875 ± 4.06

Table 5 Proportions of Subjects Showing Change in Pain Levels During Chewing

	MFP group (n and %)		Control group (n and %)	
Pain level	P3	P9	P3	P9
Pain increase	28 (57%)	41 (84%)	5 (12.5%)	10 (25%)
Pain decrease	5 (10%)	3 (6%)	—	—
No change	16 (33%)	5 (10%)	35 (87.5%)	30 (75%)

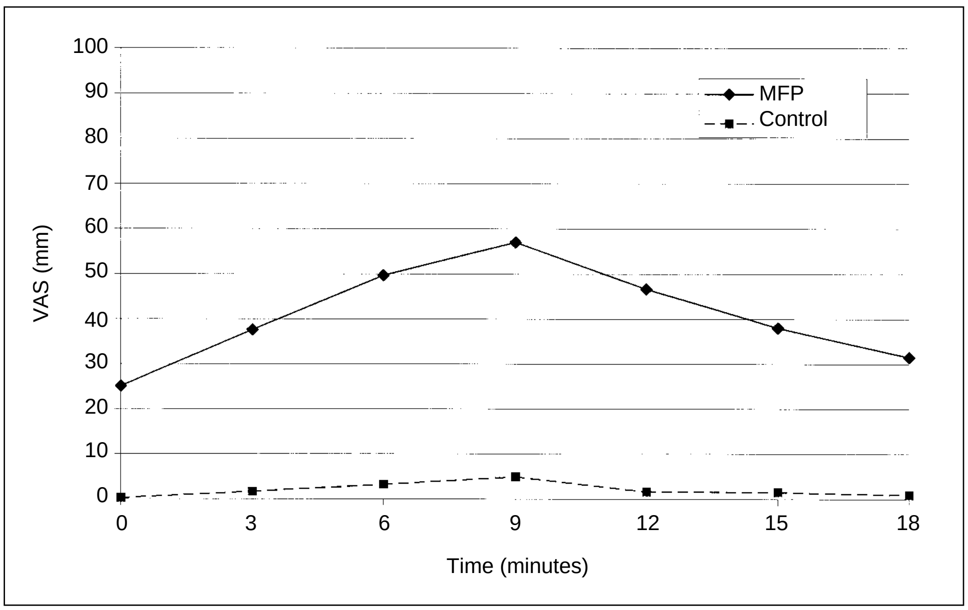


Fig 2 Pain intensity during the chewing test.

5 mm on a VAS is within the recording range of error.[11]

Functional tests for differential diagnosis are widely used in physiotherapy and orthopedics. Lobbezoo-Scholte et al[12] compared 4 orthopedic tests to evaluate TMD patients. Active exercise of jaw movements, where subjects were asked to quantify their pain intensity, was effective in the discrimination of TMD patients from healthy ones. Emphasis was placed on the importance of incorporating orthopedic tests with the conventional diagnostic tests. We agree with others[13,14] that the incorporation of physical tests, in addition to a state-of-the-art clinical examination, could add dimension to the accepted diagnostic criteria.

Masticatory muscles in MFP patients have been reported to have lower endurance when strenuous tasks have been performed. Submaximal continuous clenching in MFP patients, until the patient senses pain, has been reported to be 7 times shorter than in healthy controls.[9] Maximal voluntary clench (MVC) values in MFP patients are far lower than those in asymptomatic subjects.[15] An intramuscular injection of hypertonic saline in healthy subjects causes muscle pain and lower MVC values.[16] Functional impairments in other muscles also appear in the presence of pain.[17,18]

In the present study, reduction in mouth opening in the MFP group was in accordance with the finding of Stohler et al[19] that in the presence of pain, the maximal active mouth opening is relatively reduced compared to normal subjects (although it could stay within the normal range).

This study was an extension of the chewing study conducted by Dao et al,[8] with a prolonged chewing time and frequent patient VAS reports during and after the chewing exercise. In accordance with the findings of the latter study, we also found 3 pain responses among the MFP patients: increase, decrease, or no change in pain intensity. It is possible that prolongation of the chewing phase led to different proportions of these pain responses. The 3 MFP patients who reported a decrease in pain at the end of the chewing phase could not be assessed and at this point could not clarify the idea of 2 distinct MFP pain groups of patients. However, the lack of complete uniformity in pain behavior was observed in both studies and could also be attributed to mixed MFP populations, some of whom may have had a different pain origin, even though the MFP group was screened strictly according to the RDC/TMD criteria. The absence of cervical pain and dysfunction upon examination was an inclusive criteria in the present study; however, differential diagnosis of orofacial pain that originates in the structures of the upper cervical area could be confusing and difficult.[20]

In the present study, all MFP patients with limited mouth opening (Ib) showed a pain increase during the chewing phase. It may well be that the patients exhibiting limited mouth opening had a more severe MFP compared to those without limitation (Ia). Among those who did not exhibit limited mouth opening, all 3 pain responses were observed. The pain increase response, with various degrees of severity, is expected to occur in a musculoskeletal disorder as a result of strenuous muscular exercise. The remaining 2 pain responses are not fully understood. One should doubt that the pain originates in the masticatory muscles if patients report no change during this type of exercise.[21,22] The phenomenon of a decrease in the pain level while chewing intensively and continuously is relatively rare and needs further investigation and clarification.

In our opinion, the incorporation of functional tests for the purpose of differential diagnosis, whether or not the pain originates in the masticatory system, is potentially beneficial in the examination of orofacial pain patients. The protocol needs further refinement, the chewing material needs further assessment (chewing wax as opposed to chewing gum, for example), and more research in other MFP and control populations will contribute to the discriminatory effectiveness of this functional test.

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