

Myofascial pain: ultrasound amplitude > width of the masseter muscle

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Authors: P. MORENO GRANERO, P.-R. Rafael, B. Jose, M. Maria, M. L. Peris Pérez; Valencia/ES
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Aims and objectives

Parafunctional activity of the masticatory muscles is considered a risk factor for TMD. (1) The prospective cohort study carried out in the OPPERA Project (*Orofacial Pain Prospective Evaluation and Risk Assessment*) has detected a significant increase in the relative risk of painful TMD associated to frequent or multiple parafunctional activities.(2)

Exercises involving skeletal muscle contraction against external resistance are effective in improving muscle mass balance by stimulating muscle protein synthesis. The result is muscle hypertrophy after chronic resistance training.(3) Muscle hypertrophy is not only induced by high-intensity contractions. Low-intensity training can result in increased muscle mass similar to that produced by high-intensity resistance training.(4) So, sustained muscle contraction against resistance, leads to an increase in muscle mass.

Whereas parafunctional activities (increased activity of the masticatory muscles) to be a possible risk factor for myofascial pain, and assuming that chronic muscle activity against resistance causes muscle hypertrophy, the hypothesis to be contrasted is that individuals with chronic myofascial pain of the masticatory muscles will have larger size (wider) muscles than people without this disorder.

The present study was designed to determine whether subjects with TMD manifesting as chronic MFP with participation of the masseter muscle (MM) present significantly greater width of the muscle as evidenced by ultrasound.

Methods and materials

The study was carried out in the Department of Stomatology and Maxillofacial Surgery of Valencia University General Hospital (Valencia, Spain), following approval by the local Clinical Research Ethics Committee. A case-control design was used. A total of 31 subjects diagnosed with myofascial pain of the masticatory muscles were included between October 2014 and January 2016, based on the following inclusion/exclusion criteria:

- A diagnosis of myofascial pain (according to the *Research Diagnostic Criteria for Temporomandibular Disorders [RDC/TMD]*), (5) with involvement of at least one of the two MMs at some of the three diagnostic points (muscle origin, body or insertion).
- A minimum evolution of three months from pain onset.
- At least one occlusal contact in each posterior segment (premolars and molars).

Exclusion criteria:

- Subjects with a history of major surgery and/or radiotherapy in the maxillofacial region.
- Minor surgery in the maxillofacial region during the previous three months.
- Organic disease of either MM (cysts, tumors, infections) detected during the magnetic resonance imaging (MRI) and/or ultrasound explorations.
- Systemic muscle disease.
- Subjects under 18 years of age.

A total of 35 controls were selected from among subjects with TMD but without a diagnosis of myofascial pain in the orofacial region.

After signing of the informed consent document, ultrasound was used to explore both temporomandibular joints (TMJs) and the masticatory muscles (masseter and temporal muscles) in all the MFP-subjects and controls. All the explorations were made by the same operator (PM) specialized in musculoskeletal ultrasound and blinded to the clinical diagnosis. An Aplio 500 Premium® ultrasound system with a linear probe operating in the range of 5-14 MHz was used (Toshiba™, Otawara, Japan).

With the subject in dorsal decubitus, the ultrasound probe was positioned perpendicular to the anterior margin of the MM and external surface of the mandibular ramus, between 2-2.5 cm above the lower mandibular margin. The subject was instructed to establish contact with the teeth of both arches, though without applying pressure (UOC). Then the maximum transverse width of both MMs from the internal band of the epimysium (external surface of the ascending mandibular ramus) to the external fascia at the intermediate

point between the origin and insertion of the muscle was measured (Fig. 1). The subject was then instructed to occlude the teeth with maximum force, and again the width of both MMs likewise at the intermediate point between the origin and insertion of the muscle was measured (Fig. 2).

Comparison was made of the MM width of the MFP-subjects and controls under both UOC and at maximum contraction, followed by comparison of the increase in muscle width (amplitude) at maximum contraction both in absolute terms (width at maximum contraction minus UOC width) and as relative values (width at maximum contraction / UOC width). Case-control comparisons were made using single-factor analysis of variance (ANOVA) for variables with a normal distribution, and the Mann-Whitney U-test for variables with a non-normal distribution. Normal data distribution was assessed using the Shapiro-Wilk test. Linear correlations were used to analyze the influence of MFP-subject age and the duration of the disorder upon the main study variables. A statistical significance level of $p < .05$ was used in all cases.

Repeat measurements on the ultrasound images of 10 MFP subjects and 10 controls were carried out between 2-3 months after the first exploration, with calculation of the intraclass correlation coefficient. Values less than 0.4 being assumed to imply study suspension.(6)

The statistical analysis was performed using the SPSS version 22.0 statistical package for Microsoft Windows (IBM Corp., Armonk, NY, USA).

Images for this section:

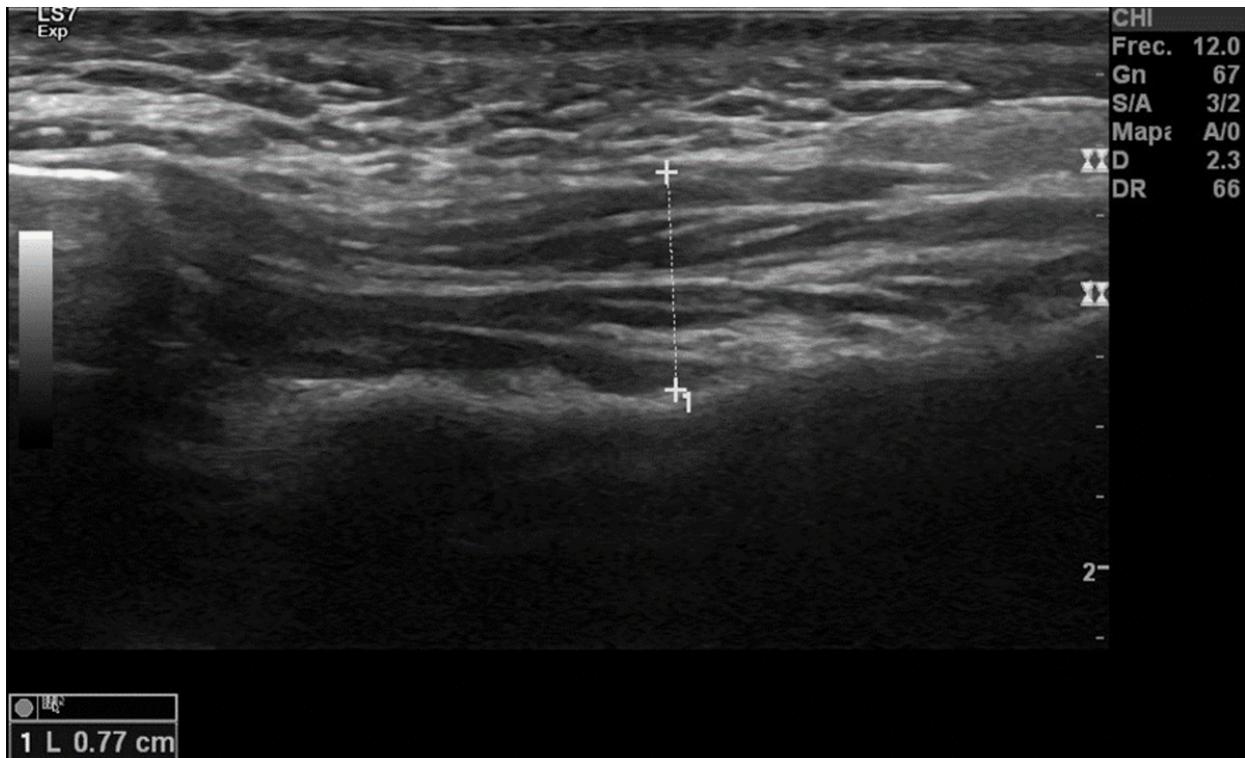


Fig. 1: Masseter muscle width under resting conditions.

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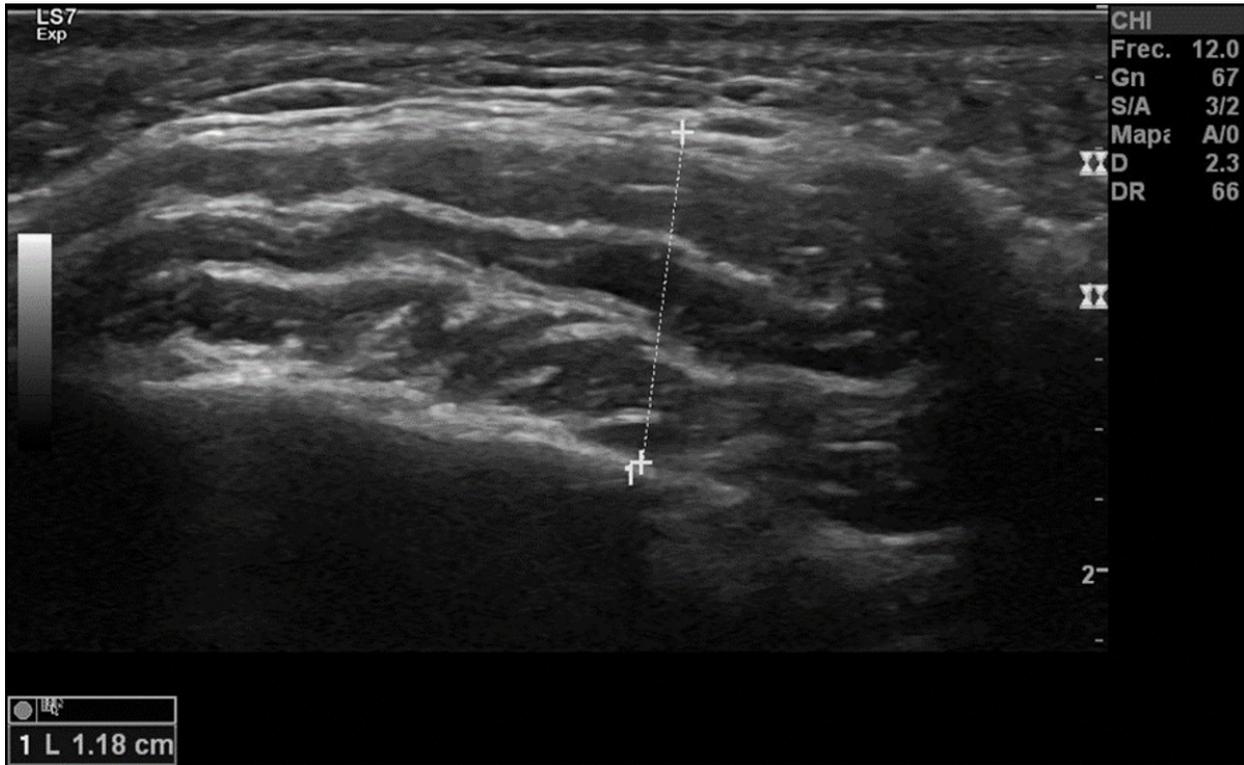


Fig. 2: Masseter muscle width maximum contraction.

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Results

A total of 66 subjects were included in the study: 31 MFP-subjects and 35 controls. None of the MFP-subjects or controls were excluded due to ultrasound-detected organic MM disease. Likewise, no subjects required exclusion *a posteriori* due to the absence of teeth in posterior segments, since the routine panoramic X-rays obtained on the first visit in all subjects with TMD excluded this possibility. The gender distribution was 8 males and 27 females in the control group and one male and 30 females in the study group. The mean age was 42.3 ± 17.5 years in the study group and 43.9 ± 16.9 years in control group ($F=0.48$; $p=.49$).

Twelve MFP-subjects presented MFP with involvement of the right MM (38.7%); 11 presented MFP with involvement of the left MM (35.5%); and 8 presented MFP with involvement of both MMs (25.8%).

First, the intraclass correlation coefficient was calculated (required for reliability and continuation of the study) based on 10 MFP-subjects and 10 controls selected at random between 2-3 months after the first measurement, again with blinding of the ultrasound evaluator. All the correlation coefficients were $> .75$, thus confirming the reliability of the measurements (Table 1).(6)

No significant differences were observed in the width of the MMs under either resting conditions or at maximum contraction between the MFP-subjects and controls. Indeed, all the measurements were found to be very similar in both groups, with an apparently low standard deviation (Table 2).

Likewise, there were no statistically significant differences in the increase in width (amplitude) of the MMs between the MFP-subjects and controls referred to either side, in both absolute terms (width at maximum contraction minus UOC width) and as relative values (width at maximum contraction / UOC width)(Table 3)

The influence of the location of MFP upon MM width was evaluated comparing the MFP-subjects with unilateral MFP (12 right side, 11 left side) versus the control group, using the Mann-Whitney U-test. No significant differences were observed (Table 4).

The influence of age upon MM width was assessed by linear regression analysis. The Pearson correlation coefficient revealed no significant differences. The Spearman correlation coefficient based on the left MM under resting conditions likewise revealed no statistically significant differences. Linear regression analysis was also used to examine the influence of the duration of MFP upon MM width among the MFP-subjects, and revealed no significant differences (Table 5).

Images for this section:

Table 1. Intraclass correlation coefficient (ICC) for successive measurements.

Muscle	N	Pearson correlation coefficient	R ²	ICC
Right masseter (UOC)	20	0.86	0.74	0.84
Right masseter (contraction)	20	0.81	0.64	0.81
Left masseter (UOC)	20	0.93	0.87	0.93
Left masseter (contraction)	20	0.81	0.66	0.92

Fig. 3

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Table 2. Transverse width of the masseter muscles of MFP-subjects and controls under UOC conditions and at maximum contraction (in mm).

Muscle	Width (mm)		Control test	P-value	95% CI (difference of means)
	Cases	Controls			
Right masseter (UOC)	8.9±1.9	8.6±1.6	0.77 ^(a)	.44	- 0.52_1.18
Right masseter (contraction)	11.8±2.2	11.7±1.9	0.25 ^(a)	.80	- 0.88_1.13
Left masseter (UOC)	8.5±1.4	8.2±1.5	523.0 ^(b)	.80	- 0.43_0.96
Left masseter (contraction)	11.4±1.8	11.5±1.8	0.13 ^(a)	.89	- 0.94_0.82

^(a)single-factor ANOVA;
^(b)Mann-Whitney U-test

Fig. 4

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Table 3. Absolute and relative increase in masseter muscle width at maximum contraction (amplitude)

	Cases (mean±SD) (%)	Controls (mean±SD) (%)	Control test	P-value	95%CI (differenc e of means)
Increase in right masseter width (mm)	2.9±1.4 32.6%	3.1±1.2 36.0%	517.5 ^(a)	.75	-0.8_1.1
Increase in left masseter width (mm)	2.9±1.7 37.9%	3.3±0.9 40.2%	-.96 ^(a)	.34	-1.0_0.4
Contraction/UOC width ratio of right masseter	1.3±0.3	1.4±1.2	447.0 ^(b)	.22	-1.4_0.1
Contraction/UOC width ratio of left masseter	1.3±0.2	1.4±0.1	-.99 ^(a)	.33	-1.4_-0.1

^(a)single-factor ANOVA;
^(b)Mann-Whitney U-test

Fig. 5

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Table 4. Comparison of absolute masseter muscle width (in mm) according to the location of myofascial pain.

	Cases			Controls			U-test ^(a)	P-value	95%CI (difference of means)
	N	Muscle	Mean±SD	N	Mean±SD				
Right myofascial pain	12	Right masseter (UOC)	8.4±1.2	35	8.6±1.6	193.5	.70	-1.1_0.8	
	12	Right masseter (contraction)	10.9±1.8	35	11.7±1.9	153.5	.17	-1.9_0.6	
Left myofascial pain	11	Left masseter (UOC)	8.5±1.5	35	8.2±1.5	183.5	.82	-0.7_1.3	
	11	Left masseter (contraction)	11.2±1.6	35	11.5±1.8	164.0	.48	-1.5_0.8	

^(a)Mann-Whitney U-test

Fig. 6

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Table 5. Relationship between the duration of myofascial pain and masseter muscle width

Muscle	Coeff. β	P-value	R ²
Right masseter (UOC)	0.01	.23	0.05
Right masseter (contraction)	-0.09	.63	0.01
Left masseter (UOC)	0.2	.08	0.11
Left masseter (contraction)	0.34	.06	0.12

Fig. 7

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Conclusion

According to the working hypothesis, the masticatory muscles of subjects with chronic MFP should be of greater width under resting conditions, and with a lesser increase in width under contraction, compared with the healthy controls. The present study identified no significant differences in either variable in the MMs of subjects suffering MFP with involvement of these muscles.

Only two publications in the literature have been found comparing a hypothesis similar to the present study. One of them detected statistically significant differences in MM width under resting conditions and in percentage width increase (equivalent to width at maximum contraction / UOC width ratio) between subjects with MFP and their controls. (9,10,11,12) The second article identified in the literature only reported significant differences in right MM thickness between subjects with MFP and their controls, though in contrast to what might be expected, thickness was found to be greater in the control group (11.16 ± 1.37 mm versus 10.07 ± 1.45 mm). (13) With the exception of the dimension of the right MM under resting or UOC conditions, the results of both studies are similar.

Positioning of the probe represents a potential source of bias in the ultrasound exploration. Emshoff and Bertram found that the maximum width is observed in the middle portion of the MM, and that measurements from various positions at one same level barely differ provided the ultrasound probe is kept perpendicular to the long axis of the muscle. (10,14) Both the present study and the two studies used to compare the results made use of this ultrasound exploration procedure.

A considerable number of studies have examined the relationship between MM thickness as determined by ultrasound and facial growth pattern (15,16), malocclusions (17), dental condition (18,19), and even gender. (16,20,21) Not consider these variables in these study, since doing so would have fragmented the sample into too many subgroups, thereby adversely affecting the statistical power of the study.

Although the results obtained do not allow rejection of the null hypothesis, some of the data obtained suggest that rejection of the hypothesis cannot be ruled out entirely. In effect, with the exception of the left MM under contraction, all the values were higher in the MFP-subjects than in the controls (Table 2); the relative increase in muscle width under contraction was greater among the controls; and it is observed a nonsignificant tendency towards greater muscle width with a longer duration of MFP.

The present study study contributes new information on a subject that has been little investigated to date. To our knowledge, this is the first study involving standardized clinical diagnostic criteria, with reproducible UOC and maximum contraction positions, and with analysis of each side independently.

The relevance of this study is referred to the absence of changes in the dimensions of the MM in subjects presenting MFP with involvement of this muscle. This suggests the need to reconsider the hypothesis of an increase in muscle mass associated to muscle hyperactivity in the context of this disease condition.

In conclusion, no statistically significant differences in MM width between MFP subjects with involvement of these muscles and the controls as determined by ultrasound under both UOC conditions and at maximum contraction have been found.

Personal information

Pilar Moreno

Staff physician. Department of Radiodiagnosis. Valencia University General Hospital. Valencia (Spain)

Avda. Tres Cruces 2, 46014 - Valencia (Spain)

Rafael Poveda-Roda

Staff physician. Department of Stomatology and Maxillofacial Surgery. Valencia University General Hospital. Valencia (Spain)

Avda. Tres Cruces 2, 46014 - Valencia (Spain)

José Bagán

Chairman of Oral Medicine. Faculty of Medicine and Dentistry, Valencia University. Head of the Department of Stomatology and Maxillofacial Surgery. Valencia University General Hospital. Valencia (Spain)

Avda. Tres Cruces 2, 46014 - Valencia (Spain)

María Margaix

Dental surgeon. Associated Professor of Oral Medicine. Faculty of Medicine and Dentistry, Valencia University. Valencia (Spain)

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