Journal of Dental Health and Oral Research

Open Access

Research Article

A Descriptive Study Using Ultrasonography to Compare the Internal Echogenic Pattern of the Masseter Muscle in Patients With and Without Oral Submucous Fibrosis

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Received Date: 20-04-2022; **Accepted Date:** 19-05-2022; **Published Date:** 27-05-2022

Abstract

Objectives: The increased muscle activity and diminished blood supply following connective tissue changes in Oral Submucous Fibrosis (OSF) patients lead to muscle degeneration and fibrosis. The histopathological examination of OSF patients confirms fibrosis, but it also causes scarring and worsens OSF. Ultrasonography (USG) has been utilized in recent research to assess the echogenic patterns of the head and neck muscles in OSF patients. The study aimed to compare the echogenic pattern of the masseter muscle in OSF patients to that of normal mucosa using USG.

AK Nabeel | Volume 3; Issue 2 (2022) | JDHOR-3(2)-048 | Research Article

Citation: AK Nabeel, et al. A Descriptive Study Using Ultrasonography to Compare the Internal Echogenic Pattern of the Masseter Muscle in Patients With and Without Oral Submucous Fibrosis. J Dental Health Oral Res. 2022;3(2):1-12.

DOI: https://doi.org/10.46889/JDHOR.2022.3203

Methods: The study population was split into cases and controls. The cases were 63 subjects who were clinically diagnosed with OSF. In comparison, the controls were 63 subjects who were randomly selected from the outpatient clinic of Oral Medicine and Radiology, Government Dental College, Thiruvananthapuram. According to Khanna and Andrade's criteria, OSF subjects were divided into four groups based on their clinical findings. A high-resolution real-time LOGIQUE C5 ultrasonic scanner with 7-12MHz transducers was used to image the masseteric muscle.

Results: In the present study, type II internal echogenic pattern (64.4 %) was predominant, followed by type III and type I in OSF subjects. So, type I internal echogenic patterns might be associated with normal muscles, and types II and III internal echogenic patterns might be associated with pathologic changes. A good interobserver agreement was observed.

Conclusion: In OSF patients, the appearance of the masseter muscle's internal echogenic pattern showed a varied pattern from that of normal types.

Keywords

Ultrasonography (USG); Oral Submucous Fibrosis (OSF); Masseter Muscle; Internal Echogenic Pattern

Introduction

Ultrasonography (USG) is a powerful imaging tool for a wide range of diseases and organ systems. It's a useful clinical tool for assessing head and neck anatomy and pathology in particular. USG has been widely utilized in evaluating various head and neck conditions, such as diseases of the thyroid gland, parathyroid gland, salivary gland, and lymph nodes in both screening and further detailed examination. Diagnostic studies and initial screening using USG have become more preferred, especially in light of mounting evidence of possible future harm from ionizing radiation use.

Previously muscle area and structural alterations, including masticatory muscles, were visualized by Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) [1-3]. USG, in comparison to these modalities, is a quick, easy-to-use, and relatively inexpensive technique. Various investigators studied different muscles of the body using USG. Such observations were made on the quadriceps muscle by Heckmatt, et al., in 1988, Sipila and Suominen in 1991, and on the rectus femoris, vastus medialis, vastus lateralis, and biceps brachii muscles by Dock, et al., in 1990 [4-6].

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Ariji, et al., investigated the thickness of the masseter muscle in 25 female patients with Temporomandibular Disorder (TMD), which was measured at rest and maximum contraction using USG and found that there were significant differences in the width at rest and the increased ratio by contraction between the patient and control groups. They also categorized the internal echo pattern of masseter muscle into three types [7].

Much research has been done on ultrasound to evaluate the masseter muscle in healthy volunteers, patients with inflammation, and patients with temporomandibular disorders [8-14]. Only a few studies have focused on USG to assess the masseter muscle thickness and internal echogenic pattern in patients with OSF [15-20]. So, the present study was undertaken to evaluate the internal echogenic pattern of the masseter muscle in OSF patients using USG and compare it with that of normal mucosa.

Materials and Methods

This study was carried out at the Government Dental College in Thiruvananthapuram in the Oral Medicine and Radiology department.
Sample size is calculated using the formula

$$n = \frac{2\sigma^2 X (Z\alpha+Z\beta)^2}{(\mu_2-\mu_1)^2}$$

Where,

n = Number of subjects needed in each group

σ = Standard Deviation, which is taken as 2.61 from the pilot study

$\mu_2-\mu_1$ = Mean difference, which is taken as 1.72 from the pilot study

α = Type I error = 5 %

Therefore $Z_\alpha = 1.96$

β = Type II error = 20 %

Therefore $Z_\beta = 0.84$

Therefore,

$n = 2 \times (2.61^2/1.72^2) \times (1.96+0.84)^2$

= 36 in each group

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A total of 126 subjects were taken up for the study after explaining the procedure and getting their informed consent. The study population was divided into cases and controls. Cases consisted of 63 subjects who were clinically diagnosed as having OSF and controls consisted of 63 subjects selected from the patients attending the outpatient clinic of Oral Medicine and Radiology, Government Dental College, Thiruvananthapuram for routine dental treatment. The research subjects were chosen at random, with no regard for their age, gender, or other factors. Before beginning the study, permission from the Institutional Ethical Committee, Government Dental College, Thiruvananthapuram was acquired. Subjects who declined to participate in the research or who had severe systemic illnesses were excluded.

Subjects with complaints such as spicy food intolerance, burning sensation of the mouth, and progressive difficulty in opening mouth and tongue movements were taken in for a thorough examination. To arrive at a clinical diagnosis of OSF, a comprehensive history and thorough clinical examination were performed. All the subjects' information was entered into a proforma. According to Khanna and Andrade's criteria, the subjects in the case group were classified into four stages [21]. The four stages were:

Stage I (Very early cases) - Normal mouth opening, burning sensation, excessive salivation, acute ulceration, and recurrent stomatitis.
Stage II (Early cases) - Interincisal width during mouth opening: 26-35 mm, primarily affected areas are soft palate and faucial pillars, buccal mucosa appears mottled and marbled, with dense, pale, depigmented, and fibrosed areas alternating with normal pink mucosa, red erythematous patches, and widespread sheets of fibrosis.
Stage III (Moderately advanced cases) - Interincisal width during mouth opening: 15-25 mm, trismus, palpable vertical fibrous bands with a firm attachment to underlying tissue, fibrous bands in the soft palate appears to radiate from the anterior faucial pillar or pterygomandibular raphe in a scar-like appearance, atrophy of vermillion border of the lips, patient unable to puff out the cheeks or whistle, reduced mouth opening, and unilateral posterior cheek involvement of the soft palate and faucial pillar.
Stage IVa (Advanced cases) - Stiffness/inelasticity of the oral mucosa, mouth opening: 2-15 mm (interincisal opening), trismus, uvula seen to be involved as a shrunken, small, and fibrous bud, fauces thickened, shortened, and firm on palpation, tongue movement restricted, papillary atrophy (diffuse), the lips-circular band felt around the entire mouth, the intraoral examination is difficult.
Stage IVb (Advanced cases) - With premalignant and malignant changes, OSF and leukoplakia, OSF, and squamous cell carcinoma.

To confirm the diagnosis of OSF, all subjects in the case group had an incision biopsy. In the control group, no biopsies were done.

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Ultrasonographic Examination

The imaging was done with a high-resolution real-time LOGIQUE C5 ultrasonic scanner with 7-12MHz transducers. The ultrasonographic pictures were assessed independently by the investigator and sonologist to determine the interobserver agreement.

The internal echogenic pattern of the masseter muscle was evaluated. The echogenic bands, which corresponded to muscle-tendon, were evaluated subjectively according to their visibility and width. Both right and left sides of the masseter muscle were evaluated in the case and control groups. The masseter muscle appearance was classified into one of the following three types described by Ariji, et al., [7].

Type I - The fine bands were visible in the muscle. Include three subtypes with different band appearances
Subtype Ia - Only a transverse fine band at the middle depth of the muscle
Subtype Ib - A fine transverse band and several short bands
Subtype Ic - Several short bands without a transverse band
Type II - Thickening and the weakened echo intensity of the bands
Type III - The internal bands disappeared or were reduced in number

Statistical Analysis

Statistical Package for Social Science (SPSS) V 23 was used to evaluate all of the data. 'Chi-Square test' was used to assess the significance of internal echogenic patterns between study groups. A 'p' value of 0.05 or less was considered statistically significant. The interobserver agreement on the internal echogenic pattern of masseter muscle was assessed using Cohen's Kappa.

Results

A total of 126 subjects were involved in the study. The study population was divided into cases and controls. Cases consisted of 63 subjects who were clinically diagnosed as having OSF and controls consisted of 63 subjects selected from the patients attending the outpatient clinic of Oral Medicine and Radiology, Government Dental College, Thiruvananthapuram for routine dental treatment.

The subjects in this study's case group varied from 27 to 73 years old, with a mean age of 48.75±9.14 years. The control group's subjects varied in age from 26 to 71 years old, with a mean age of 49.05±10.05 years.

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According to Khanna and Andrade's criteria, the subjects in the case group were classified into four stages [21]. The most prevalent stage was the moderate stage (stage III) with 29 subjects. Three subjects were in very early stage (stage I) and 11 in early-stage (stage II). The remaining 20 subjects were in advanced stage (stage IV); among them, 7 had coexisting carcinoma (stage IVb).

Analysis of Ultrasonographic Imaging

Ultrasonographic imaging was carried out on both right and left masseter muscle of all subjects included in the study, using a high-resolution real-time LOGIQUE C5 ultrasound scanner with 7-12MHz transducers. The internal echogenic patterns of both masseter muscles were recorded separately (Fig. 1). The ultrasonographic findings of each group are described in the following sections.

The internal echogenic pattern of the masseter muscle (control group) 84.9 % of subjects in the control group had type I internal echogenic patterns, and 13.5 % had type II internal echogenic patterns of the masseter muscle in USG. Only one case (1.6 %) had a type III internal echogenic pattern of the masseter muscle (Fig. 2).

Among subjects with type I internal echogenic pattern, 55.2 % had subtype Ia, 24.2 % had subtype Ib, and 20.6 % had subtype Ic internal echogenic pattern (Fig. 3).

The internal echogenic pattern of the masseter muscle (case group)

The internal echogenic pattern of the right masseter muscle

In the case of the right masseter, Types I and II internal echogenic patterns were observed in 54 (85.7 %) and 8 (12.7 %) control subjects, respectively, and only 1 (1.6 %) subject showed type III internal echogenic pattern. Conversely, there were 10 (15.9 %), 39 (61.9 %), and 14 (22.2 %) case subjects in types I, II, and III internal echogenic patterns, respectively (Fig. 2). A significant difference in the distribution of types between the case and control groups was noted.

Among controls with type I internal echogenic pattern, there were 31 (57.4 %), 13 (24.1 %), and 10 (18.5 %) subjects in subtypes Ia, Ib, and Ic, respectively. Among cases with type I internal echogenic patterns, there were 4 (40 %), 3 (30 %), and 3 (30 %) subjects in subtypes Ia, Ib, and Ic, respectively (Fig. 3).

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The internal echogenic pattern of the left masseter muscle

In the case of the left masseter, Types I and II internal echogenic patterns were observed in 53 (84.1 %) and 9 (14.3 %) control subjects, respectively, and only 1 (1.6 %) subject showed type III internal echogenic pattern. Conversely, there were 9 (14.3 %), 42 (66.7 %), and 12 (19 %) case subjects in types I, II, and III internal echogenic patterns, respectively (Fig. 2). A significant difference in the distribution of types between the case and control groups was noted.

Among controls with type I internal echogenic pattern, there were 28 (52.8 %), 13 (24.5 %), and 12 (22.6 %) subjects in subtypes Ia, Ib, and Ic, respectively. Among cases with type I internal echogenic patterns, 3 (33.3 %) subjects were in each subtype (Fig. 3).

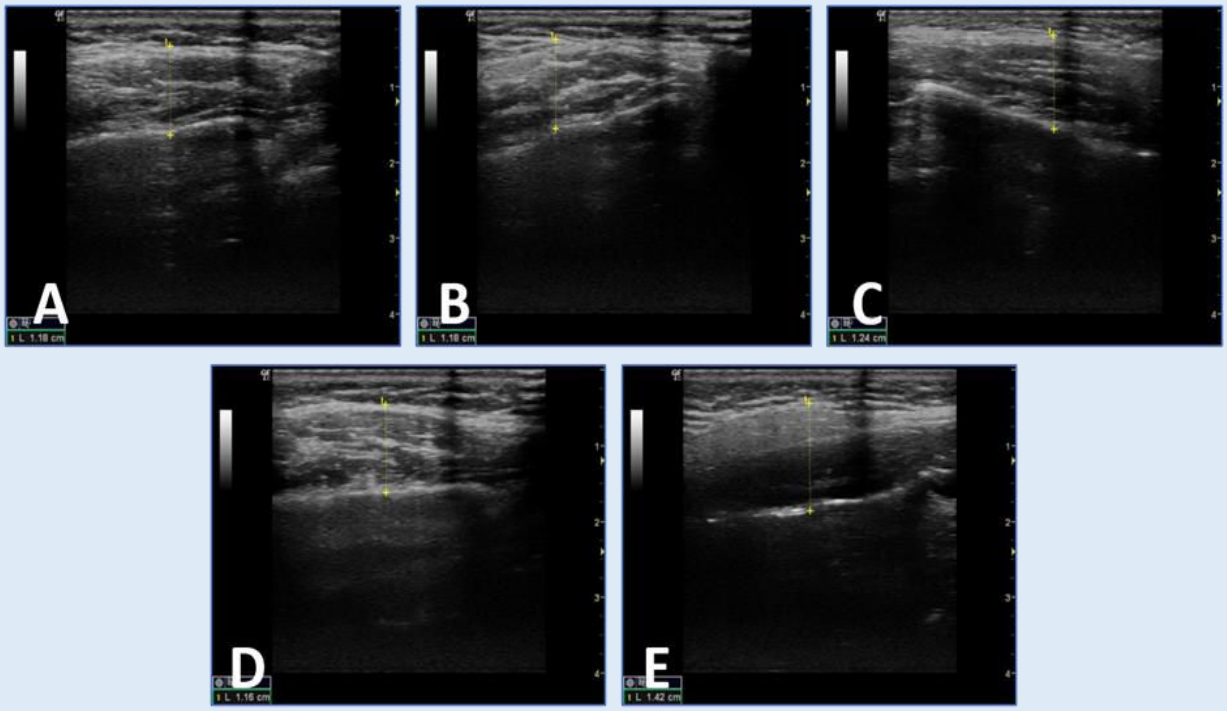

Figure 1: Types Internal Echogenic patterns of the Masseter muscle: A) Subtype Ia internal echogenic pattern characterized by only a fine transverse band in the middle depth of the muscle. B) Subtype Ib internal echogenic pattern characterized by a fine transverse band and several short bands. C) Subtype Ic internal echogenic pattern characterized by several short bands but no transverse band. D) Type II internal echogenic pattern characterized by thickening and weakened echo intensity of the bands. E) Type III internal echogenic pattern characterized by the disappearance or reduction in the number of the bands.

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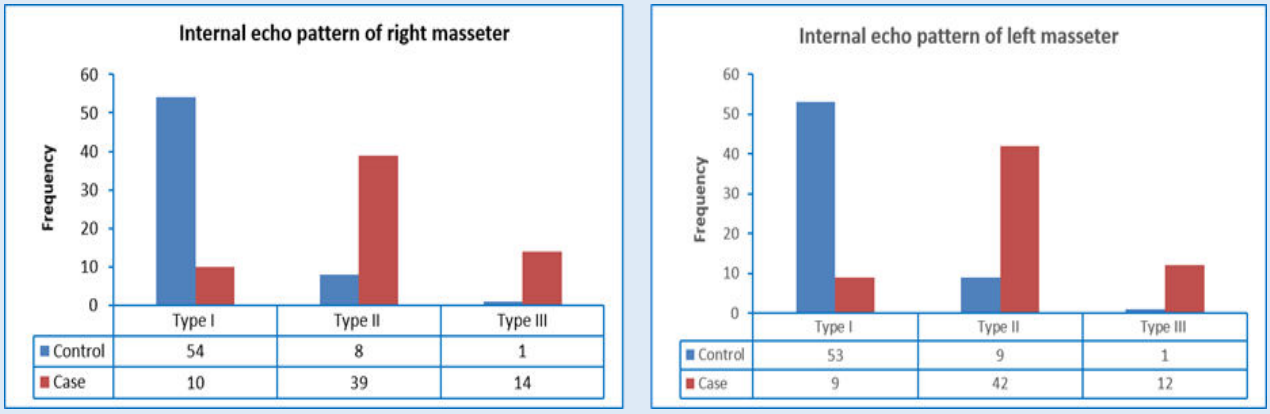

Figure 2: Internal echogenic pattern of masseter muscle: Graphs showing internal echogenic pattern of masseter muscle among controls and cases.

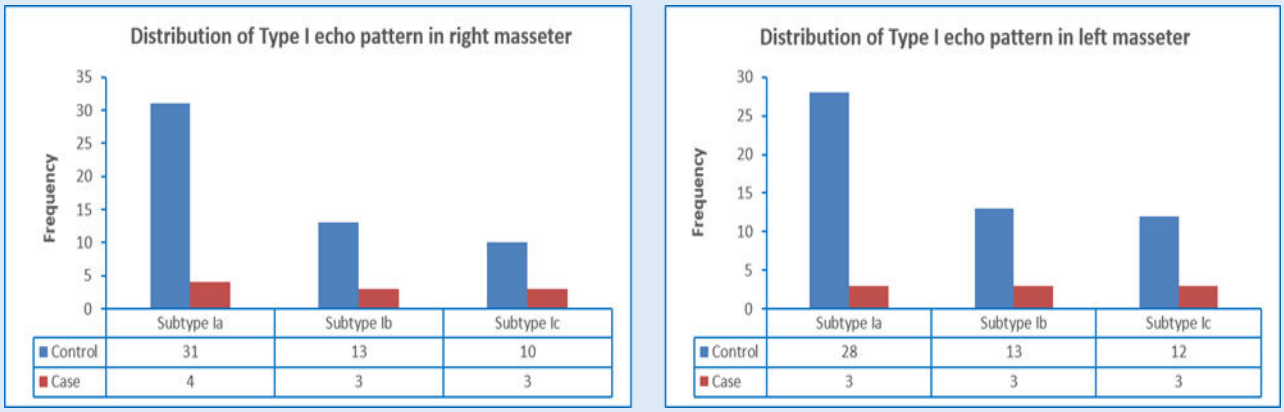

Figure 3: Distribution of Type I echogenic pattern: Graphs showing distribution of Type I echogenic pattern of the masseter muscle among controls and cases.

Interobserver Variability

The interobserver agreement on the internal echogenic pattern of masseter muscle was assessed using Cohen's Kappa. The calculated Kappa was 0.893 and 0.892 for the right and left masseter, respectively (Table 1). It was 0.812 and 0.813 for subtypes of type I on the right and left masseter, respectively (Table 2). There appeared to be a substantial agreement between the two observers in evaluating the internal echogenic pattern of masseter muscle using USG.

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The internal echogenic pattern of the masseter						
Right Masseter			Observer 1			Total
			Type I	Type II	Type III	
	Observer 2	Type I	62	0	0	62
		Type II	2	43	2	47
		Type III	0	4	13	17
	Total		64	47	15	126
	Measure of agreement Kappa = 0.893				P<0.001	
Left Masseter			Observer 1			Total
			Type I	Type II	Type III	
	Observer 2	Type I	60	0	0	60
		Type II	2	47	2	51
		Type III	0	4	11	15
	Total		62	51	13	126
	Measure of agreement Kappa = 0.892				P<0.001	

Table 1: Cohen's Kappa assessment for types of internal echogenic patterns: The frequencies of different types of internal echogenic patterns assessed by both observers.

The internal echogenic pattern of the masseter in Type 1						
Right Masseter			Observer 1			Total
			Subtype 1a	Subtype 1b	Subtype 1c	
	Observer 2	Subtype 1a	31	2	0	33
		Subtype 1b	3	12	1	16
		Subtype 1c	0	1	12	13
	Total		34	15	13	62
	Measure of agreement Kappa = 0.812				P<0.001	
Left Masseter			Observer 1			Total
			Subtype 1a	Subtype 1b	Subtype 1c	
	Observer 2	Subtype 1a	27	2	1	30
		Subtype 1b	2	13	0	15
		Subtype 1c	1	1	13	15
	Total		30	16	14	60
	Measure of agreement Kappa = 0.813				P<0.001	

Table 2: Cohen's Kappa assessment for Type I pattern: The frequencies of different type I internal echogenic patterns assessed by both observers.

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Discussion

Subjects, who reported to the outpatient clinic of the Department of Oral Medicine and Radiology, Government Dental College, Thiruvananthapuram, were screened. A total of 126 subjects were involved in the study. 63 Subjects with features suggestive of OSF were taken up for the ultrasonographic analysis after recording history and after getting informed consent. An equal number of subjects, matched for sex and age, who were selected from the patients attending the outpatient clinic of Oral Medicine and Radiology, Government Dental College, Thiruvananthapuram for routine dental treatment were enrolled as controls.

In the current study, 84.9 % of subjects in the control group presented with type I internal echogenic pattern, and 13.5 % had type II internal echogenic pattern of the masseter muscle in USG. Only one case (1.6 %) was found to have the masseter muscle's type III internal echogenic pattern. A similar result has been stated in a study by Imanimoghaddam, et al., wherein 90 % of healthy subjects demonstrated type I internal echogenic pattern and 10 % with type II internal echogenic pattern [22]. Ariji, et al., and Iyengar, et al., found that the highest frequency of echogenic pattern was the type I followed by type II in controls [7,20]. In the present study, among controls with type I internal echogenic pattern, 55.2 % had subtype Ia, 24.2 % had subtype Ib, and 20.6 % had subtype Ic internal echogenic pattern. This is probably one of the few studies where frequencies of different type I echogenic patterns have been studied.

In the present study, type II internal echogenic pattern (64.4 %) was predominant, followed by type III (20.6 %) and type I (15 %) in case subjects. Iyengar, et al., noticed similar findings in OSF patients.20 Ariji, et al., and Sasaki, et al., observed a predominant type II internal echogenic pattern of the masseter muscle in patients with a temporomandibular disorder associated with myofascial pain [7,23]. It was also noted that all the three subtypes of type I echogenic patterns were equally distributed among cases. There are very few studies on different type I echogenic patterns.

The echogenic pattern of superficial anatomical structures evident on USG is related to the difference in the acoustic impedance between the tissues [6]. Fine transverse hyperechoic bands are usually observed in USG images of normal muscles [10]. Studies have demonstrated a reduction in the number of echogenic bands in an inflamed muscle, and hence, it has been suggested that echogenic bands are significant indicators of masseteric inflammation [24]. Sasaki, et al., observed a significant difference in the distributions of types of internal appearance of masseter muscle before and after treatment of the temporomandibular disorder [23]. Prolonged chewing of areca nut and other commercial preparations may have resulted in work hypertrophy of the masseter muscle. This hypertrophy of the muscle leads to stretching

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of the fascia in the muscles, which may alter the muscles' echogenic pattern [12]. So to conclude, type I internal echogenic patterns might be associated with normal muscles, and types II and III internal echogenic patterns might be associated with pathologic changes [7,20].

Conclusion

The study showed that the appearance of the internal echogenic pattern of the masseter muscle in OSF patients showed a varied pattern from that of normal types. In comparison to clinical and histopathological examination, USG can be considered a valuable, radiation-free, and non-invasive diagnostic tool for evaluating OSF. However, more research with bigger sample size is needed to create an appropriate internal echogenic pattern to distinguish between different phases of OSF.

Conflict of Interest

There are no conflicts of interest.

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