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RESEARCH ARTICLE

ULTRASONOGRAPHIC EVALUATION OF MASSETER MUSCLE HYPERTROPHY IN OSMF PATIENTS

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ABSTRACT

Background and objectives: Oral submucous fibrosis is a well-recognized and most prevalent premalignant condition of oral mucosa in India and Southeast Asia. Frequent and prolonged chewing of tobacco exerts undue pressure on muscles of mastication, which in turn may result in work hypertrophy of muscle. The present study was undertaken to measure thickness of masseter muscle at rest and at clenching position by ultrasonography in oral submucous fibrosis patient and in control group, and also to establish the normal value of masseter muscle thickness ultrasonographically and to prove that ultrasonography is reliable diagnostic technique for the evaluation of masseter muscle hypertropy in oral submucous fibrosis patient.

Materials and methods: Ultrasonographic measurements of masseter muscle thickness were performed using high frequency linear transducer for 45 subjects comprising of 30 oral submucous fibrosis patients and 15 controls.

Results: Study group showed higher thickness both on right and left side masseter muscle and also in relaxed and contracted state when compared to controls. The thickness of masseter muscle is more in contracted state than relaxed state which was highly significant

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INTRODUCTION

Oral submucous fibrosis (OSMF) is a potentially malignant disorder that primarily affects any part of the oral cavity and sometimes even the pharynx.1People with OSMF carry a high risk of developing oral cancer (Devathambi and Nalini Aswath, 2013; Goel *et al*., 2010). The tissues most frequently affected by OSMF in the oral cavity are buccal mucosa and retromolar area, followed by the soft palate, palatal fauces, uvula, tongue, and labial mucosa (Devathambi and Nalini Aswath, 2013). Clinical diagnosis of OSMF is usually made based on several characteristic features of OSMF, including intolerance to spicy foods, blanching and stiffness of the oral mucosa, fibrous bands in the buccal or labial mucosa, and progressive inability to open the mouth (Lee *et al*., 2009). The overall prevalence of OSMF in India is about 0.5% with a range of 0.2-1.2% in different regions of the country (Devathambi and Nalini Aswath, 2013; Raina *et al*., 2005).

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The exact etiology of OSMF is not well understood. The different causative agents include intake of spicy food, chewing of betel nut, betel quid, and preparations containing tobacco (pan masala, gutka, Khaini, etc.). 1,4 OSMF has a high rate of morbidity because it causes a progressive inability to open the mouth, resulting in poor eating and consequent nutritional deficiencies. OSMF also has a significant mortality rate because it is a precursor to oral cancer, particularly squamous cell carcinoma, seen in 7.6% of the cases (Devathambi and Nalini Aswath, 2013; Dyavanagoudar, 2009). Ultrasonography (USG) is particularly suitable for imaging superficial structures of the head and neck region. USG provides both qualitative and quantitative assessments. Qualitatively, it provides information on the nature of a lesion and its relation to adjacent normal structures. Quantitatively, it assesses the dimensions of the lesion, its distance from the skin surface and its relative proximity to the skin and mucosal surfaces. Up till now and despite extensive studies, there is no conclusive evidence of adverse biological effects of the use of USG as it does not produce ionizing radiation (Devathambi and Nalini Aswath,

2013). This preliminary study included USG measurements of MM in OSF patients who were chronic gutkha chewers with a clinically appreciable MMH. This study also aimed to reproduce the normal values of masseter muscle thickness ultrasonographically (Kamala *et al*., 2010). Idiopathic masseter muscle hypertrophy (IMMH) was first described by Legg in 1880, reporting on the case of a 10-year-old girl. A hypertrophied masseter will alter facial lines, generating discomfort and negative cosmetic impacts for many patients. Benign masseteric hypertrophy is a relatively uncommon condition that can occur unilaterally or bilaterally. Unilateral- or bilateral hypertrophy of the masseter muscle is characterized by an increase in the volume of the muscle mass. This condition is benign and asymptomatic (Biruktawit Kebede and Shimalis Megersa, 2011).

Masseter muscle (MM) is morphologically the largest structure with greater biting force (Kamala *et al*., 2010; Bedi, 1996). An association of oral submucous fibrosis (OSMF) and masseter muscle hypertrophy (MMH) might represent increased functional demand on masseter muscle because of gutkha chewing habit (Dyavanagoudar, 2009; Haider *et al*., 2000). Fibrosed buccal mucosa causes constriction of the tissue and results in flattening of the cheek, giving it a sunken cheek appearance, which exacerbate the appearance of the masseter muscle (Kamala *et al*., 2010; Haider *et al*., 2000). Masseter Muscle Hypertrophy usually presents

MATERIALS AND METHOD

The study was carried out in the department of Oral Medicine and Radiology, Meenakshi Ammal Dental College and Hospital, Chennai. The study was carried out among the patients who visited the dental out patient. The study group was divided into two as Group A and Group B. Group A comprised of study population and Group B consists of control Population. The study design was approved by the Ethics Research Committee (Annexure I).

Group A: Study Group

30 patients with oral submucous fibrosis were included in this group. The patients were diagnosed on the basis of clinical and histological features.

Group B: Control Group

15 patients age and gender matched the study group with no history of tobacco associated habits and lesion, chewing gum habit and also without any parafunctional habits such as bruxism.

Inclusion Criteria

The clinical diagnosis of oral submucous fibrosis was made using the criteria as mentioned by Gupta *et al*. (1992) classified OSMF69 based on physical finding such as:

Grade 1: Blanching of Oral Mucosa without any symptom.

Grade 2: Burning sensation, xerostomia, vesicles and ulcers in mouth, tongue not involved.

Grade 3: Grade 2 + restricted mouth opening.

Grade 4: Grade 3 + palpable fibrous bands, tongue not involved.

Grade 5: Grade 4 + tongue involvement.

Grade 6: Submucous fibrosis with histologically proven oral cancer.

Exclusion Criteria

- Patients with no history of areca nut or tobacco chewing.
- Patients with no appreciable malocclusion, parafunctional habits like bruxism or any other clinically diagnosed oral mucosal lesion.

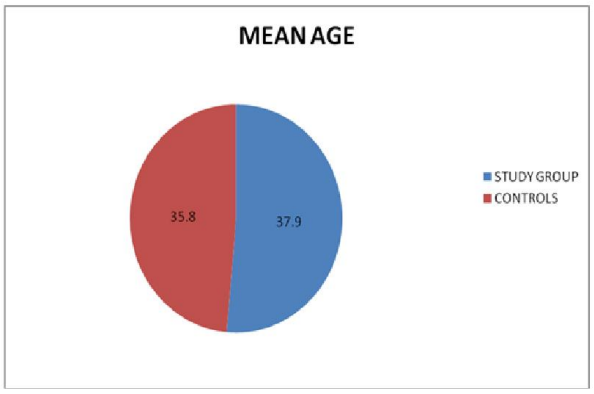
METHODOLOGY

All the patients fulfilling the above criteria were informed about the study being conducted and signed consent form were obtained. All the enrolled subjects were then interviewed and examined on the dental chair in the dental outpatient department using diagnostic instruments and recorded in a prepared case sheet proforma. All the details of the patients like name, age, sex, occupation and communication address were recorded. A detailed history consisting of chief complaint, history of past and present illness, past medical history if any was recorded. Emphasis was laid on recording any oral habits of chewing areca nut, paan (betel quid), ghutkha, mawa, khaini and other tobacco related products, use of these product/products per day with number of times used per day, duration of contact and placing the quid etc. Inquiry was also made regarding cigarette or bidi smoking with frequency and duration of the habit. Routine haemogram for analyzing the Hb%, bleeding time, clotting time and Random blood sugar was performed. Ultrasound of the masseter muscle performed on either side followed by incisional biopsy to histopathologically prove the lesion as OSMF.

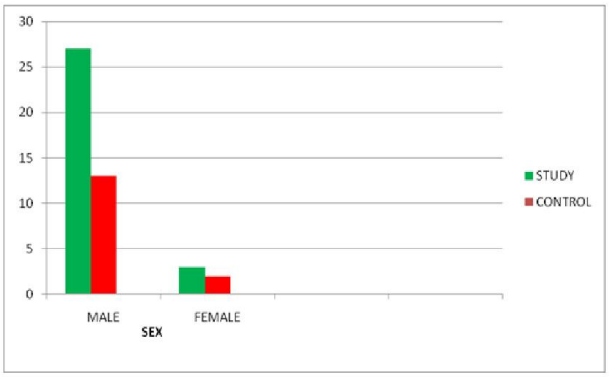
PROCEDURE

The ultrasound was performed with patient in supine position by a single trained radiologist using Logic P5 ultrasound unit with a high frequency linear transducer (10-15 MHz). The real time imaging of masseter was performed both in relaxed and contracted state. Vascularity of the muscle was also checked using real time color Doppler. The high frequency linear transducer was run along the cheek postero-anteriorly from the ramus of the mandible to the body of the mandible. The maximum thickness of masseter muscle was carefully observed in the first 3 cases and ascertained as the inferior border to the superficial lobe of the parotid gland. With that as the reference point, the measurement was recorded, then the subject was asked to clench his teeth and the measurement was recorded again.

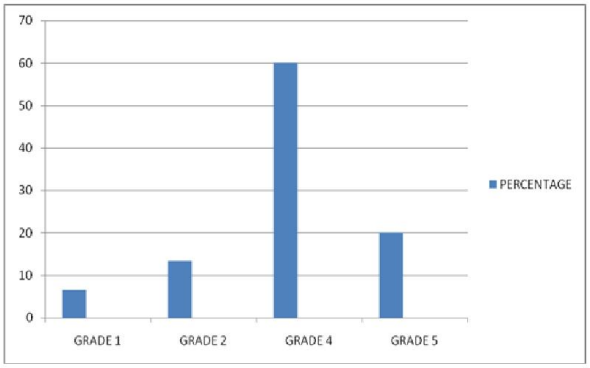
Vascularity was also assessed using color Doppler. The procedure was repeated again on the opposite side. The readings were noted down in a table as shown below. In recent years, Ultrasonography (USG) has proved to be an accurate, convenient, easy and an inexpensive method used to measure the masseter muscle mass. After extensive studies there is still no conclusive evidence that USG can cause any adverse biological effects at diagnostic power levels (Kamala *et al*., 2010; Bakke *et al*., 1992).



Graph 1. Mean Age of the Control & Study Group



Graph 2. Male: Female Ratio In Control & Study Group



Graph 3. Grade Percentage In The Study Group

RESULTS

The study consisted of 45 patients who visited department of oral medicine and radiology at Meenakshi Ammal Dental College. These patients were divided into the following groups:

Group A: (Study Group)

30 patients who were clinically diagnosed and histologically proved as Oral Submucous Fibrosis (OSMF)

Group B: (Control Group)

15 patients age and gender matched the study group with no history of tobacco associated habits and lesion, chewing gum habit and also without any parafunctional habits such as bruxism.

DEMOGRAPHIC DATA

AGE: The subjects age ranges from 20-65 years. Their mean age in Group A is 37.93 ± 2.29, whereas in Group B is 35.80 ± 2.81. Mean age of Group A is 37.9 and Group B is 35.8.There is no significant difference noticed as Group B (control group) is matched with Group A (study group).

GENDER: In Group A males were 27 which accounts for 90% and 3 are female making up for the remaining 10% **;** In Group B males were 13 (86.7%) and females 2 (13.3%) respectively.

Ultrasonographic Evaluation of Masseter Muscle In Group A & Group B

In the control group, the mean relaxed thickness of right and left masseter muscle was 12.66 mm and 12.25 mm, respectively, whereas the mean contracted thickness of right and left masseter muscle was 13.92 mm and 13.66 mm, respectively. In the study group, the mean relaxed thickness of right and left masseter muscle was 14.02 mm and 13.65 mm, respectively, whereas the mean contracted thickness of right and left masseter muscle was 15.92 mm and 15.50 mm, respectively.

The comparison of right versus left masseter muscle thickness was not significant in control group, both in relaxed and contracted state. In study group, the relaxed versus contracted thickness of masseter muscle was highly significant, $p < 0.001$. On comparing the ultrasonographic measurements of the right and left masseter muscle thickness in study and control groups, in relaxed and contracted state, revealed that, the mean of the relaxed and contracted thickness of muscles on both right and left side was highly significant, $p < 0.001$ in the study as well as in the control groups. Relaxed versus contracted muscle thickness in study and control group was also highly significant with $p < 0.001$. The study group showed higher thickness, both on the right and left side in relaxed as well as in the contracted state when compared to the controls. The thickness of masseter muscle was more in contracted state than relaxed state both in study as well as control group, which was highly significant. Comparison of right versus left masseter muscle thickness (both in relaxed and contracted states) in the study and control groups was not significant, $p > 0.05$.

MASTER CHART

Table 1. Group A (Study Group)

S.no	Name	Age/sex	Grade	Left masseter relaxed (mm)	Left masseter clenched (mm)	Right masseter relaxed (mm)	Right masseter clenched (mm)
1	Balaji	24/m	4	13.2	15.5	13.2	16.7
2	Shiva kumar	27/m	4	13.4	16.8	16	17.6
3	Ganesh	32/m	1	16.4	17	16.9	17.3
4	Mohd.waquar	25/m	5	15.6	16	14	14.9
5	Gunasekaran	24/m	2	16.9	18.9	16.4	17.8
6	Shanthi	38/f	5	11.8	16.4	12.5	16.3
7	Rajesh	20/m	4	14.3	15.3	15.1	16
8	Selvam	48/m	5	12.4	14.2	15.9	17.1
9	Thameem ansari	43/m	5	16.4	17.4	12.9	15.4
10	Mahendran	62/m	4	13.2	15.5	17.9	21.1
11	Sadagopan	62/m	5	12.7	13.1	11.8	14.4
12	Jakir ali	25/m	2	10.7	13.6	10.5	11.2
13	Abubaker	60/m	4	14	14.9	12.1	14
14	Jagadeesh	40/m	4	11.2	12.9	11.1	12.3
15	Sunitha jain	42/f	1	12.9	14.8	14.9	15.2
16	Sathish raju	34/m	4	16.8	17.7	17.3	18.8
17	Jacob	48/m	4	11	17	12	17
18	Pandian	23/m	4	15.4	16.4	12.7	15.8
19	Madhisekaran	65/m	2	13.2	15.9	14.6	15.4
20	Sisubalan	49/m	4	15.8	16.5	16.8	18.5
21	Birendra pandey	42/m	4	14	15.2	13.9	17
22	Pawan	27/m	4	12	15	12	16
23	Kumaran	37/m	5	13	16	12	16
24	Mallika	42/f	2	7	10	9	11
25	Ramesh	37/m	4	12.8	14.2	16.7	17.5
26	Prakash	24/m	4	9.7	11.4	10.1	11.9
27	Arjun	32/m	4	12.8	15.5	14.6	15.1
28	Prasath	36/m	4	13.6	13.7	14.5	15.1
29	Lakshmi kanthan	34/m	4	17.3	19.8	15	17.7
30	Karthik	34/m	4	11.5	11.8	12.2	12.3

Table. 2 Group B (Controls)

S.no	Name	Age	Sex	Left masseter relaxed (mm)	Left masseter clenched (mm)	Right masseter relaxed	Right masseter clenched
1	J.k.singh	26	M	15.3	16.4	14.2	14.3
2	Anjali	41	F	13.5	15.4	12.5	13.3
3	Manjula	42	F	13.2	13.2	14.2	15
4	Shanmuga sundaram	25	M	12.5	13	13	13.2
5	Vasanth	30	M	17.5	17.6	16	16.1
6	Naveen kumar	26	M	13.6	14.2	14	15.3
7	Khatak bahadur	37	M	13.4	13.9	13.3	13.8
8	Bhandari	42	M	16.4	18	16.2	18.6
9	Nygin	21	M	14.3	15.2	14	15.1
10	Nitin	22	M	13.4	14.9	13	14
11	Bhaskar	60	M	12.8	14.2	13.3	15
12	Abraham	47	M	14.2	15.4	14.2	14.8
13	Jeevan	39	M	13.7	14.7	13.7	14.4
14	Ravi	45	M	13.3	14.2	13.2	14.8
15	Sekar	34	M	16.3	16.8	15.9	16.4

Table 3. Mean Age

GROUP A (CASES)	37.9
GROUP B(CONTROL)	35.8

Table 4. Gender

STUDY GROUP	MALE	PERCENTAGE	FEMALE	PERCENTAGE
GROUP A (CASES)	27	90%	3	10%
GROUP B (CONTROLS)	13	86.7%	2	13.3%

Table 5: Mean of Ultrasonographic findings of Group A (Study Group)

MASSETER MUSCLE	MEAN	P VALUE
Left Masseter Relaxed(mm)	13.65	0.017*
Left Masseter clenched (mm)	15.50	0.001**
Right Masseter Relaxed (mm)	14.02	0.019*
Right Masseter Clenched(mm)	15.92	0.001**

NOTE : ** denotes significant at 1 level (Highly Significant), *denotes significant at 5 level (Significant)

Table 6. Mean of Ultrasonographic findings of Group B (Control Group)

Left Masseter Relaxed(mm)	12.25
Left Masseter clenched (mm)	13.66
Right Masseter Relaxed (mm)	12.66
Right Masseter Clenched(mm)	13.92

PHOTOGRAPHS

ARMAMENTARIUM

PROCEDURE

ULTRASONOGRAPHIC IMAGES

High resolution scan done using a linear transducer demonstrating images of masseter muscle in relaxed and clenched position bilaterally.

DISCUSSION

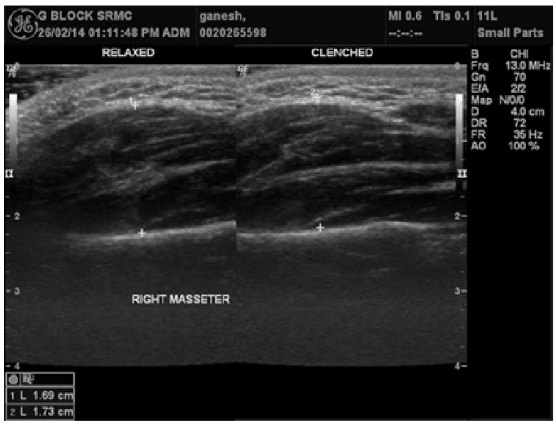
OSMF is predominantly found among the people of South Asia and is closely associated with the habit of chewing betel nut and tobacco products (Goel *et al*., 2010).

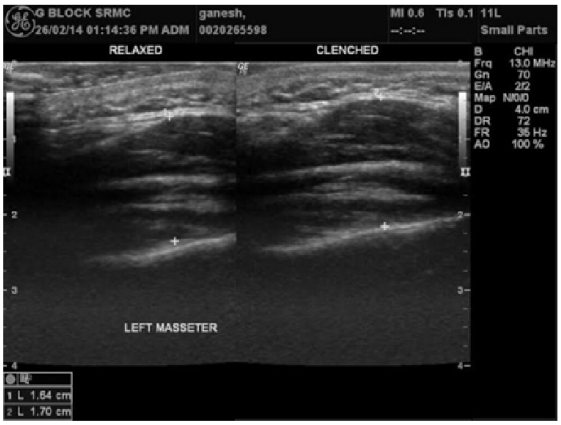
The overall prevalence of oral submucous fibrosis in India is about 0.5% with a range of 0.2□1.2% in different regions of the country. Various etiological factors are being studied, such as genetic, autoimmune, nutritional, and environmental factors. Also studied are habits like intake of spicy food, chewing of betel nut, betel quid, and tobacco preparations (pan masala, gutkha, tobacco, etc.) (Raina *et al*., 2005). OSMF also has a significant mortality rate because it can transform into oral cancer, particularly squamous cell carcinoma as seen in 7.6% of the cases (Dyavanagoudar, 2009). Devathambi *et al* suggests OSMF can occur at any decade, but the majority of the patients are between 20 and 40 years of age. In our study, the mean age of the study group (OSMF) was found to be 37.2.

The masseter, a thick quadrate masticatory muscle, arises from the zygomatic arch and inserts into the inferior lateral aspect and angle area of the mandibular ramus (Biruktawit Kebede and Shimalis Megersa, 2011). Masseter hypertrophy is an asymptomatic persistent enlargement of one or both masseter muscles resulting from a work hypertrophy, initiated by clenching, bruxing, or heavy gum chewing and this occurs primarily in younger patients (Biruktawit Kebede and Shimalis Megersa, 2011). In older age groups with dental deterioration, there is an inability to fully activate the masseters and any pre-existing masseter hypertrophy tends to recede (Biruktawit Kebede and Shimalis Megersa, 2011). Anatomically, most of the masseteric thickness is along the inferior portion of the mandibular ramus, where the facial contour normally tapers. With masseter hypertrophy, the patient's face takes on a characteristic rectangular configuration (Biruktawit Kebede and Shimalis Megersa, 2011). Our study proves that when bite force is increased, as in case of prolonged and frequent tobacco chewing, it will result in over development of muscles of mastication, which is in accordance with the study of Kamala *et al*, Devathambi *et al*, Manjunath *et al*. Several investigators have attempted to measure masseter muscle size using imaging techniques. Ultrasound has been used to measure thickness (Kiliaridis 2003 and Kalebo, 1991; Bakke *et al*., 1992; Raadsheer *et al*., 1994; Ruf *et al*., 1994; Kubota *et al*., 1998), width (Ruf *et al*., 1994) and crosssectional area (Ruf *et al*., 1994; Close *et al*., 1995; Stavros Kiliaridis, 2003). Volume was measured using CT by Gionhaku and Lowe (1989), Xu *et al*. (1994) and Matsushima *et al*. (1998). No report has been published to date of masseter volume measurement using ultrasound.

The USG measurements in control group of the current study can be compared to a USG study done by Bakke *et al*. (1992) in 13 women of 21 to 28 years whose masseter muscle thickness was 8.83 to 11.08 mm in relaxed state, and 9.84 to 12.57 mm in contracted state (Bakke *et al*., 1992). The USG measurements in study group can be compared to a study done in 31 subjects (15 males and 16 females) by Profitt *et al* (1983) with masseter muscle hypertrophy in full dentition, which showed that direct USG measurements of masseter muscle hypertrophy should replace the computed tomography as the definite investigation procedure (Proffit *et al*., 1983). The major advantages of ultrasound are the better accessibility, lower costs, individual planning of the section planes, the ease of repetition, and the fast potential to quantify muscle atrophy in bilateral comparison. Bilateral comparison is possible.

Grade 1





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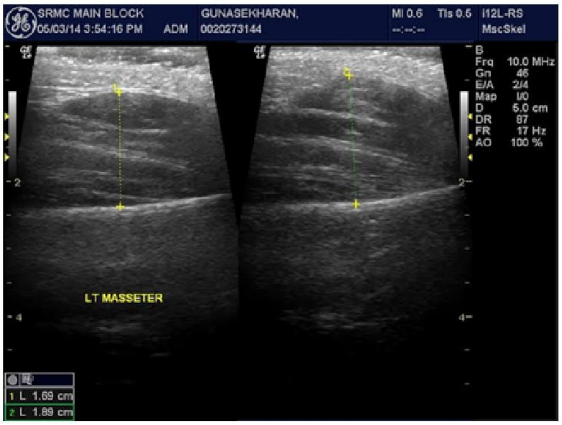

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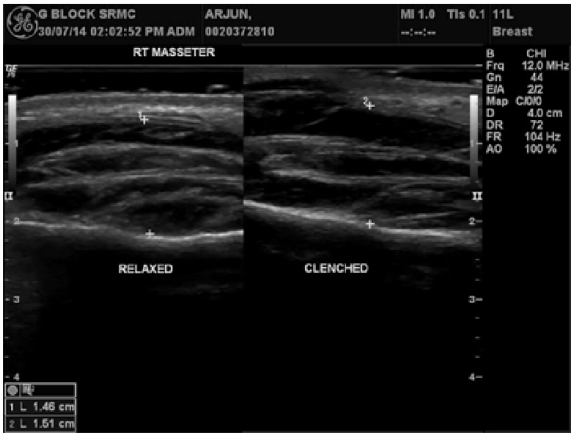

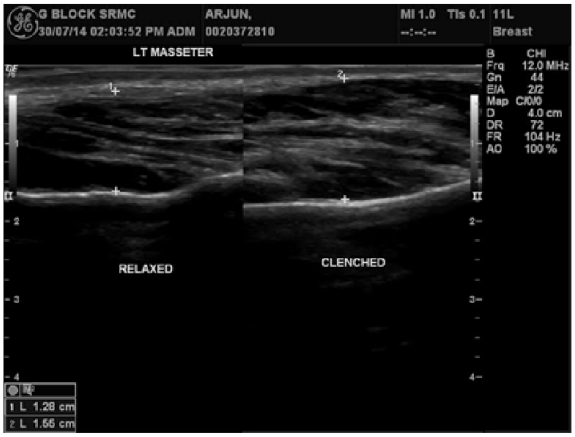

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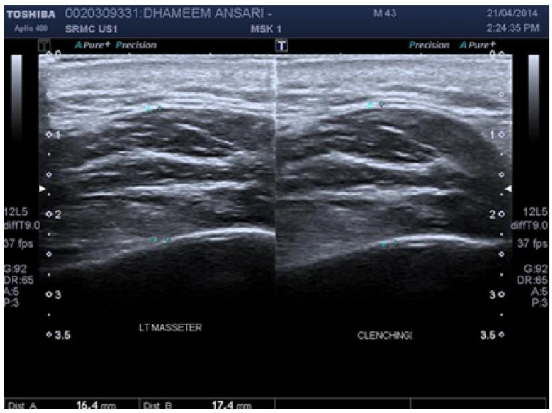

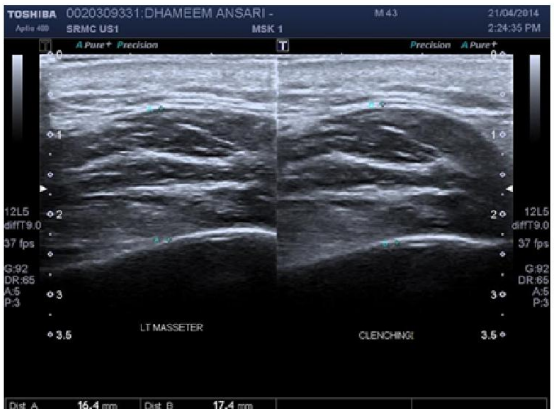

Doing so, we can detect even small remnants of musculature (Gerd Fabian Volk *et al*., 2014). Ultrasound is operator dependent and reading of the scan is dependent on the radiologist's experience. A probe with a higher frequency to penetrate effectively and produce good quality images is essential to be diagnostic (Devathambi and Nalini Aswath, 2013). In the present study, we have evaluated the thickness of the masseter muscle in a relaxed and clenched position, using Ultrasound. The measurements of the study group are 13.65 mm on the left side in relaxed position and 14.02 mm on the right side. On clenching the readings are 15.50 mm on the left side and 15.92 mm on the right side respectively. The mean masseter muscle thickness of the control group on the left side in relaxed position is 12.25 mm and on the right side in relaxed position is 12.66 mm respectively. On clenching the mean on the left side is 13.66 mm and on the right side is 13.92 mm.

Thus in this study, study group showed higher thickness of masseter muscle both on the right and left sides, and also in the relaxed and contracted state when compared with the controls. The thickness of masseter muscle is more in contracted state than in relaxed state in both groups. Similar increase in the bulk of the muscular tissue during contraction has been observed by various studies conducted earlier. The present study is in accordance with these studies. Both the groups were found to be statistically significant which is in accordance with the studies done by Kamala *et al*, Devathambi *et al*. The difference between the right side and the left side in the control and the study group was insignificant which was in accordance with the study by Kamala *et al*. There was an increase of muscle mass observed in the study group when compared to the control group in relaxed position. Hence a definite hypertrophy coexists in OSMF patients than the normal population, which is in accordance with the studies done by Kamala *et al*, Devathambi *et al*. The mean volume of the masseter muscle mass obtained in the control group cannot be assumed to be the normal volume of the masseter muscle in general, as the sample size is small. To obtain such volume, study has to be performed on a large number of patients, which has still not been recorded in any literature so far. In the present study, OSMF patients were graded according to Gupta *et al* (1992) classification. In the present study, there were 2 patients with Grade 1 (6.6%), 4 patients with grade 2 (13.4%), 18 patients with Grade 4 (60%) and 6 patients with Grade 5 (20%). Kamala *et al* observed a gradual increase in the masseter muscle mass with an increase in grades. In the present study, grade of OSMF did not bear any significance in masseter muscle hypertrophy as the grades were disproportionately obtained. The duration of the habit in the present study ranges from one year to 20 years. Duration also did not bear much significance in the study. Vascularity of the masseter muscle was also checked using color Doppler, altered vascularity was observed only in one patient. Biopsy was performed for the study cases, as it still remains the gold standard to confirm the disease (Krithika, 2013). All the cases in the study group were histologically proven as OSMF. Grade 1 patients (2 patients) were excluded from biopsy.

Future ultrasonographic studies are advised with larger samples of OSMF thereby the incidence of masseter muscle hypertrophy in OSF patients could be strongly established in the near future.

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