

Role of Ultrasonography in Evaluation of Oral Submucous Fibrosis Patients: A Systematic Review

Santosh R Patil¹⁾, G Maragathavalli¹⁾, DNSV Ramesh²⁾, Krishna A Rao³⁾,
Vinod Bandela⁴⁾, Mohammad Khursheed Alam⁵⁾

ABSTRACT

Aim: The aim of this systematic review was to retrieve and analyze various clinical studies investigating the role of ultrasonography (USG) in evaluation of oral submucous fibrosis (OSMF).

Material and Method: Literature was searched in electronic search engines from January 2000 to December 2019. The identified articles were independently screened according to set criteria for selection of titles. The full text articles retrieved were assessed for eligibility and the studies meeting the criteria were assessed for qualitative and quantitative evidence.

Results: The electronic searches yielded a total of 31 articles and among these 12 full text articles were selected and assessed. Ultrasound is proved to be a reliable real time imaging tool in evaluating the muscle and submucosal thickness in patients with oral submucous fibrosis.

Conclusion: Ultrasonography is safe and conventional modality for assessing muscle and submucosal thickness, especially in terms of availability and cost factor.

KEY WORDS

ultrasonography, oral submucous fibrosis, systematic review

INTRODUCTION

Oral submucous fibrosis is a chronic disease of insidious onset of unknown cause affecting the oral and oropharyngeal region characterized by progressive fibrosis of submucosa of oral cavity. OSMF is considered as a disease of collagen metabolic disorder presenting with increased collagen production along with minimal degradation of collagen fibres¹⁾.

OSMF is known to progress in to the stage of oral epithelial dysplasia and malignancy, so it is regarded as a premalignant condition. OSMF involves the oral mucosa and also the pharynx and upper gastrointestinal tract²⁾. The presenting features of OSMF are, progressive inability to open the mouth, inflammation and progressive fibrosis of the submucosal tissues, other features include, blanching, decreased mobility and depapillation of tongue, depigmentation of oral mucosa, ulcers, vesicles, nasal twang and deafness in sever cases³⁾. This condition is commonly noted in the population of Indian subcontinent and Southeast Asia^{3,4)}. Areca nut and its products are considered as the prime causative factors to cause OSMF along with some other less proven agents⁵⁻⁹⁾.

MATERIAL AND METHODS

This review was carried out by all the authors with an objective to systematically retrieve and analyse clinical studies investigating the role of ultrasonography in evaluation of OSMF. The authors performed an electronic search of various English databases like PubMed, SCOPUS, and Science Direct from January 2000 to December 2019. The MESH keywords were Ultrasound, Muscle, Submucosa, Thickness, Pathology, combined with OSMF. Thus identified titles and abstracts through the search engines were independently screened by first and second contributors according to set inclusion and exclusion criteria for selection of abstracts. Full text articles of the selected abstracts were retrieved by the third contributor and further retrieval of titles / abstracts was done by cross referencing of full text articles by other contributors. The full text articles were assessed for eligibility by the all the contributors and the selected studies were assessed for the quality of their reporting by all authors.

Inclusion criteria

Original studies, clinical trials, case control studies, that reported

Received on May 6, 2020 and accepted on August 7, 2020

1) Department of Oral Medicine and Radiology, Saveetha Dental College and Hospitals
Chennai, India

2) Department of Oral Medicine and Radiology, AMES Dental College and Hospital
Raichur, India

3) Department of Preventive Dentistry, College of Dentistry, Jouf University
Jouf, Kingdom of Saudi Arabia

4) Department of Prosthodontics, College of Dentistry, Jouf University
Jouf, Kingdom of Saudi Arabia

5) Department of Orthodontics, College of Dentistry, Jouf University
Jouf, Kingdom of Saudi Arabia

Correspondence to: Santosh R Patil
(e-mail: drpsantosh@gmail.com)

Table 1: Summary of studies using USG to evaluate the OSMF

Authors (Year)	Objectives	Methodology	Observations
Kamala <i>et al.</i> (2010) ¹³	To measure thickness of masseter muscle at rest and at maximum clenching position by USG with masseter muscle hypertrophy in OSMF patients	USG measurements of masseter muscle thickness were performed for 40 subjects comprising 20 oral submucous fibrosis patients and 20 controls.	OSMF patients showed higher thickness in masseter muscle when compared to controls.
Manjunath <i>et al.</i> (2011) ¹⁴	To evaluate oral OSMF by clinical and histopathological examination, and compare the results with those from USG findings	30 clinically diagnosed OSMF patients were subjected to both USG and histopathological evaluation before treatment. Later, only USG examination was done during 4th and 8th week of treatment.	USG evaluation revealed 6 individuals with unilateral fibrotic bands and 24 individuals were with bilateral fibrotic bands. USG demonstrated number, length and thickness of the fibrotic bands.
Devathambi <i>et al.</i> (2013) ¹⁵	To evaluate the efficacy of USG in assessing the severity of oral OSMF and also to assess the relationship between OSMF and hypertrophy of the masseter muscle	The submucosal thickness in buccal mucosa and masseteric muscle hypertrophy were measured using USG in 60 patients comprising 30 OSMF patients and 30 controls.	As the stages of OSMF advanced there was an increase in submucosal thickness of the buccal mucosa as well as masseter muscle in the study group when compared with controls
Krithika <i>et al.</i> (2013) ¹⁶	To characterize the sonographic features of the buccal mucosa in patients with OSMF	Three groups (controls with areca-related habits, controls without areca-related habits and clinically diagnosed OSF cases), each comprising 30 subjects, were included in the study. After a thorough clinical examination, USG was performed.	The submucosa that appeared hypoechoic in the control groups had significantly increased echogenicity in the case group. The differentiation between the submucosa and the muscle layer was not clear in the case group.
Chakarvarty (2014) ¹⁷	To evaluate the thickness of masseter muscle in OSMF patients and to compare it with normal patients.	50 subjects, 25 OSMF patients and 25 normal individuals were evaluated. The thickness of masseter muscle was evaluated by USG	A positive association between masseter muscle hypertrophy and OSMF was noted. Thickness of masseter muscle was found to be more in OSMF patients as compared to control.
Kant <i>et al.</i> (2014) ¹⁸	to find out the cross-sectional thickness of the masseter, anterior temporalis and orbicularis oris muscles by ultrasonography comparing with healthy controls	40 patients with OSMF were included in the study group, and the patients were divided into four, i.e. Group I (mouth opening > 35mm), Group II (mouth opening between 30 and 35 mm), Group III (mouth opening between 20 and 30 mm) and Group IV (mouth opening < 20 mm). USG thickness of the masseter, anterior temporalis and orbicularis oris muscles were recorded in patients with OSMF and 20 controls.	Thickness of the masseter muscle was significantly reduced in Group IV when compared with the control group. The anterior temporalis and orbicularis oris muscles remained unaffected
Agarwal <i>et al.</i> (2017) ¹⁹	To evaluate the presence and thickness of submucosal fibrosis OSMF patients ultrasonographically and to correlate these findings with the clinical stage and histological grade of OSMF.	Forty participants (20 OSMF cases and 20 controls) were included in the study. After clinically staging, USG was performed and after that punch biopsy was taken and the specimen was graded histopathologically.	The cases showed increased submucosal thickness as compared to the controls. The USG measurements statistically correlated with the clinical stage and histopathological grade of OSMF.
Sadaksharam <i>et al.</i> (2017) ²⁰	To evaluate the therapeutic efficacy of oral pentoxifylline in the treatment of OSMF by assessing the clinical symptoms, and submucosal layer thickness and echogenicity using USG	30 study subjects were included in the study and divided into oral pentoxifylline and dexamethasone group. Burning sensation, mouth opening, USG submucosal thickness, and echogenicity were recorded both pre- and post-operatively.	A highly significant reduction in burning sensation, improvement in mouth opening, and changes in submucosal thickness were noticed in both groups, and significant in echogenicity in both the groups was noticed.
Tiwari <i>et al.</i> (2017) ²¹	To measure the submucosal thickness in OSMF patients and in normal healthy individuals and to evaluate the changes in the vascularity by using color	50 male subjects out of these 40 and 10 healthy subjects were evaluated. Submucosal thickness of labial and buccal mucosa was measured with USG	A significant increase seen in all the measured sites in cases. The increase in the thickness was found to be increase with the severity of the disease. There was decrease in vascularity in OSMF as compare to controls.

Nadendla <i>et al.</i> (2018) ²³	To evaluate the efficacy of USG as a noninvasive tool in assessing the severity of OSMF by measuring the submucosal thickness and also to correlate the sonographic changes with clinical staging.	The submucosal thickness of the upper and lower labial mucosa, anterior and posterior portions of the right and left buccal mucosa were measured using USG in 64 patients comprising of 32 OSMF patients and 32 controls.	As the stages of OSMF advanced, there was an increase in submucosal thickness of the buccal mucosa in the study group when compared with controls.
Dupare <i>et al.</i> (2018) ²³	To evaluate the role of USG in oral OSMF patients.	A total of 150 underwent USG evaluation of submucosal thickness and vascularity, bilaterally on buccal and labial mucosae was performed.	A statistically significant increase in mean submucosal thickness was shown, and a decrease in vascularity with the advancement of severity of the OSMF.
Mukul <i>et al.</i> (2019) ²³	To find the potential use of ultrasound elastography to objectively quantify the clinical presentation in accordance with severity of the clinical condition in OSMF.	The study sample consisted of 27 clinically diagnosed and staged participants with OSMF. USG was done and color-coded scheme was used to qualitatively grade the eight different zones of oral mucosa with the use of stress-strain elastography.	The results obtained between the elastographic grading and clinical grading came out to be highly significant. The sensitivity and specificity of the diagnostic method were 90.9% and 20%, respectively.

the role of ultrasound in evaluating OSMF published in peer-reviewed journals were included in the current review.

Exclusion Criteria

Review articles, case reports, studies with no clear characterization of subjects, with no clear intervention and outcomes were excluded

RESULTS AND DISCUSSION

The electronic searches yielded a total of 31 articles and among these 12 full text were identified through manual search were independently screened according to set inclusion and exclusion criteria for selection of Titles / abstracts. The investigators were not blinded to journal names or authors.

OSMF is considered as a disease of collagen metabolic disorder in which there is increased collagen synthesis along with limited collagen degradation. Advani observed involvement of the muscles in the fibrosis process and presented illustration showing replacement of the muscle by fibrous tissue¹⁰. Sumthi *et al.*, noted varying degrees of muscle changes including atrophy, degeneration and necrosis of fibres in OSMF subjects. These changes in the muscle may be a manifestation of disease, atrophy being secondary to the limited functional activity of the muscles which is brought about by fibrosis or whether it is an essential part of the disease process itself¹¹.

Ultrasound in Dentistry

In diagnostic Ultrasound, high frequency sound waves enter in to the human body by a transducer and echoes from tissue interface are detected and observed on a monitor. The transducers are designed to generate longitudinal waves hence only those waves can pass through tissues get reflected. Audio frequency of a sound wave is 20 KHz and waves below this are termed as infrasonic and above this as Ultrasound. In Medical Ultrasound, the frequency of 1-15 MHz (2.5, 3.5, 7.5 and 10 MHz) is generally used. The transducer possesses a property of piezoelectric effect so that they convert sound waves in to electrical waves and vice versa¹².

Applications of USG in dentistry

- To identify the reduction and healing of fractures.
- To detect pathologies of parotid glands, where solid and cystic lesions can be reliably differentiated
- To view cervical lymph node enlargement
- Used to guide FNAC (or) FNAB
- To identify and locate sialoliths

- Imaging of temporomandibular joint
- Detection of pathologies of vascular origin

Advantages

- Non-ionizing imaging tool
- Non-invasive technique
- Cost benefit
- Real time imaging

Looking back over the historical aspects of medical ultrasonic imaging, it is clear that the genuinely significant innovations which have occurred have taken place from advancements in the applications of physics and engineering.

In recent practice, the utilization of USG has spread all through various fields of medical specialties, as it is a precise, simple and advantageous modality.¹⁴ Till date, there has been no decisive proof of adverse biological hazards on the utilization of ultrasound energy at diagnostic levels¹⁶. USG provides information on the nature of the pathology and its relation to adjacent anatomical structures. Quantitatively, it evaluates the dimensions of the lesion, its distance from the skin surface and its relative proximity to skin and mucosal surfaces¹⁵.

USG has been demonstrated to be a dependable diagnostic imaging modality for the assessment of cross-sectional measurements and areas of muscles of the head and neck region¹¹. It has been reported that in OSMF subjects, muscle overactivity results in increased consumption of glycogen thereby leading to depletion of glycogen. The enhanced activity of muscles and compromised blood supply following connective tissue alteration owing to extensive OSMF leads to degeneration of muscles and fibrosis. Previous study reported that, submucosal thickness and masseter hypertrophy enhances with advancing stage of OSMF¹⁵.

The dimensions and functions of the head and neck muscles can be evaluated by numerous methods. In recent studies, USG has been employed to evaluate the cross-sectional dimensions of the muscles of the head and neck region. USG is an uncomplicated methodology that represents considerable improvement relative to conventional techniques to assess muscle dimensions, particularly in terms of clinical availability and cost^{16,17}.

Previous studies stated that USG could be a better diagnostic tool compared to clinical and histopathological examination¹⁴. And it could be an effective non-invasive, zero radiation tool for assessing the progression of OSMF¹⁵. Krithika *et al.*, noted that USG of the buccal mucosa presented enhanced submucosal echogenicity and minimal echo differentiation between submucosa and muscle layer in OSMF patients. The authors suggested that, USG may be employed as a non-invasive imaging tool to assess the disease extent and severity across the entire buccal mucosa to supplement clinical observations¹⁶. USG also proved to be a reliable adjunctive modality in diagnosing, staging¹⁹ and also a safer tool without ionizing radiation to evaluate the prognosis of OSMF²².

USG when applied for longer duration is known to elevate the tem-

perature of buccal mucosa locally due to its absorption by the tissue proteins that converts the ultrasonic waves into heat. With this concept, USG is also used to treat OSMF patients and significant improvement was noted²⁴.

The summary of various studies regarding the use of USG in evaluation of oral submucous fibrosis has been summarized in Table 1.

CONCLUSION

Various study in the literature confirmed that USG is a reliable and safe modality for diagnosing the OSMF without causing any discomfort to the patient and it provides information regarding submucous thickness, muscle thickness and may also used for treatment evaluation.

REFERENCES

- Patil S, Khandelwal S, Maheshwari S. Comparative efficacy of newer antioxidants spirulina and lycopene for the treatment of oral submucous fibrosis. *Clin Cancer Investig J* 2014; 3: 482-6.
- Patil SR, Yadav Y, Al-Zoubi IA, Maragathavalli G, Sghaireen MG, Gudipani RK *et al.* Comparative Study of the Efficacy of Newer Antioxidants Lycopene and Oxitard in the Treatment of Oral Submucous Fibrosis. *PesquisaBrasileiraemOdontopediatria e ClinicaIntegrada* 2018, 18(1): e4059.
- Patil S, Halgatti V, Maheshwari S, Santosh BS. Comparative Study of the Efficacy of Herbal Antioxidants Oxitard and Aloe Vera in the Treatment of OSMF. *J ClinExp Dent* 2014; 6(3): 265-70.
- Patil S, Maheshwari S. Proposed new grading of oral submucous fibrosis based on cheek flexibility. *J ClinExp Dent* 2014; 6(3): 255-58
- Patil S, Santosh BS, Maheshwari S, Deoghare A, Chhugani S, Rajesh PR. Efficacy of oxitard capsules in the treatment of oral submucous fibrosis. *J Can Res Ther* 2015; 11: 291-4
- Patil S, Al-Zarea BK, Maheshwari S, Sahu R. Comparative evaluation of natural antioxidants spirulina and aloe vera for the treatment of oral submucous fibrosis. *J Oral Biol Craniofac Res.* 2015; 5(1): 11-15. doi: 10.1016/j.jobber.2014.12.005
- Patil SR, Maragathavalli G, Ramesh DNSV, Vargheese S, Al-Zoubi A, Alam MK. Assessment of maximum bite force in oral submucous fibrosis patients: a preliminary study. *PesquiBrasOdontopediatriaClinIntegr.* 2020; 20: e4871. <https://doi.org/10.1590/pboci.2020.009>
- Santosh R Patil, G Maragathavalli, DNSV Ramesh, Ibrahim A. Al-Zoubi, RatheeshRajendran, Mohammed KhursheedAlam. The Role of Antioxidants and Natural Agents in the Management of Oral Submucous Fibrosis: A Systematic Review. *International Medical Journal.* April 2020; Vol. 27, No. 2, pp. 199-203.
- Santosh R Patil, G Maragathavalli, DNSV Ramesh, MS Munishekar, Krishna A Rao, Mohammad KhursheedAlam. Comparative Efficacy of Newer Antioxidants Spirulina and Oxitard for the Treatment of Oral Submucous Fibrosis. *International Medical Journal* Vol. 26, No. 2, pp. 135-138, April 2019
- Advani DG. Histopathological studies before and after kepacort in Oral submucous fibrosis. MDS thesis. University of Bombay; 1982. p. 83.
- Sumathi M K, Narayanan B, Malathi N. A prospective transmission electron microscopic study of muscle status in oral submucous fibrosis along with retrospective analysis of 80 cases of oral submucousfibrosis. *J Oral MaxillofacPathol* 2012; 16: 318-324
- KB Senthil, Mahabob N. Ultrasound in dentistry a review. *J Indian Acad Dent Spec* 2010; 1(4): 36-38.
- Kamala KA, Annigeri RG, Ashok L. Ultrasonic diagnosis of masseteric hypertrophy in oral submucous fibrosis: A preliminary study. *J Indian Acad Oral Med Radiol* 2010; 22: 197-200.
- Manjunath K, Rajaram P C, Saraswathi T R, Sivapathasundharam B, Sabarinath B, Koteeswaran D, Krithika C. Evaluation of oral submucous fibrosis using ultrasonographic technique: A new diagnostic tool. *Indian J Dent Res* 2011; 22: 530-6
- Devathambi JR, Aswath N. Ultrasonographic evaluation of oral submucous fibrosis and masseteric hypertrophy. *J Clin Imaging Sci.* 2013; 3(Suppl 1): 12. Published 2013 Dec 31. doi: 10.4103/2156-7514.124057
- Krithika C, Ramanathan S, Koteeswaran D, Sridhar C, Sathesh Krishna J, Shiva Shankar MP. Ultrasonographic evaluation of oral submucous fibrosis in habitual areca nut chewers. *DentomaxillofacRadiol.* 2013; 42(9): 20120319. doi: 10.1259/dmfr.20120319
- Chakarvarty A, Panat SR, Sangamesh NC, Aggarwal A, Jha PC. Evaluation of masseter muscle hypertrophy in oral submucous fibrosis patients -an ultrasonographic study. *J ClinDiagn Res.* 2014; 8(9): ZC45-ZC47. doi: 10.7860/JCDR/2014/8892.4857
- Kant P, Bhowate RR, Sharda N. Assessment of cross-sectional thickness and activity of masseter, anterior temporalis and orbicularis oris muscles in oral submucous fibrosis patients and healthy controls: an ultrasonography and electromyography study. *DentomaxillofacRadiol.* 2014; 43(3): 20130016. doi: 10.1259/dmfr.20130016
- Agarwal RK, Hebbale M, Mhapuskar A, TepanM. Correlation of ultrasonographic measurements, histopathological grading, and clinical staging in oral submucousfibrosis. *Indian J Dent Res.* 2017 Sep-Oct; 28(5): 476-481.
- Sadaksharam J, Mahalingam S. Evaluation of Oral Pentoxifylline in the Management of Oral Submucous Fibrosis - An Ultrasonographic Study. *ContempClin Dent.* 2017; 8(2): 200-204.
- Tiwari M, Deoghare A, Sharma A, Saha S, Poptani R. Evaluation of OSMF with Ultrasonography. *Int J Oral Health Dent;* 2017; 3(3): 169-174
- Nadendla LK, Tatikonda VK, Bangi BB, Bhayya H, Devulapally RV, PokalaA. Sonographic imaging of fibrosis of oral mucosa and its correlation with clinical staging in oral submucousfibrosis. *J Cancer Res Ther.* 2018 Jan-Mar; 14(2): 394-397. doi: 10.4103/0973-1482.183194.
- Dupare A, Dhole A. Ultrasonographic evaluation of submucosal thickness in oral submucous fibrosis patients: a cross-sectional study. *Pol J Radiol.* 2018; 83: e280-e288. Published 2018 Jun 14. doi: 10.5114/pjr.2018.76795
- Mukul SK, Kumar S, Pandey S, Mokhtar EA, Kumar A. Ultrasound elastography as a potential diagnostic aid in oral submucous fibrosis. *Natl J MaxillofacSurg* 2019; 10: 129-33
- Dani VB, Patel SH. The effectiveness of therapeutic ultrasound in patients with oral submucosal fibrosis. *Indian J Cancer* 2018; 55: 248-50