RESEARCH PAPER

Comparison of Extended Nasolabial Flap Versus Buccal Fat Pad Graft in the Surgical Management of Oral Submucous Fibrosis: A Prospective Pilot Study

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Abstract

Aim To evaluate the application of extended nasolabial flap versus buccal fat pad graft in the surgical management of oral submucous fibrosis.

Settings and Design This prospective study was carried out in the Department of Oral and Maxillofacial Surgery, Tamil Nadu Government Dental College and Hospital, Chennai.

Material and Methods A total of 8 patients (6 men and 2 women) with age range from 21 to 65 years were selected for study. These 8 patients were randomly divided into two groups of four namely group 1 and group 2. In group 1 patients, reconstruction was planned with extended nasolabial flaps and in group 2 patients, reconstruction was planned with buccal fat pad graft respectively.

Statistical Analysis Used Paired *t* test, Independent sample *t* test, ANOVA test.

Results The mean preoperative mouth opening in group 1 was 8.5 mm and in group 2 was 11.75 mm. The mean increase in group 1 after one year of postoperative period was 21.50 mm and in group 2 was 24.75 mm.

Conclusions In the present study, buccal fat pad graft proved to give better results as the interposition material as it has good patient acceptance, rapid epithelization, minimal donor site morbidity and minimal intra and postoperative complications.

Keywords Oral submucous fibrosis · Extended nasolabial flap · Buccal fat pad graft · Inter-incisal mouth opening

Introduction

‘Oral submucous fibrosis’ (OSMF) is a well known entity described since the time of Sushruta as ‘Vidari’ [1]. In modern literature, this condition was first described by

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Schwartz as ‘atrophica idiopathica mucosa oris’ in 1952 [2]. The term ‘oral submucous fibrosis’ was coined by Joshi in 1953 [3].

Oral submucous fibrosis is an insidious, chronic, disabling disease that affects entire oral cavity, sometimes pharynx and rarely larynx. It is characterised by blanching and stiffness of the oral mucosa which leads to progressive limitation of mouth opening and intolerance to hot and spicy food [4]. With further progression, it leads to difficulty in mastication, speech, and swallowing. It is most commonly seen in the Indian subcontinent with prevalence in south east Asia ranging from 0.04–24.4 % [5]. Consumption of areca nut is the main etiological factor in this condition [6]. The precancerous nature of this condition was first described by Paymaster in 1956 [7]. It is an established precancerous condition with malignant transformation risk of 1.9–7.6 % [8–10].

The management of oral submucous fibrosis aims to improve mouth opening and relieve the symptoms. Severe degree of trismus is a challenging surgical problem. Various surgical treatment modalities have evolved but the mainstay is release of fibrosis by excision of fibrous bands with or without grafts. Reconstruction of the defect after incision and release of fibrous bands is done with variety of options such as skin grafts [11], island palatal mucoperiosteal flap [12], bilateral tongue flap [13], the superficial temporal fascia flap with split thickness skin graft [14], radial forearm flaps [15–17], flaps from anterolateral thigh [18], artificial dermis [19], buccal fat pad graft [20] and nasolabial flaps [21]. In severe trismus cases, bilateral coronoidectomy and temporalis myotomy can be performed to relieve the trismus and enhance the mouth opening [22].

This study was done to evaluate the application of extended nasolabial flap versus buccal fat pad graft in the surgical management of oral submucous fibrosis to achieve acceptable mouth opening and reduction of symptoms after release of fibrosis, to improve masticatory efficiency and speech of the patient and to reduce the long term morbidity and mortality of the patient.

Subjects and Methods

This prospective study included those patients who reported to our department with clinical diagnosis of oral submucous fibrosis.

Inclusion Criteria

- Patients with moderately advanced or advanced stage of oral submucous fibrosis with inter-incisal mouth opening of less than or equal to 15 mm and with long standing positive history of habits.

- Patients in whom diagnosis is confirmed clinically, histopathologically and in whom any malignancy is ruled out.
- Patients with a high level of motivation to give up deleterious habits.

Exclusion Criteria

- Medically compromised patients (ASA class III and IV).
- Patients not willing for consent and one year follow up.
- Patients with history of surgical treatment for oral submucous fibrosis.
- Patients with clinical or radiological presentation of any other cause of trismus.

A total of 8 patients (6 men and 2 women) with age range from 21 to 65 years who fulfilled the above criteria were randomly selected for study. These 8 patients were divided randomly into two groups of four namely group 1 and group 2. In group 1 patients, reconstruction was planned with extended nasolabial flaps and in group 2 patients, reconstruction was planned with buccal fat pad graft respectively. Clinical examination, routine haematological investigations and radiographs were done for all patients.

All patients were explained about the procedure and limitations of the surgery and informed consent was obtained from each patient. Preoperative inter-incisal distance was measured using simple ruler and recorded in millimeters (Figs. 1a, 2a).

Surgical Procedure

Anaesthesia

All patients were treated under general anaesthesia through nasoendotracheal intubation using retrograde/blind nasal/fiberoptic method.

Incision and Fibrous Bands Release

Intraoral bilateral infiltration was given along the planned incision line with 1:2,00,000 epinephrine concentration. Incisions were made using number 15 Bard Parker blade on each side of buccal mucosa at the level of occlusal plane away from Stenson’s duct orifice. Incisions extended from the corner of the mouth anteriorly to the anterior pillar of fauces, soft palate and/or pterygo-mandibular raphe posteriorly depending on the extent of fibrous bands felt by palpation. Blunt dissection and undermining was done with artery forceps until on palpation there were no fibrous bands restrictions were felt (Figs. 1b, 2b).

Fig. 1 Case of reconstruction by Extended Nasolabial Flap. **a** Pre-operative photograph and mouth opening, **b** Incision, fibrous band release and forceful opening of mouth, **c** Marking of extended Nasolabial flap, **d** Elevation of flap, **e** Creation of transbuccal tunnel,

f Transposing the flap intraorally, **g** Flap sutured over the defect, **h** Adaptation of flap after three months, **i** Postoperative photo after 1 year showing mouth opening of 43 mm and scars

Achievement of Optimum Mouth Opening

Using Fergusson's mouth gag, mouth was forcefully opened (Figs. 1b, 2b). All patients underwent bilateral

coronoidotomy through same incision to enhance the mouth opening. Inter-incisal mouth opening of 40–45 mm was achieved for all patients. Haemostasis was achieved in all patients.

Fig. 2 Case of reconstruction by Buccal Fat Pad Graft. **a** Preoperative mouth opening, **b** Incision, fibrous band release and forceful opening of mouth, **c** Exposure of buccal fat pad graft through defect after

dissection, **d** Buccal fat pad graft sutured over the defect, **e** Healing after three months, **f** Postoperative mouth opening after 1 year showing mouth opening of 41 mm

Reconstruction with Extended Nasolabial Flap

In group 1 patients, in whom reconstruction was planned with extended nasolabial flap, extractions of upper and lower third molars were done. In these patients, after incising the fibrous bands and achieving acceptable range of mouth opening, bilateral elliptical shaped nasolabial flaps were marked with methylene blue ink (Fig. 1c). Flaps extended from the tip of the nasolabial fold to the inferior border of the mandible. The medial incision line followed the nasolabial folds till the inferior third and the width of the flap was kept 1.5–2 cm with medial and lateral limbs of the incision tapering at the ends. Bilaterally, flaps were raised in the plane of superficial musculoaponeurotic system from both ends to the region of central pedicle 1 cm away from the corner of the mouth (Fig. 1d). The diameter of the pedicle was roughly 1.5–2 cm.

A transbuccal tunnel was created near the region of modiolus (Fig. 1e). The flap was then transposed intraorally in tension free manner (Fig. 1f). The superior wing of the flap was sutured to the posterior edge of the defect while inferior wing was sutured to the anterior edge of the defect using 3-0 monocryl suture material (Fig. 1g). Generous undermining of the donor site was done in the subcutaneous plane and layerwise closure done with 3-0 vicryl for deeper layer and 5-0 prolene for skin.

Reconstruction with Buccal Fat Pad Graft

In group 2 patients, in whom reconstruction was planned by buccal fat pad graft after incising the fibrous bands and achieving acceptable range of mouth opening, buccal fat pad was approached through the postero-superior margin of the created defect. After blunt dissection, buccal fat pad

was teased out gently with index finger until sufficient amount was obtained to cover the defect without tension (Fig. 2c). Buccal fat pad was then secured over the defect with 3-0 vicryl suture material using interrupted and mattress sutures (Fig. 2d).

Postoperative Care and Follow Up

All the patients received prophylactic antibiotic coverage and nasogastric feeding for 1 week. Extra-oral sutures were removed on the seventh post-operative day for extended nasolabial flap patients. Initial physiotherapy was started within 48 h post operatively with mouth opening exercises and placing mouth prop inter-incisally. After tenth post-operative day, intense physiotherapy was started using Heister's mouth gag. Patients were asked to use Heister's mouth gag to open the mouth to optimum range and then keep mouth prop in between incisors to maintain it for 15–20 min. Patients were asked to repeat the same procedure 5 times a day. Patients were also asked to use ice cream sticks in increasing order to keep mouth opening to the optimum. Frequency of exercise was increased to 10 times a day.

Patients were instructed and motivated during follow up to continue the physiotherapy themselves for 6 months and followed up. The inter-incisal mouth opening was recorded 1 month, 3 months, 6 months and one year postoperatively (Figs. 1i, 2f) with simple ruler and recorded in millimeters during follow up period.

Results

The mean age of group 1 and group 2 was 45 years and 29.5 years respectively. The mean preoperative mouth opening in group 1 was 8.5 mm and in group 2 was 11.75 mm. In group 1, mean one year postoperative mouth opening was 30 mm and in group 2 was 36.50 mm. The mean increase in group 1 after one year of postoperative period was 21.50 mm and in group 2 was 24.75 mm. (Tables 1, 2, 3, 4 and 5) The results reveal that extended nasolabial flap led to statistically non-significant changes in the mouth opening over a period of time with *p* value of 0.265. However, buccal fat pad graft method showed statistically significant improvement in the mouth opening over a period of time with *p* value of 0.043 (Table 6).

Discussion

Oral submucous fibrosis is a precancerous condition with high prevalence in the Indian subcontinent. It has wide variety of etiological factors, among which chewing betel

nut and tobacco is the most common and accepted one [23–25]. In our study, all patients had a positive history of chewing some form of betel nut or tobacco or combination of both for variable duration.

The various conservative treatment modalities for oral submucous fibrosis were proposed. These include oral administration of vitamins [13, 26, 27], antioxidants [13, 28] and Iron supplements [13], Zinc [29], topical application of Gold [30], Iodides as well as intralesional injections of Hyaluronidase [13], Hydrocortisone [13], Placental extract [13], Triamcinolone [13], Interferon gamma [31], and enzymes like Collagenase [13, 32], Chymotrypsin [13]. Drugs like Pentoxifylline, Buflomedil Hydrochloride and Nylidrin were used to improve the circulation to the affected area [13, 33]. All our patients had positive history of the treatment with one or more of the conservative modalities but reported that they were not useful.

Surgical therapy is beneficial in cases presenting severe trismus and which are not responding to the medicinal treatment. After surgical therapy, oral mucosa should regain and retain its normalcy and there should be reduction in the risk of oral cancer. Relapse is the common complication after surgical release of trismus.

Mere cutting of the fibrotic bands followed by forcible mouth opening and allowing secondary epithelization left an unsatisfactory rigid buccal mucosal surface even when attempts were made to reduce collagen formation by insertion of steroid impregnated pack [23]. It resulted in scar formation and recurrence of trismus. Additional procedures like temporalis myotomy and bilateral coronoidectomy can be performed to enhance mouth opening [34, 35].

Results with skin grafting to cover the raw areas have been disappointing as the incidence of shrinkage, contracture and rejection of graft was found to be very high because of the poor oral conditions and subsequent recurrence of symptoms [12]. Split thickness skin grafts along with bilateral temporalis muscle myotomy or coronoidectomy were effective, but have the drawbacks of secondary contracture formation in temporalis tendon and muscle and pterygomandibular raphae, which appears to be the principal cause of restricted mouth opening [23]. Recurrence of symptoms was common in the studies conducted by Khanna and Andrade [12], Morawetz et al. [30] and Lai [36]. The other limitation of split thickness skin graft is the morbidity associated with donor site along with maintenance of mouth opening post operatively for 7–10 days which is the most unpleasant and uncomfortable experience for the patient [23].

Palatal island flaps based on greater palatine artery to cover the defects of oral submucous fibrosis has been employed by Khanna and Andrade [12]. The technique of

Table 1 Mouth opening at different time intervals in Group 1 (Extended nasolabial flap) patients

Patient S. N.	Age/sex	Pre-operative mouth opening (mm)	Intra-operative mouth opening (mm)	1 month post-operative mouth opening (mm)	3 months post-operative mouth opening (mm)	6 months post-operative mouth opening (mm)	1 year post-operative mouth opening (mm)
1.	65/F	2	40	25	10	10	10
2.	27/M	15	50	40	41	43	43
3.	43/F	5	40	30	28	26	25
4.	45/M	12	45	38	41	43	42

Table 1 shows the mouth opening at preoperative, intraoperative, 1 month, 3 months, 6 months and 1 year postoperative stage for patients treated with extended nasolabial flap

Table 2 Mouth opening at different time intervals in Group 2 (Buccal fat pad graft) patients

Patient S. N.	Age/sex	Pre-operative mouth opening (mm)	Intra-operative mouth opening (mm)	1 month post-operative mouth opening (mm)	3 months post-operative mouth opening (mm)	6 months post-operative mouth opening (mm)	1 year post-operative mouth opening (mm)
1.	28/M	8	44	40	25	25	25
2.	29/M	10	45	40	40	38	38
3.	40/M	14	45	42	42	43	43
4.	21/M	15	45	42	40	40	40

Table 2 shows the mouth opening at preoperative, intraoperative, 1 month, 3 months, 6 months and 1 year postoperative stage for patients treated with buccal fat pad graft

Table 3 Mean values for group 1

	Minimum value (mm)	Maximum value (mm)	Mean value (mm)
Preoperative mouth opening	2	15	8.5
Intraoperative mouth opening	40	50	43.75
1 month postoperative mouth opening	25	40	33.25
3 months postoperative mouth opening	10	43	30
6 months post-operative mouth opening	10	43	30.5
1 year post-operative mouth opening	10	43	30

Table 3 shows the mean values obtained for preoperative, intraoperative, 1 month, 3 months, 6 months and 1 year postoperative mouth opening for patients treated with extended nasolabial flap

utilizing the palatal island flaps was found to be simple. But the use of island palatal flap has limitations such as its involvement with fibrosis and second molar tooth extraction is required for flap cover without tension [37]. Bilateral palatal flaps leave a large raw area on the palatal bones. Sometimes the defect created may be large and local flaps may not be able to cover the entire defect.

Tongue flaps have also been used for treating oral submucous fibrosis but have disadvantages such as, postoperative dysphagia, disarticulation, the risk of postoperative aspiration and need for additional surgery for detachment of the pedicle [12]. The involvement of tongue in oral

submucous fibrosis often precludes its use in treating oral submucous fibrosis [12, 34].

Application of amniotic membrane is of little benefit when used in single layer over deep buccal defects [36]. Human placental grafts can also be applied to cover the defects. It has shown little beneficial results when combined with submucosal injection of Dexamethasone [4].

Bilateral radial artery forearm free flaps [15] and the bipaddled radial forearm flap [16] from single donor site require micro vascular expertise. The procedure is time consuming and technically demanding. Donor site morbidity as well as unsightly scar formation are other

Table 4 Mean values for group 2

	Minimum value (mm)	Maximum value (mm)	Mean value (mm)
Preoperative mouth opening	8	15	11.75
Intraoperative mouth opening	44	45	44.75
1 month postoperative mouth opening	40	42	40.50
3 months postoperative mouth opening	25	42	36.75
6 months post-operative mouth opening	25	43	36.50
1 year post-operative mouth opening	25	43	36.50

Table 4 shows mean values obtained for preoperative, intraoperative, 1 month, 3 months, 6 months and 1 year postoperative mouth opening for patients treated with buccal fat pad graft

Table 5 Mean increase in mouth opening after one year

	Mean preoperative mouth opening (mm)	Mean postoperative mouth opening after 1 year (mm)	Mean increase in mouth opening after 1 year (mm)
Group 1	8.5	30	21.50
Group 2	11.75	36.50	24.75

Table 5 shows the mean increase in mouth opening after 1 year for group 1 and group 2

Table 6 Statistical significance of data

Intervals	Group 1 (Extended nasolabial flap)				Group 2 (Buccal fat pad graft)			
	Mean	SD	F value	p value	Mean	SD	F value	p value
Pre-operative mouth opening	8.50	6.028	1.868	0.265	11.75	3.304	11.455	0.043
Intra-operative mouth opening	43.75	4.787			44.75	.500		
1 month post-operative mouth opening	33.25	6.994			41.00	1.155		
3 months post-operative mouth opening	30.00	14.674			36.75	7.890		
6 months post-operative mouth opening	30.50	15.843			36.50	7.937		
1 year post-operative mouth opening	30.00	15.684			36.50	7.937		

Table 6 shows statistical significance of data for both groups

disadvantages. 40 % of the patients require secondary de-bulking procedures because of hair on forearm. Extractions of third molars are required to avoid flap inclination between teeth. Flaps from anterolateral thigh [18] were used for reconstruction of buccal defects after release of fibrosis but drawbacks include donor site morbidity and need for de-bulking of flap.

The nasolabial flap has advantages such as, the donor site is in the same operating field, reliable and rich vascularity, provides versatility in design, proximity to the defect, ease of flap elevation, supple skin, thus aiding in increasing mouth opening and causing minimal esthetic deformity, while the disadvantages being intraoral hair

growth, temporary widening of oral commissure and occasional hypertrophic scar at the donor site [21].

The use of nasolabial flaps in treatment of oral submucous fibrosis is more suitable for juxtaposed defects, in particular those of buccal mucosa, and is increasingly popular. The nasolabial flap provides a good example of the transposition flap principle in which the unavoidable tension is transferred from the defect to the donor area where there is sufficient tissue elasticity to absorb it. The colour and texture match is excellent and in older patients, the donor scar is quite inconspicuous as in older patients in whom skin redundancy at the nasolabial fold is abundant [38].

The versatility of the nasolabial flap depends upon several factors. Owing to a dual blood supply from both facial and ophthalmic arteries, the flap can be either superiorly or inferiorly based [39]. Intraorally placed nasolabial flap provides 15 cm² of durable lining [40], a mobile pedicle with sufficient blood supply to be safely transposed at the time of primary tumour resection even after ligation of the facial artery.

The classic nasolabial flap is an oblique cheek flap based either superiorly or inferiorly. Often used for alar and lip reconstruction, this type of flap has been suggested in the past for palatal and floor of the mouth reconstruction. The flap usually extends inferiorly to an area lateral to the nasolabial fold, but it can be carried more inferiorly to the area of the oral commissure to provide a longer more versatile flap [39]. As this part of the cheek remains soft and supple even many years after repair, this led to development of the application of bilateral nasolabial flaps to cover the defect created by excision of fibrotic bands, by Kavarana and Bhathena [41] with promising results in 3 cases.

Nasolabial flap can be either cutaneous, subcutaneous, musculocutaneous or island nasolabial flaps. In our study we employed bilateral modified single-stage winged extended nasolabial island flaps [21] in all our 4 patients. The length of the flap was adequate to cover the intraoral defect and layered closure of donor site was achieved to minimize postoperative extraoral scar. In our study, the 1 year postoperative mouth opening in Group 1 subjects (who received extended nasolabial flap) was in the range of 10 mm to 43 mm with mean value of 30 mm. The mean increase in the group 1 after 1 year of postoperative period was 21.50 mm.

Intraoperative complications like damage to facial vessels, parotid duct and branches of facial nerve were not encountered in any of the 4 patients included in the study. None of the flaps showed either bluish discoloration due to venous congestion or whitish discoloration due to poor arterial blood supply in the postoperative phase and no infection was encountered in any of our cases. Complications such as flap loss, flap avulsion, obstructive sialadenopathy or wound dehiscence were not encountered in our series. Intraoral hair growth was observed in 2 male patients from fifth post-operative day which was managed by regular trimming. The donor site healed uneventfully and flaps adapted to oral mucosa in all our cases (Fig. 1h). Although the scars were perceptible in all cases, they were readily accepted by the patients (Fig. 1i). In our series, one 65 year old female patient did not co-operate for vigorous postoperative exercise therapy and the condition relapsed in 3 months.

Buccal fat pad graft has advantages such as, rich vascular supply, minimal donor site morbidity, ease of surgery

which can be performed under local anaesthesia on an outpatient basis, improvement in physiologic functions of cheek after surgery, good patient acceptance, and minimal postoperative morbidity while disadvantages being anterior reach of the graft are limited and limited use for larger defects.

Buccal fat pad by virtue of its anatomic position and the ease with which it can be accessed and mobilized without causing any noticeable defect in the cheek or mouth was felt to be reliable interposition material [25]. The procedure, considering the anatomic proximity of the donor and the recipient site, is not a prolonged one. The graft can be approached through the same buccal incision, which was used to release the fibrosis. Should it fail, the consequences are not serious. The bulk of buccal fat pad in our series was found to be adequate in all cases and it maintained its position as interposition material post operatively, similar to the findings of Yeh [20], Lai [36], Rapidis [42] and Ganizo [43].

Yeh [20] obtained the mean postoperative mouth opening value of 31.2 mm over a follow up period of mean 21.3 months. In our study, the mean age of group 2 was 29.5 years. The 1 year postoperative mouth opening range in Group 2 subjects (who received buccal fat pad graft) was 25 mm to 43 mm with mean value of 36.50 mm. The mean increase in the group 2 after 1 year of postoperative period was 24.75 mm

Improvement in the physiologic functions like suppleness and elasticity of the buccal mucosa was noticed on clinical examination post operatively. The graft began to show signs of epithelization from 2nd week. This observation is similar to studies done by Yeh [20] Rapidis [42], Alkan [44], Tideman [45]. Satisfactory healing was observed after three months (Fig. 2e).

No intraoperative or postoperative complications were found in group 2 patients. One patient of group 1 in our series experienced a relapse with mouth opening of 25 mm after 3 months. All patients noted significant reduction in symptoms of intolerance to spice and ulcerations in the period of 1 year follow up, except in one 65 year old female of group 1 in whom the condition relapsed.

Surgical treatment should be coupled with cessation of betel quid or gutkha chewing, daily mouth opening exercises, and proper nutrition in order to manage properly both early and advanced stages of oral submucous fibrosis.

In the present study, buccal fat pad graft proved to give better results as the interposition material as it has good patient acceptance, rapid epithelization, minimal donor site morbidity and minimal intra and postoperative complications. However, further studies should be conducted in large sample size with long term follow up to evaluate the efficacy of buccal fat pad graft over extended nasolabial flap in surgical management of oral submucous fibrosis.

Compliance with Ethical Standards

Conflict of interest No conflict of interest for any author.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

- Kaviraj BK (1911) An english translation of the Susruta Samhita Vol. II Nidhana-sthana to Kalp-sthana. 111–112 [Chapter 16]
- Schwartz J (1952). Atrophia idiopathica mucosa oris. In: Presented at the 11th International Dental Congress, London
- Joshi SG (1953) Submucous fibrosis of the palate and pillars. *Indian J Otolaryngol* 4:1–4
- Gupta D, Sharma SC (1988) Oral submucous fibrosis—a new treatment regimen. *J Oral Maxillofac Surg* 46:830–833
- Pindborg JJ, Murti PR, Bhonsle RB, Gupta PC, Daftary DK, Mehta FS (1984) Oral submucous fibrosis as a precancerous condition. *Scand J Dent Res* 92:224–229
- Pillai R, Balaram P, Reddiar KS (1992) Pathogenesis of oral submucous fibrosis. *Cancer* 69:2011
- Paymaster JC (1956) Cancer of the buccal mucosa: clinical study of 650 cases in Indian patients. *Cancer* 9:431–435
- Murti PR, Bhonsale RB, Pindborg JJ, Daftary DK, Gupta PC, Mehta FS (1985) Malignant transformation rate in oral submucous fibrosis over a 17 year period. *Commun Dent Oral Epidemiol* 13:340–341
- Cox SC, Walker DM (1996) Oral submucous fibrosis: a review. *Aust Dent J* 41:294
- Tang JG, Jian XF, Gao ML, Ling TY, Zhang KH (1997) Epidemiological survey of oral submucous fibrosis in Xiangtan City, Hunan Province, China. *Commun Dent Oral Epidemiol* 25:177
- Yen DJC (1982) Surgical treatment of submucous fibrosis. *Oral Surgery Oral Med Oral Pathol* 54(3):269–272
- Khanna JN, Andrade NN (1995) Oral submucous fibrosis: a new concept in surgical management—report of 100 cases. *Int J Oral Maxillofac Surg* 24:433–439
- Jiang X, Hu J (2009) Drug treatment of oral submucous fibrosis: a review of the literature. *J Oral Maxillofac Surg* 67:1510–1515
- Mokal NJ, Raje RS, Ranade SV et al (2005) Release of oral submucous fibrosis and reconstruction using superficial temporal fascia flap and split skin graft—a new technique. *Br J Plast Reconstr Surg* 58:1055
- Wei FC, Chang YM, Kildal M, Tsang WS, Chen HC (2001) Bilateral small radial forearm flaps for the reconstruction of buccal mucosa after surgical release of submucosal fibrosis: a new reliable approach. *Plast Reconstr Surg* 107:1679–1683
- Lee JT, Cheng LF, Chen PR, Wang CH, Hsu H, Chien SH et al (2007) Bipaddled radial forearm flap for the reconstruction of bilateral buccal defects in oral submucous fibrosis. *Int J Oral Maxillofac Surg* 36:615–619
- Tsao CK, Wei FC, Chang YM et al (2010) Reconstruction of the buccal mucosa following release for submucous fibrosis using two radial forearm flaps from a single donor site. *J Plast Reconstr Aesthet Surg* 63:1117
- Huang JJ, Wallace C, Lin JY et al (2010) Two small flaps from one anterolateral thigh donor site for bilateral buccal mucosa reconstruction after release of submucous fibrosis and/or contracture. *J Plast Reconstr Aesthet Surg* 63:440
- Ko EC, Shen YH, Yang CF, Huang IY, Shieh TY, Chen CM (2009) Artificial dermis as the substitute for split-thickness skin graft in the treatment of oral submucous fibrosis. *J Craniofac Surg* 20:443–445
- Yeh CJ (1996) Application of the buccal fat pad to the surgical treatment of oral submucous fibrosis. *Int J Oral Maxillofac Surg* 25:130–133
- Borle RM, Nimonkar PV, Rajan R (2009) Extended nasolabial flaps in the management of oral submucous fibrosis. *Br J Oral Maxillofac Surg* 47:382
- Chang YM, Tsai CY, Kildal M, Wei FC (2004) Importance of coronoidotomy and masticatory muscle myotomy in surgical release of trismus caused by submucous fibrosis. *Plast Reconstr Surg* 113:1949–1954
- Canniff JP, Harvey W, Harris M (1986) Oral submucous fibrosis—its pathogenesis and management. *Br Dent J* 160:429–433
- Gupta DS, Dolas R, Iqbal A (1992) “Treatment modalities in submucous fibrosis—How they stand today?” Study of 600 cases. *Indian J Oral Maxillofac Surg* 7(43):1
- Bhonsle RB, Murthi PR, Gupta PC, Mehta FS (1976) Reverse dhumti smoking in Goa—an epidemiological study of 5449 villages for oral precancerous lesions. *Indian J Cancer* 13:301–305
- Aziz SR (2008) Oral submucous fibrosis: case report and review of diagnosis and treatment. *J Oral Maxillofac Surg* 66:2386–2389
- Mehrotra D, Pradhan R, Gupta S (2009) Retrospective comparison of surgical treatment modalities in 100 patients with oral submucous fibrosis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 107:e1
- Gupta S, Reddy MVR, Harinath BC (2004) Role of oxidative stress and antioxidants in aetiopathogenesis and management of oral submucous fibrosis. *Indian J Clin Biochem* 19:138
- Kumar A, Sharma SC, Sharma P et al (1991) Beneficial effect of oral zinc in the treatment of oral submucous fibrosis. *Indian J Pharmacol* 23:236
- Morawetz G, Katsikeris N, Weinberg S, Listrom R (1987) Oral submucous fibrosis. *J Oral Maxillofac Surg* 16:609–614
- Haque MF, Meghji S, Nazir R et al (2001) Interferon gamma may reverse oral submucous fibrosis. *J Oral Pathol Med* 30:12
- Lin HJ, Lin JC (2007) Treatment of oral submucous fibrosis by collagenase: effects on oral opening and eating function. *Oral Dis* 13:407
- Sharma JK, Gupta AK, Mukhija RD et al (1987) Clinical experience with the use of peripheral vasodilator in oral disorders. *Int J Oral Maxillofac Surg* 16:695
- Borle RM, Borle SR (1991) Management of oral submucous fibrosis: a conservative approach. *J Oral Maxillofac Surg* 49:788–791
- Kothari MC, Hallur N, Sikkerimath B, Gudi S, Kothari CR (2012) Coronoidectomy, masticatory myotomy and buccal fat pad graft in management of advanced oral submucous fibrosis. *Int J Oral Maxillofac Surg* 41:1416–1421
- Lai DR (1995) Clinical evaluation of different treatment methods for oral submucous fibrosis. A 10 –year experience with 150 cases. *J Oral Pathol Med* 24:402–406
- Khanna JN (1995) Oral submucous fibrosis: a new concept in surgical management: report of 100 cases. *IJOMS* 24:433–439
- Hosaka Y, Tsukagoshi T, Sasaki E, Yokoyama S (1999) The use of otherwise redundant skin to provide nasal lining in the reconstruction of full—thickness alar defects by nasolabial flap repair. *Br J Plast Surg* 52:29–32
- Gewirtz HS, Eilber FR, Zream HA (1978) Use of nasolabial flap for reconstruction of the floor of the mouth. *Am J Surg* 136:508–511

40. Morgan RF, Chambers RG, Jaques DA, Hoopes JE (1981) Nasolabial flap in intraoral reconstruction—review of 55 cases. *Am J Surg* 142:448–450
41. Kavarana NM, Bhathena HM (1987) Surgery for severe trismus in submucous fibrosis. *Br J Plast Surg* 40:407–409
42. Rapis Alexander D (2000) The use of the Buccal fat pad for Reconstruction of oral defects: review of literature and report of 15 cases. *J Oral Maxillofac* 58:158–163
43. Martin Granizo R (1997) Use of buccal fat pad to repair intraoral defects: review of 30 cases. *Br J of Maxillofac Surg* 35:81–84
44. Alkan A (2003) The reconstruction of oral defects with Buccal Fat Pad. *Swiss Med Wkly* 133:465–470
45. Tideman H, Bosanquet A, Scott J (1986) Use of the buccal fat pad as a pedicled graft. *J Oral Maxillofac Surg* 44:435