Surgical Interventions in Oral Submucous Fibrosis: A Systematic Analysis of the Literature

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Abstract

Background Oral submucous fibrosis (OSMF) is a potentially malignant disorder of the oral cavity. The surgical management of this condition involves excision of the fibrotic bands and interpositional grafts to retain the increased oral opening. Various procedures and graft material have been utilised with differing success rates.

Objectives The present review aims to collate and analyze from world literature the different modalities utilized in the surgical management of OSMF. The reasons for the choice of a particular surgical procedure, the study protocol, the average follow-up period and the results were scrutinized.

Materials and Methods The PRISMA protocol was followed for the systematic review. Search engines and medical databases like Ovid, Medline, Pubgate, Researchgate, PubMed, Google etc. were tapped for information related to the subject. The search words “OSMF”, “surgical interventions in OSMF”, “flaps and grafts in treatment of OSMF” were employed for retrieval of data. An analysis of the treatment modalities, the reason for the selection of a particular modality, the organization of the sample selection and the follow-up periods including the proclaimed success rates was done.

Results The review resulted in a total of 56 articles on the subject from the sources mentioned above. A total of 995 surgically treated cases were included in the analysis. Interestingly the review revealed very few controlled clinical trials, most being random trials on surgical procedures in small groups of patients with very short follow

up periods. The choice of procedure seems to be determined entirely by the preference of the operator/s.

Conclusions There exist no definite protocols for the adoption of a particular treatment mode in OSMF. Adequate documentation and follow up need to be established to statistically analyse the results and proclaimed successes of various treatment modalities.

Keywords Oral submucous fibrosis · Surgical interventions · Flaps · Grafts · Review

Introduction

Oral submucous fibrosis (OSMF), now labeled as a “potentially malignant disorder”, is rather unique in its clinical presentation. The progressive irreversible fibrosis of the submucosa causes trismus, an inability to consume the average spicy food that people in the subcontinent are accustomed to, and carries a high risk of malignant transformation [1].

Most treatment modalities in OSMF have centered on relief of the burning sensation and release of the fibrotic bands to assist oral opening. Predictably the release of the fibrotic bands has been the basis of all surgical techniques employed, while medical interventions have dwelt on the suppression of the inflammatory response and prevention of progressive fibrosis.

Surgical management of OSMF has involved excision of the fibrotic bands either by the scalpel or using a laser, with or without the use of interpositional grafts to maintain the oral opening.

The present review aimed at accessing information regarding the surgical modalities of treatment for OSMF from the available literature. The study aimed at minutely

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analyzing the results with respect to adopted modes of treatment, the sample size selection, the results and the purported follow-ups. Special emphasis was placed on the criteria for “successfully managed” inferences based on accepted criteria.

Methodology

The PRISMA protocol was followed for the systematic review [2]. The search engines Medline/PubMed, Cochrane database, Ovid, Researchgate, Pubget and non-medical search portals like Google etc. were tapped for the data. Keywords included “surgical treatment of OSMF”, “OSMF”, “oral premalignant conditions” and “oral potentially malignant conditions”. While the initial search was restricted to indexed journals, ongoing review revealed studies published in peer reviewed local journals not yet indexed in PubMed. These were accessed from the web and from publications in the library. As per the guidelines established in the protocol, following identification of articles, duplicates were removed. The obtained set was subdivided into articles published in PubMed and non-PubMed journals. Studies that incorporated surgical and medical treatment concomitantly were excluded. Anti-inflammatory drugs used intra- and immediate post-operatively were not considered as medical treatment and studies incorporating these were included for analysis. Oral physiotherapy for maintenance of occlusion post-operatively was also included as standard surgical protocols.

Results

The review resulted in a total of 56 articles on the subject from the sources mentioned above (Fig. 1). 12 articles were from non-indexed journals and the rest were from peer reviewed indexed sources. Most of the case studies originated from the Indian subcontinent and the Chinese mainland.

A total of 995 cases that were surgically treated were included in the systematic-analysis. In some series multiple treatments were carried out concomitantly on the same patient. For example, following excision of the fibrotic bands, inter-positional grafts were placed and then covered with split skin grafts (SSG). In such cases the treatment mode was denoted as the inter-positional graft and the SSG were omitted from inclusion; being the secondary or passive mode of treatment. Only in those cases where following excision of the bands, SSG were utilized as primary coverage was inclusion done under the category of grafts. Surgical intervention in OSMF seemed to follow a predictable treatment plan. Excision of fibrotic bands was the

Fig. 1 The PRISMA flow diagram used in the systematic analysis with the observed results (adapted from Prisma 2009 flow diagram, Moher et al. [2])

primary procedure. The scalpel was the most common method with lasers having been used in a small number. Post excision, the treatment pathways varied: a majority of studies included use of inter-positional grafts to maintain the increased oral opening, graft choice, site and technique seemed to be dependent on the operator and the surgical unit. In some cases, SSG, collagen membranes and artificial dermis was used to cover the area of surgical excision. A few studies used masticatory muscle myotomies and coronoidectomies as adjuncts to ensure continued oral opening with or without placement of the inter-positional grafts.

Table 1 gives an overview of the surgical treatment modalities used in the management of OSMF.

The treatment protocols based on the review could broadly be divided into the following steps:

- Step 1: Excision of fibrotic bands with scalpel or using lasers.
- Step 2: Coverage of the mucosal defect using flaps, grafts and collagen membranes.
- Step 3: Adjunctive procedures intraoperatively included coronoidectomies and masticatory muscle myotomies.
- Step 4: Post operative oral physiotherapy, dietary supplementation and other medications.

Many studies used multiple surgical and medical protocols; rather limited number of participants to draw conclusive evidence, and indeterminate follow-up periods. There seems to be a trend in reporting individual treatment protocols rather than a planned approach when dealing with

Table 1 An overview of the treatment modalities gleaned from the literature

Treatment modalities	No. of articles in review	Indexed/non indexed	Total no of cases (% of total cases)	Average follow up period
Lasers	7	3/4	48 (4.82 %)	3–36 months
Local flaps				
Intraoral				
Tongue	5	5/0	138 (13.97 %)	1–84 months
Palatal	1	1/0	33 (3.32 %)	48 months
Buccal fat pad	14	9/5	139 (13.97 %)	2 weeks–36 months
Extraoral				
Nasolabial	12	8/4	227 (22.81 %)	6–66 months
Temporalis fascia	1	1/0	5 (0.5 %)	–
Distant flaps				
Radial forearm free flaps	5	4/1	65 (6.53 %)	3–48 months
Thigh flaps	1	1/0	9 (0.90 %)	Mean 16.2 months (10–33 months)
Grafts				
Split skin grafts ^a	4	4/0	96 (9.65 %)	10 weeks–48 months
Collagen membrane	6	3/3	107 (10.75 %)	3–24 months
Artificial dermis	3	3/0	61 (6.13 %)	3–6 months
Human placenta/amnion grafts	2	2/0	39 (3.92 %)	NA
Other adjunctive modalities				
Coronoidectomies/muscle myotomies	1	1/0	22 (2.21 %)	6 months
Oral stents	5	3/2	6 (0.5 %)	3–36 months
Total	67 ^b	41/17	995	2 weeks minimum to 84 months maximum

^a Only those cases primarily covered by split skin grafts included^b More than one study attempted different treatment options**Table 2** Lasers used for treatment of oral submucous fibrosis

S. no.	Author	Type of laser	No of cases	Follow-up
1.	Chaaya et al. [3]	CO ₂	NA	NA
2.	Chaudhary et al. [4]	ErCr:YSGG	1	–
3.	Murugavel et al. [8]	Diode Laser	5	NA
4.	Talsania et al. [9]	Diode laser	8	36 months
5.	Kameshwaran et al. [5]	KTP-532 laser	15	12 months
6.	Nayak et al. [6]	KTP-532	9	12 months
7.	Shah et al. [7]	“Opus-5” diode laser	10	3 months
Total			48	3–36 months

the disorder. Controlled trials and multicenter studies were conspicuous by their restricted numbers.

Discussion

Primary Excision

The common method of primary excision was the scalpel. Band excision was not delineated specifically nor was the

extent and the direction specified. It is a well established fact that vertical bands are more common in the buccal mucosa, diffuse fibrosis without delineated bands are common in the tongue and circumferential bands following the outline more common on the soft palate. A few articles did mention the extent of vertical excision as the level of parotid papilla, but majority of the articles listed “excision of palpable bands” as the preparatory step of the surgical intervention.

Primary excision using lasers were reported in six studies [3–8] (Table 2). The most common lasers used

were the ErYCCG laser [3], KTP 532 [4, 5], and the diode lasers [6–9]. The choice of lasers seems to have been determined by their availability in the surgical unit rather than a scientific selection. Laser excision seemed to have been carried out in limited areas of fibrosis and only in cases related to the buccal mucosa. Reports of use of lasers in other oral sites was not forthcoming. Apart from standard postoperative physiotherapy, no secondary procedures were used in conjunction with lasers. The efficacy of laser excision was rated as good, excellent, with follow ups extending to a maximum of 6 months only. No controlled cohort studies of scalpel excision compared with lasers were reported.

Following excision of the fibrous bands, treatment modalities diverged from use of conservative adjunctive surgical procedures like coronoidotomy/coronoidectomy and/or muscle myotomy only [9], to use of interpositional grafts based on local pedicle flaps or distant free flaps. A third group included coverage of the excised band area with split thickness grafts, collagen membranes and artificial dermis.

Conservative Adjunctive Surgical Procedures

Detachment of the coronoid process from its temporalis muscle attachment (coronoidotomy) or intentional sectioning of the coronoid process with or without detachment of the muscle (coronoidectomy) was the most common procedure described in adjunct to primary excision of the bands [9]. The use of this procedure was found to be popular even in cases where interpositional grafts were placed.

The justification for use of this procedure seems to be release of the pull of temporalis muscle during oral excursions. In a parallel study, Chang et al. [10] carried out coronoidectomy in 18 head and neck cancer patients having trismus secondary to maximal radiation. The coronoidectomy was carried out after standard physical therapy for 3 months failed to increase oral opening. The results were quite encouraging and the authors reported a substantial increase in oral opening (postoperative oral opening was maintained at ≥ 35 mm) at the 6- and 12-month follow up period. The authors have further stated that the tumour location, tumour excision, or the addition of surgical resection had no impact on outcome. The procedure seems to have a beneficial effect on the outcome of OSF surgically treated patients.

Interpositional Grafts (Flaps)

Use of interpositional grafts in areas of band excision have been the most populous methods of surgical intervention in OSF. The grafts used in the studies have been divided, for

purposes of discussion, into local flaps and distant flaps. Local flaps imply donor sites in the head and neck region transposed to the oral cavity by pedicle attachments. Distant flaps include free flaps with arteriovenous anastomoses from donor sites in the arm and thigh.

Local Flaps

Local flaps were further subdivided into intraoral and extraoral flaps.

(A) Intraoral flaps

- (a) Tongue flaps
- (b) Palatal island flaps

(B) Extraoral flaps

- (a) Buccal fat pad
- (b) Nasolabial flap
- (c) Temporalis fascia flap

Intraoral Flaps

Tongue Flaps Tongue flaps were used as interpositional grafts in five studies [11–15]. A total of 138 patients were treated with this technique with a follow up period ranging from 1 to 84 months. Bhargava et al. [11] used tongue flaps in a group of 25 patients with a follow up period of 3 years and reported satisfactory results. Tepan et al. [12] reviewed surgical treatment modalities in 100 patients in their unit. 25 patients out of 100 were treated with tongue flaps. The results were said to be satisfactory but the review period was listed as 1 month. The single longest follow up of surgically treated cases was published by Mehrotra et al. [13]. The authors used the tongue flap procedure for interpositional graft stabilization in 60 OSF patients over a 7-year period. The authors reported good maintenance of oral opening and graft health extending through the follow up period.

The use of a tongue flap is rather surprising in the treatment of OSMF. Apart from the short-term morbidity of the donor site in terms of speech and mastication, post operative fibrosis and constriction of tongue mass can have deleterious effects on the lifestyle of the patient. The most important factor against usage of a tongue flap, or for that matter any intraoral flap, is the possibility of the donor area being afflicted with the disease process. OSMF is a potentially malignant condition with affliction of almost all parts of the oral mucosa at the time of diagnosis. Whilst surgeons using intraoral flaps for reconstruction in the treatment of this condition may very well justify their choice by stating that the donor site did not show *clinical* evidence of disease affliction, the likelihood of changes

Table 3 Analysis of buccal fat pad used for treatment of oral submucous fibrosis in literature

S. no.	Author/s	No. cases	Follow up	Remarks
1.	Chao et al. [20]	16	5 weeks	Histological study 10 bilateral and 6 unilateral Epithelization found to occur in 5 weeks time
2.	Girotra et al. [18]	1	NA	1 OSMF amongst 20 other cases of OAF
3.	Gupta et al. [27]	1	6 months	IOO increased from 8 to 32 mm
4.	Nataraj et al. [25]	15	6 months	Of a group of 30 cases IOO increased from 11 to 32 mm One relapse reported
5.	Jeevan Kumar et al. [19]	20	10–30 months	IOO increased from mean of 15.6–40.5 mm in 6 months
6.	Mehta et al. [28]	1	4 weeks	IOO increased from 20 to 50 mm
7.	Pandya et al. [22]	1	6 months	NF done in the same patient on the other side IOO increased from 7 to 28 mm
8.	Sharma et al. [23]	28	12 months	Gr I IOO increased from 19.6 to 35 mm Gr II IOO increased from 12.92 to 31.76 mm
9.	Surej Kumar et al. [29]	1	2 weeks	IOO increased from 14 to 35 mm
10.	Krishna Prasad et al. [26]	3	36 months	3 out of 10 patients treated with BFP IOO increased from 17–22 to 34–37 mm
12.	Yeh [21]	9	21.3 months	Pedicled buccal fat pad with or without coronoidectomy IO increase of mean 19.1 mm achieved
13.	Lai et al. [24]	25	24 months	IO increased from 30–35 to 38 mm at 2 years follow up period
14.	Saravanan and Vinod Narayan [30]	8	6 months	IO increased from 18 to 30 mm
15.	Kothari et al. [31]	10	12 months	IO increased from 14.7 mm (mean) to 35–45 mm
Total		139	2 weeks–36 months	

already having set in are very high. All the studies reported above did not involve a biopsy to rule out histopathological involvement of the tongue.

Palatal Island Flaps The palatal flap based on the greater palatine artery was used by Golhar et al. [15] in 33 patients of their series of 100 cases. The use of this flap was reported only in this series, as no articles using this flap were available in the literature for treatment of OSMF. Interestingly the authors have adopted temporalis myotomies and coronoidectomies as adjunctive procedures in their patients treated with the palatal flaps.

The limited use of this flap amongst oral surgeons is probably due to restrictions imposed in harvesting the flap, postoperative morbidity to the donor site which heals by secondary intention and the limited reach of the flap. Overextension of the flap may lead to torsion and flap failure. There may be a need to extract the second maxillary molars to allow the flap to reach the host site. The involvement of the palatal tissue in the disease process precludes this area as the graft site of choice.

Buccal Fat Pad The buccal fat pad as an interpositional graft was the second most popular technique in the treatment of OSMF (139/995–13.97 %) (Table 3). The easy access of the buccal fat tissue in close proximity to the

surgical site, its volume and its non-involvement in the disease condition make it an ideal choice as a donor site. In addition the relatively less morbidity associated with procedure and the simplicity of the technique of harvesting the fat tissue justify its popularity. 15 articles in the literature used the buccal fat pad and all reported adequate retention and maintenance of oral opening following the procedure [10, 15–25]. Major hurdles included the rather limited reach of the flap for coverage of the anterior regions of the oral cavity, the chances of damage to the parotid papilla and duct during harvesting and secondary infection in the post operative phases. Coverage of the fat tissue with collagen membranes and SSG have also been advocated to circumvent this problem.

Of the 13 reports, seven studies also used adjunctive myotomy and coronoidotomy during the treatment.

Intraoral flaps accounted for 31.16 % (310/995) of the total cases treated signifying the comfort level of the operator in their usage.

Extraoral Flaps

Nasolabial Flap The nasolabial flap proved to be the most popular procedure used in the surgical treatment of OSMF

Table 4 Analysis of nasolabial flaps used for treatment of oral submucous fibrosis

S. no.	Author/s	No. of cases	Follow-up period	Remarks
1.	Krishna Prasad et al. [26]	5	36 months	Oral opening pre-op 10 mm increased to 26 mm
2.	Tauro [39]	85	66 months	Bilateral flaps harvested from all patients (total flaps = 170)
3.	Agarwal et al. [38]	27	12 months	Oral opening pre-op 11 mm increased to 39 mm
4.	Kshirsagar et al. [40]	6	6 months	All 3rd molars extracted Postop 2 cases had coronoidectomy for decreased IO opening < 30 mm Oral opening increased from 15 to 39 mm Bilateral coronoidectomy done for IIO < 20 mm
5.	Borle et al. [32]	47	24 months	Additional coronoidotomy/coronoideotomy Increase in oral opening from 14 to 41 mm
6.	Cunha-Gomes et al. [34]	12	18 months	Cases of OSCC in OSMF NF used in non OSCC site afflicted with advanced OSMF IO increased from 8.75 to 37.5 mm
7.	Maria et al. [33]	10	12 months	IOO increased from 20 to 35 mm
8.	Janjua et al. [35]	5	6 months	Bilateral NFs used IOO increased from 12.3 to 34.5 mm
9.	Kavarana et al. [37]	3	–	Bilateral NFs
10.	Mehrotra et al. [13]	25	–	Out of total 100 cases treated with different treatment regimens IOO increased from 14.82 to 35.64
11.	Pandya et al. [22]	1	6 months	Simultaneous NF and BFP on the same patient Coronoidectomy + extraction of 3rd molars done IOO increased from 7 to 28 mm
12.	Patel et al. [36]	1	–	OSCC development in NF

(Table 4). Twelve articles were available in the literature which had used this donor site [10, 18, 22, 26–34]. Apart from the standard technique of harvesting, modifications have been utilized as in an extended incision going down to the lower lip to facilitate flap tissue with an extended reach. The use of the nasolabial flap for repair of orofacial defects is well established. Apart from the easy accessibility, the availability of a healthy vascular pedicle based on the inferior nasal vessels and the possibility of using this flap to cover almost all regions in the oral cavity make it a well justified choice for the treatment of OSMF. In addition the non-involvement of the flap in the disease condition is an advantage.

Most of the studies using the nasolabial flap reported post operative oral openings of over 35 mm at the end of the follow up periods which ranged from 1 to 36 months. In the single largest study using nasolabial flaps David Tauro reported satisfactory oral opening of 40 mm post-operatively in his series of 85 cases. The common complications following this flap have been scars in the facial region, decrease or accentuation of the nasolabial fold and development of hair on the flap tissue in the intraoral region. Restricted width of the flap preclude its usage in wide band excision of extensive OSMF.

The nasolabial flap has been used for reconstruction of surgical defects in patients with OSMF who developed oral squamous cell carcinoma [28]. The authors reported the satisfactory coverage, release of trismus and maintenance of oral opening with this flap.

Interestingly secondary development of oral squamous cell carcinoma has been reported [30]. The report indicated use of nasolabial flap for surgical treatment of OSMF and subsequent development of carcinoma in the flap tissue. This secondary involvement of graft tissue indicates the dangers of spread of primary tissue changes especially when dysplastic changes are involved. Such a development has not been frequent.

Temporalis Fascia Flap The use of the temporalis fascia flap as an interpositional graft in the surgical management of OSMF is rather limited with only one study having adopted this procedure. Janjua et al. [35] carried out this technique on five patients and reported good results. The procedure involved detachment of the masseter muscle insertion in the zygomatic arch and temporalis attachment to the coronoid process before the flap was raised. The flap was then covered with a split skin graft. All five cases reported satisfactory uptake and maintained vascular supply. The incision was hidden in the temporal hairline.

Table 5 Analysis of grafts, collagen membranes and other artificial structures used for treatment of oral submucous fibrosis

S. no.	Author	No. of cases	Follow up period	Remarks
Collagen grafts				
1.	Chen et al. [50]	32	–	100 % success rate
2.	Nataraj et al. [25]	15	6 months	IOO increased from 12 to 38 mm
3.	Jiang et al. [51]	8	6 months	Used heterogenous acellular dermal matrix IOO increased from 12.04 to 29.33 mm Micronutrient therapy given concomitantly in few patients
4.	Ko et al. [52]	21	3 months	IOO increased from 15.5 to 25 mm
5.	Manjunath et al. [56]	1	–	–
6.	Paramhans et al. [57]	30	24 months	Bilateral coronoidectomy done concomitantly IOO increased from 10.1 mm (mean) preop to 34.27 (mean) post op at end of 2 years
Split skin grafts (SSGs)				
1.	Lai et al. [24]	25	24 months	SSG harvested from thigh IO increase from 30–35 to 50 mm
2.	Huang et al. [54]	54	6 months	IO increase from about 18–19 to 22–36 mm dependent on patients cooperation
3.	Khanna and Andrade [16]	15	48 months	Mean post op IO was 35–45 mm
4.	Morawetz et al. [58]	2	10 weeks	Regression in one patient
Human placental/amnion grafts				
1.	Lai et al. [24]	25	24 months	IO increased from 30–35 to 60 mm
2.	Gupta and Sharma [55]	14	10 weeks	Satisfactory oral opening
Artificial dermis				
1.	Chen et al. [50]	32	–	No immunologic reactions observed
2.	Jiang et al. [51]	8	6 months	No immunologic reactions observed
3.	Ko et al. [52]	21	3 months	No immunologic reactions observed

The temporalis fascia is the farthest in reach amongst the local flaps. Its coverage of anterior defects, presence and growth of hair in grafted tissue and morbidity of temporal hollowing are common problems incident on the procedure. The flap seems to be the least popular amongst all facial flaps preferred.

Distant Flaps The use of microvascular anastomoses has opened new donor sites for oral reconstruction. Free flaps serve the advantage of secondary donor areas unaffected by the local disease process, no encumbrances of anatomical restrictions in the oral region and abundance of virtually all forms of tissue layers including muscle and bone for reconstruction. The high expertise, high operating costs and potential failure of anastomoses are decidedly the prominent drawbacks.

Interestingly use of free flaps for surgical management of OSMF has been reported only from the Chinese subcontinent with no reports available from other regions of the world. Five studies using a split technique of a radial forearm free flap from a single donor site and a single study using a similar split flap harvested from anterolateral thigh based on the lateral dorsal circumflex artery have been described [36–40] (Table 6). All the studies reported

common complications of aberrant microvascular stenosis in the anastomoses and need for debulking at a later stage. Interestingly development of squamous cell carcinoma in a free flap has been reported, though this seems to be a rare occurrence [37]. Table 4 gives an overview of the studies that utilized this technique and the follow up results.

The use of free flaps in the Indian subcontinent has not been reported so far. Obvious reasons would be the limited availability of surgical expertise and the abundance of local donor sites which satisfy the needs of reconstruction of this condition. Free flap usage seems a bit of an overkill at this juncture in the primary surgical management of OSMF. The justification of free flaps is probably more in areas of extensive reconstruction incident on treatment of oral malignancies.

Use of Grafts

Split skin grafts (SSG), collagen membranes and artificial dermis, human placenta and amnion have been the common materials preferred in the grafting of mucomuscular defects in the surgical management of OSMF [10, 20, 35] (Table 5).

Table 6 Analysis of other types of flaps used in the treatment of oral submucous fibrosis

S. no.	Type of flap	No. of cases	Follow-up (months)	Remarks
Radial forearm free flaps				
1.	Celik et al. [46]	26	3–48	IOO increased from 15 mm (mean) preop to 35 mm (mean) post op With or without temporalis myotomy and coronoidectomy 23 % of patients developed OSCC during follow up period
2.	Lee et al. [49]	6	19	Double-skin paddled radial forearm flap from single donor site IOO increased from 3.3 mm (mean) preop to 30 mm (mean) post op With masticatory muscle myotomy and coronoidotomy 5/6 flaps survived uneventfully 1 flap salvaged after arterial thrombosis 1 patient developed TMJ subluxation
3.	Lee et al. [47]	10	21	Bipaddled radial forearm flap from single donor site With masticatory muscle myotomy and coronoidotomy IOO increased from 2.3 mm (mean) preop to 28.2 mm (mean) postop 2 flaps needed revision due to bulkiness 1 patient developed TMJ subluxation
4.	Tsao et al. [48]	8	19.8	Two flaps from same donor site IOO increased from 8.25 mm (mean) preop to 29.88 mm (mean) postop
5.	Wei et al. [45]	15	12	Bilateral radial forearm free flaps used With or without temporalis myotomy and coronoidotomy 6 flaps needed debulking, 1 had partial necrosis 1 patient developed OSCC at flap site
Thigh flaps				
1.	Huang et al. [53]	9	10–33	Two anterolateral thigh flaps based on descending branch of lateral circumflex femoral artery used—single donor site IOO increased from 9.6 mm (mean) preop to 23.8 mm (mean) postop 4 flaps needed secondary debulking in 3 patients
Palatal island flaps				
1.	Khanna and Andrade [16]	33	48	In conjunction with temporalis myotomy and coronoidectomy. Donor site covered with SSGs
Tongue flaps				
1.	Khanna and Andrade [16]	7	48	Dorsal tongue flap coverage
2.	Golhar et al. [15]	21	36	Anterior- and posterior-based dorsal tongue flaps used
3.	Mehrotra et al. [13]	25	1	—
4.	Ramadass et al. [14]	60	84	Single dorsal rotation pedicle flap
5.	Tepan et al. [12]	25	36	—

The use of SSG, and allogenic materials is purely supportive and protective in the post operative healing period. Two groups of studies using grafts was noted in the review. In one group the graft material served as the main and only coverage of the defect. In the other group grafts served to protect interpositional flaps as a secondary coverage. There were no control studies available for comparison between these groups. The use of commercially available dermis and collagen seems to be gaining popularity due to the ready availability and the decreased incidence of morbidity in donor sites when harvesting SSG.

The use of human placental grafts and human amnion has been reported in older studies. The potential availability of

innate steroid therapy and collagen degrading enzymes in the placenta and amnion is an added therapeutic benefit of this graft, in addition to the passive coverage. The difficulties in harvesting placental grafts and human amnion and ethical problems have largely rendered the use of this graft redundant (Table 6).

Other Adjunctive Modalities

In addition to the mainstream use of grafts and flaps following tissue excision, studies have reported on use of prosthetic devices in the maintenance of the postoperative oral opening 41–43. Three studies using oral stents as

Table 7 The advantages and disadvantages of flaps used in the treatment of oral submucous fibrosis

S. no.	Type of flaps	Advantages	Disadvantages
1.	Buccal fat pad	Accessible Unaffected by disease process in mouth Adequate material available for coverage of posterior areas Limited morbidity to patient in terms of esthetics Limited expertise needed Chairside procedure can be done under local anesthetic	Anterior reach inadequate and regions anterior to canines have to be left uncovered Inadequate harvesting of BFD due to atrophy in chronic and severe cases of OSMF Excessive fear of breakdown and loss due to lack of protection of tissue
2.	Nasolabial flap	Accessible Unaffected by disease process in mouth	Limited reach even when extended NFs are used Esthetic morbidity in terms of postoperative scar, loss of nasolabial crease Limited width of flap material for coverage Requires second procedure for detachment
3.	Tongue flap	Accessible Good muscular bulk available Adequate pedicle vascular supply based on lingual vessels	Dysphasia Disarticulation Risk of postoperative aspiration Limited amount of donor tissue due to inadequate reach Lack of stability and dehiscence due to uncontrolled tongue movements (38 % of patients with OSMF have tongue involvements) Requires second procedure for detachment
4.	Palatal pedicle flap	Accessible Adequate vascular supply of pedicle based on greater palatine vessels	Limited reach and coverage; 2nd molar extraction required at times to extend reach Fibrotic involvement of the site Coverage and healing of donor site a problem and increases morbidity Requires second procedure for detachment
5.	Temporalis fascia flap	Accessible Unaffected by disease process in mouth	Limited reach Coverage of posterior areas of mouth only possible Hollowing of temporal region of face can sometimes occur Esthetic morbidity in terms of post operative scar Requires second procedure for detachment
6.	Radial forearm flaps	Accessible Unaffected by disease process in mouth	Flaps are hairy Procedure requires high expertise, not cost effective Limitations of flap survival due to dependence on microvascular anastomoses Requires second procedures to debulk and in cases of failure of anastomoses Extraction of 3rd molar required to avoid flap inclination between teeth
7.	Anterolateral thigh flaps	Adequate tissue bulk Can be used for coverage of large defects Unaffected by disease process in the mouth	Procedure requires high expertise, not cost effective Limitations of flap survival due to dependence on microvascular anastomoses Second procedures to debulk and in cases of failure of anastomoses sometimes required
8.	Coverage with membranes and split skin grafts	Commercially available Least morbidity to donor site Adequate protection of host site during healing	Increased incidence of post operative contractures Common failure of SSGs due to lack of vascular supply Best used as immediate coverages

intermediary prosthetic rehabilitation devices were available in the review [22, 44, 45]. These stents serve as valuable adjuncts in guiding the postoperative functionality of healing tissue following excision of the bands. In addition one case report depicted an improvised device that acted as a graft stabilizing clip during the immediate postoperative period [46].

Table 7 presents an overview of the advantages and disadvantages of the surgical procedures employed in the treatment of OSMF.

Conclusion

The surgical treatment of OSMF is primarily aimed at releasing the trismus caused by the fibrotic bands and maintenance of oral opening in the postoperative period. Prominent findings of this review were the lack of concerted treatment protocols, restricted follow-up periods and the lack of controlled studies to assess the evidence of efficacy of a particular procedure. Most studies were in the form of case reports and involved individual units. Multi-center studies were conspicuous by their absence. Evidence based reports were lacking and thus the treatment efficiencies could not be definitively assessed.

In view of the predominance of this affliction to occur in our subcontinent it is imperative that standardized protocols based on experiences of large centers be evolved to guide the maxillofacial surgeon in the treatment. The indications for surgical interventions should be clearly outlined and treatment procedures delineated based on the intensity of pan-oral involvement. Individual preferences should be modified and guided so that corroborative evidence on treatment results can be analysed for productive surgical audit.

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