ORIGINAL ARTICLE

Combined endoscopic and intra-oral approach for chronic maxillary sinusitis of dental origin—a prospective clinical study

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Abstract

Aims and objectives The traditional Caldwell-Luc approach for maxillary diseases has been criticized for its short-comings such as removal of a large amount of bone, numbness of the teeth, flap dehiscence, and recurrent sinusitis. On account of its minimal invasiveness and physiological approach, functional endoscopic sinus surgery (FESS) has come to replace the Caldwell-Luc approach for the treatment of chronic rhinosinusitis. Chronic maxillary sinusitis of dental origin (CMSDO) is a less common variant on the chronic rhinosinusitis spectrum whose treatment involves simultaneous management of both the diseased maxillary sinus and the dental source of infection. Thus, this study was undertaken to assess the efficacy of FESS when combined with an intra-oral approach for the treatment of CMSDO.

Material and methods Eighteen patients with CMSDO in the age group of 18–50 years were treated with a combined endoscopic and intra-oral approach (buccal advancement flap with/without buccal fat pad) in this study. The patients were followed up for a total duration of 18 months. The primary outcome measurements were the SNOT-22 Quality of Life questionnaire and the Lund and Mackay CT Scan Scoring Criteria. The Friedman test was used to assess improvement in the above variables and the level of significance was set at 0.05.

Observations and results There was a statistically significant reduction ($p < 0.05$) in both the above parameters at all post-operative intervals. Two patients presented with epistaxis (immediate post-operative phase) and synechiae (second week follow-up interval). Both complications were successfully resolved. Two patients showed recurrence at the 6th-month interval for which they underwent revision surgery successfully. Overall, results were maintained even at the 18th month follow-up interval.

Conclusion The endoscopic approach appears to be a reliable, minimally invasive technique associated with less morbidity and stable long-term results. Thus, a multi-disciplinary approach between maxillofacial surgeons and otolaryngologists is essential in the treatment of CMSDO.

Keywords Maxillary sinusitis · Endoscopy · Buccal fat pad · Antrostomy · Caldwell-Luc

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Introduction

Chronic maxillary sinusitis (CMS) is a pathological condition that occurs due to a transient disruption in the normal physiologic flow patterns of the muco-ciliary layer. Traditionally, the Caldwell-Luc (CDL) procedure was performed for CMS wherein the hyperplastic inflamed tissue and sinus lining were stripped completely. When present, antral pathologies (e.g., cysts and benign tumors) and foreign bodies were also removed through the same opening. However, this procedure had its own drawbacks such as removal of a large amount of bone, numbness of the teeth in the vicinity, flap dehiscence, and recurrent sinusitis [1–3].

Functional endoscopic sinus surgery (FESS) eventually replaced the CDL technique as the gold standard for the treatment of CMS on account of its minimally invasive nature and physiological approach [4]. Similarly, osteoplastic bone lid techniques were created in a bid to avoid the complications associated with the CDL technique while retaining its surgical accessibility [5].

Up to 25% of cases presenting with CMS are associated with a dental origin (chronic maxillary sinusitis of dental origin, CMSDO) and treatment involves addressing both the odontogenic cause and the sinusitis [6–13]. The rationale of our clinical study was to assess the feasibility and limitations of functional endoscopic sinus surgery in combination with an intra-oral approach for the treatment of CMSDO [2, 14–17].

Aims and objectives

To evaluate the clinical outcomes after combined surgical approach of FESS and buccal advancement flap with/without buccal fat pad graft in CMSDO patients:

- Resolution of clinical symptoms as per the Sino-Nasal Outcome Test – 22 Quality of Life scoring criteria for CMS.
- Radiographic evaluation of disease resolution in the paranasal sinuses using the Lund and Mackay classification for CT scan scoring for CMS.
- Calculation of the following indices: Success Rate, Recurrence Rate, Revision Surgery Rate and Crude Complication Rate.

Materials

A case of CMS is established when the patient gives a positive history for rhino-sinusal symptoms persisting for at least 3 months in spite of receiving medical therapy for at least 1 month. There should also be evidence of sinus disease on the CT scan and/or endoscopic examination [7, 18, 19]. To further classify the condition as CMSDO, it is mandatory to identify a dental origin [6–13]. Patients presenting with rhinosinusitis of non-dental origin, asthma, allergies, immunodeficiencies, blood dyscrasias, medication-related osteonecrosis of the jaws, osteoradionecrosis, anatomical abnormalities of the nasal and para-nasal structures, and any uncontrolled major systemic illnesses (e.g., diabetes and hypertension) were excluded from the study.

Once institutional ethical committee approval was obtained, a prospective clinical study from January 2014 to January 2016 was carried out in the Department of Oral and Maxillofacial Surgery of a government-run teaching hospital cum tertiary referral center. During this period, 25 patients (between the age group of 18–50 years) presented with chronic maxillary sinusitis of whom only 18 patients with CMSDO were included in the study after obtaining their informed consent. Of the 7 remaining patients, 5 were diagnosed as CMS of non-dental origin and 2 were CMSDO with uncontrolled diabetes mellitus and hence were excluded from the study. All patients signed an informed consent agreement.

The Sino-nasal Outcome Test-22 (SNOT-22) Quality of Life (QoL) questionnaire was selected to measure the symptomatic relief experienced by the patients after the FESS procedure as it was an already validated tool that was easily applicable and encompassed the spectrum of symptoms associated with sinusitis (22 questions covering 5 groups of symptoms: nasal, paranasal, sleep related, social, and emotional impairment). Symptom severity was graded as follows: 0 no problem, 1 very mild problem, 2 mild or slight problem, 3 moderate problem, 4 severe problem, and 5 problem as bad as it can be. Mean symptom scores were calculated with a minimum score of 0 and a maximum score of 110 [19–21].

The Lund and Mackay classification for CT scan scoring was also used to validate the therapeutic efficiency of FESS from a radiographic perspective. For each of the paranasal sinuses (maxillary, anterior ethmoid, posterior ethmoid, frontal, and sphenoid), scores of 0 to 2 (0 no opacification, 1 partial opacification, 2 total opacification) were given for each side separately. Additionally, scores were given for the osteo-meatal complex of each side (0 no obstruction, 2 obstruction) [21].

Methods

The study was conducted by a 4-member team (1 otolaryngologist and 3 maxillofacial surgeons). The surgery was always performed by the same team of one maxillofacial surgeon and one otolaryngologist. The 2nd maxillofacial surgeon was responsible for recording the baseline pre-operative clinical and radiographic data. The 3rd maxillofacial surgeon was responsible for recording post-operative clinical and radiographic data and was blinded from the pre-operative values.
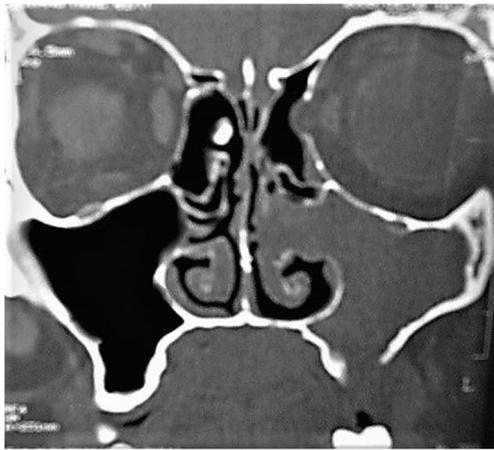
Fig. 1 Left maxillary sinusitis (total opacification) with blockage of the osteo-meatal complex and oroantral fistula due to a traumatic extraction of the 1st maxillary molar

Fig. 3 Drainage of the maxillary sinus after removal of the polypoid mass (DMO draining maxillary ostium)

A thorough clinical examination by the otolaryngologist and the maxillofacial surgeon was performed pre-operatively. A high-resolution CT scan (Fig. 1), nasal endoscopic examination (Fig. 2), and intra-oral examination were done to determine the source of infection, the location of the fistula, the anatomical extent of the sinus disease, and the presence of any foreign body in the sinus. The SNOT-22 questionnaire and the Lund and Mackay CT scan scoring criteria were used to record pre-operative baseline data.

All the patients were operated under total intravenous anesthesia. The nasal tissues were infiltrated with 2% lignocaine with 1:200,000 concentration Adrenaline. The FESS procedure was performed initially by the otolaryngologist to avoid damaging the subsequently reconstructed sinus floor. Using a 0° endoscope, an incision was made on the uncinate process with a sickle knife, grasped with a Blakeley forceps, and removed with a twisting movement, thus uncapping the infundibulum. Any polyps that were found in the infundibulum w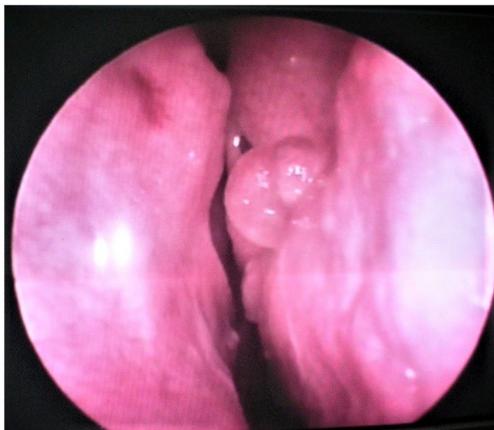ere removed (Fig. 3). After clearing the bulla ethmoidalis and the middle ethmoidal cells, the maxillary sinus ostium was then identified with a 30° endoscope. The natural ostium was identified and, if needed, enlarged posteriorly by punching out its bony walls using an Ostrum's reverse cutting forceps (Fig. 4). Forty-five-degree and 70° endoscopes were used to visualize the interiors of the maxillary sinus. The hyperplastic inflamed tissue and polyps within the maxillary sinus were removed with an angulated micro-debrider and the underlying maxillary sinus lining was exposed. Though the sinus lining appeared infected and swollen, it was not stripped off completely due to its strong regenerative ability (3, 22). The foreign body within the sinus (if present) was removed with the help of an extra-long curved antrum grasping forceps. The nose was packed with roller gauze soaked in liquid paraffin to achieve hemostasis and was removed at the end of the procedure.

The next part of the surgery, carried out by the maxillofacial surgeon, involved removal of the source of infection followed by the closure of the oroantral fistula. Teeth with
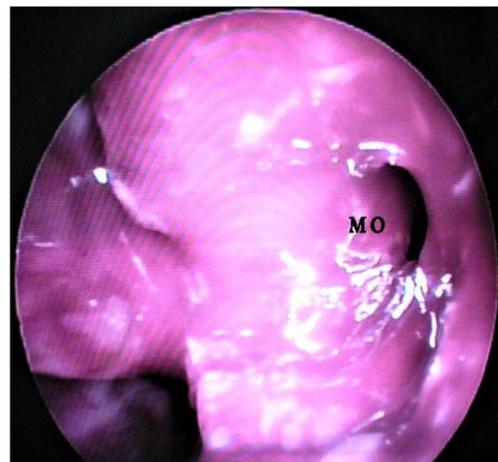

Fig. 2 Polypoid mass emerging from the left osteo-meatal complex

Fig. 4 Left maxillary ostium cleared of disease (MO maxillary ostium)

apical/marginal periodontitis and failing implants in close proximity of the maxillary sinus floor were removed. The intra-oral sites were then curetted to remove any pathologic tissue. Implant site defects and extraction sockets were closed with a single layered buccal advancement flap (BAF). Oroantral fistulae were closed in a 2-layered manner using the (BFP) buccal fat pad (inner layer) and the buccal advancement flap (outer layer).

No major complications were encountered intra-operatively. The patients were discharged by the 1st or 2nd post-operative day and were prescribed routine nasal decongestants, analgesics, and antibiotics (oral fixed dose combination of amoxicillin-clavulanate 625 mg twice daily) post-operatively for a period of 7 days. The patients were placed on sinus precautions for a period of 3 weeks (avoiding sneezing, coughing, and activities involving heavy breathing; nasal irrigation instructions). Post-operative follow-ups were performed at fixed intervals (2 weeks, 4 weeks, 6 months, 12 months, and 18 months) (Fig. 5). The clinical examination included an intra-oral examination, nasal endoscopic examination, and filling out of the SNOT-22 QoL questionnaire. CT scans were repeated post-operatively at the 6th month and the 18th month and scored using the Lund and Mackay Scoring Criteria (Fig. 6).

All patients presented with mild facial swelling in the immediate post-operative phase which resolved by the 2nd day. Two patients presented with epistaxis in the immediate post-operative phase which was resolved by packing the nasal cavity with a nasal tampon. At the 2-week interval, the above two patients also exhibited with minor synechiae formation between the lateral nasal wall and septum. The adhesions were divided with an endoscope in an out-patient setting. On account of the synechiae being small, a spacer was not placed, and on subsequent follow-ups, the synechiae did not re-form.

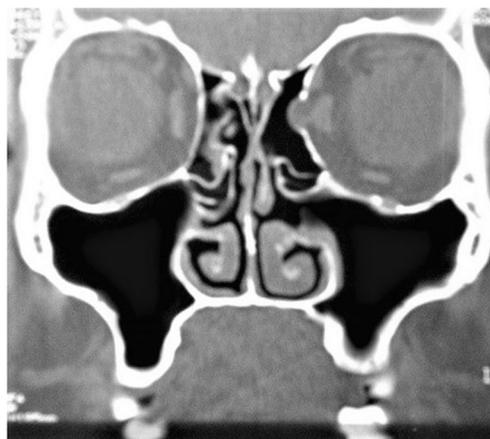Fig. 5 Post-operative intra-operative site showing adequate healing at 6 months

Fig. 6 Post-operative CT scan showing a clear maxillary sinus and patent osteo-meatal complex at 18 months

Two patients presented with recurrence of sinusitis and wound dehiscence of the oral surgical site at the 6-month interval. Revision surgery (FESS with a 2 layered closure using BAF and BFP) was performed, and both cases reported significant improvement of symptoms with no signs of relapse at the 12th and 18th month follow-up intervals. Mobilizing the BFP for the 2nd time was more difficult on account of the scarring and required considerable dissection.

The data obtained was compiled on a MS Office Excel Sheet (v 2010) and was subjected to statistical analysis using Statistical Package for Social Sciences (SPSS v 21.0, IBM). The demographic details were depicted as percentages and frequencies for categorical data and mean and standard deviation (SD) for numerical data.

Comparison of the SNOT-22 scores and CT scan scores at various time intervals was done using the Friedman test, as the dependent variables of the study (SNOT-22 QoL score and Lund and Mackay CT scan score) exhibited continuous data. For all the statistical tests, $p < 0.05$ was considered to be statistically significant. The α error was kept at 5% and the β error at 20%, thus giving a power of 80% to the study.

Results

A total of 18 patients were enrolled in the study. Female patients made up 55.6% ($n = 10$) of the sample. The mean age of the patients was 33.94 years (SD = 8.941). The patients reported persistence of rhino-sinusal symptoms for a mean period of 15.39 weeks (SD = 3.051). The mean duration of medical therapy reported by the participants was 5.56 weeks (SD = 1.723). The 2 most common etiological agents were tooth root displaced into the maxillary sinus with oroantral fistula (33.33%) and oroantral fistula due to traumatic dental extraction in the maxillary posterior region (27.8%) (Table 1).

Table 1 Table showing descriptive demographic details

Variable	Categories	Frequency	Percent
Gender	Female	10	55.6
	Male	8	44.4
Medications	Nasal decongestants	18	100
	Topical nasal steroids	11	61.1
	Anti-histaminic	11	61.1
	Antibiotics	18	100
Etiology	Apical periodontitis	3	16.7
	Displaced tooth root with OAF	6	33.3
	Failed implant	3	16.7
	Marginal periodontitis/deep pockets	1	5.6
	OAF due to traumatic dental extraction	5	27.8

OAF oroantral fistula, *BAF* buccal advancement flap, *BFP* buccal fat pad, *FESS* functional endoscopic sinus surgery, *CMS* chronic maxillary sinusitis

The most common symptoms were (94.4%) nasal obstruction, (88.9%) chronic dental pain, and (83.3%) facial pain/pressure (Table 2). The symptoms were accorded scores with the help of the SNOT-22. The mean pre-operative SNOT-22 score was 64.83. The mean post-operative SNOT-22 scores were 32.94 at 2 weeks, 31.61 at 1 month, 26.39 at 3 months, 16.50 at 6 months, 10.22 at 12 months, and 8.44 at 18 months. The Friedman test showed that there was a statistically highly significant difference for the intra group comparison of the SNOT-22 Score ($p < 0.01$). The highest score was at the baseline followed by which there was a fall in scores observed with time with the least score being at the 18-months follow-up interval (Table 3).

The CT scan was scored as per the Lund and Mackay classification. The mean pre-operative score was 3.67 (SD 0.767). The maxillary sinus displayed total or subtotal opacification on the CT scan. Obstruction of the osteomeatal complex, if present, was also evident on the CT scan. The post-operative scores were 1.61 (SD 1.290) at 6 months and 0.78 (SD 0.647) at 18 months. The Friedman test showed that there was a statistically highly significant difference seen for the intra group comparison of the CT scan scoring ($p < 0.01$). The highest score was at the baseline followed by which there was a fall in scores observed with time with the least score being at the 18-month follow-up interval (Table 4).

Two layered closure, i.e., FESS with BAF and BFP ($n = 11$), was performed in cases that showed evidence of an oroantral fistula due to a traumatic dental extraction or a tooth root displaced into the maxillary sinus. Single layered closure, i.e., FESS with BAF alone ($n = 7$), was performed post removal of failed implants and over extraction sockets in cases of apical and marginal periodontitis. The mean duration of procedure for FESS with BAF alone was 44.29 min (SD 2.430) and for FESS with both BAF and BFP was 56.91 min (SD 3.419). The need to secure an additional layer by mobilizing the buccal fat pad increased the overall duration by 11–12 min on an average. This difference was found to be statistically significant when using the unpaired t test ($p < 0.01$). The unpaired t test also proved that there was no statistically significant difference ($p > 0.05$) on comparison of the duration of hospitalization between "FESS with BAF alone" (1.29 days) vs "FESS with both BAF and BFP" (1.73 days) (Table 5).

The same 2 patients that displayed immediate postoperative epistaxis also displayed synechiae at the 2nd week interval. Thus, a total of 2 patients suffered from complications, and the raw complication rate for the study was 11.11%. Two cases of recurrence were documented at the 6-monthly interval. The cases responded to revision surgery (combined FESS with intra-oral BAF and BFP) with no signs of relapse at the 12th and 18th month follow-up intervals. Thus, the recurrence rate and revision surgery rate of our study was 11.11%. Finally, the overall success rate of our study was 88.89% (Table 6).

Table 2 Table showing the distribution of symptoms

Variable	Category of symptoms	Frequency	Percent
Facial pain/pressure	Major	15	83.3
Facial congestion	Major	13	72.2
Nasal obstruction	Major	17	94.4
Nasal discharge	Major	14	77.8
Altered sense of smell	Major	12	66.7
Headache	Minor	14	77.8
Halitosis	Minor	11	61.1
Fatigue	Minor	12	66.7
Cough	Minor	11	61.1
Ear pain/pressure	Minor	11	61.1
Chronic dental pain	Minor	16	88.9

Category of symptoms according to Lanza and Kennedy [7]

Table 3 Comparison of SNOT-22 Score with various time intervals

Time	N	Mean	Std. Deviation	Minimum	Maximum	Median	Chi square value	P value of Friedman Test
Pre-op	18	64.83	12.664	45	90	61.50		
2 weeks	18	32.94	9.032	24	58	29.00		
1 month	18	31.61	8.161	24	55	30.00	92.856	$p<0.01$
3 months	18	26.39	4.175	20	33	25.50		
6 months	18	16.50	13.535	0	56	12.00		
12 months	18	10.22	3.979	3	18	9.50		
18 months	18	8.44	2.093	4	12	9.00		

Discussion

The Caldwell-Luc technique was the traditional approach for diseases of the maxillary sinus. The underlying principle of the technique was to remove the source of infection and the entire sinus lining through a bony window in the region of the canine fossa followed by which an inferior meatal antrostomy (IMA) would provide a means for gravity-dependent drainage and sinus irrigations in the post-operative phase [1, 22, 23]. However, this approach was not without its own set of complications, e.g., flap dehiscence, removal of a large amount of bone adding to the difficulty of prosthetic rehabilitation of the same region, devitalization of teeth, and infra-orbital region paresthesia. Complete stripping of the sinus lining often leads to chronic pain, sclerosis of the sinus walls, osteitis, and regenerated sinus lining with a poor muco-ciliary function. There was also a trend for slower recovery and increased need for revision surgeries on account of persistent inflammation in the sinus due to the unaddressed blocked ostium [1, 3, 7, 15, 22–25].

The complications associated with the CDL approach were primary attributed to removal of bone from the antero-lateral wall of the maxilla and stripping of the sinus mucosa. The osteoplastic lid technique and its modifications were conceived to reduce the complications associated with the original CDL procedure while still retaining its surgical accessibility. The sinus mucosa is also not removed completely unless irreversibly diseased which contributes to the rapid recovery of normal ventilation and drainage. However, the disadvantages include unpredictable resorption, fracture, and dislodgement of the trap door fragment into the sinus. Furthermore, the use of osteosynthesis material increases the cost of the procedure and may be a potential source of future infection due to hardware failure [5, 26–29].

In our study, we have combined functional endoscopic sinus surgery with an intra-oral approach as an alternative method to treat chronic maxillary sinusitis of dental origin. Currently, FESS is predominantly the domain of otolaryngologists and most maxillofacial surgeons have minimum to no training in the same. We hope to create awareness regarding the superiority of this approach and stress the need for a multidisciplinary approach with otolaryngologists when treating a condition like CMSDO which makes up 12–24% of the overall disease burden of chronic maxillary sinusitis.

FESS (based on the work of Prof. Messerklinger and Wigand) was introduced in the 1970s and 1980s. The underlying principle of FESS was a limited resection of the inflammatory and/or anatomical defects that interfere with the normal muco-ciliary clearance to achieve a patent osteo-meatal complex. It was also important to clear out any residual disease in the adjacent para-nasal sinuses (e.g., ethmoidal air cells) as it would lead to persistent blockage of the osteo-meatal complex and subsequent re-infection of the already treated sinuses [7, 17, 25, 30]. The use of an endoscope

Table 4 Comparison of Lund and Mackay CT scan scoring with various time intervals

	N	Mean	Std. Deviation	Minimum	Maximum	Median	Chi square value	P value of Friedman Test
Pre-op CT	18	3.67	.767	3	5	3.50		
6 months CT	18	1.61	1.290	1	5	1.00	28.500	$p<0.01$
18months CT	18	.78	.647	0	2	1.00		

*Scoring for each para-nasal sinus of each side = total opacification [2], partial opacification [1], no opacification [0]

*Scoring for each osteo-meatal complex = obstruction [2], no obstruction [0]

Table 5 Comparison between FESS with buccal advancement flap only and FESS with both buccal advancement flap and buccal fat pad

	Groups	N	Mean	Std. deviation	Std. error mean	T value	p value
Duration of Procedure (min)	Only BAF	7	44.29	2.430	.918	− 8.461	$p < 0.01$
	Both	11	56.91	3.419	1.031		
Hospitalization Duration (days)	Only BAF	7	1.29	.488	.184	− 1.923	$p = 0.073$
	Both	11	1.73	.467	.141		

BAF buccal advancement flap, *BFP* buccal fat pad, *Both* BAF with BFP

enabled for direct visualization of the field thus requiring minimal exposure, dissection, and elevation of the tissues resulting in minimal swelling and cheek discomfort postoperatively. Furthermore, only the polyps and hyperplastic infected sinus tissue were removed. The sinus membrane lining that appeared swollen/hyperemic was not removed in view of its high regenerative potential [22, 30]. The minimally invasive nature of FESS and the creation of a patent osteo-meatal complex (for ventilation and clearance of sinus secretions) allowed for a faster recovery and shorter duration of hospitalization [2, 3, 15, 22].

FESS-based studies also proved that the natural mucociliary clearance pattern towards the ostium in middle meatus remained unchanged despite the presence of an additional surgical antrostomy [e.g., the inferior meatal antrostomy (IMA) traditionally used in conjunction with the Caldwell-Luc approach]. Furthermore, the middle meatal antrostomy (MMA) exhibited a higher patency rate (85–98%) as compared to that of the IMA (70–82%) with some studies reporting closure of the IMA as early as 3 months. Thus, the more traditional IMA was eventually replaced by the MMA which was commonly performed in FESS [1, 21, 23].

In our study, a total of 18 cases of CMSDO were operated based on the principles of FESS and combined with an intra-oral procedure to re-create a barrier between the oral cavity and the maxillary sinus. The only statistically significant difference between the single layered closure and double layered closure techniques was the additional time of 11–12 min required to harvest and secure the buccal fat pad over the intra-oral site. On an average, patients belonging to both groups were admitted for 1–2 days post-operatively until facial swelling subsided. Though not clinically significant, the double-layered closure group had a longer post-operative stay due to the increased amount of facial swelling associated with the procedure.

The SNOT-22 scores showed a statistically significant improvement at all intervals with a reduction from a mean score of 64.83 pre-operatively to a mean score of 8.44 at 18 months. The Lund and Mackay CT scan scores also showed a statistically significant improvement at all intervals with a reduction from a mean score of 3.67 pre-operatively to a mean score of 0.78 post-operatively at 18 months. The maxillary sinus and osteo-meatal complex were predominantly involved in the CT scan while the ethmoidal cells were less commonly involved

Table 6 Literature-based success, recurrence, and revision surgery rates FESS with/without combined intra-oral approach in CMSDO (table modified from Giovannetti et al. 2014)

Functional endoscopic sinus surgery with/without intra-oral procedure

Studies	Total cases	Success		Recurrence		Revision surgery	
		Number	Rate	Number	Rate	Number	Rate
Lopatin et al. (2002)	70	67	95%	3	4.28%	3	4.28%
Costa et al. (2007)	17	17	100%	0	0%	0	0%
Chiapasco et al. (2009)	27	23	85%	4	14.81%	1	3.7%
Andric et al. (2010)	14	14	100%	0	0%	0	0%
Albu and Baciut (2010)	104	95	91.34%	9	8.65%	9	8.65%
Hajiioannou et al. (2010)	4	4	100%	0	0%	0	0%
Chiapasco et al. (2012)	20	16	80%	4	20%	1	5%
Giovannetti et al. (2014)	20	20	100%	0	0%	0	0%
Our study	18	16	88.89%	2	11.11%	2	11.11%
Average rate			93.36%		6.54%		3.63%

and the presentation was always unilateral. It must be noted that direct correlation between the Lund and Mackay CT scan score and the SNOT-22 score has never been proven conclusively [31]. Nonetheless, both the above variables prove the clinical efficacy of FESS when combined with an intra-oral procedure for the treatment of CMSDO.

There is considerable controversy regarding the use of perioperative antibiotics for most otolaryngologic procedures. Evidence-based reviews of post-operative care in endoscopic sinus surgery by Rudmik et al. [32], Rudmik et al. [33], and Weber et al. [21] suggested that post-operative antibiotic therapy has a beneficial effect on improvement of symptoms and endoscopic appearance in the short-term. The papers recommended a long course of antibiotics of up to 14 days postoperatively. However, meta-analyses by Saleh et al. [34] and Patel et al. [35] suggested that there was no need for routine pre-operative antibiotic therapy for patients undergoing functional endoscopic sinus surgery for routine CMS, the exception being the usage of nasal packs or splints for more than 48 h. The recommend antibiotic course for clean contaminated head and neck surgery was restricted to the intra-operative and post-operative phase (up to 24 h).

However, Little et al. [9] and Saibene et al. [10] suggested that CMSDO is different from routine CMS on account of its dental etiology, associated bacteriology, and higher microbial load. The bacteriology is polymicrobial in nature with predominantly anaerobic organisms (which is more in common with those found in periodontal and endodontic infections). As there was a communication between the nasal and oral cavity, the surgical procedure can also be considered to be of the clean contaminated type. It is important to note that the study was conducted in the Department of Oral and Maxillofacial Surgery of a government-run teaching hospital cum tertiary referral center in Mumbai, India. Majority of the patients treated at this center belonged to the lower socioeconomic strata of society. This demographic of patients routinely suffers from poor oral hygiene, poor nutrition, and lack of basic needs, e.g., clean accommodation. For all the reasons mentioned above, it was decided to continue post-operative antibiotics for a period of 7 days; contrary to the current recommendation of intra-operative and post-operative antibiotics up to 24 h. Chiapasco et al. [36] also administered antibiotics in the treatment of CMS due to maxillary sinus grafting for a duration of 7–10 days post-operatively, similar to our recommendation.

A 25-year review of the complications in FESS by Stankiewicz et al. revealed an overall complication rate of 3.1% with cerebrospinal fluid leak, hemorrhage, and orbital hematoma occurring more commonly. It should be noted that need for revision surgery, synechiae, scarring, and minor bleeding (not requiring any intervention) were considered as poor outcomes instead of complications in the above study. This leads to an overall lower complication rate as compared

to other studies [37]. Our study had a raw complication rate of 11.11%, as only 2 out of 18 patients exhibited both immediate post-operative bleeding that required packing with a nasal tampon. The reason for a higher complication rate in our study could be attributed to its smaller sample size. Both the recurrent CMSDO cases in our study had initially presented with an oro-antral fistula due to a traumatic dental extraction. This is also in line with the literature wherein a higher failure rate is seen in cases of chronic oro-antral fistulae [7, 15, 22].

Based on the above data, our study had an overall success rate of 88.89%, a recurrence rate of 11.11%, a revision surgery rate of 11.11%, and a raw complication rate of 11.11%. Our values were on the higher side of the acceptable range found in the literature. This could once again be attributed to the smaller sample size of our study [15] (Table 6).

Conclusion

The health and normal function of the paranasal sinuses and their lining mucous membranes depends primarily on two important factors: ventilation and drainage. Normal ventilation of the sinuses requires a patent pathway connecting the ostium to the nasal cavity. When the osteo-meatal complex is involved, the middle meatal antrostomy helps create a patent airway and also represents the most important advantage that FESS has over the Caldwell-Luc and osteoplastic lid techniques. FESS is also minimally invasive and hence allows for a quicker post-operative recovery and a shorter hospital stay. Based on the results of our study, one can conclude that FESS should be considered as a part of an oral and maxillofacial surgeon's armamentarium in the treatment of CMSDO and working together with an experienced otolaryngologist will lead to stable long-term results and minimal complications.

Compliance with ethical standards

Ethics committee approval This work obtained local institutional ethics committee approval (EC/OMFS/NDS-09/2013).

Informed consent Informed consent was acquired from all patients.

References

1. Al-Belasy FA (2004) Inferior meatal antrostomy: is it necessary after radical sinus surgery through the Caldwell-Luc approach? J Oral Maxillofac Surg 62(5):559–562

2. Jacob KJ, George S, Preethi S, Arunraj VS (2011) A comparative study between endoscopic middle meatal antrostomy and Caldwell-Luc surgery in the treatment of chronic maxillary sinusitis. Indian J Otolaryngol Head Neck Surg 63(3):214–219

3. Costa F, Emanuelli E, Robiony M, Zerman N, Polini F, Politi M (2007) Endoscopic surgical treatment of chronic maxillary sinusitis of dental origin. J Oral Maxillofac Surg 65(2):223–228

4. Stammberger PW (1990) Functional endoscopic sinus surgery. Concept, indications and results of the Messerklinger technique. Eur Arch Otorhinolaryngol 247(2):63–76

5. Scolozzi P, Martinez A, Lombardi T, Jaques B (2009) Lateral antrotomy as a surgical approach for maxillary sinus: a modified technique with free bone flap repositioning and fixation with a titanium plate. J Oral Maxillofac Surg 67(3):689–692

6. Lechien JR, Filleul O, Costa de Araujo P, Hsieh JW, Chantrain G, Saussez S (2014) Chronic maxillary rhinosinusitis of dental origin: a systematic review of 674 patient cases. Int J Otolaryngol 2014:1–9

7. Albu S, Baciut M (2010) Failures in endoscopic surgery of the maxillary sinus. Otolaryngol - Head Neck Surg 142(2):196–201

8. Lanza DC, Kennedy DW (1997) Adult rhinosinusitis defined. Otolaryngol Head Neck Surg 117(3 Pt 2):S1–S7

9. Little RE, Long CM, Loehrl TA, Poetker DM (2018) Odontogenic sinusitis: a review of the current literature. Laryngoscope Investig Otolaryngol 3(2):110–114

10. Saibene AM, Vassena C, Pipolo C, Trimboli M, De Vecchi E, Felisati G et al (2016) Odontogenic and rhinogenic chronic sinusitis: a modern microbiological comparison. Int Forum Allergy Rhinol 6(1):41–45

11. Vidal F, Coutinho TM, de Carvalho Ferreira D, de Souza RC, Gonçalves LS (2017) Odontogenic sinusitis: a comprehensive review. Acta Odontol Scand 75:623–633

12. Longhini AB, Ferguson BJ (2011) Clinical aspects of odontogenic maxillary sinusitis: a case series. Int Forum Allergy Rhinol. 1(5): 409–415

13. Arias-Irimia O, Barona-Dorado C, Santos-Marino JA, Martínez-Rodríguez N, Martínez-González JM (2010) Meta-analysis of the etiology of odontogenic maxillary sinusitis. Med Oral Patol Oral Cir Bucal 15(1):3–6

14. Fusetti S, Emanuelli E, Ghirotto C, Bettini G, Ferronato G (2013) Chronic oroantral fistula: combined endoscopic and intraoral approach under local anesthesia. Am J Otolaryngol - Head Neck Med Surg 34(4):323–326

15. Giovannetti F, Priore P, Raponi I, Valentini V (2014) Endoscopic sinus surgery in sinus-oral pathology. J Craniofac Surg. 25(3):991–994

16. Horowitz G, Koren I, Carmel NN, Balaban S, Abu-Ghanem S, Fliss DM, Kleinman S, Reiser V (2016) One stage combined endoscopic and per-oral buccal fat pad approach for large oro-antral-fistula closure with secondary chronic maxillary sinusitis. Eur Arch Oto-Rhino-Laryngology 273(4):905–909

17. Adams T, Taub D, Rosen M (2015) Repair of oroantral communications by use of a combined surgical approach: functional endoscopic surgery and buccal advancement flap/buccal fat pad graft. J Oral Maxillofac Surg 73(8):1452–1456

18. Meltzer EO, Hamilos DL, Hadley JA, Lanza DC, Marple BF, Nicklas RA, Bachert C, Baraniuk J, Baroody FM, Benninger MS, Brook I, Chowdhury BA, Druce HM, Durham S, Ferguson B, Gwaltney JM Jr, Kaliner M, Kennedy DW, Lund V, Naclerio R, Pawankar R, Piccirillo JF, Rohane P, Simon R, Slavin RG, Togias A, Wald ER, Zinreich SJ (2004) Rhinosinusitis: establishing definitions for clinical research and patient care. J Allergy Clin Immunol 114(6 SUPPL):155–212

19. Abdalla S, Alreefy H, Hopkins C (2012) Prevalence of sinonasal outcome test (SNOT-22) symptoms in patients undergoing surgery for chronic rhinosinusitis. Clin Otolaryngol 37:276–282

20. Browne J (2003) The National Comparative Audit of Surgery for Nasal Polyposis and Chronic Rhinosinusitis

21. Weber RK, Hosemann W (2015) Comprehensive review on endonasal endoscopic sinus surgery. GMS Curr Top Otorhinolaryngol Head Neck Surg 14:Doc08

22. Lopatin AS, Sysolyatin SP, Sysolyatin PG, Melnikov MN (2002) Chronic maxillary sinusitis of dental origin: is external surgical approach mandatory? Laryngoscope. 112(6):1056–1059

23. Huang YC, Chen WH (2012) Caldwell-luc operation without inferior meatal antrostomy: a retrospective study of 50 cases. J Oral Maxillofac Surg 70(9):2080–2084

24. Andric M, Saranovic V, Drazic R, Brkovic B, Todorovic L (2010) Functional endoscopic sinus surgery as an adjunctive treatment for closure of oroantral fistulae: a retrospective analysis. Oral Surgery, Oral Med Oral Pathol Oral Radiol Endodontol 109(4):510–516

25. Govindaraj S, Adappa ND, Kennedy DW (2010) Endoscopic sinus surgery: evolution and technical innovations. J Laryngol Otol 124(3):242–250

26. Katauczek F, Nkenke E, Wagner F, Seemann R (2015) A modified bone lid for osteoplastic surgery of the maxillary sinus. Int J Oral Maxillofac Surg 44(7):889–891

27. Naros A, Peters JP, Biegner T, Weise H, Krimmel M, Reinert S (2018) Fungus ball of the maxillary sinus—modern treatment by osteoplastic approach and functional endoscopic sinus surgery. J Oral Maxillofac Surg

28. Xu GZ, Yang C, Fan XD, Hu YK, Yu CQ (2015) Functional surgery for the treatment of dentigerous cyst in the maxillary sinus. J Craniofac Surg 26(2):e84–e86

29. Yura S, Kato T, Ooi K, Izumiyama Y (2010) Access to the maxillary sinus using a bone flap with sinus mucosal and mucoperiosteal pedicles. Oral Surgery, Oral Med Oral Pathol Oral Radiol Endodontol 109(2):e8–e12

30. Kennedy DW, Shaalan H (1989) Reevaluation of maxillary sinus surgery: experimental study in rabbits. Ann Otol Rhinol Laryngol 98(11):901–906

31. Hopkins C, Browne JP, Slack R, Lund V, Brown P (2007) The Lund-Mackay staging system for chronic rhinosinusitis: how is it used and what does it predict? Otolaryngol - Head Neck Surg. 137(4):555–561

32. Rudmik L, Soler ZM, Orlandi RR, Stewart MG, Bhattacharyya N, Kennedy DW, Smith TL (2011) Early postoperative care following endoscopic sinus surgery: an evidence-based review with recommendations. Int Forum Allergy Rhinol 1(6):417–430

33. Rudmik L, Smith TL (2012) Evidence-based practice. Postoperative care in endoscopic sinus surgery. Otolaryngol Clin N Am 45:1019–1032

34. Saleh AM, Torres KM, Murad MH, Erwin PJ, Driscoll CLW (2012) Prophylactic perioperative antibiotic use in endoscopic sinus surgery: a systematic review and meta-analysis. Otolaryngol - Head Neck Surg (United States) 146(4):533–538

35. Patel PN, Jayawardena ADL, Walden RL, Penn EB, Francis DO (2018) Evidence-based use of perioperative antibiotics in otolaryngology. Otolaryngol - Head Neck Surg (United States). 158(5):783–800

36. Chiapasco M, Felisati G, Zaniboni M, Pipolo C, Borloni R, Lozza P (2013) The treatment of sinusitis following maxillary sinus grafting with the association of functional endoscopic sinus surgery (FESS) and an intra-oral approach. Clin Oral Implants Res 24(6):623–629

37. Stankiewicz JA, Lal D, Connor M, Welch K (2011) Complications in endoscopic sinus surgery for chronic rhinosinusitis. Laryngoscope. 121(12):2684–2701