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Odontogenic sinusitis: causes, symptoms and treatment. A review of current literature and concepts

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SUMMARY

Objective. Diagnosis of odontogenic maxillary sinusitis (OMS) often is misdiagnosed as rhinosinusitis, the main symptoms of these diseases are the same: facial pain, postnasal discharge, and congestion. However, OMS and rhinogenic sinusitis require different treatments. Without addressing dental factors in odontogenic sinusitis, conventional rhinitis treatment will often fail, and symptoms will persist. This review aims to assess the most recent literature about OMS causes, symptoms, and treatment.

Material and methods. Literature analysis was carried out on the basis of PRISMA guidelines. Eligible articles no older than 5 years were included, with a few exeptions. An electronic search was performed using MEDLINE (PubMed), The Cochrane Library, and ScienceDirect databases.

Results. More than one possible cause for the development of OMS has been identified. The literature indicates that anaerobic microorganisms are found in the case of sinusitis, but there is no consensus regarding the initial exact causative bacteria of this disease. Symptoms of OMS can be one-sided facial pain, purulent anterior rhinorrhoea, headache, cacosmia, pressure or nasal congestion, post-nasal drip. For better diagnostic of OMS imaging modalities are used. Management of OMS requires dual treatment. The treatment of the disease should begin with the need to remove the causative factor. Antibiotic therapy alone is not used for the treatment of odontogenic sinusitis, but can be used to relieve symptoms. It should be prescribed in accordance with the antibiogram after causative factor is removed. When the dental and medical treatment is not enough for sufficient management of OMS surgery is required.

Conclusion. It is evident that the etiology of OMS includes more than one etiological factor, just as the causative agents of this pathology are various bacteria. Therefore, one of the key elements in choosing the treatment of OMS should be a proper diagnosis.

Keywords: odontogenic sinusitis; Caldwell-Luc procedure (CLP); endoscopic sinus surgery (ESS); Modified endoscopic-assisted sinus surgery (MESS).

INTRODUCTION

The human body has four pairs of paranasal sinuses each named for the bone within which they pneumatized: the sphenoid, frontal, ethmoid, and maxillary (1). They are air-filled and mucosa-lined spaces communicating with the nasal cavity and are located in the maxillofacial region. The function of these spaces is to warm and humidify the air and to contribute to the body's defense against any infectious disease (2). If the function of the maxillary sinus is disturbed, inflammation may occur. Inflammation of the sinus can be of rhinogenic and odontogenic origin. Sinusitis is the inflammation of the sinus floor lined by mucosa, mainly caused by allergens, and respiratory pathogens, as well as sinus mucosal alteration that can be caused by odontogenic factors (3). It is interesting that in 1943 prof. William H. Bauer was the first who did histopathological analysis and found that when odontogenic microorganisms infiltrate the bone of the upper jaw, it spreads through lymphovascular channels and reaches the sinus covering the Schneiderian membrane. Since then the term odontogenic maxillary sinusitis (OMS) has been used (4). The location of the teeth in the maxillary bones and their proximity

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to the maxillary sinus floor may determine that various diseases of the teeth and periapical tissues may affect the health of the maxillary sinus (5). Diagnosis of OMS often is misdiagnosed as rhinosinusitis (6), because the main symptoms of these diseases are the same: facial pain, postnasal discharge, and congestion. However, OMS and rhinogenic sinusitis require different treatments (7). Without addressing dental factors in odontogenic sinusitis, conventional rhinitis treatment will often fail, and symptoms will persist (6). It is important for specialists to make the right diagnosis to ensure effective treatment (8).

This review aims to assess the most recent literature on causes, symptoms, and treatment of OMS.

MATERIAL AND METHODS

Literature analysis was carried out on the basis of PRISMA guidelines. Eligible articles no older than 5 years were included, with a few exeptions. An electronic search was performed using MEDLINE (PubMed), The Cochrane Library, and ScienceDirect databases. The following key-words were used: Odontogenic sinusitis; Caldwell-Luc procedure (CLP); Endoscopic sinus surgery (ESS); Modified endoscopic-assisted sinus surgery (MESS). After investigating abstracts and titles studies which did not meet the criteria were excluded. In the final stage, full-text analysis and selection of complete articles for careful reviewing and analysis according to the eligibility criteria were made: in vivo studies published in the English language. Editorials, letters, in vitro, case reports, animal studies, and abstracts were excluded.

EPIDEMIOLOGY

Odontogenic maxillary sinusitis is more common in recent data than reported in previous studies. Although it was previously reported that odontogenic sinusitis could occur in 10-12% of sinusitis cases (9). However, most recent studies have shown that odontogenic maxillary sinusitis could occur in 45%-75% of sinusitis cases when the evaluation is performed using computer tomography data (10,11).

ETIOLOGY

More than one possible cause for the development of OMS has been identified. The number of cases has been increasing in recent years, due to the increase in dental procedures that can cause sinusitis, therefore iatrogenic factors became one of the main causes of the development of OMS (12). Lechien *et al.* (13) observed factors that could cause sinusitis, and the main factor after examination of 674 patients' cases files was iatrogenic, which occurred for 65.7% of patients (13). More recent studies have shown similar results. Zirk *et al.* (12) examined 121 patients, who suffer from OMS, and have had surgery: extractions, augmentation, or implant surgery. The study revealed, that 69 patients who have undergone dental procedures have had odontogenic maxillary sinusitis.

Another way for infection to reach the maxillary sinus and cause inflammation is endodontic and periodontics infections. One of the main reasons to sinusitis development is endodontic disease, that includes apical pathologies such as periapical periodontitis with or without bone destruction, pulp necrosis, root fractures, and periapical lesions (PAL) (Periapical cysts, abscesses, and granulomas) (11). Apical periodontitis usually leads to periapical lesions, as mentioned before, and these states can cause odontogenic maxillary sinusitis. Oliveira de Lima *et al.* (16) observed 159 maxillary sinuses and 413 teeth from 83 different patients, and it was observed that maxillary sinusitis was in 83 maxillary sinuses (52.2%). The author indicates that endodontic infection 50.6% was the most common cause of sinus infection (49.1%). Therefore, periodontal disease can be one of initiating reasons for sinusitis to develop. Turfe Z. *et al.* (11) observed patients who had a diagnosis of OMS, it was found that only 3.3% of all patients had periodontology issues, which caused odontogenic sinusitis. Zhu J *et al.* (14) study was investigating 27 cases retrospectively and found that 23 out of 27 (85.2%) patients have had periodontal problems, which caused OMS.

One more possible infection way to the sinus is the oroantral fistula (OAF). OAF is an unnatural opening between the maxillary sinus and the oral cavity. Extraction of premolars and molars in the upper jaw is the main reason (48 %) for this pathology to appear. Moreover, cyst and tumoral removal

Table 1. Frequencies of ODS-associated bacteria compared between endodontic and OAF pathologies causing ODS (18)

OMS-associated bacteria	Endodontic (n=40) (%)	OAF (N=22) (%)	p
Mixed anaerobes	40.0	40.9	0.944
Fusobacteria spp.	15.0	27.3	0.242
Eikenella corrodens	10.0	27.3	0.675
Streptococcus intermedius	22.5	27.3	0.675
Streptococcus anginosus	5.0	13.6	0.337
Streptococcus constellatus	7.5	9.1	1.00

interventions (18.5 %) and traumas (7.5%) can lead to OAF development (17). This type of factor for sinusitis development was observed in Abdulkader Y. study (18), where he indicated that out of 62 patients with OMS, 22 (35.5%) had a temporary or permanent oroantral fistula.

Table 2. Pooled frequencies of bacteria cultured from sinuses of odontogenic maxillary sinusitis (OMS) patients (n=210) (22)

Bacteria	Isolates	Frequency amongst all 210 patients
Aerobic (Gram-Positive)		
α-Hemolytic streptococcus (non-typed)	43	20.5
Streptococcus intermedius	16	7.6
Microaerophilic streptococcus	12	5.7
Streptococcus constellatus	9	4.3
Streptococcus anginosus	5	2.4
Streptococcus sanguinis	1	0.5
Streptococcus mitis	1	0.5
Gemella morbillorum	1	0.5
Streptococcus pneumoniae	6	2.9
β-Hemolytic streptococcus (non-typed)	2	1
Streptococcus Group A	5	2.4
Streptococcus Group F	3	1.4
Streptococcus Group G	1	0.5
Staphylococcus aureus	33	15.7
Staphylococcus lugdunensis	2	1
Enterococcus faecalis	1	0.5
Aerobic (Gram-Negative)		
Pseudomonas aeruginosa	10	4.8
Eikenella corrodens	9	4.3
Klebsiella spp.	9	4.3
Escherichia coli	8	3.8
Enterobacter aerogenes	4	1.9
Neisseria spp.	3	1.4
Haemophilus influenzae	3	1.4
Moraxella catarrhalis	3	1.4
Haemophilus parainfluenzae	2	1
Aggregatibacter aphrophilus	2	1
Serratia marcescens	2	1
Proteus mirabilis	1	0.5
Citrobacter koseri	1	0.5
Acinetobacter spp.	1	0.5
Anaerobic		
Prevotella spp.	62	29.5
Fusobacterium spp.	46	21.9
Peptostreptococcus spp.	44	21
Porphyromonas spp.	21	10
Bacteroides spp.	17	8.1
Veillonella parvula	11	5.2
Propionibacterium acnes	9	4.3
Eubacterium spp.	4	1.9
Clostridium spp.	2	1
Actinomyces	1	0.5
Dialister pneumosintes	1	0.5
Mixed anaerobes (non-typed)	25	11.9

MICROBIOLOGY

OMS is polymicrobial in nature (19). The literature indicates that anaerobic microorganisms are found in the case of sinusitis, but there is no consensus regarding the initial exact causative bacteria of this disease. Abdulkader Yassin-Kassab B. *et al.* (18) have observed 276 cases retrospectively, and it was determined that the predominant bacteria in the case of sinusitis are anaerobes: Fusobacterium nucleatum, Peptostreptococcus micros, and aerobes: Streptococcus intermedius (gram-positive), Eikenella corrodens (gram-negative). Tajima S. *et al.* (20) was observing 87 patients' cases retrospectively and found that the main microorganisms prevailing in cases of odontogenic sinusitis are *Peptostreptococcus sp., Prevotella sp., Streptococcus anginosus* group, and *Fusobacterium sp.* Studies show, that one specific species of bacteria (*Pseudomonas aeruginosa*) prevails when there is an allocated foreign body in the maxillary sinus (12). There is no significant difference between bacteria cultures isolated when OMS is caused by endodontic or OAF (Table 1) (18). Therefore, detecting these types of bacteria can help confirm the diagnosis of OMS (Table 2) (22).

CLINICAL EVALUATION AND DIAGNOSIS

When diagnosing odontogenic sinusitis, it is important to make an accurate assessment and use appropriate tests to diagnose the disease. However, there are no agreed evaluation criteria for this disease, and the definition of it often varies as well (21).

Intranasal examination with anterior rhinoscopy or nasal endoscopy is used for examination, and often unilateral purulent rhinorrhea or edema is seen (22). However, it is not as sensitive detection of sinusitis as imaging modalities (23). Studies show that diagnostic of sinusitis requires multidisciplinary evaluation, using additional diagnostic methods such as computed tomography, orthopantomogram, dental radiogram, assessment of the dental condition, and Water's

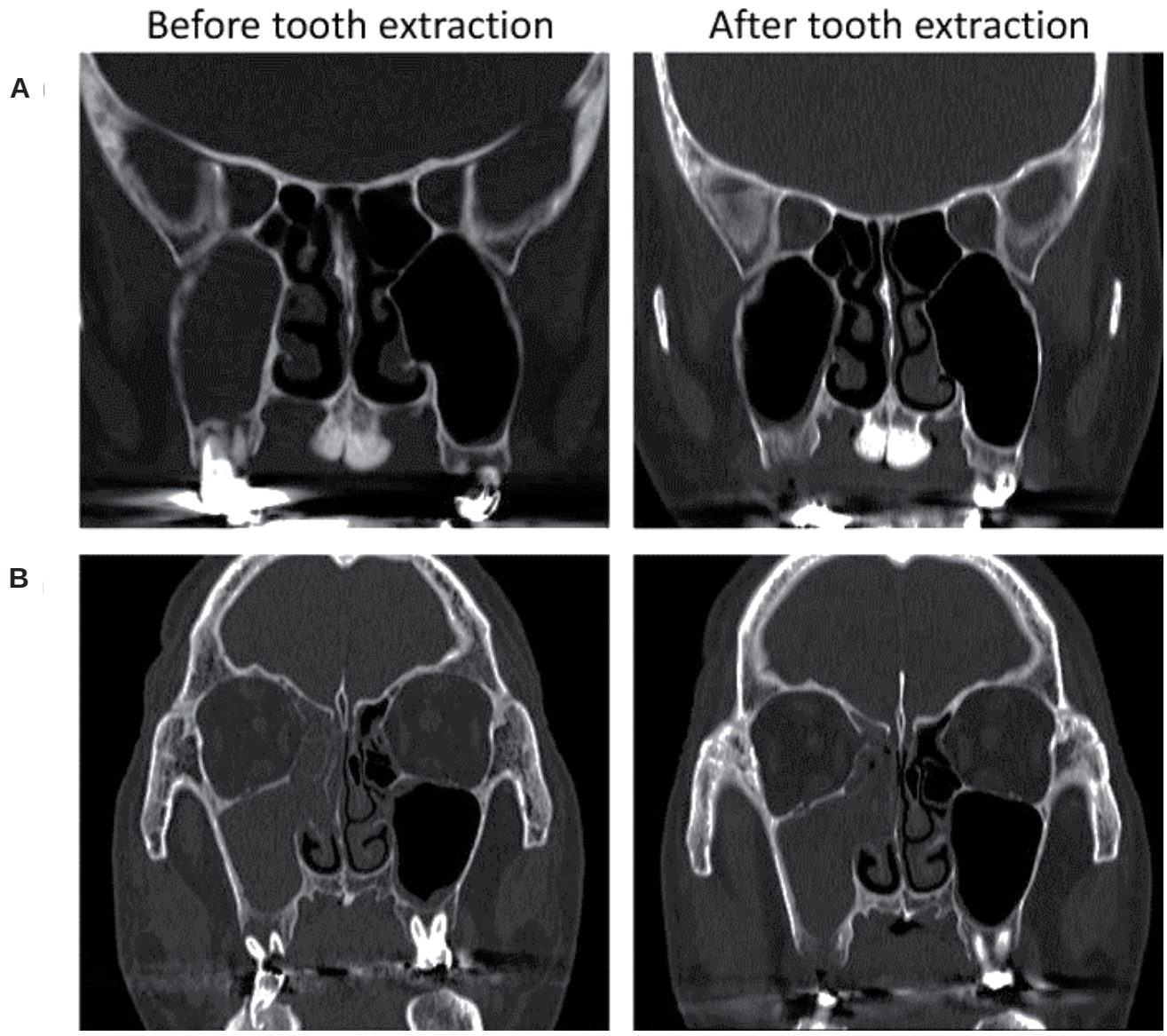

Fig. 1. Computed tomography (coronal plane) image obtained before and after extraction. A – image of a representative case showing an improvement in the total opacification of the right maxillary sinus after tooth extraction. B – image of a representative case showing no change in the total opacification of the right maxillary sinus and ethmoid sinus after tooth extraction (26).

radiogram (21). It is also very important to evaluate symptomatic anamnesis. However, if sinusitis becomes chronic, the symptoms may disappear, and the patients will have no complaints (24).

Symptoms of odontogenic maxillary sinusitis (23, 25):

- One-sided facial pain
- Purulent anterior rhinorrhoea
- Headache
- Cacosmia
- Pressure or nasal congestion
- Post-nasal drip

DISEASE MANAGEMENT

Management of OMS requires dual treatment. The treatment of the disease should begin with the need to remove the causative factor. When the causative factor is eliminated, there is a need to remove pathogenic sinus mucosa, so that infection would be stopped (19). It is

Table 3. Comparison of two surgery types (Caldwell-Luc and ESS) used for OMS treatment (32)

	Caldwell-Luc	ESS
Significantly decreased facial pain (1month post-op.)		+
Significantly decreased nasal obstruction	+	+
Significantly decreased nasal discharge	+	+
Significantly decreased headache (12 month post-op.)		+
Significantly increased halitosis (1 month post-op.)	+	
Significantly decreased hyposmia/anosmia (1 month post-op.)		+
Significant relief of ear pressure (1 month post-op.)		+
Significantly increased epistaxis (1 month post-op.)		+

important to mention that medical treatment should be used together with surgical treatment.

Odontogenic treatment – elimination of causative factor

When it comes to endodontic or periodontal treatment, it will not be successful when used alone (15). However, Yoshida H. *et al.* observed 32 patients who had tooth extraction as the only treatment method. The author was evaluating CT scans before and after the extraction and found that if only the maxillary sinus was opacified, tooth extraction was a sufficient method of treatment. However, if opacification was observed beyond the maxillary sinus, this method of treatment is no longer applicable. It is important to mention that the entire treatment was applied in the background of antibiotics (Clarithromycin, Amoxicillin, Cefdinir) on an outpatient basis (Figure 1) (26).

Medical treatment

Antibiotic therapy alone is not used for the treatment of odontogenic sinusitis, but can be used to relieve symptoms (15). It should be prescribed in accordance with the antibiogram. Correct antibiotic treatment should be directed against aerobic and anaerobic bacteria. Zirk *et al.* (12) were observing 121 cases and determined that the antibiotic of the first choice is the penicillin beta-lactamase inhibitor combination such as Amoxicillin/Sulbactam, or Piperacillin/Tazobactam, which efficacy reached 80% and 93% respectively. Also, it was found that piperacillin, clindamycin and cefuroxime, cefotaxime; fluoroquinolones, such as moxifloxacin and ciprofloxacin, and tetracyclines could be used when the patient is allergic to penicillin (27). The study showed that clindamycin had the least adequate effect and it could affect only 50% of bacteria. Therefore, amoxicillin plus clavulanic acid should be prescribed for post-operative use on an outpatient basis for 10 days, since 70% of bacteria are susceptible to amoxicillin/clavulanate (28, 29).

Surgical treatment

When the dental and medical treatment is not enough for sufficient management of OMS surgery is required. There are three main types of surgery used for the treatment of OMS Caldwell-Luc surgery, Endoscopic sinus surgery, and Modified endoscopic surgery.

Caldwell-Luc surgery

The incision is made from the canine ridge that runs around 3-3.5 cm parallel to the teeth. Then periosteum has to be elevated over canine fossa till Infraorbital foramen. Using cutting bur or gouge and hammer the antrum is opened. The size of the bony opening should be around 1.5-2 cm. diameter. When the bony opening is created, inflammatory mucosa is removed. After the maxillary sinus is treated, nasoantra.l window should be made to help natural removal of packing from antrum, sinus cavity then filled with single long ribbon gouge which is soaked in Betadine if hemostasis is needed (30).

The main advantage of this operation is that the operative field can be seen widely, which allows removal not only foreign bodies from the sinus, but also inflammatory masses, cysts, or tumors (30). However, there are obvious disadvantages, such as long hospitalization, high cost, and high risk of complications. Therefore, studies show that 9-15% of patients will need second surgery after the Caldwell-Luc surgery was performed. Caldwell-Luc surgery is less used these days because of its limitation, so this type of procedure only recommended when the better access to sinus is needed (7).

Endoscopic sinus surgery (ESS)

Performing ESS there are four types of endoscope used 0°, 30°, 45°, 70°. In the beginning of procedure 0° endoscope is used and the cut on the uncinate process is made, then the infundibulum is uncapped. After that the maxillary sinus ostium is identified using 30° endoscope. If the natural ostium is too small, it could be enlarged. Two endoscopes 45° and 70° are used to investigate the inside of the maxillary sinus and remove inflammatory mucosa. This procedure also allows to remove foreign bodies, for that purpose extra-long curved forceps are used (31).

ESS has advantages over Caldwell-Luc due to shorter hospitalization time, minimal intervention resulting in smaller scars, and less chance of complications. Most importantly, this procedure can eliminate the dental infection factor (32).

Caldwell-Luc and ESS surgeries postoperative analysis is given in Table 3 (32).

Modified endoscopic surgery (MES)

The Caldwell-Luc and ESS, was widely used, but both had their drawbacks, which were sought to be eliminated using a combination of these two surgery methods. MES was suggested as less complication-inducing, efficient and easy way for sinus approach.

When processing MES the buccal full-thickness mucoperiosteal flap is done at first, and afterward the osteotomy is done. For this purpose, Piezoelectric instruments are used. After the bone lid is removed, there is sufficient field of view to the part of the sinus. An endoscope then is inserted and

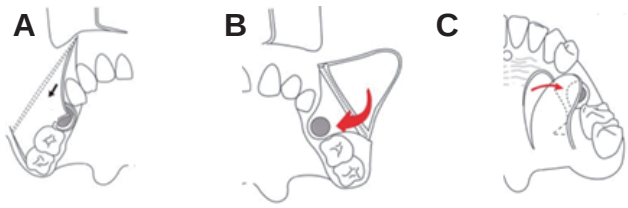

Fig. 2. Schematic drawings of an oroantral fistula closure in the oral cavity. A – direct closure; B – buccal flap; C – palatal rotational flap (39).

used to see a deeper picture of sinus, find foreign bodies or detect inflammatory masses (35). After the sinusitis mucosa or foreign bodies are removed from the sinus, buccal wall should be closed by the tissues sutured above it. However, literature says that for better closure and faster healing process the buccal wall can be closed by using osteosynthesis plate. This method could be used for Caldwell-Luc surgery as well (34).

Treatment of oroantral fistula

In case of sinus infection before OAF closure procedures, drainage and irrigation with saline is mandatory. The process should be repeated until there are no inflammatory elements left in the exudate. The choice of treatment depends on the duration and size of the OAF opening. Usually figure-of-eight suture is enough to close OAF properly, in other cases buccal or palatal flap is required (35). If the figure-of-eight suture is not enough for proper OAF closure there are many other closing techniques, such as local and soft tissue flaps.

Direct closure

No additional incision is required to perform this type of closure. Soft tissues around the fistula are sutured, and this method of covering is used to cover fistulas of small intensity, no more than 3mm in diameter (37, 38) (Figure 2, A).

Buccal Flap

In 1936, the buccal flap method of closing OAF was introduced (Figure 2, B). During this procedure, a trapezoidal mucoperiosteal flap is performed above the defect, and stitched after that. When performing this type of flap surgery, sufficient blood circulation is ensured, which allows us to judge the good results of healing. The main disadvantage of this type of flap is that buccal sulcus could decrease in depth (40).

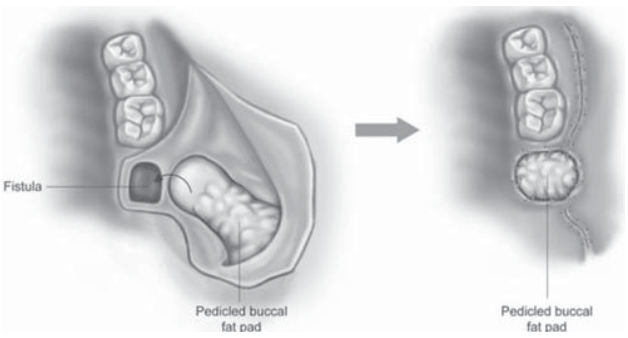

Fig. 3. Buccal fat pad schematic representation (41).

Buccal Fat Pad (BFP)

Lobulated form of fatty tissue incapsulated in thin fibrin could be the right alternative for OAF closure (Figure 3). The BFP used for transplantation is a great way to ensure good blood supply. Such an uncovered fat pad, due to the above-mentioned good blood supply, quickly epithelizes and heals after just two weeks after surgery. However, for large defects, such a technique is not suitable, since the fat pad may show graft necrosis, or a new fistula could form.

Palatal Rotational Flap

To close large defects, palatal rotational flap is used (Figure 2, C) (39). Initially, a subepithelial flap of a rotating shape is cut out, then rotated ant sutured over the fistula in two ways though the tunnel made palatinaly or over the fistula directly. Flaps of this type are divided according to their thickness and direction of movement (42). It is important to involve at least one larger palate artery when making this type of flap in order to ensure blood circulation and prevent necrosis from occurring. In the donor site secondary healing happens in two weeks after the surgery.

CONCLUSION

It is evident that the etiology of OMS includes more than one etiological factor, just as the causative agents of this pathology are various bacteria. Therefore, one of the key elements in choosing the treatment of OMS should be a proper diagnosis. Further research should be directed to the goals of diagnosing, managing and improving the treatment of OMS.

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