

# Etiologies and Treatments of Odontogenic Maxillary Sinusitis: A Systematic Review

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## Abstract

**Context:** Maxillary sinusitis is an important issue in dentistry and maxillofacial surgery. This study aims to present a systematic review of etiologies and treatments of odontogenic maxillary sinusitis.

**Evidence Acquisition:** An electronic database search was performed based on related MeSH keywords. Articles published between January 2001 and December 2014 was selected according to the inclusion criteria. The information extracted from various studies was categorized in various tables.

**Results:** The study selected 19 studies. In most studies, oroantral fistula (OAF) was the most common etiology of odontogenic sinusitis. *Alpha-hemolytic streptococcus* was the most common flora in sinusitis with dental origin. The literature shows that the Caldwell-Luc approach may be the best method for treating sinusitis in cases of displaced teeth.

**Conclusions:** OAF is a common cause of odontogenic maxillary sinusitis and may easily be treated by endoscopy and fistula closure. Maxillofacial surgeons and dentists should consider this problem to avoid misdiagnosis and prevent complications.

**Keywords:** Endoscopy, Paranasalsinuses, Sinusitis, Oroantral Fistula

## 1. Context

The maxillary sinuses are the most important paranasal sinuses in dentistry and maxillofacial surgery due to their proximity to the roots of upper dentition (1, 2). The importance of the maxillary sinuses becomes clearer when it is understood that dental sources are responsible for 10 - 12% of maxillary sinusitis and that late diagnosis and treatment of this problem can lead to severe complications, including orbital cellulitis and cerebral abscesses (3, 4). Hence, accurate detection and immediate treatment of odontogenic maxillary sinusitis is an important issue in dentistry (5). In addition, the microbiology of odontogenic sinusitis differs from that of other maxillary sinusitis, necessitating treatment plans based on the source of infection (6, 7).

Several investigations have proposed signs and symp-

toms of maxillary sinusitis that have dental sources (8, 9). Some studies have categorized the dental etiologic factors of sinusitis according to their frequency and importance (10-12). However, these studies did not suggest the same dental etiologic factors and proposed various methods of diagnosing sinusitis that had dental sources (11-13). In addition, the literature identifies no common treatment approach for odontogenic sinusitis (14-16).

Several literature reviews have addressed diagnosing and treating maxillary sinusitis with dental sources, but none are systematic or present adequate information about this issue (3, 4, 17). In fact, there is some bias in these article reviews (17, 18). Publication bias and heterogeneity are found in nearly all of them. Publication bias is a limitation of meta-analysis, in which

researchers are influenced to select articles with significant results (19). In addition, it is difficult to avoid heterogeneity in a meta-analysis because of the dissimilarity of the various studies. To reduce publication bias, this study used Rosenthal's file drawer method to estimate it.

Because of the above-mentioned publication bias and heterogeneity, the existing literature lacks a systematic review of maxillary sinusitis with dental origin. Therefore, this study aims to present a systematic review of etiologies and treatment plans for odontogenic maxillary sinusitis and to provide better insight into various dental etiologic factors of this type of sinusitis.

## 2. Evidence Acquisition

### 2.1. Data sources

The authors searched various electronic databases, including Medline (PubMed), Embase, the Science Direct databases, and the Cochrane Library, for papers published between January 2001 and December 2014. The MeSH search terms used were "odontogenic sinusitis" OR "odontogenic maxillary sinusitis" in combination with (AND) "treatment" OR "diagnosis". In addition, "maxillary sinusitis" in combination with (AND) "dental source" OR "dental origin" OR "etiology" was used.

### 2.2. Study Selection

All titles and abstracts returned by the search were appraised using the inclusion criteria, which were the following.

Clinical trials; papers investigating only maxillary sinusitis, not pan-sinusitis cases; maxillary sinusitis with dental origin that was compared to other etiologies; investigations assessing diagnosis, treatment, or microbiology of odontogenic sinusitis.

Excluded were animal studies, case reports, review articles, grey literatures (conference lectures, posters, and technical reports), and investigations that did not compare odontogenic sinusitis with other etiologies (Figure 1).

### 2.3. Data Extraction

To prevent possible reviewer bias during appraisal of the papers, all identifying information, such as authors' names, journal names, and publishing dates, were ignored. To reduce the selection bias, each researcher in the present study checked the extracted data separately. All data regarding the frequency of dental etiologies, microbiology, treatment methods, and success rate were extracted and organized in Tables 1 - 4.

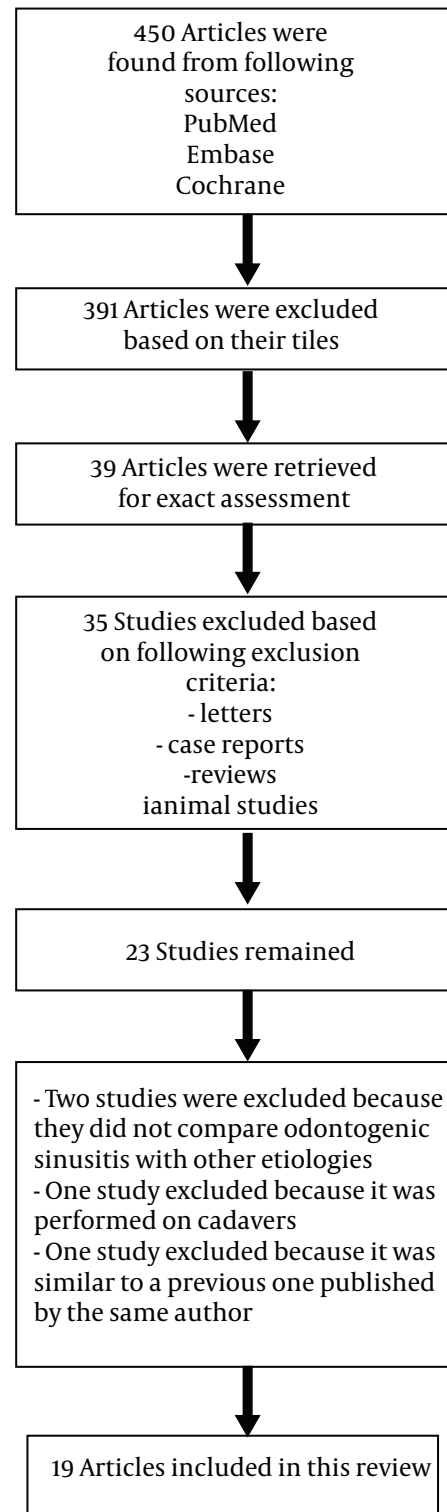


Figure 1. Article Selection Flowchart

**Table 1.** Major Features of the Articles Included

Reference	Major Feature
Charfi et al. (2007) (10)	They concluded dental causes were dominated by para-apical cysts (29%).
Chemli et al. (2012) (15)	Nasal endoscopy has improved the surgical management of odontogenic sinusitis. It is reliable and has a low rate of complications.
Longhini et al. (2011) (9)	Unrecognized periapical abscess is a cause of ESS failure, and the radiological report frequently fails to note the periapical infection.
Bomeli et al. (2009) (20)	Mucosal thickening demonstrated a similar relationship with dental sources, so that sinuses having both > 2/3 fluid opacification and moderate mucosal thickening were 86% more likely to have an identifiable dental source.
Ugincius et al. (2006) (21)	They found OAF to be the most important factor in chronic sinusitis.
Racic et al. (2006) (12)	They concluded that odontogenic sinusitis is a complication in 85% of oral cavity surgery patients, which should be taken into consideration for prevention.
Costa et al. (2007) (22)	The endoscopic approach to chronic maxillary sinusitis of dental origin is a reliable method associated with less morbidity and lower incidence of complications.
Lee et al. (2010) (11)	Dental implants and dental extractions were the most common etiologic factors related to the development of odontogenic sinusitis.
Puglisi et al. (2011) (23)	They proved that among anaerobic flora, the <i>Peptostreptococcus</i> and <i>Prevotella</i> species were the most common in chronic odontogenic sinusitis.
Beaumont et al. (2005) (13)	Their results reinforce the importance of taking a careful, detailed history and of thorough clinical and radiographic evaluation prior to performing sinus augmentation.
Brook et al. (2005) (24)	They proved that among aerobic flora, alpha-hemolytic streptococci were the most common species in acute odontogenic sinusitis.
Brook et al. (2007) (25)	They proved that among anaerobic flora, Gram-negative <i>bacilli</i> were the most common species in acute odontogenic sinusitis.
Kondrashev et al. (2010) (26)	They showed that anaerobic flora is the most common cause of chronic odontogenic sinusitis.
Andric et al. (2010) (14)	They concluded that FESS, combined with OAF closure by buccal flap, might be an effective, safe option for treating selected cases of chronic odontogenic sinusitis with OAF.
Khudaibergenov et al. (2011) (27)	They suggested osteoplastic sinusotomy as a simple approach for treatment of sinusitis cases with OAF.
Selmani et al. (2006) (28)	Iatrogenic maxillary sinusitis should be considered a serious infection. The Caldwell-Luc approach is a suitable treatment in these cases.
Huang et al. (2011) (29)	The Caldwell-Luc approach is a suitable treatment when sinusitis is related to a foreign body.
Ippolitov et al. (2004) (30)	They proved that ESS may be an appropriate treatment of odontogenic sinusitis.
Nurbakhsh et al. (2011) (31)	They concluded that endodontic treatment may lead to resolving sinus mucositis that has an odontogenic source.

**Table 2.** Major Features of Excluded Articles

Title of the Paper	Major Feature
Baidik et al. (2011) (32)	This investigation was executed on cadavers, so it was excluded from the present study.
Baidik et al. (2011) (33)	This article focused only on one aspect of odontogenic sinusitis, and the authors did not compare odontogenic sinusitis with other etiologies. Articles of this type lead to misunderstanding and were excluded from the present study.
Jung et al. (2007) (34)	The authors did not compare the odontogenic sinusitis with other etiologies. Articles of this type lead to misunderstanding and were excluded from the present study.
Racic et al. (2004) (35)	This article was similar to reference number 10 and so was excluded.

**Table 3.** The Most Common Dental Etiological Factors in Various Investigations<sup>a</sup>

Author and Year	Etiology	Consideration
Charfi et al. (2007) (10)	Chronic apical periodontitis	Periapical cysts were the most common factor.
Chemli et al. (2012) (15)	Chronic apical periodontitis	Other than apical leakage, the etiologies were displaced teeth and OAF.
Longhini et al. (2011) (9)	Chronic apical periodontitis	Dental pathology was noted in dental films.
Bomeli et al. (2009) (20)	OAF	Dental source was identified as the most common factor when the fluid opacification of sinuses was more than two-thirds.
Ugincius et al. (2006) (21)	OAF	The OAF was the most important factor in chronic sinusitis.
Racic et al. (2006) (12)	OAF	The OAF after extraction of the upper first molar was the most common factor.
Costa et al. (2007) (22)	OAF	The OAF was the most often cause of chronic maxillary sinusitis.
Lee et al. (2010) (11)	Iatrogenic	Iatrogenic factors, including dental implants and tooth extractions, were the most common causes.
Puglisi et al. (2011) (23)	Iatrogenic	A sinus lift procedure was the most common etiological factor.
Beaumont et al. (2005) (13)	Chronic periodontitis	Periodontal infection was the most common cause of chronic sinusitis.

<sup>a</sup>Abbreviation: OAF, oroantral fistula.

**Table 4.** The Bacteriological Distribution of Odontogenic Maxillary Sinusitis<sup>a</sup>

Reference	Acute sinusitis			Chronic sinusitis		
	Aerobic flora	Anaerobic flora	Mixed flora	Aerobic flora	Anaerobic flora	Mixed flora
Brook et al. (2005) (24)	2 (10)	10 (50)	8 (40)	3 (11)	11 (39)	14 (50)
Brook et al. (2007) (25)	2 (11)	7 (39)	9 (50)			
Kondrashev et al. (2010) (26)				13 (33.3)	25 (66.7)	
Puglisi et al. (2011) (23)				15 (37.5)	25 (62.5)	

<sup>a</sup>Values are presented as No. (%).

**Table 5.** Microbiology of Odontogenic Maxillary Sinusitis

Reference	Acute Sinusitis		Chronic Sinusitis	
	Aerobic flora	Anaerobic flora	Aerobic flora	Anaerobic flora
Brook et al. (2005) (24)	Alpha-hemolytic streptococci, Microaerophilic streptococci, and <i>Staphylococcus aureus</i>	Gram-negative bacilli, <i>Peptostreptococcus</i> , and <i>Fusobacterium</i> spp	Alpha-hemolytic streptococci, microaerophilic streptococci, and <i>Staphylococcus aureus</i>	Gram-negative bacilli, <i>Peptostreptococcus</i> , and <i>Fusobacterium</i> spp
Brook et al. (2007) (25)	Alpha-hemolytic streptococci, Microaerophilic streptococci, <i>Streptococcus pyogenes</i> and <i>Staphylococcus aureus</i>	Gram-negative bacilli, <i>Peptostreptococcus</i> spp, <i>Fusobacterium</i> spp, and <i>Propionibacterium acnes</i>		
Puglisi et al. (2011) (23)			<i>Staphylococcus aureus</i> and <i>Streptococcus pneumonia</i>	<i>Peptostreptococcus</i> species and <i>Prevotella</i> species

### 3. Results

The study identified 450 articles from initial search criteria (Figure 1). After reading and evaluating the abstracts, the researchers discarded articles unrelated to the inclusion criteria. Finally, 19 studies were included (Tables 1 and 2). Of the 19 papers, 10 were related to diagnosis of odontogenic sinusitis, 4 were microbiological studies, and 9 were related to presenting a treatment method.

#### 3.1. Dental Etiologies

As Table 3 shows, 10 articles investigated various dental

causes of odontogenic maxillary sinusitis. Oroantral fistula (OAF) was the most common cause of maxillary sinusitis that had dental origin. The second most common cause was chronic apical periodontitis.

#### 3.2. Microbiology of Odontogenic Sinusitis

Data extracted from microbiological studies are organized in Tables 4 and 5. These data suggest that anaerobic bacteriological flora is the most common cause of chronic odontogenic sinusitis, while the predominant flora are mixed in cases with acute sinusitis.

**Table 6.** Treatment Plans for Odontogenic Maxillary Sinusitis<sup>a</sup>

Reference	Etiology	Treatment plan	Rate of success
Andric et al. (2010) (14)	OAF	FESS + OAF closure	FESS, combined with OAF closure might be an effective treatment for chronic odontogenic sinusitis with OAF.
Khudaibergenov et al. (2011) (27)	OAF	Osteoplastic sinusotomy	They suggested this treatment plan as a simple approach in cases of sinusitis with OAF.
Selmani et al. (2006) (28)	Displaced tooth	Caldwell-Luc	With this approach, the sinuses were radiographically clean after one month after foreign bodies and the infected mucosa were removed.
Costa et al. (2007) (22)	Displaced tooth	ESS	An endoscopic approach to draining all involved sinuses can promote successful closure of OAF.
Huang et al. (2011) (29)	Displaced tooth	Caldwell-Luc	This treatment plan is safe, simple, and fast, with minimal complications for removing displaced teeth.
Chemli et al. (2012) (15)	Displaced tooth	Caldwell-Luc + OAF closure	There were two cases of recurrent sinusitis.
Ippolitov et al. (2004) (30)	Periapical infection	Endoscopy	This treatment method led to a stable cure.
Longhini et al. (2010) (16)	Periapical infection	Tooth extraction + ESS	ESS had been unsuccessful before tooth extraction.
Nurbakhsh et al. (2011) (31)	Periapical infection	RCT	The dental treatment alone did not lead to absolute cure of maxillary sinusitis.
Chemli et al (2012) (15)	Periapical infection	RCT + endoscopy	Nasal endoscopy is a reliable method and has a low rate of complications.

<sup>a</sup>Abbreviations: ESS, endoscopic Sinus surgery; FESS, functional endoscopic sinus surgery; OAF, oroantral fistula; RCT, root canal therapy.

In acute odontogenic maxillary sinusitis, Gram-negative bacilli, *Peptostreptococcus*, and *Fusobacterium* spp are the predominant bacterial flora, although the literature indicates no certain flora for chronic cases.

### 3.3. Treatment Plans for Odontogenic Sinusitis

Table 6 shows various treatment methods suggested in the literature. The Caldwell-Luc approach is the most popular method for treating sinusitis caused by displaced teeth, roots, or dental materials. Endoscopic sinus surgery (ESS) was the most common treatment plan for cleaning the antrum and the infected mucosa.

## 4. Conclusions

The importance of maxillary sinusitis has been mentioned in the literature, although this issue is ignored by some dentists and maxillofacial surgeons (5). The complications of maxillary sinusitis may be life threatening, and dental sources have been reported as responsible for 10 - 12% of these problems by some studies (3, 4) and up to 40% by other studies (18). Several investigators have studied the frequency of odontogenic maxillary sinusitis and have presented various treatment methods (15, 22). The importance of this issue necessitates a systematic review in order to collect the information in various studies and propose a standard protocol for diagnosing and treating maxillary sinusitis that has dental sources. The purpose

of the current study was to provide a better understanding of this topic.

OAF was the most common cause of odontogenic maxillary sinusitis among all dental etiologies (12, 20-22) All OAFs led to chronic sinusitis, while other dental etiologies caused acute sinusitis. It should be noted that OAF mostly led to odontogenic sinusitis, especially chronic cases, although the sinusitis may be silent at first, without any signs or symptoms (21, 22). Dentists and maxillofacial surgeons must be aware of OAF as a complication of tooth extraction and attempt to close the fistula as soon as possible to prevent maxillary sinusitis.

Studies of the microbiology of odontogenic sinusitis have proved that anaerobic bacterial flora is the most important microbiologic factor in maxillary sinusitis that has dental origin (23-26). In one study, mixed bacterial flora were more common in acute odontogenic sinusitis (25). Among aerobic flora, *Staphylococcus aureus* was the common cause of acute and chronic odontogenic sinusitis in all studies (23-25). The second most predominant aerobic floras in acute and chronic maxillary sinusitis with dental sources were alpha-hemolytic and microaerophilic streptococci, which were common in all studies (24, 25) except one (23). The predominant anaerobic flora was *peptostreptococcus* in all studies, while the anaerobic Gram-negative bacilli were the second most common factor in most studies (23-25). Furthermore, other studies showed that the most common causes of rhinosinusitis were *Staphylococcus aureus*



and *Pneumococcus* (36, 37). These findings suggest that the flora implicated in odontogenic sinusitis are very similar to the flora in the oral cavity. Alpha hemolytic streptococci are responsible for dental decay, so they may easily invade the inferior border of the maxillary sinuses and causes inflammation. After the aerobic flora initiate inflammation and use the oxygen, the anaerobic flora continue proliferating and inflaming the mucosal membranes. In most cases of sinusitis, the predominant flora were mixed, as seen in periapical infections.

The literature showed that although closure of the OAF may be necessary to treat chronic odontogenic sinusitis, ESS may be the best method for cleaning the inflamed and proliferated membrane (14, 22, 27). Studies of sinusitis due to displaced teeth or dental material showed that the Caldwell-Luc technique might be the best approach for treating these cases (15, 28, 29). In such cases, this treatment plan may be the simplest and safest method, with minimal complication. Three studies assessed the effect of dental treatment in odontogenic sinusitis cases (15, 16, 31), showing that dental treatments might be helpful in such cases but are not complete treatments by themselves. Longhini et al. suggested that dental infections may be the cause of ESS failure in maxillary sinusitis. They proved that ESS might be an appropriate treatment approach after dental treatments (16). ESS is a surgical treatment for various types of sinusitis, including chronic, recurrent acute, fungal, and bacterial. In this technique, an endoscope is passed through the nose and inserted into the sinus to provide an internal view of the sinus so that the infected membrane, mucocoeles, and other small objects blocking the sinus opening can be removed. The problem with this technique is the proximity of anatomical structures such as the orbital nerve, internal carotid, and eyes. Any clinician using this technique must be expert in it. In addition, this treatment is not appropriate for removing large blocking objects.

The present study aimed to present comprehensive data about odontogenic sinusitis. Selection bias is one of the most important issues that must be addressed in an article review. To address it, this review selected articles that both evaluated odontogenic sinusitis and compared it to other etiologies, because those studies that addressed only odontogenic sinusitis did not present appropriate treatment plan or accurately represent the prevalence of the problem. In addition, the study used heterogeneity testing and Rosenthal's file drawer method to avoid publication bias. Heterogeneity tests on the articles reviewed yielded results that were not significant ( $P$  value > 0.05). The Rosenthal number obtained was 58.6, meaning that 58.6 articles with the opposite results would need to be published before the findings of the present study should be ignored.

One limitation of the present study was the inability to hand-search the literature. Another was the limited number of articles in this field.

Dental etiologies are responsible for about 10 - 40% of

maxillary sinusitis, and OAF may be the most common cause of all. The literature contains several treatment plans that may be effective, depending on the dental etiology of the sinusitis. Dentists and maxillofacial surgeons must consider dental factors as important causes of maxillary sinusitis and must be aware of various treatment approaches.

## Footnotes

**Authors' Contribution:** Fahimeh Akhlaghi was the supervisor of the research team and the articles were checked by her. Mohammad Esmaeelinejad writes the manuscript. The search process and data extraction were performed by Mohammad Esmaeelinejad.

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