World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(REVIEW ARTICLE)

A Review of Odontogenic Maxillary Sinusitis

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World Journal of Advanced Research and Reviews, 2025, 28(02), 1307–1311

Publication history: Received on 30 September 2025; revised on 08 November 2025; accepted on 12 November 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.28.2.3790

Abstract

Background: Odontogenic maxillary sinusitis (OMS) is an infection of the maxillary sinus caused by issues with the posterior maxillary dentition or as a complication of dental procedures. The prevalence of OMS varies widely, with epidemiological data from Indonesia indicating a rate of 0.57%, while studies using computed tomography (CT) report prevalence as high as 26.9%. Anatomical factors such as the proximity of the first maxillary molars to the sinus floor and sinus pneumatization significantly influence susceptibility to OMS.

Objective: To investigate the causes, diagnostic methods, and management strategies for odontogenic maxillary sinusitis (OMS), with a focus on its microbiological composition, clinical manifestations, and treatment approaches.

Methods: A comprehensive review of existing epidemiological data, clinical case studies, and imaging techniques for diagnosing OMS was conducted. Specific attention was given to cone-beam computed tomography (CBCT) as the diagnostic standard, as well as the pharmacological and surgical treatments for OMS, including the use of decongestants, antibiotics, corticosteroids, Functional Endoscopic Sinus Surgery (FESS), and Modified Endoscopy-Assisted Maxillary Sinus Surgery (MESS).

Results: OMS is primarily caused by iatrogenic events like oroantral fistula formation, implant displacement, sinus lift procedures, and extrusion of endodontic materials, alongside infections from periapical origins. The condition is often polymicrobial, with anaerobic bacteria (e.g., *Peptostreptococcus* spp. and *Fusobacterium* spp.) predominating, and in some cases, fungal infections such as *Aspergillus* can also occur. Symptoms include nasal obstruction, purulent nasal discharge with a fetid odor, maxillofacial pain, and halitosis. CBCT provides superior diagnostic accuracy for visualizing anatomical changes. Pharmacological treatments are effective in managing the infection, and surgical interventions like FESS and MESS are less invasive and more effective than the traditional Caldwell-Luc procedure.

Conclusion: Odontogenic maxillary sinusitis is a significant condition that necessitates accurate diagnosis and comprehensive management, involving both medical and surgical interventions. The collaboration between dental and otolaryngology specialists is critical for effective treatment, and advancements in diagnostic imaging like CBCT and minimally invasive surgical techniques have improved patient outcomes. Addressing the odontogenic source of infection is crucial to achieving optimal therapeutic results.

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Keywords: Odontogenic maxillary sinusitis; Maxillary sinus; Odontogenic infection; Cone-beam CT; Functional endoscopic sinus surgery.

1. Introduction

Odontogenic maxillary sinusitis (OMS) is an infectious condition affecting the maxillary sinus, originating from pathological conditions of the posterior maxillary dentition or as a complication of dental interventions. The maxillary sinus is the largest of the paranasal sinuses and is anatomically located in close proximity to the roots of the posterior maxillary teeth, especially the first molar. This close proximity plays a crucial role in the development of OMS, as infections in these teeth can easily extend into the sinus cavity.

The primary causes of OMS are odontogenic infections, which arise from conditions such as periapical abscesses, periodontitis, and odontogenic cysts. Additionally, OMS can result as a complication of dental procedures such as tooth extraction, implant placement, sinus lift procedures, and extrusion of endodontic materials like gutta-percha or amalgam into the sinus. This review aims to explore the pathogenesis of OMS and analyze its distribution according to periapical (P2) and iatrogenic (M1) types, with a particular focus on the anatomical factors that contribute to its development. Understanding the anatomical relationship between the posterior maxillary teeth and the sinus floor is crucial for preventing OMS during dental procedures.

2. Methods

This narrative review was conducted by analyzing various retrospective studies, radiographic data, and clinical reports published in dental and medical journals. The review specifically examined the prevalence of OMS both in Indonesia and internationally, assessing the anatomical relationship between the posterior maxillary teeth and the sinus floor. Studies employing computed tomography (CT) and cone-beam computed tomography (CBCT) were included to provide an in-depth understanding of the distribution and anatomical predispositions of OMS. Additionally, the review examined the microbiology, clinical presentations, and treatment modalities for OMS, which encompass both pharmacological and surgical approaches.

The review focused on the main etiologies of OMS, including both primary odontogenic infections and complications arising from dental procedures. Furthermore, it analyzed the pharmacological treatments employed in the management of OMS, such as systemic antibiotics, decongestants, and corticosteroids. Surgical management strategies, particularly Functional Endoscopic Sinus Surgery (FESS) and Modified Endoscopy-Assisted Maxillary Sinus Surgery (MESS), were also reviewed, comparing their effectiveness and invasiveness with the traditional Caldwell-Luc procedure.

3. Results

The prevalence of OMS varies considerably across studies. A retrospective study conducted in Indonesia found a relatively low prevalence of 0.57% based on panoramic radiographs of 11,326 patients. In contrast, a CT-based study reported a much higher prevalence of 26.9%. The majority of cases were observed in individuals aged 26–45 years, with a slight male predominance. OMS was most frequently associated with the first maxillary molars, which are located close to the sinus floor and are the most commonly implicated teeth in odontogenic pathology.

Radiographic analysis indicated that the most frequent anatomical relationship between the posterior maxillary teeth and the sinus floor was a Type 3 relationship, where the root apices protrude into the maxillary sinus. This was particularly common for the first molars, where the roots are close to or extend into the sinus cavity. Studies by Ramadhanty et al. and Henria et al. found that the highest prevalence of this relationship occurred in the first molars, with root apices extending more than 2 mm into the sinus.

Data from a study by Pei et al. using cone-beam computed tomography (CBCT) showed that the Type 3 relationship, in which the apices of the roots protrude into the sinus, was most clearly detected. The study demonstrated that CBCT, with its higher spatial resolution, offers more precise imaging compared to conventional panoramic radiography, thereby enhancing the detection of anatomical relationships between tooth roots and the sinus floor.

OMS is primarily caused by iatrogenic factors, such as oroantral fistula (OAF) formation following tooth extraction, displacement of implants into the sinus, postoperative infections from sinus lift procedures, and extrusion of endodontic materials like gutta-percha or amalgam into the sinus. In addition to iatrogenic causes, OMS can also develop from primary odontogenic infections. Microbiologically, OMS is typically polymicrobial, with anaerobic species such as

Peptostreptococcus spp. and *Fusobacterium* spp. predominating, while fungal pathogens like *Aspergillus* can sometimes be implicated.

Clinically, OMS is characterized by symptoms such as nasal obstruction, unilateral purulent nasal discharge with a fetid odor, maxillofacial pain, and halitosis. It is often associated with a history of dental procedures or odontogenic indicators such as dental pain, periapical pathology, or prior dental interventions. Accurate diagnosis of OMS requires a combination of clinical evaluation and radiographic imaging, with CBCT considered the gold standard due to its superior anatomical resolution compared to conventional imaging techniques.

Pharmacological treatment for OMS typically involves systemic antibiotics to target the infection, decongestants to alleviate sinus obstruction, and corticosteroids to reduce inflammation. Surgical management is often required for more severe cases, with FESS and MESS considered more effective and less invasive than the traditional Caldwell-Luc procedure.

4. Discussion

The pathogenesis of odontogenic maxillary sinusitis (ODMS) is primarily associated with the spread of infection from the posterior maxillary teeth into the maxillary sinus. The process generally originates from an infectious dental focus, such as a periapical abscess, periodontitis, odontogenic cyst, or complications following iatrogenic interventions, including tooth extraction, implant placement, sinus augmentation, or extrusion of endodontic materials. Owing to the close anatomical relationship between the tooth roots and the sinus floor, periapical and advanced periodontal infections readily precipitate an inflammatory response in the sinus mucosa. Importantly, microbial spread may occur even in the absence of cortical bone perforation, as pathogens can disseminate via the bone marrow, vascular channels, or lymphatic pathways. This cascade of infection ultimately results in disruption of the Schneiderian membrane, impaired mucociliary clearance, and ostial obstruction, thereby facilitating bacterial colonization and subsequent sinusitis (Raj et al., 2022).

Once microorganisms reach the sinus cavity, they initiate an inflammatory response in the Schneiderian mucosa, characterized by edema and mucosal thickening (MT). Radiologically, MT was historically regarded as pathological at thresholds >6 mm; however, more recent studies have suggested >2 mm as clinically relevant when associated with sinonasal symptoms (Zirk et al., 2017). This inflammatory process compromises mucociliary function, leading to stasis of secretions and obstruction of the ostiomeatal complex. Reduced drainage decreases intranasal oxygen levels, creating an anaerobic environment favorable to polymicrobial colonization by oral pathogens such as *Peptostreptococcus*, *Prevotella*, and *Fusobacterium*. These microbial communities differ substantially from those typically observed in rhinogenic sinusitis (Brook, 2016; Little, 2018).

In iatrogenic cases involving oro-antral communication (OAC) or oro-antral fistula (OAF), direct contamination of the sinus cavity is highly probable. Evidence indicates that untreated OACs exceeding 2 mm frequently progress to acute sinusitis within days, with approximately 50% of cases occurring within 4–48 hours and up to 90% within two weeks (Little, 2018). Similarly, displaced foreign bodies or extruded endodontic materials within the sinus can serve as persistent foci of infection. Certain materials, particularly zinc-based sealers, may also predispose to fungal superinfection, most notably *Aspergillus* spp. (Troeltzsch et al., 2015).

Prolonged inflammation contributes to progressive histopathological changes, including mucosal hyperplasia, papillary surface folding, mononuclear cell infiltration, fibrosis, dysregulation of epithelial tight-junction proteins such as claudin-4, and upregulation of pro-inflammatory mediators such as IL-17. These alterations exacerbate mucociliary dysfunction, perpetuate chronicity, and may promote extension to adjacent paranasal sinuses (Ren et al., 2017). Clinically and radiographically, ODMS is typically unilateral, underscoring the need for correlation between dental history and three-dimensional imaging (CBCT/CT) to confirm odontogenic etiology. Consequently, effective management generally requires targeted dental intervention—such as endodontic therapy, extraction, or OAF closure—complemented by otolaryngological assessment and treatment where indicated (Little, 2018).

Anatomical variations of the maxillary posterior teeth further contribute to ODMS pathogenesis. Psillas et al. (2021) reported that first molars were implicated in 35.6% of cases, followed by second molars (22%), third molars (17.4%), and second premolars (14.4%). The predominance of first molars is attributable to anatomical factors. While the maxillary sinus floor is normally reinforced by thick cortical bone, age-related alveolar bone resorption may thin this barrier, leaving only the Schneiderian membrane separating the sinus from the oral cavity. In addition, progressive pneumatization of the maxillary sinus after permanent tooth eruption may result in protrusion of dental roots,

particularly those of the first molars, into the sinus cavity. Such proximity significantly increases the risk of periapical infection or dental procedures precipitating sinus involvement and subsequent odontogenic maxillary sinusitis.

5. Conclusion

Odontogenic maxillary sinusitis (OMS) represents a distinct subtype of sinusitis that originates from infectious or pathological processes affecting the maxillary premolars and molars, attributable to their close anatomical relationship with the maxillary sinus floor. The condition may arise secondary to periapical or periodontal disease, or as a complication of dental interventions such as tooth extraction, implant placement, sinus augmentation, or extrusion of endodontic materials into the sinus cavity. The underlying pathophysiological mechanisms involve disruption of the Schneiderian membrane, impairment of mucociliary clearance, and obstruction of sinus outflow, thereby creating an anaerobic microenvironment conducive to polymicrobial colonization dominated by oral anaerobic species.

Clinically, OMS is most often unilateral and manifests with sinonasal symptoms such as nasal obstruction, purulent anterior or postnasal discharge, maxillofacial pain or pressure, and halitosis, frequently accompanied by dental signs or a relevant history of dental procedures. Accurate diagnosis requires integration of clinical, dental, and radiological findings, with cone-beam computed tomography (CBCT) offering superior diagnostic accuracy compared with conventional imaging modalities. Effective management necessitates eradication of the odontogenic source of infection in conjunction with appropriate medical or surgical treatment of the sinus. Consequently, OMS constitutes a unique pathological entity situated at the interface of dental and rhinological practice, emphasizing the necessity of multidisciplinary collaboration to achieve optimal therapeutic outcomes.

Compliance with ethical standards

Disclosure of conflict of interest

There is no conflict of interest declared by authors in this study.

Statement of ethical approval

This article does not contain any experiment performed on animals/humans' subjects by any of the authors.

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