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Iatrogenic Odontogenic Maxillary Sinusitis Caused by Displaced Dental Materials and Bone Grafts: Diagnosis and Endoscopic Management. A Narrative Review

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Running title: Iatrogenic odontogenic sinusitis: a narrative review

Abstract

Background: Odontogenic sinusitis (ODS) has traditionally been considered responsible for 10–12% of maxillary sinusitis cases, but more recent series attribute 25–40% of chronic maxillary sinusitis to a dental source. Dental procedures are now the leading cause. Root fragments, endodontic filling materials, dental implants and bone-graft particles displaced into the maxillary sinus act as foreign bodies that sustain infection and respond poorly to medical therapy.

Objective: To summarize current evidence on the etiology, pathophysiology, diagnosis and surgical management of iatrogenic ODS associated with intrasinus foreign bodies, with particular attention to complications of maxillary sinus floor augmentation and to the role of transnasal endoscopic surgery.

Methods: A narrative review of the literature indexed in PubMed/MEDLINE, Scopus and Google Scholar from 1968 to 2025 was performed using combinations of the terms “odontogenic sinusitis”, “maxillary sinus”, “foreign body”, “sinus lift”, “sinus floor augmentation”, “Schneiderian membrane perforation”, “Caldwell-Luc” and “endoscopic sinus surgery”. Consensus statements, systematic reviews, clinical series and representative case reports in English were included.

Results: In a systematic review of 674 patients with odontogenic chronic maxillary rhinosinusitis, iatrogenic causes accounted for 65.7% of cases. Implant-related procedures, tooth extractions and endodontic treatment were the predominant triggers. Schneiderian membrane perforation is the most frequent intraoperative complication of sinus floor augmentation, with reported rates ranging from approximately 10% to 60%, and may allow graft particles to migrate into the sinus cavity. Computed tomography (CT) remains the reference standard for detecting intrasinus foreign bodies and associated mucosal disease, while cone-beam CT is a low-dose alternative in dental settings. Prompt removal of the foreign body is recommended. A systematic review found that late complications occurred in 15–18% of patients after Caldwell-Luc surgery and in up to 5% after bone-lid techniques, with none reported after functional endoscopic sinus surgery (FESS).

Conclusions: An intrasinus foreign body should be suspected in any patient with chronic, therapy-resistant maxillary sinusitis and a history of dental treatment. CT should be obtained in all such cases. Transnasal endoscopic removal, extended where necessary to an endoscopic medial maxillectomy, offers excellent visualization with low morbidity and is becoming the preferred approach. Close collaboration between dental surgeons and otorhinolaryngologists, together with careful preoperative planning and gentle handling of the Schneiderian membrane, is essential for prevention.

Keywords: Odontogenic sinusitis; maxillary sinus; foreign bodies; sinus floor augmentation; Schneiderian membrane perforation; endoscopic sinus surgery; iatrogenic disease

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1. Introduction

The paired maxillary sinuses occupy the body of the maxilla between the nasal and oral cavities. Each sinus has a pyramidal shape, measuring approximately 2.5 cm in width, 3.75 cm in height and 3 cm in depth in the adult [1]. Because of this position, the sinus is exposed to pathogens from both the nasal cavity and the oral cavity. The roots of the maxillary second molars lie closest to the sinus floor, followed by those of the first and third molars and the premolars. In some individuals the root apices project directly into the sinus, separated from the lumen only by the Schneiderian membrane, the thin mucoperiosteal lining of the sinus [2, 3]. After loss of posterior maxillary teeth, the residual alveolar ridge undergoes resorption through physiological remodeling of the socket and progressive pneumatization of the sinus towards the crest [4]. Bone volume is

therefore often insufficient for implant placement, and sinus floor augmentation is frequently required.

Maxillary sinusitis is a symptomatic inflammation of the sinus mucosa, most commonly secondary to viral, bacterial, allergic or fungal rhinitis. Any dental condition or intervention that breaches the sinus floor can also cause sinusitis, which is then termed odontogenic sinusitis (ODS). Classical estimates attributed 10–12% of maxillary sinusitis cases to a dental origin [5], but more recent data suggest that ODS accounts for 25–40% of chronic maxillary sinusitis and remains under-recognized [6, 7]. ODS differs from rhinogenic sinusitis in its pathophysiology, microbiology and treatment. It typically involves a single side and a polymicrobial, often anaerobic, flora, and it requires management of both the sinus disease and its dental source [8, 9].

Iatrogenic forms of ODS are of particular clinical importance. Displaced root apices during extraction, perforation of the sinus membrane during extraction or implant placement, extrusion of root canal filling material beyond the apex and migration of bone-graft particles after sinus floor augmentation all introduce a foreign body into the sinus. In the presence of a foreign body, a smaller bacterial inoculum is sufficient to establish infection, and the resulting sinusitis is typically refractory to standard medical therapy [8]. The introduction of rigid endoscopes, and the concept of functional endoscopic sinus surgery based on Messerklinger's description of mucociliary clearance pathways, has transformed the surgical management of these patients [10].

The aim of this review is to summarize current evidence on the etiology, pathophysiology, clinical presentation, imaging and surgical treatment of iatrogenic ODS associated with intrasinus foreign bodies of dental origin. Particular emphasis is placed on complications of maxillary sinus floor augmentation and on the role of the transnasal endoscopic approach as an alternative to conventional open surgery.

2. Materials and Methods

This article is a narrative review. The electronic databases PubMed/MEDLINE, Scopus and Google Scholar were searched for publications from 1968 to 2025 using combinations of the following terms: "odontogenic sinusitis", "odontogenic maxillary sinusitis", "maxillary sinus", "foreign body", "root displacement", "dental implant migration", "sinus lift", "sinus floor augmentation", "Schneiderian membrane perforation", "Caldwell-Luc" and "endoscopic sinus surgery". Reference lists of relevant articles were screened manually for additional sources. International consensus statements, position papers, systematic reviews and meta-analyses, clinical series and representative case reports published in English were considered. Priority was given to consensus

documents and systematic reviews; classical studies were retained where they established concepts still in use. Because of the heterogeneity of the available evidence, no quantitative synthesis was attempted, and the findings are presented descriptively.

3. Results and Discussion

3.1. Epidemiology and etiology

Dental interventions are now the dominant cause of ODS. In a systematic review of 674 patients with chronic maxillary rhinosinusitis of dental origin, iatrogenic factors accounted for 65.7% of cases, whereas apical periodontal pathology accounted for 25.1%. The first and second molars were the teeth most frequently involved [11]. Approximately 60% of iatrogenic sinusitis cases are associated with dental treatment. Among these, a substantial proportion results from surgical trauma, the formation of an oroantral communication and the subsequent displacement of foreign bodies such as implants, root fragments and bone grafts into the sinus [12]. In the series reported by Felisati et al., dental implant placement was responsible for about 30% of sinonasal complications, tooth extraction for about 20% and endodontic procedures for about 15% [13].

Felisati et al. proposed an outcome-oriented classification of sinonasal complications of dental disease or treatment that divides patients into three groups: complications of pre-implant procedures such as sinus floor augmentation (group I), complications of implant placement (group II) and complications of conventional dental treatment or dental disease (group III). Each group has its own surgical protocol combining endoscopic sinus surgery and intraoral procedures [13]. The classification was later validated prospectively in 128 consecutive patients, 97.7% of whom recovered completely after treatment according to the protocol [14]. The main iatrogenic sources of intrasinus foreign bodies are summarized in Table 1.

Table 1. Main iatrogenic sources of foreign bodies in the maxillary sinus

Dental procedure	Typical foreign body	Mechanism of displacement	References
Tooth extraction	Root apex, root fragment, entire tooth (often third molar)	Thin or absent sinus floor; excessive apical force; inadequate visualization	[11, 12]

Dental procedure	Typical foreign body	Mechanism of displacement	References
Endodontic treatment	Gutta-percha, sealer (zinc oxide–eugenol), paste, silver points	Overinstrumentation and overfilling beyond the apex	[15, 16]
Implant placement	Titanium implant, healing abutment, cover screw	Insufficient residual bone height; lack of primary stability; pressure changes in the sinus	[13, 17]
Sinus floor augmentation	Particulate bone graft or substitute	Schneiderian membrane perforation; overfilling of the subantral space	[18–20]
Instrument failure	Fractured bur, needle, file	Instrument breakage or slippage during surgery	[21]

3.2. Pathophysiology

The mechanism by which a foreign body produces sinus disease is not fully understood. The size, weight and chemical composition of the object are thought to cause chronic irritation of the sinus mucosa, leading to ciliary dysfunction, ostial obstruction, impaired drainage and retention of secretions [10]. Retained secretions create an anaerobic environment that favors bacterial and fungal growth and ultimately leads to secondary infection [8]. Small particles may be transported by mucociliary clearance to the natural ostium and expelled into the nasal cavity. From there they can be aspirated, particularly during sleep, and cause aspiration pneumonia or lung abscess [22]. Alternatively, a dislodged particle may lodge in and occlude the ostium itself. This mechanism has been documented for bone-graft material after sinus augmentation [18].

Dental filling materials deserve special mention. Gutta-percha, silver points, root canal sealers and amalgam contain heavy metals and other compounds, including zinc, titanium, and salts of calcium, barium, sulfur and bismuth. Zinc oxide in particular has been shown to promote the growth of *Aspergillus* species. Extrusion of these materials into the sinus therefore predisposes to non-invasive fungal ball (mycetoma) formation [16, 23, 24]. Overextended endodontic material is one of the most

frequently reported foreign bodies of dental origin in the maxillary sinus [15].

3.3. Clinical presentation

Symptoms of iatrogenic ODS are non-specific and include purulent or foul-smelling rhinorrhea, nasal obstruction, facial pain or pressure, headache, cacosmia and, occasionally, fever. They may appear within weeks or only years after the causative dental intervention, and the dental history is often incomplete or not volunteered by the patient [6, 9]. An odontogenic source should therefore be considered whenever headache, facial pain or nasal congestion follows a dental procedure. An intrasinus foreign body should be suspected in any patient with chronic sinusitis that does not respond to medical therapy, especially when there is a history of dental work. In many patients the foreign body is detected only after signs of chronic rhinosinusitis have developed, and in others it is an incidental finding on imaging performed for unrelated reasons [25]. The international multidisciplinary consensus recommends that otorhinolaryngologists confirm sinusitis primarily by nasal endoscopy, looking for middle meatal purulence, edema or polyps, while dental providers confirm the dental pathology by clinical examination and dental imaging. Each specialty should refer patients to the other when ODS is suspected [9].

Importantly, an oroantral communication may already have healed by the time the patient presents, and the oral examination may be unremarkable. In such cases, iatrogenic sinusitis caused by a foreign body can be suspected only on the basis of imaging findings [12].

3.4. Imaging

Panoramic radiography combined with an occipitomental (Waters) view has traditionally been used to localize displaced objects in the maxillary sinus, but superimposition limits its accuracy [26]. Cone-beam computed tomography (CBCT) provides high-resolution three-dimensional images at a lower radiation dose and has proven reliable for detecting intrasinus foreign bodies and their relationship to the alveolar ridge and dental roots. However, CBCT is not universally available and is used mainly in dental practice. Multidetector CT remains the gold standard for comprehensive evaluation of the paranasal sinuses, as it demonstrates both the foreign body and the extent of mucosal disease, including the patency of the ostiomeatal complex [25, 26]. Magnetic resonance imaging (MRI) is superior to CT for soft-tissue assessment and can be useful for detecting organic foreign bodies and differentiating fungal disease, but ferromagnetic objects must be excluded before MRI is performed [26]. CT, or at least CBCT, is recommended for every patient with sinusitis and a history of dental procedures [9].

3.5. Sinus floor augmentation and its complications

Maxillary sinus floor augmentation (MSFA), commonly referred to as a sinus lift, aims to provide sufficient bone height and width for implant placement in the atrophic posterior maxilla. The technique was introduced by Tatum in the 1970s and first published in detail by Boyne and James [27, 28]. In the classical lateral window approach, mesial and distal vertical releasing incisions connected by a crestal incision allow elevation of a buccal mucoperiosteal flap and exposure of the lateral sinus wall. A bony window is created in the lateral wall, and the Schneiderian membrane is carefully detached and elevated apically without compromising its integrity. The space created is filled with graft material. Implants may be placed simultaneously (one-stage technique) or after graft maturation (two-stage technique). The two-stage approach is chosen when residual bone height is insufficient to achieve primary implant stability [29, 30].

In patients with adequate residual bone height, the sinus floor can be elevated through the alveolar crest using the osteotome technique described by Summers. This less invasive procedure elevates the sinus floor through the implant osteotomy itself [1, 31]. A wide range of graft materials is used, from autogenous bone harvested from the iliac crest, chin or mandibular ramus to allografts, xenografts and synthetic bone substitutes, alone or in combination [32].

Although MSFA is predictable and highly successful, with implant survival rates exceeding 90% in systematic reviews [29, 30], complications do occur. Perforation of the Schneiderian membrane is the most frequent intraoperative complication, with reported rates ranging from approximately 10% to 60% [19, 33–36]. Risk factors include sinus septa, a thin membrane, a narrow angle between the lateral and medial sinus walls, irregular bone contours, overpacking of graft material, limited surgical experience and technical errors [32, 34]. A perforation that occurs or enlarges after grafting is difficult to repair adequately and allows particulate graft to escape into the sinus cavity. The mucosa then reacts to the graft as a foreign body, producing an inflammatory response, recurrent infection and, in some cases, ostial obstruction [18, 19]. Of all the paranasal sinuses, the maxillary sinus is most commonly affected by iatrogenic infection. Other sinuses may become involved secondarily as the infection spreads, resulting in pansinusitis [13, 14].

3.6. Surgical management

Early surgical removal of a displaced foreign body is recommended to prevent sinusitis, mucous retention cysts, antrolith formation and a persistent oroantral fistula. Many authors advocate removal even in asymptomatic patients, because a retained foreign body may later cause acute or chronic rhinosinusitis, fungal disease or abscess formation in

adjacent structures [12, 17]. Three principal approaches are used: the transalveolar (intraoral) approach, the Caldwell-Luc (canine fossa) approach and the transnasal endoscopic approach. These may be used alone or in combination (Table 2).

The transalveolar approach is based on the observation that most displaced roots fall onto the sinus floor or remain close to the socket. The root can then be retrieved and the fistula closed in a single procedure. However, this approach is unsuitable when the alveolar ridge is intact and no fistula is present. The Caldwell-Luc operation has been performed for more than a century and offers wide access and direct visualization of the entire sinus. Its drawbacks include postoperative facial pain and swelling, hypoesthesia of the cheek due to infraorbital nerve injury, and paresthesia of the anterior maxillary teeth due to injury of the anterior superior alveolar nerve. In children it also carries a risk to developing tooth buds and facial growth [37]. In a systematic review of foreign body removal from the maxillary sinus, late complications occurred in 15–18% of patients treated with the Caldwell-Luc approach and in 0–5% of those treated with replaceable or pedicled bone-lid techniques, whereas no late complications were reported after FESS. The authors concluded that FESS should probably become the gold standard, although the quality of the evidence was limited [17].

Many of the endoscopic procedures reported in the literature were combined with an open approach. Costa et al. described an endoscopically assisted procedure for removal of dental filling material from the sinus combined with endodontic surgery of the causative tooth [38], and Friedlich and Rittenberg reported an endoscopically assisted Caldwell-Luc procedure for retrieval of a dental bur [21]. Chandrasena et al. subsequently reported the removal of a root accidentally displaced into the sinus using an exclusively transnasal endoscopic technique [39]. The standard endoscopic approach consists of a middle meatal antrostomy, which simultaneously restores ventilation and drainage of the sinus. Angled endoscopes (45° and 70°) combined with curved suction tubes, flexible curettes and angled forceps provide access to most of the sinus lumen. Foreign bodies located on the anterior wall or on the floor of the alveolar recess may be inaccessible through a standard antrostomy. In these cases the approach can be extended to an endoscopic medial maxillectomy with preservation of the nasolacrimal duct, or combined with a limited canine fossa puncture [13, 14].

A recent case reported by Sikdar et al. illustrates these principles [20]. A 68-year-old man presented with recurrent nasal obstruction and bilateral facial pain that had persisted for several months despite medical treatment. CT revealed multiple hyperdense foreign bodies in both maxillary sinuses. The patient could not recall the details of dental

treatment received several months earlier, and the material was initially interpreted as extruded endodontic filling. Material lying free in the left sinus was cleared through a middle meatal antrostomy with angled endoscopes and instruments. On the right side, the material was firmly adherent to the sinus floor and required an endoscopic medial maxillectomy with preservation of the nasolacrimal duct. Retrospective review of the CT images identified dental implants in the alveolar ridge, indicating that the foreign material was extruded bone graft from a previous sinus lift that had partly integrated on the right side. Recovery was uneventful [20]. The case highlights two practical points: the dental history is often incomplete, and careful review of the CT images for implants and graft material is essential for planning the extent of surgery.

Compared with the canine fossa approach, the transnasal endoscopic approach offers better visualization of the sinus and the ostiomeatal complex, is less invasive, avoids injury to the dental roots and the infraorbital nerve, and is associated with lower morbidity and a shorter recovery period [17, 37]. It also simultaneously addresses ostial obstruction, the key pathophysiological factor maintaining infection. When an oroantral fistula or a failed implant is present, endoscopic sinus surgery should be combined with intraoral management, such as fistula closure with a buccal or palatal flap or implant removal, as recommended by the Felisati–Saibene protocol [13, 14].

Table 2. Comparison of surgical approaches for removal of foreign bodies from the maxillary sinus

Approach	Main indications	Advantages	Limitations
Transalveolar (intraoral)	Recently displaced root near the socket; open oroantral communication	Single-stage retrieval and fistula closure; no external incision	Limited view of the sinus; unsuitable with an intact ridge; does not address ostial obstruction
Caldwell-Luc (canine fossa)	Large or anteriorly located objects; extensive mucosal disease	Wide access; direct visualization of the entire sinus	Infraorbital nerve hypoesthesia, dental paresthesia, facial swelling; late complications in 15–18%

Approach	Main indications	Advantages	Limitations
Transnasal endoscopic (middle meatal antrostomy ± medial maxillectomy)	Most foreign bodies; associated chronic rhinosinusitis	Restores physiological drainage; excellent visualization with angled scopes; low morbidity, short recovery	Limited reach to the anterior wall and alveolar recess through a standard antrostomy; requires endoscopic expertise
Combined endoscopic and intraoral	Foreign body with oroantral fistula or failed implant	Treats sinus disease and dental source in one session	Longer operation; requires an interdisciplinary team

Based on references [13, 14, 17, 37, 39].

3.7. Prevention and interdisciplinary care

Most iatrogenic intrasinus foreign bodies are preventable. Preoperative three-dimensional imaging allows assessment of residual bone height, sinus septa, membrane thickness and pre-existing sinus disease before extraction of posterior maxillary teeth, endodontic treatment of teeth in close relation to the sinus, implant placement or sinus augmentation [9, 32]. During MSFA, gentle elevation of the Schneiderian membrane, avoidance of overpacking with graft material and immediate repair of any perforation reduce the risk of graft migration [33, 34]. Pre-existing sinus disease should be treated before augmentation. Because ODS lies at the interface between dentistry and otorhinolaryngology, the general otorhinolaryngologist is often unfamiliar with the details of modern endodontic and implant procedures, whereas the dental practitioner may not recognize the rhinological consequences. Structured interdisciplinary collaboration from diagnosis to follow-up is therefore strongly recommended [9, 14].

4. Conclusions

Iatrogenic odontogenic maxillary sinusitis is a growing problem, driven mainly by the widespread use of dental implants and sinus floor augmentation. Besides displacement of root apices during extraction, it may result from perforation of the sinus membrane with extrusion of root canal filling materials or from migration of implants and bone-graft particles. An intrasinus foreign body should be suspected in any patient with chronic, therapy-resistant maxillary sinusitis and a history of dental

treatment, and CT should be obtained in all such cases. Once the diagnosis is confirmed, the foreign body should be removed surgically, even in asymptomatic patients, because it may give rise to bacterial or fungal rhinosinusitis and, rarely, to orbital or intracranial complications. Transnasal endoscopic surgery, extended to an endoscopic medial maxillectomy when the foreign body is firmly adherent or difficult to reach, provides excellent visualization and low morbidity and is becoming the preferred approach. Careful preoperative assessment, gentle handling of the Schneiderian membrane and close cooperation between dental surgeons and otorhinolaryngologists are the keys to prevention and successful treatment.

Declarations

Author contributions: U.A.K.: conceptualization, supervision, critical revision of the manuscript. S.S.A., N.Kh.A., S.G.U., D.Kh.S., A.A.T.: literature search, data extraction, drafting of the manuscript. All authors read and approved the final version of the manuscript.

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