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REVIEW ARTICLE

DENTAL IMPLANT DISPLACEMENT INTO THE MAXILLARY SINUS: AN EVIDENCE-INFORMED CLINICAL REVIEW AND ANATOMY-DRIVEN MANAGEMENT ALGORITHM—A NARRATIVE REVIEW

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Abstract

Background: Displacement of a dental implant into the maxillary sinus is uncommon but clinically important. Management is complicated by inconsistent terminology and by the need to distinguish a stable, osseointegrated implant that merely protrudes radiographically beyond the sinus floor from a truly displaced implant that has lost bony support and migrated into the sinus cavity.

Objective: To provide a focused, clinically oriented synthesis of the etiology, risk factors, diagnosis, complications, prevention, and management of dental implant displacement into the maxillary sinus, and to propose an anatomy-driven decision framework integrating implant stability, three-dimensional location, sinus health, oroantral pathology, and surgical accessibility.

Methods: A focused narrative review was performed using PubMed/MEDLINE as the principal database, supplemented by reference-list screening of relevant systematic reviews, consensus statements, cohort studies, case series, and clinically informative case reports. Search concepts included dental implant displacement or migration, maxillary sinus, sinus floor elevation, implant protrusion, CBCT, foreign body removal, endoscopic sinus surgery, transoral retrieval, Caldwell-Luc, and odontogenic sinusitis. Evidence from systematic reviews, larger clinical series, and multidisciplinary consensus statements was prioritized for general recommendations; case reports and small series were used primarily to illustrate unusual locations and technical approaches. No meta-analysis or formal risk-of-bias grading was performed.

Results: Implant displacement is multifactorial. Reduced residual bone height, posterior maxillary atrophy, poor bone quality, inadequate primary stability, inappropriate implant dimensions or trajectory, excessive insertion force, sinus augmentation-related complications, and subsequent loss of osseous support may contribute. CBCT is central when true displacement is suspected because it defines implant location, residual support, sinus anatomy, mucosal disease, and accessibility. A stable implant with preserved osseous support and limited radiographic sinus protrusion should not be equated with a freely displaced implant. For true displacement, retrieval is generally favored, with timing and route individualized according to symptoms, sinus pathology, oroantral communication, implant mobility and location, ostiomeatal drainage, and surgical accessibility. Transoral, transnasal endoscopic, endoscope-assisted, and combined approaches each have appropriate indications.

Conclusion: Treatment should not be determined by radiographic sinus penetration alone. The decisive variables are implant stability, three-dimensional location, sinus health, anatomical accessibility, and associated oroantral or sinonasal disease. Prevention through three-dimensional planning and reliable primary stability remains fundamental. The proposed algorithm is an evidence-informed expert synthesis and requires prospective clinical validation.

Keywords: dental implant; implant displacement; implant migration; maxillary sinus; CBCT; sinusitis; endoscopic surgery; transoral retrieval; oroantral communication; clinical algorithm.

1.INTRODUCTION

Dental implants are an established treatment modality for the rehabilitation of partially and completely edentulous patients. Implant placement in the posterior maxilla, however, remains technically demanding because tooth loss is commonly followed by alveolar ridge resorption and progressive pneumatization of the maxillary sinus. The resulting reduction in residual vertical bone height and the relatively low-density bone frequently encountered in this region can compromise implant anchorage and primary stability.[1–3]

Sinus floor elevation has substantially expanded the indications for implant rehabilitation in the atrophic posterior maxilla and is generally associated with favorable implant survival.[1–3] The development of contemporary sinus floor elevation was founded on the pioneering work of Boyne and James, who described grafting of the maxillary sinus floor with autogenous marrow and bone, followed by the development of maxillary and sinus implant reconstruction techniques described by Tatum.[4,5] Nevertheless, sinus augmentation introduces specific intraoperative and postoperative complications.[6] Schneiderian membrane perforation is among the most frequently reported intraoperative events, whereas postoperative complications may include infection, graft-related complications, wound problems, and sinus pathology.[7–9] Changes in the augmented sinus volume may also occur over time and should be considered during long-term treatment assessment.[10]

One uncommon but clinically important complication is displacement of a dental implant into the maxillary sinus. Implant displacement may occur during implant insertion, in the early postoperative period, or later following loss of osseous support.[11–13] Reported contributing factors include insufficient residual bone height, inadequate primary stability, poor bone quality, inappropriate implant dimensions or positioning, excessive insertion forces, complications associated with sinus augmentation, failure of osseointegration, and progressive loss of supporting bone.[12–16] Implant displacement has also been reported following internal sinus floor elevation and may occur in both grafted and nongrafted maxillary sinuses.[14,17]

The clinical presentation of displaced implants is heterogeneous. Retrospective studies and clinical reports have demonstrated variability in the timing of displacement, implant position, associated symptoms, and underlying anatomical conditions.[13,18] Implant displacement may be associated with local or sinonasal complications and therefore requires individualized clinical assessment.[15,18]

Treatment of dental implant displacement into the maxillary sinus represents a distinct clinical problem. Published clinical studies have described different therapeutic strategies according to implant location, mobility, sinus condition, and accessibility.[19–22] Foreign bodies of dental or iatrogenic origin may similarly require surgical retrieval when they remain within the maxillary sinus or produce associated complications.[20–22]

Accurate imaging is essential for determining the anatomical position of a displaced implant and for selecting an appropriate treatment strategy. Cone-beam computed tomography (CBCT) can provide three-dimensional information regarding the relationship of the implant to the sinus floor, sinus walls, surrounding bone, and adjacent anatomical structures.[23] The radiographic appearance of an implant within or protruding into the maxillary sinus should, however, be interpreted in the context of implant stability and osseous support.

Terminology is clinically important because radiographic penetration of an implant into the maxillary sinus does not necessarily represent true displacement. An otherwise stable and osseointegrated implant with limited radiographic protrusion beyond the sinus floor may remain clinically functional and does not automatically require removal.[24] In contrast, an implant that has lost osseous support and is mobile or freely located within the sinus cavity represents true displacement and requires a different clinical assessment. The distinction is particularly important because treatment should not be based on radiographic appearance alone but should incorporate implant stability, three-dimensional position, sinus condition, symptoms, and associated oroantral or sinonasal pathology.[24]

The distinction between radiographic protrusion and true displacement has been specifically addressed by an international multidisciplinary consensus. The consensus emphasized that radiographic protrusion of an osseointegrated implant into the maxillary sinus or nasal fossae should be distinguished from actual displacement and that management should take into account clinical symptoms and associated sinonasal disease.[24] This distinction provides an important clinical basis for avoiding unnecessary implant removal while ensuring appropriate treatment when true displacement or sinonasal complications are present.

Several surgical approaches have been described for removal of displaced implants from the maxillary sinus. These include transoral retrieval through the alveolar ridge or lateral sinus wall, Caldwell–Luc-type approaches, transnasal endoscopic removal, endoscope-

assisted transoral techniques, and combined approaches.[19,21,22,25]

The choice of approach depends on the three-dimensional location of the implant, its mobility, the condition of the sinus, the presence of oroantral communication or infection, the status of the ostiomeatal drainage pathway, and the accessibility of the foreign body.[20–25]

Endoscope-assisted transoral retrieval has been described as a minimally invasive alternative for selected implants displaced into the maxillary sinus.[26] Other reports have documented unusual implant migration and emphasize that implant location may change over time or become difficult to localize clinically.[27] Transnasal endoscopic techniques have also been successfully used for retrieval of migrated implants through the nasal cavity and sinus drainage pathway.[28] These reports support an individualized, anatomy-driven approach to surgical retrieval.

More recent evidence has further contributed to the development of structured management strategies. A multicenter retrospective cohort study evaluated implant displacement into the maxillary sinus and proposed a management protocol based on the clinical and anatomical characteristics of individual cases.[29] Such evidence is particularly relevant to the development of standardized clinical pathways for diagnosis, observation, retrieval, and multidisciplinary treatment.

The condition of the maxillary sinus is another important component of treatment planning. When implant displacement is accompanied by sinus inflammation or other sinonasal disease, collaboration among oral and maxillofacial surgeons, implant clinicians, and otorhinolaryngologists may be appropriate. Current multidisciplinary consensus statements on odontogenic sinusitis emphasize the importance of identifying the dental source, evaluating sinonasal disease, and coordinating treatment when both dental and sinonasal pathology are present.[30,31] The European Position Paper on Rhinosinusitis and Nasal Polyps also provides a broader framework for the assessment and management of sinonasal disease and its relevant anatomical and inflammatory features.[32]

A displaced implant may remain asymptomatic, particularly when it does not interfere with sinus drainage or produce significant mucosal irritation. However, symptomatic cases may present with facial discomfort, nasal obstruction, malodor, recurrent sinonasal symptoms, maxillary sinusitis, or oroantral communication.[11,13,15,20–22]

The clinical significance of these findings depends on the implant's exact location, degree of mobility, relationship to the sinus walls and drainage pathway, and the presence of associated sinonasal pathology.[11,24,29]

Three-dimensional imaging, particularly CBCT, therefore plays a central role when implant displacement is suspected. CBCT can establish the precise three-dimensional position of the implant and its relationship to the sinus walls, residual osseous support, sinus floor, and adjacent anatomical structures.[23,24] It can also provide information regarding mucosal thickening, opacification, bony defects, and other findings relevant to surgical planning.[23]

In patients with suspected odontogenic or implant-related sinus disease, radiographic assessment should be interpreted together with the clinical sinonasal findings because the presence and severity of sinus pathology may influence both treatment timing and the choice of surgical approach.[30–32]

The available literature remains heterogeneous and consists of systematic reviews, retrospective studies, case series, and case reports, with substantial variation in patient characteristics, mechanisms of displacement, clinical presentation, imaging findings, associated sinus pathology, and treatment strategies.[11–29]

Although recent consensus statements and multicenter clinical studies provide a more structured evidence base, differences remain in the terminology used to describe implant protrusion and displacement and in the indications for retrieval.[24,29]

Despite these contributions, a clinically practical framework that clearly separates stable radiographic protrusion from true displacement and integrates implant stability, three-dimensional anatomy, sinus health, oroantral pathology, and surgical accessibility remains useful. Such a framework may help clinicians avoid unnecessary intervention in stable implants while facilitating timely multidisciplinary management of mobile or displaced implants associated with sinonasal disease.

The aim of this focused narrative review is therefore to synthesize current evidence on the etiology, risk factors, diagnosis, complications, prevention, and management of dental implant displacement into the maxillary sinus, with particular emphasis on (1) distinguishing stable radiographic protrusion from true displacement, (2) defining the role of CBCT and systematic sinonasal assessment, and (3) providing an anatomy-driven approach to observation, retrieval, and multidisciplinary management.

2. METHODS

2.1 Review design and scope

This article was designed as a focused narrative review rather than a systematic review or meta-analysis. The objective was to integrate clinically relevant evidence across implantology, oral and maxillofacial surgery, radiology, and otorhinolaryngology, with particular emphasis on clinical decision-making, diagnostic assessment, prevention, and management rather than quantitative estimation of treatment effects.[11,24,25,29]

The review focused on dental implants protruding into, displaced into, or migrating within the maxillary sinus. Literature concerning sinus floor elevation, Schneiderian membrane perforation, odontogenic sinusitis, peri-implant disease, and other maxillary sinus foreign bodies was included when it directly informed the mechanisms, diagnosis, complications, prevention, or management of implant displacement or migration.[6–10,11–25,30–32]

2.2 Literature identification

PubMed/MEDLINE was used as the principal bibliographic database. Reference lists of relevant systematic reviews, consensus statements, and previously published reviews were also screened to identify additional clinically important publications.[7,11,21,24,29]

Search concepts included combinations of the terms *dental implant displacement*, *dental implant migration*, *implant migration into maxillary sinus*, *dental implant displaced into maxillary sinus*, *maxillary sinus*, *sinus floor elevation*, *sinus augmentation*, *implant protrusion*, *foreign body maxillary sinus*, *CBCT*, *endoscopic removal*, *functional endoscopic sinus surgery*, *transoral removal*, *Caldwell-Luc*, and *odontogenic sinusitis*. Boolean operators AND and OR were used where appropriate.

Before submission, the authors should report the final search date and, where available, the complete PubMed search strategy to facilitate reproducibility. If additional bibliographic databases were searched, these should also be explicitly identified.

2.3 Selection and evidence interpretation

Publications were considered relevant when they addressed mechanisms or causes of implant displacement, anatomical or surgical risk factors, sinus floor elevation-related complications, clinical or sinonasal manifestations, radiographic or CBCT diagnosis, differentiation of sinus protrusion from true displacement, surgical retrieval, endoscopic or transoral management, multidisciplinary treatment, or preventive strategies.[11–29,30–32]

Systematic reviews, larger clinical or multicenter studies, and multidisciplinary consensus statements were given greatest weight when formulating general clinical statements.[7,8,9,11,21,24,29]

Case reports and small case series were retained when they provided clinically relevant information about unusual mechanisms, remote migration, uncommon anatomical locations, or specific retrieval techniques.[12–18,26–28] Case reports were not used to infer comparative treatment efficacy.

Because this was a narrative review, no formal risk-of-bias assessment, evidence grading system, or meta-analysis was performed. Consequently, recommendations in this article should be interpreted according to the strength and design of the underlying literature. The management algorithm proposed below represents an evidence-informed expert synthesis rather than a formally validated clinical guideline.

3. Evidence Synthesis

3.1 Etiology and risk factors

Dental implant displacement into the maxillary sinus is best understood as a multifactorial complication involving anatomical, biomechanical, implant-related, surgical, sinus augmentation-related, and biological factors. The posterior maxilla is particularly susceptible because alveolar resorption after tooth loss frequently occurs together with progressive sinus pneumatization. Reduced residual bone height can leave insufficient cortical or cancellous bone for predictable implant anchorage.[1–3,11–15]

Bone quality is also relevant. Relatively low-density posterior maxillary bone may provide limited resistance during implant insertion. When an implant is placed in a severely atrophic site with inadequate cortical or cancellous support, primary stability may be insufficient, facilitating immediate displacement or later loss of fixation.[1–3,12,13]

Sinus floor elevation creates an additional context in which displacement can occur. Manipulation of the Schneiderian membrane, limited residual bone, inadequate osteotomy preparation, inappropriate implant trajectory, insufficient primary stability, or postoperative loss of support may contribute.[6–9,17,18]

Biological failure represents a different pathway: an initially positioned implant may later lose support because of failed osseointegration, peri-implant bone loss, or other progressive loss of fixation.[14–16]

The principal risk domains and their potential contributions are summarized in Table 1.

Table 1. Principal risk domains associated with implant displacement into the maxillary sinus

Risk domain	Examples	Potential contribution	Typical evidence base
Anatomical	Reduced residual bone height; sinus pneumatization; thin alveolar ridge	Insufficient bony support and reduced anchorage	Systematic reviews; clinical studies
Bone-related	Low-density bone; severe posterior maxillary atrophy	Reduced primary stability	Clinical studies; mechanistic evidence
Implant-related	Inappropriate length/diameter; unfavorable three-dimensional positioning	Loss of fixation or sinus penetration	Retrospective studies; case series
Surgical	Excessive insertion force; inadequate osteotomy; uncontrolled trajectory	Immediate displacement during placement	Case series; case reports
Sinus augmentation-related	Membrane perforation; insufficient residual bone; inappropriate elevation technique	Instability and sinus-related complications	Systematic reviews; clinical studies
Biological	Failure of osseointegration; progressive peri-implant bone loss	Delayed loss of support and possible migration	Clinical studies; case series
Postoperative	Functional loading of an inadequately stabilized implant	Delayed displacement after loss of fixation	Case series; mechanistic evidence

3.2 Mechanisms: immediate displacement and delayed migration

Two broad clinical mechanisms can be distinguished. Immediate displacement usually occurs during implant insertion or shortly thereafter when an implant placed in a severely atrophic posterior maxilla encounters insufficient resistance from the surrounding bone. The implant may penetrate the sinus floor and become partially or completely displaced into the sinus cavity.[12,13,17,18]

Delayed migration represents a different biological and mechanical process. An implant initially positioned within alveolar bone may subsequently lose support because of inadequate osseointegration, biological complications, progressive peri-implant bone loss, or mechanical failure.[14–16] Once sufficient support has been lost, the implant may migrate toward or into the sinus. The final position may influence symptoms, associated sinus pathology, and the feasibility of retrieval.[15,16]

3.3 Stable sinus protrusion is not synonymous with displacement

A key diagnostic distinction is between radiographic sinus protrusion and true displacement. An implant that extends beyond the radiographic sinus floor but remains osseointegrated and supported by bone should not automatically be classified as migrated. Multidisciplinary consensus has emphasized that the clinical significance of protrusion should be interpreted in relation to implant stability, symptoms, and sinonasal pathology.[24]

No universally validated dimensional threshold defines an acceptable depth of sinus protrusion. Therefore, management should not be based on millimeters of radiographic penetration alone. Stability, residual support, mucosal and sinonasal status, and longitudinal clinical findings are more relevant than protrusion depth in isolation.[24]

This subsection is important and should definitely remain. It prevents an overly simplistic conclusion that every implant penetrating the sinus is a displaced implant requiring removal.

3.4 Diagnosis and the role of CBCT

Diagnosis requires integration of clinical history, intraoral examination, conventional radiography, and three-dimensional imaging when true displacement or sinus complications are suspected. The history should establish the timing of implant placement, previous sinus augmentation, onset of symptoms, and any prior attempts at retrieval.[11–19]

Panoramic or periapical imaging may provide an initial overview, but CBCT is particularly valuable for defining the implant's three-dimensional position and relationship to residual bone, the sinus floor and walls, adjacent teeth, mucosal changes, and potential access routes.[23, 24] Imaging should also assess whether the implant remains partially supported by bone or is freely displaced, and whether sinonasal abnormalities or obstruction of the ostiomeatal drainage pathway are present.[23, 24]

ENT assessment is appropriate when significant sinonasal symptoms, chronic sinus disease, ostiomeatal complex involvement, or the need for endoscopic sinus surgery is suspected.[30–32] The main components of the diagnostic assessment are summarized in Table 2.

Table 2. Diagnostic assessment of suspected implant displacement

Component	Purpose	Key findings
Clinical history	Define timing and mechanism	Immediate vs delayed event; prior augmentation; onset and duration of symptoms
Intraoral examination	Assess local status	Wound healing; mobility; infection; oroantral communication/fistula
Panoramic/periapical imaging	Initial localization	Gross implant position; relation to sinus floor
CBCT	Three-dimensional assessment	Exact location; residual support; sinus walls; mucosal changes; access route
Sinonasal assessment	Identify associated disease	Mucosal thickening; fluid; opacification; inflammatory changes
Oroantral assessment	Detect communication	Communication between oral cavity and maxillary sinus
ENT evaluation when indicated	Assess sinus function and drainage	Sinusitis; ostiomeatal obstruction; chronic sinonasal disease

3.5 Clinical complications

The clinical consequences of displacement vary substantially. Some displaced implants remain asymptomatic, whereas others are associated with local discomfort, malodor, nasal symptoms, inflammatory changes, recurrent infection, maxillary sinusitis, or oroantral communication.[11,13,15,20–22]

The presence of a foreign body does not, by itself, establish sinusitis. Clinical and radiological assessment should distinguish an asymptomatic foreign body from established odontogenic sinonasal disease. Conversely, sinus symptoms after implant placement should not automatically be attributed to implant migration, because odontogenic sinusitis and other sinonasal disorders may produce overlapping manifestations.[30–32]

Published systematic-review data indicate that a substantial proportion of reported patients with true displacement become symptomatic and that sinusitis and/or oroantral communication are common associated findings.[11] This supports timely evaluation and, for a freely displaced implant, generally favors retrieval rather than indefinite observation.[11,29]

3.6 Prevention

Prevention begins with three-dimensional treatment planning. In patients with substantial posterior maxillary atrophy or an uncertain relationship between the alveolar ridge and maxillary sinus, CBCT should be considered to define residual bone volume, sinus anatomy, and relevant anatomical limitations.[23,24]

Implant dimensions and trajectory should be selected according to available bone, anatomical constraints, and prosthetic requirements. When residual bone is insufficient to provide predictable primary stability, sinus floor elevation or another appropriate augmentation strategy may be preferable to placement of an inadequately supported implant.[1–3,10] Careful osteotomy preparation, controlled insertion, appropriate management of the Schneiderian membrane during augmentation, and verification of primary stability are central preventive measures.[7–9] Postoperative radiographic assessment should be obtained when displacement or another complication is suspected.[11,23,24] Key preventive measures and their corresponding clinical objectives are summarized in Table 3.

Table 3. Preventive measures and clinical objectives

Preventive measure	Clinical objective
Preoperative three-dimensional assessment when indicated	Define residual bone volume, sinus anatomy, and limitations
Assessment of residual bone height and quality	Determine feasibility of conventional placement and expected primary stability
Appropriate implant dimensions	Avoid inadequate anchorage or unnecessary sinus penetration
Prosthetically driven three-dimensional planning	Establish appropriate trajectory and final position
Controlled osteotomy and insertion	Maintain planned trajectory and depth; reduce uncontrolled displacement
Careful Schneiderian membrane management	Reduce augmentation-related complications
Verification of primary stability	Identify implants at risk of early loss of fixation
Postoperative imaging when clinically indicated	Detect displacement or associated complications early

4. Clinical Decision-Making and Management

4.1 Is removal always indicated?

Management depends first on whether the implant is stable and supported by bone or has become a freely displaced foreign body. These are not equivalent clinical entities.[11,24]

For an osseointegrated implant with preserved support and radiographic sinus protrusion, absence of significant sinonasal disease may justify individualized clinical and radiological follow-up rather than prophylactic removal.[24] If sinus symptoms develop, evaluation should involve both the implant provider and an otorhinolaryngologist; treatment should address the sinus disease and the implant should not be removed solely because it protrudes radiographically.[24]

For a truly displaced, mobile, or freely located implant, the balance is different. The systematic-review literature supports retrieval, in part to prevent infectious complications.[11] The urgency and route of retrieval should nevertheless be individualized according to symptoms, sinus pathology, oroantral communication, implant location and mobility, anatomical accessibility, and the experience of the treating team.[11,19,21,25,29]

When sinusitis or other odontogenic sinonasal disease is present, dental/maxillofacial and ENT management should be coordinated. Multidisciplinary consensus on odontogenic sinusitis supports shared decision-making between dental and otorhinolaryngology providers, particularly when endoscopic sinus surgery may be required.[30,31]

4.2 Selection of the retrieval route

Transoral retrieval provides direct access through the alveolar ridge or lateral wall of the maxillary sinus and is particularly useful when the implant is close to the sinus floor or lateral wall, when an oroantral communication already provides access, or when a limited lateral window can reach the implant predictably.[25–27]

Caldwell-Luc-type access provides broad exposure but is more invasive and should generally be reserved for situations in which less invasive routes do not provide adequate access.[21,25]

Transnasal endoscopic removal offers direct visualization of the sinus through a minimally invasive route and is particularly attractive when the implant is accessible through the nasal pathway, when sinonasal disease requires simultaneous treatment, or when the implant lies near the natural drainage pathway.[19,20,28]

Endoscope-assisted transoral techniques combine direct oral access with enhanced visualization and may be useful when an implant is difficult to visualize or grasp through a conventional transoral window.[26] Combined oral and endonasal approaches may be appropriate for complex anatomy, oroantral fistula, significant sinus disease, or migration toward anatomically remote compartments.[25,29]

The choice of technique should therefore be anatomy-driven rather than based on a universal preference for one surgical route. The principal retrieval approaches, their advantages, limitations, and clinical indications are compared in Table 4.

Table 4. Comparison of principal retrieval approaches

Approach	Main advantages	Limitations	Particularly useful when
Transoral/lateral	Direct access; familiar to oral and maxillofacial surgeons	May require a larger bony window; postoperative morbidity	Implant is near sinus floor/lateral wall or oral access is direct
Caldwell-Luc-type	Broad access to sinus cavity	More invasive; greater morbidity	Foreign body cannot be accessed adequately by less invasive routes
Transnasal endoscopic	Direct visualization; minimally invasive; can treat sinonasal disease	Requires suitable anatomy and endoscopic expertise	Nasal route is favorable or concomitant sinus disease requires treatment
Endoscope-assisted transoral	Direct oral access plus enhanced visualization	Requires equipment and expertise	Implant is difficult to visualize/grasp through conventional oral access
Combined approach	Addresses oral and sinonasal components	More complex procedure	Sinus disease, fistula, difficult anatomy, or remote migration coexist

4.3 Proposed Anatomy-Driven Management Algorithm

Based on the available evidence, we propose an anatomy-driven algorithm for the clinical management of dental implants protruding into or displaced into the maxillary sinus. The initial assessment should integrate the clinical history, intraoral examination, and CBCT to determine implant stability, residual osseous support, exact three-dimensional location, relationship to the sinus floor and walls, sinonasal status, oroantral communication or fistula, and anatomical accessibility.[23,24] The implant should then be classified as either a stable implant with preserved osseous support and radiographic sinus protrusion or a true displaced implant with loss of osseous support.[24] Stable protrusion without significant symptoms or sinonasal pathology may be managed with individualized clinical and radiological follow-up, whereas a freely displaced implant generally favors retrieval.[11,24]

When sinusitis or other relevant sinonasal pathology is present, implant retrieval should be coordinated with appropriate treatment of the sinus disease.[29–32] The retrieval route should subsequently be selected according to the three-dimensional location and accessibility of the implant, the presence of sinonasal disease or oroantral communication, and the

experience of the treating team.[19–29] Transoral/lateral, transnasal endoscopic, endoscope-assisted transoral, Caldwell–Luc-type, or combined approaches may therefore be selected according to the individual anatomical and clinical circumstances.[19–29] This algorithm emphasizes individualized, anatomy-driven management rather than a universal preference for a single surgical technique **Figure 1.**

Figure 1. Proposed anatomy-driven clinical management algorithm

Important: This algorithm represents an evidence-informed expert synthesis and has not undergone prospective clinical validation. It should therefore not be interpreted as a formal clinical guideline or as a substitute for individualized clinical judgment.

5. Clinical Illustrations

Clinical illustration of implant displacement into the maxillary sinus The radiological presentation of a dental implant displaced into the maxillary sinus is illustrated in Figure 2.This clinical illustration emphasizes the importance of accurate imaging for confirming implant displacement and guiding individualized management and selection of the appropriate retrieval approach. The CT image was kindly provided by Dr. Karen Grigoryan

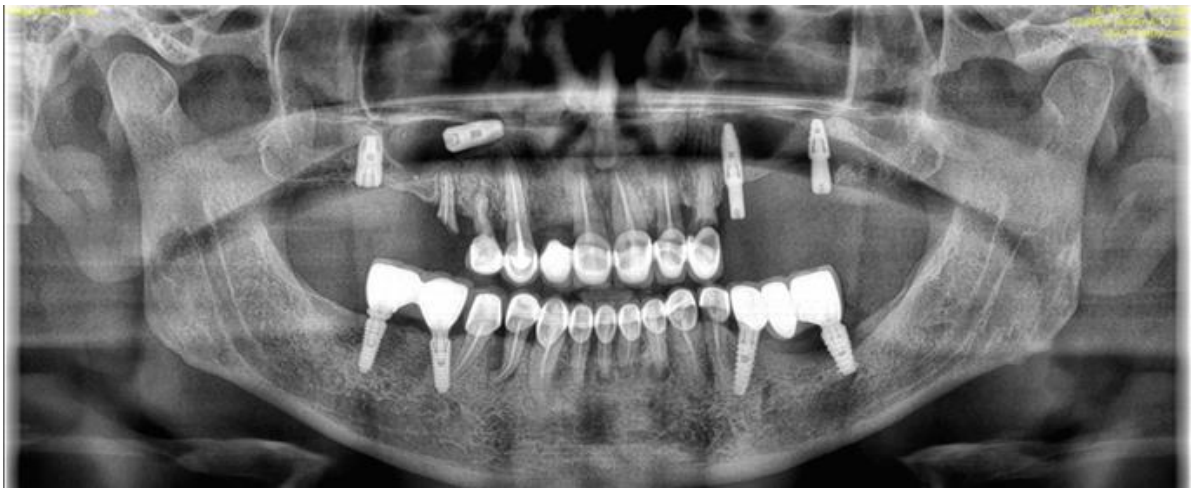

Figure 2. Clinical and radiological illustration of dental implant displacem ent into the maxillary sinus.

The schematic illustrations demonstrate the displacement of the dental implant into the maxillary sinus and its subsequent transoral surgical removal. **Figure** 3**. Panel A** illustrates the displaced implant within the maxillary sinus. **Panel B** demonstrates the transoral surgical approach and the removal of the displaced implant from the maxillary sinus through the selected access pathway. Together, the schematic illustrations demonstrate the displacement of the implant and its surgical removal.

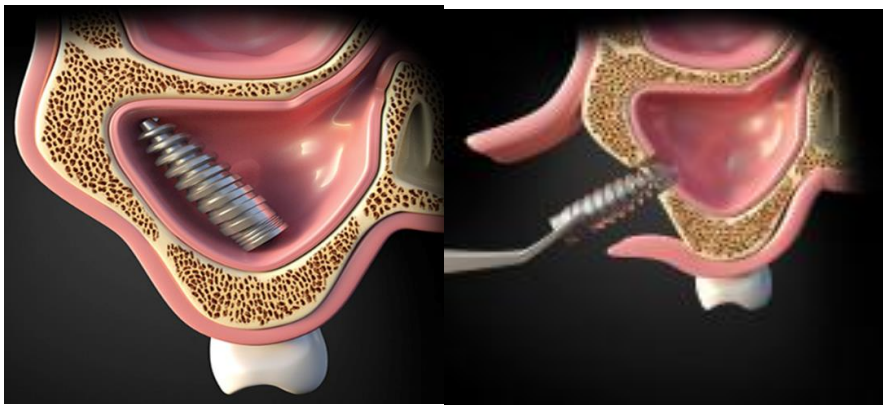

Figure 3**.** Schematic illustration of dental implant displacement into the maxillary sinus and transoral surgical removal. (A) Displacement of the dental implant into the maxillary sinus. (B) Transoral surgical removal of the displaced implant

6. DISCUSSION

The principal clinical message of this review is that radiographic protrusion of a dental implant beyond the maxillary sinus floor and true implant displacement are distinct clinical entities. This distinction is clinically important because the available literature provides different recommendations depending on implant stability and residual osseous support. A systematic review of displaced implants emphasized appropriate retrieval because of the potential for infectious complications, whereas the multidisciplinary Delphi consensus on radiographic implant protrusion indicated that stable, osseointegrated implants with preserved support should not be removed solely because of sinus penetration.[11,24] These findings support the use of implant stability and residual bone support as the initial determinants of management.[11,24]

Implant displacement is multifactorial and may result from the combination of anatomical, biomechanical, surgical, implant-related, and biological factors. The

posterior maxilla is particularly susceptible because alveolar resorption and sinus pneumatization may result in limited residual bone height, while relatively low-density bone can reduce primary stability.[1–3,4,5,10] Immediate displacement may occur during implant placement, whereas delayed migration may follow failure of osseointegration, progressive peri-implant bone loss, or loss of mechanical fixation.[12–18] The timing and mechanism of displacement should therefore be considered when interpreting clinical and radiological findings.[12–18]

The anatomical position of a displaced implant is a major determinant of treatment. Implants located near the sinus floor or lateral wall may be accessible through a transoral or lateral approach, whereas transnasal endoscopy may be preferable when the implant is accessible through the nasal pathway or when associated sinonasal disease requires endoscopic treatment.[19,20,25,26,28,29] Endoscope-assisted transoral techniques may improve visualization in selected cases, while combined approaches may be necessary for complex anatomy, oroantral fistula, significant sinus disease, or remote migration.[15,16,25–28,36–38] Consequently, no single retrieval technique can be considered universally superior.[11,19,21,22,25,29]

CBCT is central to this approach because it provides three-dimensional information that may not be adequately obtained from panoramic or periapical imaging. It allows assessment of implant position, residual osseous support, sinus walls, adjacent structures, mucosal changes, and potential surgical access routes.[23,24] CBCT-based evaluation is also particularly relevant when a foreign body is suspected within the maxillary sinus or when the precise anatomical relationship between the implant and the sinus structures must be established.[23]

However, imaging findings must be interpreted together with clinical symptoms and sinonasal findings. Radiographic sinus penetration or mucosal thickening alone does not establish symptomatic odontogenic sinusitis, and sinonasal symptoms should not automatically be attributed to the displaced implant. When sinonasal disease is present, management may require coordinated dental/maxillofacial and ENT care. Contemporary consensus statements on odontogenic sinusitis emphasize multidisciplinary diagnosis and treatment, particularly when chronic disease or obstruction of the ostiomeatal complex is present.[30–32] In these situations, successful treatment may require both removal of the dental/foreign-body source and appropriate management of the sinus pathology.[30,31]

The clinical consequences of displacement should also be interpreted in the context of the broader literature on foreign bodies within the maxillary sinus. Retrospective and systematic-review evidence has documented a range of presentations, including asymptomatic cases, sinus inflammation, infection, and oroantral communication.[11,20–22] The presence of a foreign body within the sinus does not necessarily produce immediate symptoms, but persistent foreign material may become clinically relevant when associated with sinus obstruction, inflammation, or infection.[20–22]

The distinction between an implant that merely protrudes into the sinus and an implant that has become freely displaced is therefore fundamental. Radiographic protrusion of an otherwise stable implant with preserved osseous support should not automatically be interpreted as migration.[24] Conversely, complete loss of osseous support with free displacement represents a different clinical condition and generally warrants retrieval, particularly when associated with sinonasal pathology.[11,24] This distinction is consistent with the multidisciplinary consensus concerning radiographic implant protrusion and with systematic-review evidence concerning displaced implants.[11,24]

Prevention remains preferable to retrieval. Evidence from sinus augmentation literature highlights the importance of adequate case selection, assessment of residual bone, careful Schneiderian membrane management, and control of intraoperative complications.[1–3,6–10] The development of sinus floor elevation procedures has substantially expanded the indications for implant rehabilitation in the atrophic posterior maxilla, but these procedures also introduce specific technical risks that must be considered during treatment planning.[4–9]

Three-dimensional planning, appropriate implant dimensions and positioning, controlled osteotomy and insertion, and verification of primary stability should therefore be integrated into the treatment-planning process.[1–3,10,23] When augmentation is required, appropriate management of the Schneiderian membrane and careful control of the augmentation procedure are particularly important because membrane perforation and other sinus-related complications may influence subsequent treatment.[7–9,35]

The potential relationship between implant displacement and peri-implant biological complications should also be considered. Peri-implantitis and other peri-implant diseases may result in progressive loss of supporting bone and compromise implant stability, although these conditions represent a different pathological process from the acute displacement of an implant during insertion.[33,34] In selected cases, delayed migration may therefore reflect

a sequence in which biological loss of support precedes implant mobility and subsequent displacement.[14–16,33,34]

The literature also demonstrates that implant-related foreign bodies may migrate beyond the maxillary sinus into anatomically remote craniofacial compartments. Reports have described displacement into the orbit, sphenoid sinus, and anterior cranial fossa, illustrating that migration is not invariably confined to the maxillary sinus.[36–38] These unusual reports reinforce the importance of accurate three-dimensional imaging and anatomy-driven surgical planning when the implant is not located in a readily accessible portion of the maxillary sinus.[23,36–38]

6.1 Development and clinical relevance of the proposed algorithm

The anatomy-driven management algorithm proposed in this review was developed by the authors through integration of the available literature and their clinical experience. The algorithm is intended to organize the principal clinical variables relevant to decision-making into a sequential framework: implant stability, residual osseous support, three-dimensional location, sinonasal status, oroantral pathology, anatomical accessibility, and surgical expertise.[11,24,29]

The algorithm deliberately avoids defining a numerical threshold for sinus protrusion because current evidence does not establish a universally validated millimetric cutoff for removal of a stable implant.[24] Instead, it prioritizes the clinical distinction between stable sinus protrusion and true displacement, followed by assessment of sinonasal disease and anatomical accessibility.[24,30–32]

This approach is also consistent with the available evidence concerning sinus augmentation and implant-related complications. The decision to intervene should take into account not only the radiographic position of the implant but also the quality and quantity of residual bone, the status of the sinus, the presence of oroantral communication, and the potential morbidity of the selected retrieval route.[1–3,7–10,25] The proposed framework should be regarded as an evidence-informed expert synthesis rather than a formal clinical guideline or validated clinical prediction model. Its clinical utility, reproducibility, and safety require prospective and external validation. The heterogeneous nature of the published evidence, including systematic reviews, retrospective studies, case series, and case reports, further supports cautious interpretation of the proposed pathway.[11,13,19,21,22,29]

6.2 Future research directions

Future research should move beyond isolated case reports toward multicenter prospective registries and standardized retrospective or prospective cohorts. Studies should use consistent terminology distinguishing stable protrusion, partial displacement, and free migration and should report residual bone support, implant position, timing of displacement, mobility, CBCT findings, sinus status, retrieval technique, complications, postoperative outcomes, and patient-reported outcomes.[11,29]

Three-dimensional digital planning, image-guided surgery, endoscopic navigation, and other minimally invasive technologies may further improve the management of anatomically complex cases.[23,26,28,36–38] Comparative studies are needed to determine which retrieval approaches provide the best balance between access, morbidity, sinus preservation, and postoperative recovery. Evidence from existing clinical reports and systematic reviews suggests that the choice of approach should remain individualized according to implant location, sinus condition, and anatomical accessibility.[11,19,21,25–29] Prospective validation of the proposed anatomy-driven algorithm should also be prioritized. Future studies should specifically evaluate whether classification according to implant stability and residual osseous support improves clinical decision-making, reduces unnecessary removal of stable protruding implants, and facilitates timely retrieval of freely displaced implants associated with sinonasal disease.[24,29]

7. Limitations

The available evidence on dental implant displacement into the maxillary sinus is limited and heterogeneous. Published studies vary considerably in terminology, patient characteristics, timing and mechanism of displacement, imaging protocols, associated sinonasal disease, and surgical techniques. Much of the evidence consists of retrospective studies, case series, and case reports, which are susceptible to selection and publication bias and provide limited comparative evidence.[11–22,25–29]

This article is a focused narrative review rather than a systematic review or meta-analysis. The literature search was centered on PubMed/MEDLINE with additional reference-list screening, and no formal PRISMA selection process, standardized risk-of-bias assessment, quantitative evidence grading, or meta-analysis was performed. Consequently, the review cannot provide comparative estimates of treatment efficacy. The proposed management algorithm represents an additional limitation. Although it was developed from the available literature and the authors' clinical experience, it has not undergone prospective or external validation. It should therefore be considered an evidence-informed clinical framework rather than a validated guideline. Treatment

decisions should remain individualized, particularly in patients with significant sinonasal disease, oroantral pathology, or anatomically complex migration.[24,29–32,36–38]

8. CONCLUSION

Dental implant displacement into the maxillary sinus is an uncommon but clinically important complication that requires differentiation between stable sinus protrusion and true displacement. Management should be based on implant stability, residual osseous support, three-dimensional location, sinonasal status, and anatomical accessibility rather than radiographic protrusion alone.

CBCT is essential for accurate localization and treatment planning. When true displacement occurs, retrieval is generally favored, while the surgical approach should be selected according to individual anatomy and clinical circumstances. Transoral, transnasal endoscopic, endoscope-assisted, and combined approaches may each be appropriate in selected cases. Prevention depends on appropriate three-dimensional planning, adequate primary stability, and careful surgical technique. The anatomy-driven algorithm proposed in this review, developed from the available literature and the authors' clinical experience, provides a practical framework for individualized management. Prospective multicenter studies are needed to validate this approach and establish more standardized evidence-based treatment pathways.

DECLARATIONS

Ethical approval

Not applicable to the narrative review. For any identifiable clinical images, confirm that appropriate patient consent for publication has been obtained.

Competing interests

The authors declare no conflict of interest.

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