Review article

Factors Contributing to Dental Implants Displacement inside the Maxillary Sinus and Their Treatment: A Systematic Review

Nima Dehghani[1]*, Mohadeseh Azarsina[2], Xaniar Mahmoudi[3], Mona Mohajeri Tehrani[4], Shamim Chinian[5]

1. Department of Oral and Maxillofacial Surgery, Tehran University of Medical Sciences, Tehran, Iran
2. Department of Esthetic and Restorative Dentistry, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran
3. Department of Oral and Maxillofacial Surgery, School of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran
4. Craniomaxillofacial Research Center, Tehran University of Medical Sciences, Tehran, Iran
5. Tehran University of Medical Sciences, Tehran, Iran

***Corresponding Author:**

Nima Dehghani

Department of Oral and Maxillofacial Surgery, Tehran University of Medical Sciences, Tehran, Iran

Email: nimadt2002@gmail.com

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ABSTRACT

Backgrounds: Dental implants are often utilized to replace missing teeth in the maxillary posterior region. Following tooth extraction, bone grafting, and implant placement are carried out in stages. However, in medical procedures errors are inevitable; therefore, measures should be taken to address and reduce these errors in future treatments.

Methods: Implants displaced inside the maxillary sinus were reviewed to identify the best techniques for retrieving them. We conducted a comprehensive search in Scopus, PubMed, and Web of Science databases from January 2000 to January 2023. Inclusion criteria were original studies including original cohorts, case-controls, and clinical trials that evaluated methods of retrieving displaced maxillary implants.

Results: Overall, 258 publications were identified. After elimination of duplicates and those not meeting the inclusion criteria, full texts of 24 articles were reviewed. Of the 120 displaced implants, 57 were dislocated during surgery. The most common complication following implant displacement is maxillary sinusitis, which typically manifests a year post-op.

Conclusion: Displacement of implants in the maxillary sinus is a common occurrence caused by a variety of factors. Implant displacement could lead to complications in the maxillary sinuses, paranasal sinuses, and other adjacent anatomical spaces and structures.

KEYWORDS
Dental implant; dental implant displacement; Implant failure; Maxillary sinus; Treatment outcome

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INTRODUCTION

Implants in the maxillary posterior region represents a challenging procedure due to low maxillary bone density, the maxillary sinus pneumatization, and the alveolar bone loss in the edentulous region [1]. Treatment outcome depends critically on an implant's primary stability, as it can inadvertently get dislocated into the maxillary sinus via inadequate primary stability. During insertion, insufficient primary stability may also result in implant failure at a later stage of the treatment due to inadequate bone implant integration [2].

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The maxillary arch is a sensitive site for implant placement since it is in close proximity to the maxillary sinus [3, 4]. Cases of implants displaced into the maxillary sinus during insertion or healing have been reported [2, 5].

The patient's age and the presence of teeth determine the degree of pneumatization. The pneumatization of the maxillary may cause thinning of the alveolar bone, which might result in displacement of dental implants into the sinus cavity during implantation or installment of prosthetic restorations. Implant displacement may also occur as a result of the bite forces exerted by the implant prosthesis. This failure is observed more frequently in patients with bone graft and implant placed immediately after the sinus has been elevated [6]. The reduced height of the remaining alveolar bone should also be taken into consideration, particularly when implants are placed in bone that has a minimum height of less than four millimeters after sinus elevation bone grafting [7, 8].

The preferred option is to remove displaced implant instantly. If the procedure is postponed, sinusitis must be treated with antibacterial agents and nasal decongestant medications before the implant is removed either by the Caldwell-Luc method or endoscopically [1].

In this study, displaced implants in the maxillary sinus were reviewed to identify the best retrieval techniques.

METHODS

Search strategy

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Figure 1), this systematic review and meta-analysis was conducted. We searched Scopus, PubMed, and Web of Science databases for keywords "implant" AND "maxillary" AND "removal" AND "sinus." We included English publications from 2000 to January 2023 and used Endnote software to store and analyze the articles. We screened and selected the studies that met the requirements for inclusion by reviewing the titles, abstracts, and full text of the search results.

The inclusion criteria were original studies that evaluated the methods of restoring maxillary dental implants and the original cohort, case-control, and

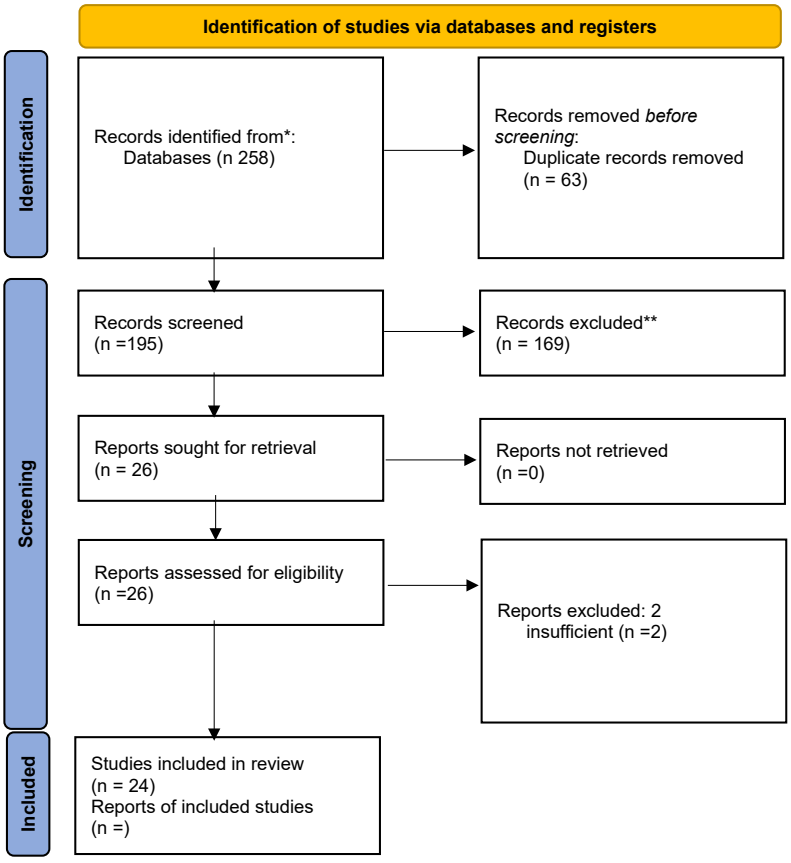

Figure1: PRISMA 2020 flow diagram

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clinical trial. The exclusion criteria were studies that reported foreign bodies or teeth, implants displaced into the other sinus, case reports, review studies, and duplicate studies. No primary human or animal research was conducted for this review, therefore IRB approval and no requirement for informed consent existed. Every study that was a part of this review underwent independent review and was approved by their respective ethical boards.

Quality Assessment and Data Extraction

We employed the Rayyan platform to screen and extract data from the studies that matched the inclusion criteria. This study used the PICO model, where P stood for patients with implants that had become misplaced into their sinuses; I stood for retrieving misplaced implants; C stood for comparing different treatment approaches based on how time-consuming and low-complication they were; and O stood for determining the optimal approach. Two reviewers appraised the quality of the studies independently applying the nine-point Joanna Briggs Institute critical appraisal checklist for studies. If there was a disagreement, a consensus was reached. The included studies fulfilled more than 50% of the quality assessment criteria. From the studies in Table 1, we extracted data on publication year, country, number of patients, removal method,

Table 1: Perforations, management, and complications in selected studies

Study Name	Count of Implants	Duration Between Placement and Dislocation	Sinus Complication	Removal	Removal Technique	Ref
Bennard/ 2022	40	3 cases: Immediately 21 cases: 6 months 16 cases: more 6 months	Sinusitis/ Ostium obstruction/ Pain, nasal discharge	Removed	11 cases: Transnasal 25 cases: transoral 4 cases: OAF†	22
Safadi/ 2020	24	Immediately	Sinusitis	Removed	Transnasal	19
Márquez/ 2022	2	4 months	Facial pain	Removed	Transoral/ Transnasal	23
Sgaramella/ 2016	21	Immediately	Sinusitis	Removed	16 cases: Transoral 5 cases: CL‡	15
Chppuis	1	Immediately	swelling of Schneiderian membrane	Removed	Transnasal	24
Flanagan	1	Immediately	No	Removed	CL‡	25
Fusari	1	Immediately	No	Removed	CL‡	26
Raghoebar and Vissink	1	5 months	No	Removed	CL‡/SL¶	27
Galindo	1	4 years	No	Not removed	-	28
Galindo Moreno	1	Before loading	No	Removed	CL‡	9
Lida	1	10 years	No	Removed	CL‡	29
Kitamura	1	3 years	Sinusitis	Removed	Transnasal	30
Kluppel	1	6 months	No	Removed	CL‡ A§/ SL¶	31
Lubbe	1	3 weeks	Facial pain	Removed	CL‡	32
Nakamura	1	Immediately	No	Removed	Transnasal	33
Ramotar	1	Immediately	No	Removed	Transnasal	34
Ridaura- Ruiz	3	4 months	No	Removed	CL‡	35
Scarano	1	4 months	Sinusitis	Removed	CL‡	36
Tilaveridis	1	Immediately	No	Removed	CL‡	37
Ucer	1	8 weeks	No	Removed	Transoral Endoscopy + SL¶	38
Galindo- Moreno	1	13 months	Yes	Removed	-	39
Borgonovo	1	6 months	swelling of Schneiderian membrane	Removed	CL‡/A§	40
Guler and Delilbasi	1	Immediately	No	Removed	CL‡	41
El Charkawi	1	Immediately	Sinusitis	Removed	Transoral Endoscopy	42

†OAF, oroantral fistula; ‡CL, Caldwell-Luc approach; §A, antrostomy; ¶SL, sinus lift with bone graft

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Table 2: Sinusitis treatment methods

Complication				
Oroantral Fistula	Ostium Obstruction	Sinusitis	Paranasal Sinus Affected	Suggested Method of removal
-	+	+	+	Transnasal endoscopy
-	-	+	-	Transoral endoscopy
+	-	±	-	Caldwell- Luc approach

time interval between insertion and displacement, and sinus complications. Lastly, we extracted information regarding publication year, research topic, study design, number of implants, period between implantation and dislocation, sinus complication, and the removal method.

Statistical Analysis

SPSS 28.0 software (IBM Corp., Armonk, NY, USA) was used for analysis. We performed Pearson's chi-square test to compare subgroups for each factor (follow-up duration, bone graft implantation, implant length, residual bone height). We established the significance level at $P = 0.05$. We also computed odd ratios (ORs) and 95% confidence intervals (CIs).

RESULTS

Search Outcome and Study Characteristics

A thorough search in Scopus, PubMed, and Web of Science databases was conducted. Overall, 258 publications that met the PICO (Patient, Intervention, Comparison, Outcome) framework of this study were selected. We then deleted duplicates and removed articles that did not meet our inclusion and exclusion criteria. The full text of the 24 remaining articles including retrospective, prospective, case-control, and cohort studies were examined (Figure 1).

The majority of displacements into the maxillary sinus occurred during the placement of implants, however they resulted few complications, such as maxillary sinusitis. Among all the cases, the time of the dislocation into the maxillary sinus for 109 implants were indicated. Among those 57 were dislocated during insertion. Others were predominantly displaced within one year after the implant insertion. Galindo-Alvarez et al. demonstrated that implants were primarily displaced after loading, according to a comparison of displacement before and after loading (Ten versus five) [9]. Most displaced implants (34 of 49) did not cause any complications. Thirty seven implants were extracted: four through trans nasal endoscopy, three through the transoral approach, and 29 through the Caldwell-Luc technique. No attempt was made to remove twelve implants Because of the patient's disinterest, lack of symptoms, or internal displacement in the digestive system (Table 1).

Chiapasco et al. found that in five of thirteen patients with sinusitis, who also had maxillary ostial occlusion, an oral method with FESS was utilized [10]. Moreover, they stated that an oral method alone may be effective when there is a fistula in the oroantral region or sinusitis that does not affect the ostium. Regardless of the method used to remove the implant, the recurrence of maxillary sinusitis was one of the many complications. In conclusion, a trans-nasal endoscopy is recommended when the ostium is obstructed, or the paranasal sinus requires treatment. However, the Caldwell-Luc method can be applied by itself or with an endoscopy in the presence of an oroantral fistula. Endoscopy is applicable when maxillary sinusitis exists, yet a thorough examination prior to surgery is necessary to determine the appropriate method (Table 2).

DISCUSSION

Due to maxilla's poor bone structure, pneumatized sinuses, and loss of alveolar bone in the absence of dentition, implant-based restoration for maxillary posterior teeth is challenging [1]. When there is inadequate primary stability during implant placement or when the implant is not properly integrated into the bone after implantation, a maxillary implant may inadvertently dislocate into the maxillary sinus [11]. While some implant displacements do not present symptoms, others may cause complications, such as maxillary sinusitis or migrating into the paranasal sinus [2]. This study describes the mechanisms of dislocation, potential complications, and implant retrieval procedures in

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accordance with the time of implant displacement.

Implant displacement can lead to infection, as indicated by swelling. A dislocated implant may contribute to adverse consequences for surrounding tissues and organs [2]. Ethmoid sinuses, orbital floors, sphenoid sinuses, and even the cranial fossa might be affected by implant displacement into the maxillary sinus [2, 12]. Implants that have caused sinusitis must be removed, and the healing of the sinus depends upon the ostium of the maxilla being opened [13]. As a result of sinusitis, transnasal surgery with functional endoscopic sinus surgery (FESS) is performed to accomplish the following: retrieving foreign bodies, removing obstructions and narrowed orifices, and treating hyperplastic, hypertrophic, or infected mucosa [2].

We found that eight studies had their implants removed right away; one study had its implants removed before it was loaded, two studies had their displaced implants removed in a matter of weeks, six studies in a matter of months, and three studies had their implants removed in a matter of years. The removal of dislocated implants ought to happen right away to stop late sinusitis caused by foreign bodies in the sinus cavity [14]. Furthermore, in this investigation, most of the studies removed the implant using the Caldwell-Luc (CL) technique, with the transnasal technique coming in second. The CL approach facilitates the removal of objects that are not suitable for endoscopic removal, either because of their size or because of excessive displacement thanks to the provided extensive view [15]. The CL approach could be employed in situations where an endoscopy failed, or chronic sinusitis is refractory [16]. Several articles, however, suggest using endoscopic surgery for the removal of displaced implants; since it is less invasive than the CL method and less likely to cause excessive damage to the maxillary sinus mucosa, it reduces wounds or bleeding in the mucosa, accelerates healing, and preserves the mucosa [2, 17, 18]. Endoscopic retrieval of implants with significant anteromedial dislocation provides greater ease of access than intraoral retrieval via the paranasal sinus [2].

Moreover, if the displacement of the implant has resulted in an oroantral fistula, it is necessary to repair the fistula transorally [2, 19]. Furthermore, antrostomy has also been reported as an effective treatment for maxillary sinusitis [15, 19]. Moreover, this technique is considered a good option when it is difficult to achieve mucosal clearance and it is impossible to remove the implant solely through the CL procedure [20]. González-García et al. suggest trans oral endoscopy and CL surgery are appropriate forms of treatment if ostium treatment is not necessary and paranasal sinuses are unaffected [21]. An endoscopy and transoral method are recommended in oroantral fistula cases.

CONCLUSION

Implant displacement in the maxillary sinus is frequent and can be caused by several factors. It is possible for implant displacement to lead to complications within the maxillary sinuses, paranasal sinuses, and other nearby areas. It is recommended that patients should undergo a thorough evaluation before selecting a treatment method to treat this condition. Since the choice of any treatment is highly dependent on the condition of the patient, it is neither possible nor appropriate to suggest a specific course of treatment for all cases.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding this study.

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