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IMPACT OF MULTIDISCIPLINARY APPROACHES ON THE DIAGNOSIS AND MANAGEMENT OF NON-NEOPLASTIC ODONTOGENIC MAXILLARY SINUS PATHOLOGIES: A RETROSPECTIVE CLINICAL, RADIOLOGICAL, AND SURGICAL STUDY

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ABSTRACT

Background: Otolaryngologists, dentists, and maxillofacial surgeons frequently manage patients with non-neoplastic odontogenic pathologies (NNOP) of the maxillary sinus (MS), a condition distinct from non-odontogenic rhinosinusitis, which often necessitates a collaborative multidisciplinary approach**. Aim** of this study was to explore the various etiologies of NNOP of the maxillary sinus, ranging from periodontitis to augmentative implant procedures, and to assess the impact of different combined expertise of Otolaryngologists, dentists, and maxillofacial surgeons in treating these conditions and how this approach reducing diagnostic errors and improving treatment outcomes

Materials and Methods: A retrospective analysis of 37 patients diagnosed with NNOP of MS from 2018–2021 was conducted. Data were gathered from clinical examinations, preoperative CBCT scans, endoscopic findings, and surgical reports. The treatment protocol involved a combination of dental, surgical, and endoscopic interventions, guided by a collaborative approach from maxillofacial surgeons, otolaryngologists, and dentists.

Results: The study identified a variety of odontogenic etiologies, including periodontal disease, traumatic extractions, and implant-related issues. The findings also highlighted the importance of early diagnosis and a tailored treatment approach that integrates dental procedures with surgical interventions. Clinical outcomes improved when managed collaboratively across specialties

Conclusion: A multidisciplinary approach, involving otolaryngologists, dentists, and maxillofacial surgeons, significantly improves the diagnosis and treatment of NNOP of MS. The development of a standardized protocol for treatment based on etiological factors can lead to better patient outcomes and reduce the likelihood of misdiagnosis.

KEYWORDS: Non-neoplastic odontogenic pathologies - Maxillary sinus- Multidisciplinary approach - Functional endoscopic sinus surgery – otolaryngologists- maxillofacial surgeons

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INTRODUCTION

Non-neoplastic odontogenic pathologies (NNOP) of the maxillary sinus (MS) are well-recognized yet often underemphasized conditions within the disciplines of otolaryngology, maxillofacial surgery, and dentistry. Approximately 10% of patients presenting with symptoms of maxillary sinusitis are found to have an odontogenic etiology. The underlying causes of NNOP are multifactorial and include endodontic infections, periapical conditions such as cysts or granulomas, as well as iatrogenic factors. [1-3] Additionally, NNOP is frequently associated with surgical breaches of the Schneiderian membrane, which can occur following dental procedures such as tooth extractions, periodontal surgery, or sinus floor augmentation, with or without the displacement of implants or grafting materials. If left untreated or inadequately managed, NNOP may progress to more severe conditions, including pansinusitis, and in rare cases, complications such as osteomyelitis, meningitis, or intracranial infections can occur. Clinical manifestations of NNOP can vary significantly among patients. While some individuals experience typical sinusitis symptoms, such as headache, nasal congestion, or postnasal drip, others may present with primarily dental pain, which can complicate diagnosis, particularly when there is no obstruction of the osteomeatal complex. [4,5] In cases where conservative dental management fails to resolve the condition, surgical intervention is commonly required. Surgical approaches for managing NNOP of the MS range from minimally invasive endoscopic procedures to more extensive open surgeries, depending on the anatomical characteristics and the severity of the condition, including the need to access the sinus floor and remove foreign bodies such as displaced implants or tooth roots. These procedures are often complex and necessitate a more invasive approach when foreign materials are involved. [6,7]

It is generally not feasible for a single specialist to effectively diagnose inflammatory processes of the paranasal sinuses, accurately apply the diagnostic tools established by international guidelines, and assess the condition of dental structures and prosthetics, particularly considering the increased complexity of the latter in recent years [8,9]. Consequently, NNOP of the maxillary sinus MS can arise not only from dental diseases such as periodontitis and caries but also from dental procedures, including extractions, endodontic treatments, implant placements, and pre-implant sinus grafting [2]

NNOP of MS present a complex challenge in diagnosis and treatment due to their multifactorial nature. While the patients did not receive incorrect treatment, the complexity of their cases necessitated a multidisciplinary approach. These conditions may arise from various etiologies such as periodontal disease, displaced dental roots, or post-surgical complications, and often manifest with symptoms that overlap with other maxillary sinus diseases. [3]

While odontogenic infections and conditions are typically managed by dental professionals, more complex cases often necessitate a multidisciplinary approach involving maxillofacial surgeons, otolaryngologists. In some cases, the management of these conditions requires the involvement of multiple specialists to ensure a comprehensive and effective treatment plan. Such multidisciplinary collaboration is crucial for refining and improving both diagnostic accuracy and treatment success. The three-year study aims to assess the impact of different combined expertise of Otolaryngologists, dentists, and maxillofacial surgeons in treating these conditions and how this approach reducing diagnostic errors and improving treatment outcomes.

MATERIALS AND METHODS

This retrospective multicentric study included 37 patients with NNOP of MS who were diagnosed and treated over 3 years. All patients were diagnosed with NNOP during their clinical evaluation and subsequently underwent surgical treatment.

Primarily, patients were referred to the department of Oral and Maxillofacial Surgery, faculty of dentistry, Beni Suef university and Otorhinolaryngology Department, Tanta University Hospital, Egypt for management of symptoms related to pathology in the upper jaw and maxillary sinus, as identified by local otolaryngologists, maxillofacial surgeons, or dentists. Adult patients of both genders, with a clinically and radiologically confirmed diagnosis of NNOP of the MS, who showed resistance to medical treatment and had consistent follow-up assessments, medical histories, and preoperative evaluations between 2018 and 2021, were included in this study, following approval from the ethics committee. Patient identifiers were anonymized to ensure confidentiality, with no mention of personal details such as names, specific age, ethnicity, or occupation unless directly pertinent to the study's conclusions. Preoperative planning for the surgical intervention involved a comprehensive clinical evaluation conducted by both the otolaryngologist and maxillofacial surgeon. A high-resolution CT scan, nasal endoscopy, and intraoral examination were performed to assess the anatomical extent of the sinus pathology and identify the presence of any foreign bodies within the sinus.

Inclusion criteria: The study included patients diagnosed with non-neoplastic odontogenic maxillary sinus pathologies, which encompass a range of conditions) such as odontogenic sinusitis, displaced dental roots, oroantral fistulas, and inflammatory cysts. These pathologies were selected due to their odontogenic etiology (arising from dental condition or procedure) and the potential for a multidisciplinary approach in management. Patients who had undergone dental or surgical interventions aimed at addressing these conditions were included in the analysis. The diagnosis of NNOP of the MS was confirmed by the presence of dental pathology or a recent dental procedure linked to the affected maxillary sinus, accompanied by unilateral opacification of the sinus adjacent to the dental condition. Patients with bilateral sinus opacification resulting from allergies or chronic sinusitis were also included, as long as they met the aforementioned criteria, including more significant opacification and involvement of the maxillary sinus adjacent to the dental pathology or procedure.

Exclusion criteria included the following: 1) Rhinosinusitis of non-odontogenic origin, 2) Acute sinusitis, 3) Systemic conditions such as uncontrolled diabetes mellitus, hypertension, and anemia, 4) Patients who did not consent to participate in the study, 5) Clinical and radiologic evidence of tumors in the maxillary sinus, 6) Involvement of sinuses other than the maxillary sinus, 7) Patients with asthma, allergies, immunodeficiencies, blood disorders, medication-related osteonecrosis of the jaw (MRONJ), osteoradionecrosis, or anatomical abnormalities of the nasal and paranasal structures, 8) Patients with fungal infections, as these represent a separate clinical entity, and 9) Individuals with unilateral maxillary sinus opacification unrelated to dental inflammation or procedures, as well as those for whom the final diagnosis was not odontogenic in origin, were also excluded from the study.

The following data were gathered: demographic information, relevant medical history including dental treatments, symptoms, endoscopic findings, affected teeth, any underlying dental pathologies, and CT imaging reports. Treatment plans were developed through collaborative discussions between maxillofacial surgeons (MFS), otolaryngologists (ENTs), and dentists. The treatment options encompassed dental interventions, surgical procedures, restorative treatments, antibiotic therapy, and functional endoscopic sinus surgery (FESS). In cases of oroantral fistulas, intraoral repair was carried out using a buccal flap and/or buccal fat pad. Functional endoscopic sinus surgery was performed as indicated. Treatment following an etiology-based approach, various techniques used to close oroantral communication/

fistula include the buccal advancement flap, palatal rotation flap, combination flaps, bone grafts, and buccal fat pad, Caldwell-Luc operation by radical canine fossa antrostomy (RA), Endoscopic sinus surgery (ESS) and ESS plus RA. The surgical procedure was consistently conducted by a team consisting of one maxillofacial surgeon and one otolaryngologist, with a second maxillofacial surgeon assigned to document the preoperative and postoperative clinical and radiographic information. Patients lacking immediate sinus surgical indication were directly transferred to dentists for conventional dental treatment first. The study was approved by the faculty of dentistry Beni-Suef University Research Ethics Committee. Approval number: # REC-FDBSU/02062022-03/EM and all patients signed informed consent forms based on the Helsinki declaration.

RESULTS

The study included 37 patients with confirmed NNOP of MS. The dental origin was evaluated by reviewing reports from department of Oral and Maxillofacial Surgery, faculty of dentistry, Beni Suef university and Otorhinolaryngology Department, Tanta University Hospital, Egypt. The demographic data and pertinent history of the patients are shown in Table 1. The patients comprised 24 males (64.9 %) and 13 females (35.1%). Their mean age was 40.9 ± 11.9 years with median 43 (8 – 64). Elveen patients (29.7%) suffered from facial pain, fourteen (37.8%) suffered from dental pain, 59.2 % suffered from foul smell, and fourteen patients (37.8%) had discharge. CBCT shows partial unilateral, total Unilateral and bilateral opacification of maxillary sinus in 48.6%, 24.3% and 27% of patients, respectively. Clinical finding and CBCT findings and their Relationship with the odontogenic etiology (Table 2,5)

Odontogenic etiology detected followed dental procedures in 14 patients (37.8 %) and 62.1% dental pathologies was the causative factor (Figure 1). Displaced tooth or dental materials in the sinus cavity and related implant procedures were present in six patients (16.2%) (Figure 2, 3, 4) were present. Three of these patients, the displaced roots or materials were removed by ESS with complete resolution. Periodontal disease was the causative factor in 17 patients (45.9%), while cyst was diagnosed in only 6 patients (16.2%). traumatic extractions resulted in oroantral fistulae in 8 patients (21.6%). Treatment following an etiology-based approach, various techniques used to close oroantral communication/fistula include the buccal advancement flap, palatal rotation flap, combination flaps, bone grafts, and buccal fat pad, Caldwell-Luc operation by radical canine fossa antrostomy (RA), Endoscopic sinus surgery (ESS) and ESS plus RA. Seven Patients (18.9%) lacking immediate sinus surgical indication were directly transferred to dentists for conventional dental treatment. Seven patients required endoscopic sinus surgery (ESS) after undergoing dental treatments. The decision to proceed with functional endoscopic sinus surgery (FESS) was determined by two factors: (1) the ongoing presence of symptoms, and (2) continued evidence of disease observed in post-treatment sinus CT scans and nasal endoscopic evaluations. Eight patients needed combined approach MFS+ESS, three of these patients had Inflammatory expansile cyst (figure 4, 5) Relation between procedures or surgical intervention performed and the odontogenic etiology (Table 4)

TABLE (1) Patients' demographic details (n = 37)

	No. (%)
Sex	
Male	24 (64.9%)
Female	13 (35.1%)
Age	
Mean ± SD.	40.9 ± 11.9
Median (Min. – Max.)	43 (8 – 64)

TABLE (2) Patients' clinical finding and CT findings in coronal and axial cut (n = 37)

	No. (%)
Clinical finding	
Facial pain	11 (29.7%)
Dental pain	14 (37.8%)
Foul smell	22 (59.2%)
Discharge	14 (37.8%)
CT finding in coronal and axial cut	
Partial unilateral opacification of maxillary sinus	18 (48.6%)
Total Unilateral opacification of maxillary sinus	9 (24.3%)
Bilateral opacification	10 (27%)

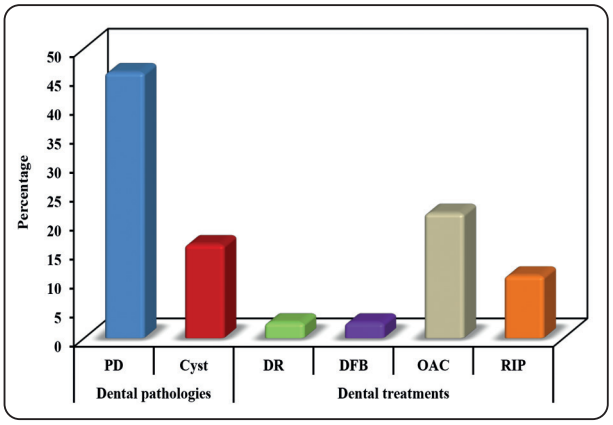

Fig. (1) Odontogenic etiology (dental pathologies and dental procedures) (PD: periodontal disease, DR: Displaced root, DFB: Displaced foreign body, OAC: oroantral communication, RIP: Related implant procedures)

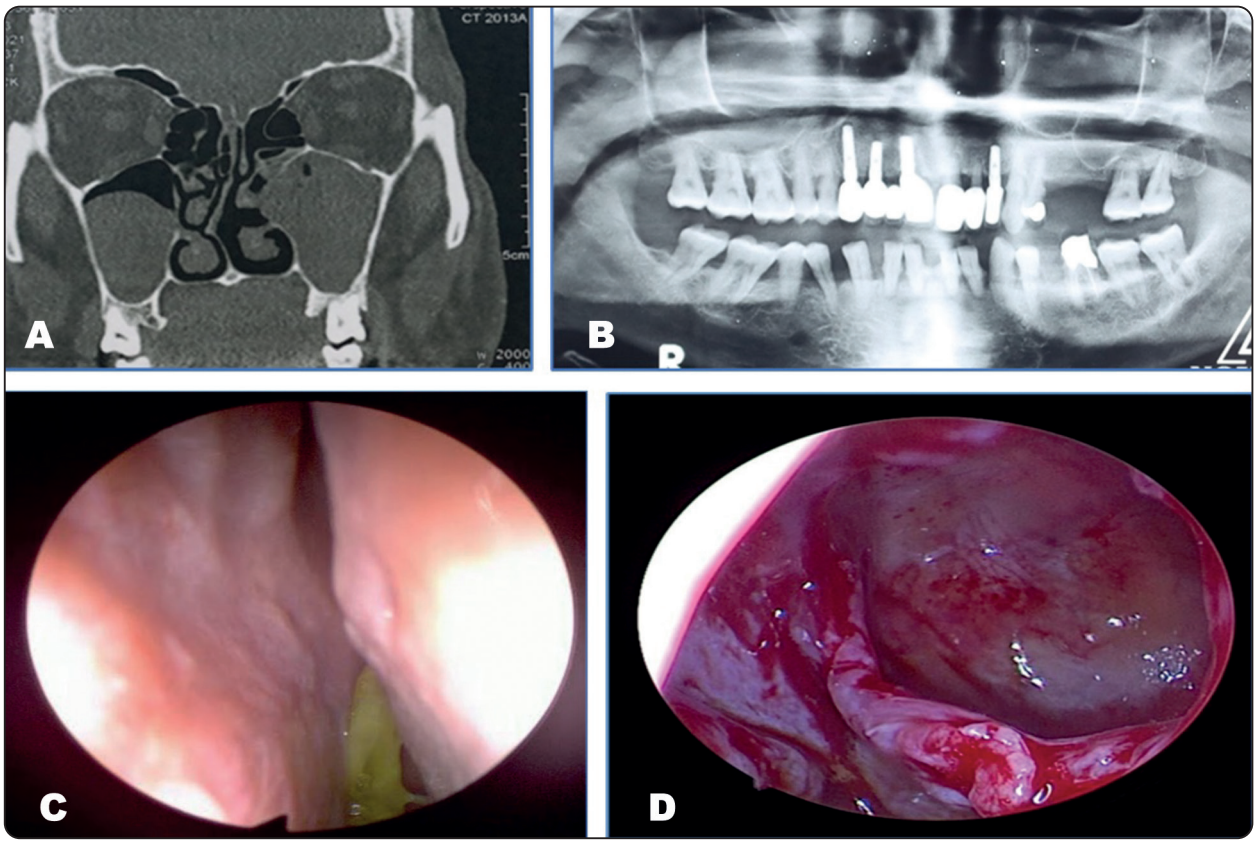

Fig. (2) A 64-year-old male patient resented with severe facial pain localized to the left maxilla also thick yellowish nasal discharge, the patient had a history of recent dental infection localized to 27. (a): A coronal cut of CT scan on paranasal sinuses revealed left maxillary sinus opacification with air bubbles inside it, the right maxillary sinus shows smooth doomed retention cyst. (b) OPG showing periapical infection of 27. (c) A 30-degree endoscopic examination under local anesthesia revealed thick yellowish discharge coming from the left maxillary sinus. (d) An intraoperative 45-degree endoscopic view of left maxillary sinus ostium after complete removal of uncinate process and connecting natural and accessory ostia. Concomitant extraction of the left upper 8 was done at the same operation. Post operative follow-up was very satisfactory for relief of all patient complaints.

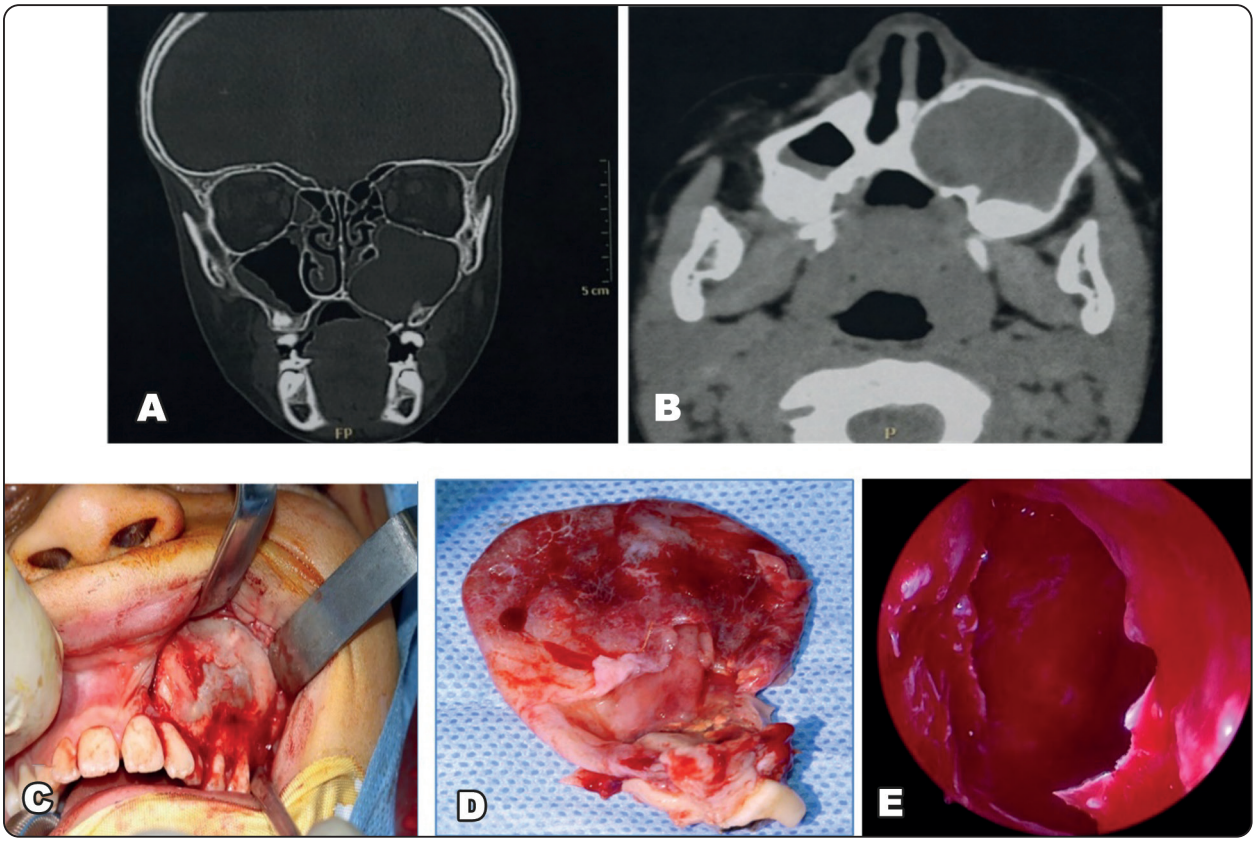

Fig. (3): An 8-year-old male patient resented with left facial swelling localized to the left maxilla also loosening of the 24, 25, 26,27 (a, b): A coronal and axial cuts of CT scan on the paranasal sinuses revealed left maxillary sinus expansile lesion (c) Combined approach of endoscopic endonasal and transoral resection was done (d) complete excision of the cyst was done (e) An intraoperative 45-degree endoscopic view of left maxillary sinus ostium after complete removal of uncinate process and widening of the left middle meatus. The final histopathological diagnosis was inflammatory odontogenic cystic lesion.

TABLE (3) Odontogenic etiology and Procedures or surgical intervention performed (n = 37)

	No. (%)
Etiology	
Traumatic extraction	8 (21.6%)
Severe periodontal disease	17 (45.9%)
Inflammatory expansile cyst	3 (8.1%)
Periapical infected cyst	3 (8.1%)
Osteotomy for implant	3 (8.1%)
Sinus lift led to communication	1 (2.7%)
Graft material	1 (2.7%)
Displaced Root	1 (2.7%)
Procedures or surgical intervention performed	
Dental	7 (18.9%)
MFS: Maxillofacial surgery	12 (32.4%)
ESS: Endoscopic sinus surgery	3 (8.1%)
Dental +ESS	7 (18.9%)
MFS+ESS	8 (21.6%)

TABLE (4) Relation between procedures or surgical intervention performed and etiology (n = 37)

	Procedures or surgical intervention performed						
	Dental (n = 7)	**MFS (n = 12)**	**ESS (n = 3)**	**Dental +ESS (n = 7)**	**MFS+ESS (n = 8)**	χ^2	^{MC}p
Etiology							
Traumatic extraction	0 (0%)	8 (66.7%)	0 (0%)	0 (0%)	0 (0%)	55.721*	<0.001*
Severe periodontal disease	7 (100%)	0 (0%)	3 (100%)	7 (100%)	0 (0%)		
Inflammatory expansile cyst	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (37.5%)		
Periapical infected cyst	0 (0%)	1 (8.3%)	0 (0%)	0 (0%)	2 (25%)		
Osteotomy for implant	0 (0%)	2 (16.7%)	0 (0%)	0 (0%)	1 (12.5%)		
Sinus lift led to communication	0 (0%)	1 (8.3%)	0 (0%)	0 (0%)	0 (0%)		
Graft material	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (12.5%)		
Displaced root	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (12.5%)		

χ2: Chi square test ***MC: Monte Carlo***

p: p value for comparison between the studied categories

****: Statistically significant at p ≤ 0.05. MFS: Maxillofacial surgery, ESS: Endoscopic sinus surgery***

TABLE (5) Relation between CT finding with Clinical finding and etiology (n = 37)

	CT finding in coronal and axial cut				
	Partial unilateral opacification (n = 18)	Total unilateral opacification (n = 9)	Bilateral opacification (n = 10)	$\chi2$	MCp
Clinical finding					
Facial pain	3 (16.7%)	0 (0%)	8 (80%)	15.788*	<0.001*
Dental pain	11 (61.1%)	3 (33.3%)	0 (0%)	10.907*	0.003*
Foul smell	13 (72.2%)	7 (77.8%)	2 (20%)	8.419*	0.018*
Discharge	8 (44.4%)	5 (55.6%)	1 (10%)	4.854	0.081
Etiology					
Traumatic extraction	7 (38.9%)	1 (11.1%)	0 (0%)	21.618*	0.008*
Severe periodontal disease	4 (22.2%)	3 (33.3%)	10 (100%)		
Inflammatory expansile cyst	1 (5.6%)	2 (22.2%)	0 (0%)		
Periapical infected cyst	2 (11.1%)	1 (11.1%)	0 (0%)		
Osteotomy for implant	2 (11.1%)	1 (11.1%)	0 (0%)		
Sinus lift led to communication	0 (0%)	1 (11.1%)	0 (0%)		
Graft material	1 (5.6%)	0 (0%)	0 (0%)		
Displaced Root	1 (5.6%)	0 (0%)	0 (0%)		

***χ^2:* Chi square test** ***MC:* Monte Carlo**

p: p value for comparison between the studied categories

****: Statistically significant at p ≤ 0.05***

Fig. (4) Graft material escape to the maxillary sinus during sinus lift

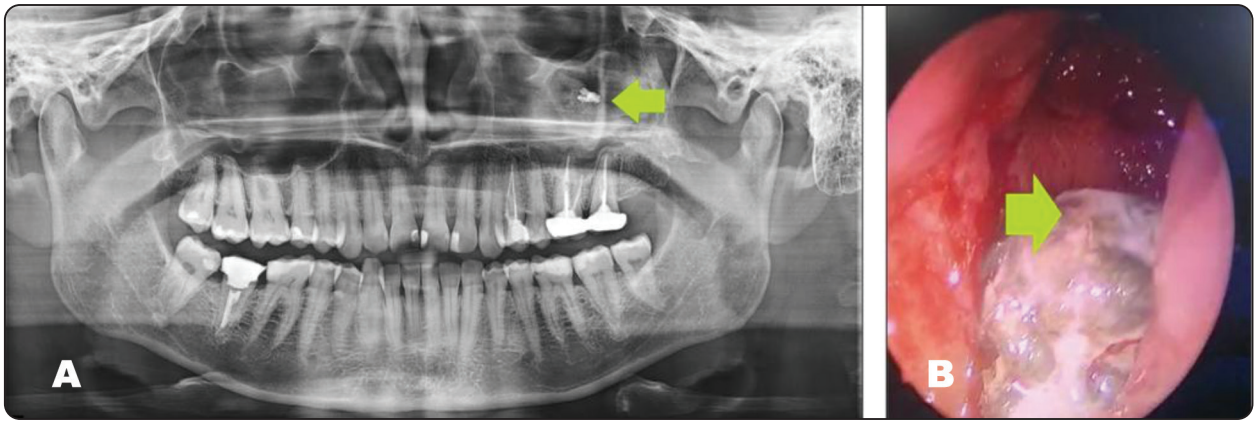

Fig. (5) A 44-year-old female patient resented with severe facial pain localized to the left maxilla, the patient had a history of recent root canal treatment to 26 and 27 . (A) OPG showing radiopaque foreign body material. (B) An intraoperative 70-degree, 4 ml endoscopic examination under local anesthesia revealed soft tissue lesion related the left maxillary sinus. complete excision of the lesion was done at the same operation. Post-operative follow-up was very satisfactory for relief of all patient complaints. The final histopathological diagnosis was fungal mass.

DISCUSSION

The maxillary sinus is an anatomically significant space that plays a pivotal role in various dental disciplines, particularly due to its proximity to the upper teeth. From an embryological perspective, the maxillary sinus is the first paranasal sinus to develop during fetal life, emerging around the 10th week of gestation. It continues to grow slowly throughout childhood, reaching its full size by the eruption of the permanent teeth around 7 years of age. This anatomical development significantly influences dental procedures, particularly those involving the maxillary posterior teeth, whose roots are in close proximity to the sinus floor. Understanding these relationships is essential in preventing complications during dental interventions, such as endodontic treatments, tooth extractions, and implants. These procedures, if not properly managed, can inadvertently lead to odontogenic sinusitis, which occurs when dental infections spread to the maxillary sinus. [10]

Odontogenic sinusitis is frequently observed in patients with maxillary sinusitis, especially when the sinus pathology is evaluated radiographically. Studies indicate that odontogenic infections account for 10–12% of all cases of maxillary sinusitis,

with more than 70% of maxillofacial CT scans depicting unilateral maxillary sinusitis attributed to odontogenic causes.[11, 12] Our findings in this study support these observations, as 48.6% of our patients presented with partial unilateral opacification of the maxillary sinus, and 59.2% of patients experienced symptoms such as foul smell, which are commonly associated with odontogenic infections. The dental origin of these infections ranged from periodontal diseases to complications following dental procedures, including root displacement, endodontic treatment failures, and traumatic tooth extractions.

The proximity of the roots of maxillary posterior teeth to the maxillary sinus floor makes them particularly vulnerable during dental procedures. Endodontic treatments, especially those involving upper posterior teeth, may inadvertently lead to complications such as displaced filling material or root displacement into the sinus cavity during extraction and rarely burs and bone graft during sinus lift (figure 4). Knowledge of anatomical relationship between maxillary posterior teeth and maxillary sinus guides in proper treatment planning, prevents complications during minor endodontic and prosthetic procedures and during extraction of upper posterior teeth which lead to iatrogenic perforation and spread of periapical infection led to maxillary sinusitis. [13-16] As noted in our study, displaced teeth or dental materials, such as root fillings or implant materials, were observed in six patients (16.2%), highlighting the importance of meticulous treatment planning and surgical precision. Root overfilling, where paste or filling material protrudes into the alveolar recess of the sinus floor, is another common contributor to chronic maxillary sinusitis.

The presence of a fungal ball in the maxillary sinus is a recognized cause of unilateral maxillary sinusitis. In some cases, a fungal ball has been associated with root filling materials. Stammberger et al. reported that in over 50% of cases, the typical radiopaque appearance of maxillary sinus concretions, identified as a sinus fungal ball, was composed of endodontic materials that had entered the sinus iatrogenically. The standard treatment approach for fungal balls involves surgical removal through endoscopic sinus surgery [17]. This was observed in our case of a 44-year-old The patient had a history of recent root canal treatment on teeth 26 and 27. Intraoperatively, a 70-degree, 4 ml endoscopic examination under local anesthesia identified a soft tissue lesion associated with the left maxillary sinus. Complete excision of the lesion was performed during the same procedure and the final histopathological diagnosis confirmed a fungal mass. (Figure 5)

Accidental perforation of the maxillary sinus floor during the surgical extraction of the first and second maxillary molars has been well documented, primarily due to the close proximity of the tooth roots to the sinus floor. Oberli et al. reported that the incidence of accidental perforation of the sinus floor, resulting in oroantral communication, was approximately 22% of patients with extracted upper premolars and molars [18]. The findings in our study align with these observations, as 21.6% of our patients developed oroantral communication as a result of traumatic extractions.

Sometimes dental cysts, tumors and inflammatory lesions may extend into the maxillary sinus. The surgical management of odontogenic maxillary sinus diseases has evolved significantly, particularly with the advent of minimally invasive techniques such as functional endoscopic sinus surgery (FESS). As demonstrated by previous studies, FESS has proven to be an effective and less invasive approach for treating maxillary sinus cysts, foreign body removal, and oroantral communications. A study on the surgical treatment of maxillary sinus cysts found that endoscopic techniques resulted in shorter procedure times and significantly less postoperative pain and hospital stay compared to the traditional

Caldwell-Luc procedure.[19,20] In our study, FESS was utilized in conjunction with maxillofacial surgery to address complex cases involving displaced dental materials or foreign bodies and surgical treatment of maxillary sinus cysts, with favorable outcomes reported in the majority of patients (Figure 2, 3)

Furthermore, the multidisciplinary approach between maxillofacial surgeons, otolaryngologists, and dentists plays a critical role in accurately diagnosing and managing NNOP of MS. As our findings reveal (Table 2), a comprehensive evaluation involving preoperative clinical and radiographic examinations, such as CBCT scans, nasal endoscopy, and dental assessments, is crucial for proper diagnosis and treatment planning. This collaborative approach ensures that the underlying odontogenic etiology is identified (Figure 1), thereby guiding the choice of appropriate surgical interventions. For instance, patients with oroantral fistulas or displaced dental materials were treated using a combination of surgical approaches, including buccal advancement flaps, palatal rotation flaps, and FESS, leading to satisfactory resolution of symptoms. The role of odontogenic infections in causing maxillary sinus pathologies underscores the importance of early detection and intervention to prevent the progression of the disease. Misdiagnosis or delayed treatment of odontogenic sinusitis can lead to chronic sinusitis, which may develop into more severe complications such as osteomyelitis, meningitis, or infectious intracranial spread.[21] Our study highlights the importance of an accurate and timely diagnosis to prevent such complications, emphasizing the need for awareness among dental professionals regarding the potential impact of dental pathologies on the maxillary sinus.

CONCLUSION

This study demonstrates that the multidisciplinary approach to the diagnosis and management of non-neoplastic odontogenic maxillary sinus pathologies significantly improves treatment outcomes. By involving various specialties, such as maxillofacial surgery, otolaryngology, and dentistry, we were able to address the multifaceted nature of these pathologies effectively, leading to better diagnosis and management. The findings underscore the importance of a coordinated approach for complex cases to achieve optimal results.

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