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Management of upper odontogenic infections and the role of multidisciplinary treatment

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ABSTRACT

Aim Odontogenic sinusitis is a group of infections related to dental conditions. It may involve the paranasal sinuses (upper odontogenic infections, UOs) and cervical-fascial spaces. Proper diagnosis and treatment of dental complications can be challenging due to unspecific clinical presentation.

Materials and methods A retrospective study of 37 patients with acute UOs treated between January 2008 and December 2018 is presented. A clear etiological and chronological relationship between the odontogenic focus and sinonasal infection was required for inclusion in the study.

Results The causes of UOs were mainly dental implantation (29.8%) and tooth extraction (18.9%). In all cases, UOs were treated with transnasal endoscopic surgery, associated with transoral procedures in 24 out of 37 patients (64.9%). Empirical antibiotic therapy was used in all cases, whereas antibiogram-driven therapy was adopted secondarily in 22 out of 37 cases (59.4%). Surgical success was achieved in 97.3% of patients.

Conclusions Multidisciplinary agreement of an otorhinolaryngologist and dental surgeon is a crucial step in proper diagnosis and treatment of UOs. A correct surgical approach and antibiogram-driven therapy are key elements of correct resolution of infection.

KEYWORDS: Odontogenic infection; Odontogenic sinusitis; Maxillary sinusitis; Dental implants.

INTRODUCTION

Odontogenic sinonasal infections are a group of pathologies deriving, as complications, from dental procedures or dental diseases. These complicated infections may arise in the upper or lower head and neck region (1). Specifically, the upper region includes anatomic structures proximal to the upper arch, called sinonasal cavities, with more common maxillary sinus involvement (2); the lower region comprises structures proximal to the lower arch (3-5). In particular, it is generally assumed that in upper odontogenic infections (UOs) almost 10-30% of maxillary sinus infections derive from an odontogenic focus (6, 7). Moreover, some studies report that 75% of patients who underwent surgery for unilateral symptoms of maxillary involvement are related to UOs (8). Unfortunately, due to its unspecific clinical presentation and constant expansion of dentistry procedures in the last three decades, UOs are probably underestimated (6). However, if not properly diagnosed and treated, these infections may lead to a rapid spread, giving rise to potentially life-threating complications (5, 6, 9).

Sign and symptoms of UOs are usually non-specific and the etiopathological relationship with univocal dental pathology is still unclear. In fact, dental and sinonasal symptoms are not strongly correlated with an odontogenic cause (6, 10). However, the clinical presentation of odontogenic sinonasal involvement include posterior nasal drip, nasal obstruction, hyposmia, cacosmia, facial pain/pressure, bad taste, and anterior purulent nasal discharge; fever can be associated with local symptoms (2, 3, 5, 6). In the majority of cases, this presentation is, initially, monolateral and confined to the maxillary sinus, and it may then spread to other paranasal sinuses and, occasionally, contralaterally (11-13). As consequence, due to clinical presentation, UOs are generally overlooked as an infectious cause by the otolaryngologist, dentist, and radiologist. Nevertheless,

if a patient refers such symptoms, accurate diagnosis is essential, not only to identify sinonasal involvement, but also to detect the specific cause of the infection, in order to resolve both sinonasal and dental pathologies.
In the present study we retrospectively reviewed our case series as a tertiary referral center by evaluating the main characteristics of upper odontogenic infections, underling the importance of a multidisciplinary approach as they can potentially lead to severe complications.

MATERIALS AND METHODS

In this retrospective study we included a series of 37 patients referring to San Raffaele Hospital, Milan, Italy, between January 2008 and December 2018 for acute, severe sinonasal odontogenic infections. Sixteen males (43.3%) and 21 females (56.7%) with a mean age of 55.89 ± 9.01 range (18-81 years) were included in the study (Table 1). The original cohort included 46 patients, but 9 patients were excluded due to non-univocal odontogenic focus or lost to follow-up.
All procedures performed were in accordance with the ethical standards of the institutional and/or national research committee and with the principles stated in the Declaration of Helsinki "Ethical Principles for Medical Research Involving 'Human Subjects", adopted by the 18th World Medical Assembly, Helsinki, Finland, June 1964, and as amended more recently by the 64th World Medical Assembly, Fortaleza, Brazil, October 2013. No approval by the Ethics Committee was needed due to the purely retrospective nature of the study. Informed consent was obtained from each patient for both treatment and use of their de-identified clinical data for study purposes.
The inclusion criteria were: 1) diagnosis of sinonasal odontogenic rhinosinusitis based on multidisciplinary agreement between otolaryngologist and dental surgeon with unanimous agreement on the odontogenic focus; 2) a clear etiological and chronological relationship between odontogenic focus and sinonasal complication; 3) odontogenic infection not responsive to medical therapy; 4) availability of pre-surgical CT scan. Disease extension and dental involvement were evaluated by sinus computed tomography (CT) and orthopantomogram (OPG) in all cases.
When a pathologic condition was detected, the first aim of treatment was to remove the main cause of the infection and guarantee proper ventilation of the sinonasal compartment. In fact, all patients in the present case series underwent standard functional endoscopic sinus surgery (FESS), eventually associated with transoral approach, and appropriate dental procedures (Table 2). In 3 cases drainage of a surgical abscesses within the palatal or canine fossa was needed. These adjunctive procedures were useful in treating concomitant dental pathologies, dominate critical areas (such the alveolar recess of the maxillary sinus), repair oro-antral communications with potential reconstruction with tension-free flap, and remove dislocated implants.
Nevertheless, we generally performed minimally invasive FESS based on middle meatal antrostomy associated with anterior ethmoidectomy and maxillary sinus washing and removal of purulent/grafting materials. Posterior ethomoidectomy, frontal sinusotomy, and sphenoidotomy was performed when radiological involvement was detected. Patients with frontal sinus involvement underwent a type I frontal drainage according to the Draf classification.
In addition, surgical purulent material was aseptically

		Upper UOs
Gender	Male	16 (43.3%)
	Female	21 (56.7%)
Age (yrs)	< 20	1 (2.7%)
	21-40	6 (16.2%)
	41-60	12 (32.4%)
	61-80	17 (46%)
	> 80	1 (2.7%)
Side	Right	13 (35.6%)
	Left	24 (64.8%)
Causes	Tooth extraction	7 (18.9%)
	Implant	11 (29.8%)
	Caries	6 (16.2%)
	Dysodontiasis	6 (16.2%)
	Endodontic procedures	5 (13.5%)
	Sinus lift	2 (5.4%)
	Pre-implantological	3 (8.1%)
	Implantological	13 (35.1%)
	"Classic" dental	21 (56.8%)
Etiologies	S. aureus	4 (10.8%)
	AHS	8 (21.6%)
	BHS Enterobacter spp E. corrodens	4 (10.8%) 2 (5.4%) 1 (2.7%)
	K. pneumoniae	2 (5.4%)
	Obligate anaerobes*	/
	MOF Culture-negative	12 (32.3%) 4 (10.8%)
	Aspergillus spp	3 (8.2%)

Features and characteristics of patient's upper odontogenic infections
UOs: upper odontogenic infections; AHS: alpha-hemolytic streptococci; BHS: beta-hemolytic streptococci; MOF: non-specific mixed oropharyngeal flora (not otherwise specified)
** Obligate anaerobes comprise Peptostreptococci spp, Propionibacterium spp, Bacteroides spp, Actinomyces sp*

TABLE 1 Characteristics of patients.

		Upper UOs
Antibiotics	PEN	18 (48.8%)
	CEP	3 (8.1%)
	FLU	12 (32.3%)
	PEN + LIN	4 (10.8%)
	Monotherapy	33 (89,1%)
	Combination therapy	4 (10,9%)
	Empirically	15 (40.6%)
	Antibiogram-driven	22 (59.4%)
Steroids	Yes	10 (27%)
	No	27 (73%)
Surgery	FESS	13 (35.1%)
	FESS + DP*	12 (32.4%)
	FESS + TO**	9 (24.3%)
	Surgical drainage*** + DP*	3 (8.1%)

Treatment of upper odontogenic infection: surgical procedures and associated medical therapy
UOs: upper odontogenic infections; PEN: penicillin; CEP: cephalosporin; LIN: lincosamide; FLU: fluoroquinolone; FESS: functional endoscopic sinus surgery; TO: transoral approach; DP: dental procedure
** Dental procedure comprehends odontoiatric procedure such as tooth extractions or endodontic treatment*
*** Transoral approaches has been performed to approach critical areas (i.e. maxillary alveolar recess), oro-antral communications and to remove dislocated/failed implants*
**** Surgical drainage through cervicotomy was made with the incision of palatal or canine fossa abscesses*

TABLE 2 Post-operative therapy administered.

collected and analyzed microbiologically (Table 1). All patients received empirical post-operative therapy for 8-10 days that was antibiogram-driven when possible. Steroid therapy was added in most severe cases (Table 2).
Follow-up visits were performed on days 1, 7, 20, and 60, once a month for the first 3 months, and then once every 3 months for 1 year.
Treatment was considered successful if there was complete resolution of infection and there were no signs of mucosal inflammation at nasal endoscopy.

RESULTS

The characteristics of patients with UOs are shown in Table 1. The causes of UOs were divided into pre-implantological complications (8.1%), implantological treatments (35.1%), and a consequence of dental procedures (56.8%), meaning infections not strictly correlated to implantology or pre-implantologic procedures. Additionally, according to the classification proposed by Felisati et al. (14, 15), we analyzed different odontogenic causes such as implant placement (29.8%), tooth extraction (18.9%), dysodontiasis (16.2%), endodontic procedures (13.5%), caries (16.2%), and sinus lift (5.4%).
Microbiological analyses of the purulent surgical discharge were negative in 4 patients (10.8%) or demonstrated non-specific oropharyngeal flora (MOF) in 12 patients (32.3%), whereas in 21 patients a positive culture was found with a prevalence for alpha-hemolytic streptococci (21.6%) (Table 2). In addition, Aspergillus spp was found in 3 cases (8.2%) associated with a MOF culture. Thus, antibiogram-driven therapy associated with personalized surgery was useful in 22 out of 37 patients: in particular, penicillins were the most used antibiotics both empirically and antibiogram-driven (48.8%). Steroids were added in 10/37 cases (27%).
Surgical procedures performed in UOs consisted of exclusive functional endoscopic sinus surgery in 13 out of 37 patients (35.1%), that was associated with dental procedures in 12 out of 37 patients (32.4%) or trans-oral approach in 9 out of 37 patients (24.3%). Conversely, two hard palate and one canine fossa abscesses causing UOs were treated exclusively with dental procedures associated with transoral surgical drainage.
The overall surgical success, defined as no clinical symptoms or endoscopic pathologic findings, was 97.3%. Only one patient required a second functional sinonasal surgery after antrostomy closure. No major surgical complications were reported intra-operatively.

DISCUSSION

Odontogenic infections are, nowadays, commonplace in otorhinolaryngological (ENT) practice and are strictly correlated to dental procedures and dental pathologies. Such infections may arise from both the upper or lower dental arches, causing upper or inferior odontogenic infections (1). Due to the expansions of dental pathologies and dentistry procedures, there has been an increase in the proportion of cases with cervico-facial and sinonasal involvement (2, 6, 8). Moreover, general comorbidities (such as diabetes, autoimmune diseases, lymphoproliferative disorders, smoking, malnutrition) may increase the risk of odontogenic infections, and may influence the severity of the pathology (5, 6, 9). However, considering the non-specific clinical presentation, the prevalence of these infections is considered to be underestimated by many authors (4, 6). Moreover, as reported by Albu and Baciut (16), the majority of recent guidelines for rhinosinusitis do not include UOs as a cause of chronic rhinosinusitis. In fact, these odontogenic diseases lack standardized clinical protocols for diagnosis and management (10). As a consequence, UOs are often overlooked by dentists, otolaryngologists, and radiologists and this usually leads to inadequate treatment (15). However, in recent years, Felisati et al. have proposed a new classification of sinonasal complications of dental diseases or treatment, in order to allow creation of a standardized

treatment protocol (14). According to this classification, odontogenic infections are divided into 3 groups: 1) pre-implantological treatment complications; 2) implantological treatment complications; 3) "classic" dental disease and treatment complications. All patients studied herein were treated in accordance with a protocol based on etiological and extension disease (14) (Table 2). This consists, in the majority of cases, in functional endoscopic sinus surgery (FESS) associated with additional trans-oral or dental procedures (15); in fact, if FESS is still the principal surgical technique used in the treatment of a variety of sinonasal pathologies, it has been demonstrated by many authors that a multimodal approach to dental pathology is essential for correct treatment of odontogenic pathologies (14, 17). Previously published results seem to be in line with our rates of surgical success (97.3%), stressing the necessity of a multidisciplinary approach. In fact, UOs have been considered a different sinonasal condition that requires precise diagnostic criteria and standardized treatment (18).

Despite sporadic reports of bilateral infections (11-13), UOs are generally unilateral, with primary maxillary sinus involvement. Moreover, UOs usually occur when the integrity of the Schneiderian's membrane is interrupted by odontogenic disease or dental procedures (2, 19), and leads to migration of oral microorganisms into the sinus causing recalcitrant infection (12, 20-22). This complication occurs easily when an atrophic alveolar process is present (23, 24) and causes an inflammatory reaction that alters mucociliary clearance (25, 26).

In our case series, the main cause of UOs was implant placement, followed by tooth extraction, caries, dysodontiasis, endodontic procedures, and sinus lifts, findings are in line with literature data (4, 24).

Implant placement is a surgical practice that has recently increased for the treatment of edentulous patients. This procedure is not always safe, particularly if performed by less experienced hands (2), both for potential anatomic variations and the underlying risk of osteointegration failure due to pre-existing risk factors such as sinonasal pathologies, acquired/congenital immunodepression and osteoporosis (2, 26, 27). Nevertheless, while complications of implant placement may be more easily detected and treated, other less frequent causes of UOs, such as caries and dysodontiasis, may be left untreated for long periods (4, 28). Constant collaboration between the ENT surgeon and dentist could potentially treat such complications more promptly and easily.

Tooth extraction, if not properly performed, is another cause of UOs (7, 22, 24). In particular, it may lead to post-surgical alveolitis with or without dental root displacement into the maxillary sinus and formation of an oro-antral fistula (7, 14, 22). This cause is more often observed in cases of divergent dental roots and complicated tooth decay, since they can facilitate tooth fracture (7). If this pathology occurs, multimodular surgery is necessary to restore both sinonasal ventilation and integrity of the Schneiderian's membrane.

Finally, endodontic therapy is another procedure that can lead to UOs: in fact, endodontic material or dental instruments may perforate the Schneiderian's membrane, reaching the maxillary sinus and giving rise to fungal colonization, most frequently Aspergillus spp microorganism, also known as "fungus ball". The anatomic relation of premolar and molar roots with the maxillary sinus increase the likelihood that endodontic therapies of these teeth may more commonly cause UOs (14).

The pathologic microorganism isolated in our UOs cases are in line with literature data (29, 30): in fact, alpha-hemolytic streptococci are more commonly isolated from purulent discharges, followed by beta-hemolytic Streptococci, Staphilococcus aureus, and gram-negative species. Negative culture was obtained in 4 cases and non-specific mixed oropharyngeal flora was evident in 12 cases. Empirical antibiotic therapy was shifted to antibiogram-driven in 59.5% of patients. This post-operative treatment, which is not stated in international guidelines, can be considered a bias in evaluating the positive results of our protocol. Nevertheless, the choice to perform post-operative antibiotic therapy is consistent with previous studies (14, 15) and should be considered to reduce resistance to antibiotics.

CONCLUSIONS

Given the different etiology and clinical findings, treatment of upper odontogenic infections requires an experienced surgeon with specific training in both FESS and oral surgery. These surgical qualities are mandatory in the management of UOs, as it is essential to treat both the odontogenic focus and sinonasal involvement. However, although the ENT surgeon may possess such expertise, multidisciplinary cooperation between the ENT surgeon with a dentist/maxillofacial surgeon is advisable in order to provide the best treatment available. In addition, well defined antibiotiogram-driven therapy should be considered to optimally treat the odontogenic infection and reduce potential antibiotic resistance.

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Conflict of interest

The authors declare that they have no conflict of interest.

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