Journal of Cranio-Maxillo-Facial Surgery 47 (2019) 1249–1254

Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

Single-step surgical treatment of odontogenic maxillary sinusitis: A retrospective study of 98 cases

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ARTICLE INFO

Article history:
Paper received 18 December 2018
Accepted 29 April 2019
Available online 4 May 2019

Keywords:
Odontogenic maxillary sinusitis
Endoscopic sinus surgery
Odontogenic infection

ABSTRACT

Purpose: The aim of this study was to review clinical and radiological presentation, surgery, and results of treatment in patients with chronic odontogenic maxillary sinusitis (OMS) treated with a single surgical procedure, including endoscopic sinus surgery (ESS) and oral surgical approaches to treat the odontogenic source of infection.
Materials and methods: A retrospective case series analysis of 98 patients was performed. All the patients received ESS. 88 patients required oral surgical approaches.
Results: Nasal symptoms were present in 58 patients (59.2%). Nasal endoscopy was positive in 65 patients (66.3%). A positive nasal endoscopy was significantly associated with nasal symptoms ($p < 0.05$). 60 patients (61.2%) had OMS of iatrogenic origin. Total opacification of the maxillary sinus was the most common radiological presentation (74.5%) and was significantly associated with nasal symptoms ($p < 0.05$). 91 patients (92.9%) had complete clinical and radiological resolution of the OMS.
Conclusions: Iatrogenic origin, sinonasal symptoms and positive clinical endoscopy are common in patients with OMS. Nasal symptoms were significantly associated with total maxillary sinus opacification and positive endoscopic clinical examination. Combining treatment of the odontogenic source of infection via an oral surgical approach and of the sinus inflammation by ESS appears to be sufficient for successfully treating patients with OMS.

1. Introduction

Odontogenic maxillary sinusitis (OMS) is a well-known disease in the fields of otolaryngology, maxillofacial surgery, and dentistry (Patel and Ferguson, 2012). The literature states that about 10% of all sinusitis cases have an odontogenic origin (Patel and Ferguson, 2012; Brook, 2006; Simuntis et al., 2014), but the real incidence could be as high as 25–40% (Albu and Baciut, 2010).

Frequently OMS is due to surgical violation of the Schneiderian membrane following tooth extraction, periodontal surgery, or sinus floor elevation, with or without misplaced implant or augmentation grafts (Simuntis et al., 2014).

The symptoms of OMS can differ from patient to patient. Some experience dental pain, or headache combined with sinusitis-like symptoms such as nasal congestion or postnasal drip, whereas others present with minimal sinusitis-like symptoms because the osteomeatal complex (OMC) is not obstructed (Brook, 2006).

Several studies reporting on OMS are based on the evaluation of radiological images and fail to correlate these findings with clinical data (Troeltzsch et al., 2015).

Surgical approaches vary from endoscopic techniques to open surgery. Endoscopic sinus surgery (ESS) is performed in order to open the sinus ostium and restore mucociliary clearance of the maxillary sinus (Costa et al., 2007), while open surgery is associated with access to the maxillary sinus floor for removal of foreign bodies using larger-scale surgical approaches (Felisati et al., 2013;

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https://doi.org/10.1016/j.jcms.2019.04.012
1010-5182/

Konstantinidis and Constantinidis, 2014). Management protocols for OMS have not yet been established in terms of both the type and time sequence of treatment (Simuntis et al., 2014).

The aim of this study was to review clinical and radiological presentation, surgery, and results of treatment in patients with OMS treated in our department with a single surgical procedure, including ESS and oral surgical approaches for treating the odontogenic source of infection.

2. Materials And Methods

2.1. Patients

We performed a 15-year retrospective study of a consecutive case series of patients with chronic OMS. 98 patients were included in this study and the approval of the local ethical committee was obtained. Before surgery all patients underwent computed tomography (CT) scans of their paranasal sinuses, or cone beam computed tomography (CBCT), nasal endoscopy, and dental examination for precise diagnosis of the location and extent of disease. CT was reviewed in order to evaluate the grade of opacification of the maxillary sinus involved and anatomical variants of the OMC. Total opacification was defined as being when there was no air in the maxillary sinus; subtotal opacification when air was present in up to 30% of the maxillary sinus volume; and partial opacification when only the floor of the maxillary sinus was not ventilated. Nasal endoscopy was reviewed in order to evaluate clinical signs of maxillary sinusitis and anatomical variation of the OMC. All the patients were followed up clinically with endoscopic examination 1 week, 2 weeks, and 6 months after discharge from the hospital for assessment of nasal and oral medication. CT scan or CBCT was performed 6 months after surgery to evaluate radiological healing of the maxillary sinus. The patients' clinical data, including sex, age, length of stay in hospital, medical record, and dental focus, were analysed.

2.2. Statistical analysis

Variables were descriptively summarized by proportion. 95% confidence intervals were calculated for each proportion using a Z test. χ (Brook, 2006) tests were also performed and p-values calculated. A p-value <0.05 was considered statistically significant.

2.3. Procedure

All the patients were treated under general anaesthesia. 88 patients received a combination of ESS and oral surgery. Ten patients received only ESS because the odontogenic source of infection was not active, i.e. previous dental or implant removal with oroantral communication spontaneously closed. For the combined procedures oral surgery was performed first. The types of treatment performed are summarized in Table 1. Closure of oroantral communication was achieved by Rehrmann's buccal advancement flap or by Bichat's buccal fat pad. After oral surgery, ESS was performed, with opening and calibration of the maxillary natural ostium, as previously described (Costa et al., 2007). Contemporary endoscopic surgical treatment of septal deviations or concha bullosa, or other alteration of the OMC, was performed. Clinical presentation, surgical treatment, and follow-up for an exemplary patient from the sample are shown in Figs. 1–6.

3. Results

Demographic, clinical, and therapeutic data for the patients examined are presented in Table 2.

Table 1
Types of treatment used on the patients examined.

Treatments	Number of procedures
ESS	10
ESS + apicectomy	7
ESS + removal of cyst with or without dental extraction	2
ESS + dental extraction with or without closure of oroantral communication	33
ESS + closure of oroantral communication	22
ESS + removal of implant	16
ESS + removal of bone graft	7
ESS + segmental osteotomy of the maxilla	1
Total	98

ESS = endoscopic sinus surgery.

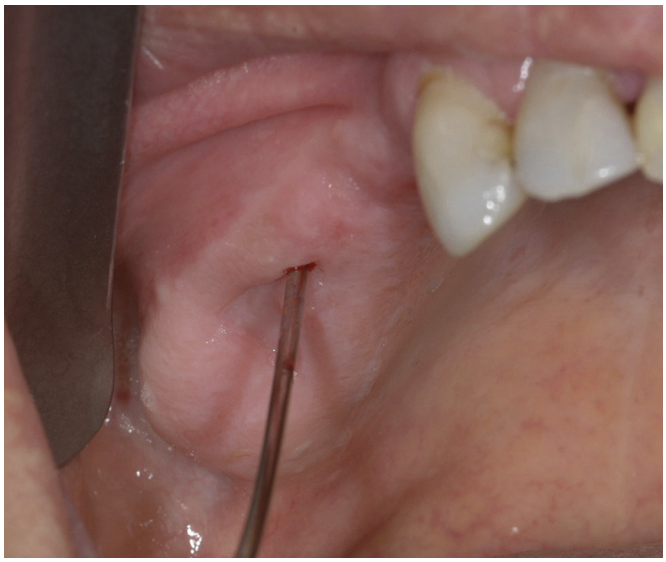

Fig. 1. Preoperative oral clinical view of a patient from the sample presenting with right maxillary oroantral communication.

98 consecutive patients — 50 males (51%) and 48 females (49%) — were included in this study. The age range was 25–85 years, with a mean age of 51.6 (±11.9) years). The mean length of stay for hospitalized patients was 3.05 (±0.58) days. OMS was

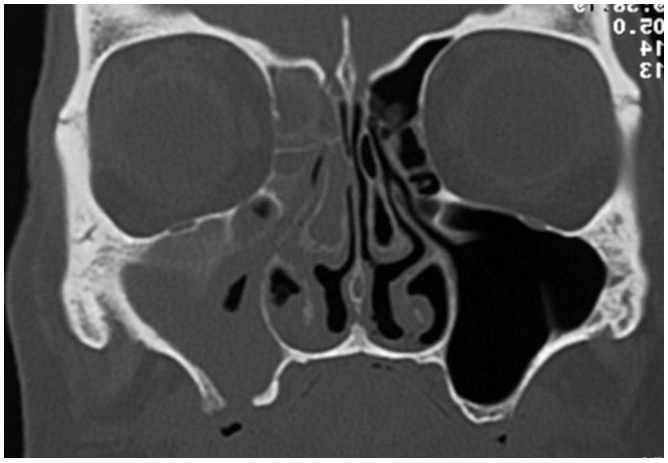

Fig. 2. Preoperative CT scan (coronal plane) showing subtotal opacification of the right maxillary sinus and of the anterior ethmoid cells, and anatomical variation of the OMC complex (concha bullosa of the middle turbinate).

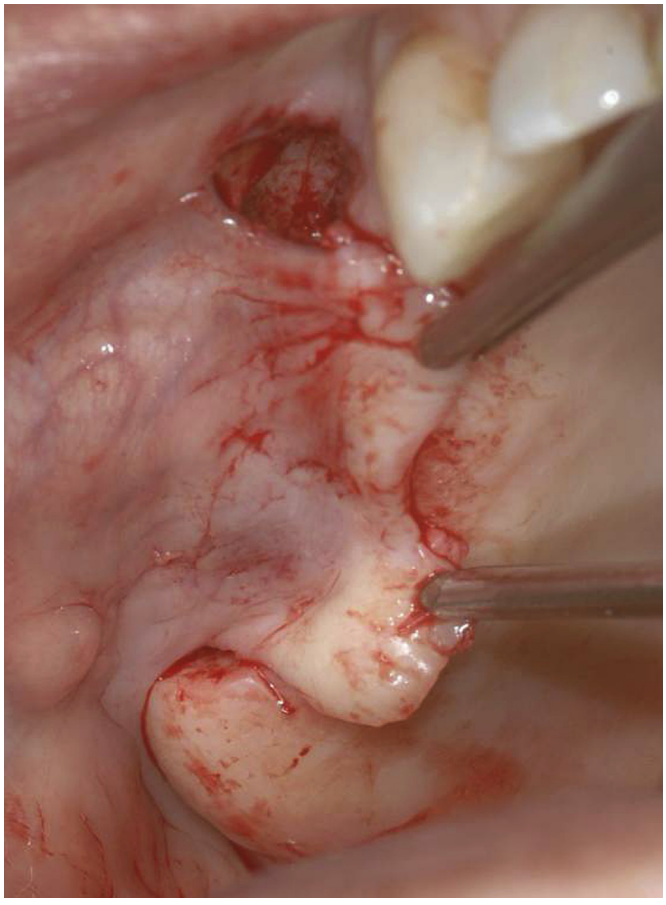

Fig. 3. Intraoperative oral surgical step: the Rehrmann's buccal advancement flap. No bone reconstruction of the alveolar crest defect was performed.

Fig. 4. Postoperative oral clinical view 6 months after surgery, showing closure of the oroantral communication with Rehrmann's buccal advancement flap.

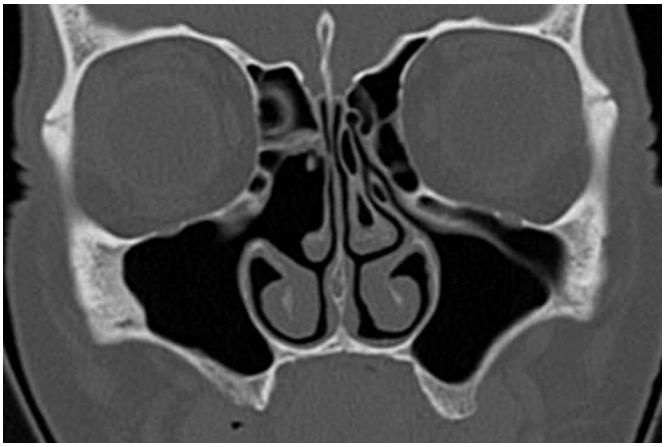

Fig. 5. 6 months postoperative CT scan (coronal plane), showing complete aeration of the right maxillary sinus and endoscopic surgical treatment of the right concha bullosa.

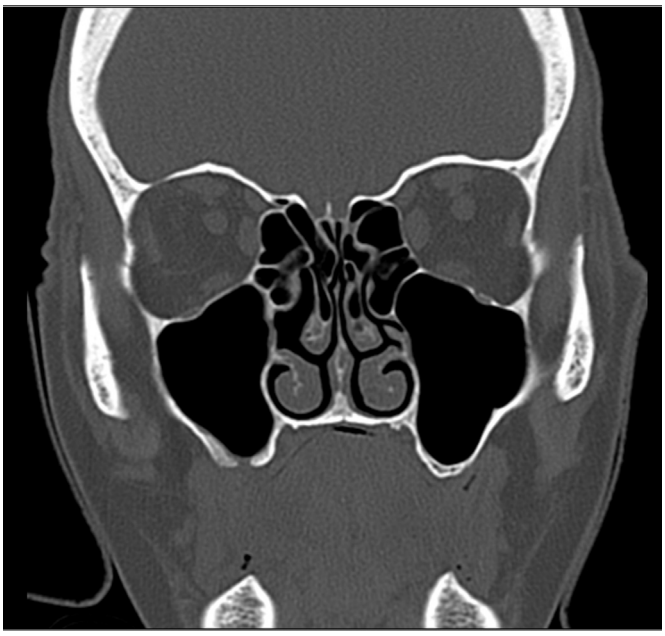

Figure 6. 6 months postoperative CT scan (coronal plane) at the level of the bony defect on the alveolar crest.

diagnosed in 55 (56.1%) cases for the right maxillary sinus and in 43 (43.9%) cases for the left maxillary sinus. 15 patients (15.3%) presented without symptoms. Nasal symptoms (postnasal drip, nasal obstruction, foul smell) were present in 58 patients (59.2%). Maxillary pain with or without swelling was present in 16 cases (16.3%); symptoms related to oroantral fistula, such as mouth nasal reflux, were present in six cases (6.1%); purulent discharge in oral cavity was found in three cases (3.1%).

Nasal endoscopy revealed mucopurulent discharge from the middle meatus with o without oedema of the uncinate process in the majority of the cases (65 cases; 66.3%) while 33 cases (33.7%) had negative endoscopic clinical examination. The proportion of endoscopic inflammatory signs in patients with nasal symptoms was 43/58 (74,1%; 95% IC: 62,8%-85,4%). The proportion of endoscopic inflammatory signs in patients without nasal symptoms was 18/40 (45%; 95% IC: 29,6%-60,4%).

Table 2
Presentation of demographic, clinical, and therapeutic data for the patients examined.

Variable	Descriptive statistics
Total number of patients	$n = 98$
Age	51.6 years (SD 11.9 years)
Sex	
Male	50 (51%)
Female	48 (49%)
Site	
Right maxillary sinus	55 (56.1%)
Left maxillary sinus	43 (43.9%)
Symptoms at presentation	
No symptoms	15 (15.3%)
Nasal symptoms (postnasal drip, nasal obstruction, foul smell)	58 (59.2%)
Maxillary pain	16 (16.3%)
Mouth–nasal reflux	6 (6.1%)
Purulent discharge	3 (3.1%)
Nasal endoscopy	
Mucopurulent discharge	65 (66.3%)
Negative	33 (33.7%)
Pathology associated with sinusitis	
Periodontitis or periapical odontgenic cystic lesion	38 (38.8%)
Immediate post-extraction oroantral fistula	25 (25.5%)
Peri-implantitis and post-sinus elevation surgery	24 (24.5%)
Previous dental extraction	7 (7.1%)
Foreign body (luxated root, dental implant)	3 (3.1%)
Medication-related osteonecrosis of the jaw	1 (1%)
Responsible teeth	
Not identified	33 (33.7%)
Identified	65 (66.3%)
Maxillary molars	48 (73.8%)
Maxillary premolars	14 (21.5%)
Wisdom teeth	3 (4.7%)
Postoperative healing	
Uneventful	91 (92.9%)
Minor complications	3 (3.1%)
Revision ESS	2 (2%)
Partial opacification of the maxillary sinus	2 (2%)

The dental origin was evaluated by reviewing surgery reports, medical history, and patients' radiological findings. In 38 cases (38.8%) OMS was related to periodontitis or periapical cysts in one or more dental elements. In 25 cases (25.5%) an oroantral communication secondary to previous tooth extraction was present and clinically identified. In 24 cases (24.5%) OMS was related to previous dental implant placement with or without maxillary sinus floor elevation and reconstruction with bone substitutes. In seven cases (7.1%) a previous dental extraction was performed but an oroantral communication was not clinically present. In three cases (3.1%) there was a foreign body within the maxillary sinus, in two cases a dental implant, and in one case a dental root. One case (1%) was secondary to bisphosphonate-related osteonecrosis of the maxilla.

Considering patients with post-extraction oroantral communication, patients with previous dental implant placement with or without reconstruction of the maxillary sinus, and patients with a foreign body within the maxillary sinus, a total of 60 patients (61.2%) had OMS of iatrogenic origin. In 65 cases (66.3%) the responsible tooth or site of implant was clearly identified. Maxillary molars (48 cases; 73.8%) were the most involved teeth. Results of the radiological findings are reported in Table 3. Total opacification of the maxillary sinus involved was present in 73 cases (74.5%), and subtotal opacification in 20 cases (20.4%), with partial opacification present in only five cases (5.1%). 35 cases (35.7%) presented anatomical variation of the OMC complex. The proportion of total maxillary sinus radiological involvement in patients with nasal symptoms was 50/58 (86,2%; 95% CI 77.3–95.1%). The proportion of total maxillary sinus radiological involvement in patients without nasal symptoms was 24/40 (60.0%; 95% CI 44.8–75.2%).

Table 3
CT radiological aspects for the patients examined.

Variable	Descriptive statistics
Maxillary sinus opacification	
Total opacification	73 (74.5%)
Subtotal opacification	20 (20.4%)
Partial opacification	5 (5.1%)
Anatomical variation of the OMC	
Normal	63 (64.3%)
Variations	35 (35.7%)
Concha bullosa	15 (15.3%)
Septal deviation	10 (10.2%)
Accessory maxillary ostium	8 (8.2%)
Paradox curvature of the middle turbinate	2 (2%)

91 (92.9%) of the 98 cases examined in this study had complete clinical and radiological resolution of the OMS 6 months after the surgical procedure.

Seven cases (7.1%) had complications. Three (3.1%) had minor complications requiring revision under local anaesthesia. Two cases (2%) presented complete opacification and clinical symptoms secondary to closure of the maxillary natural ostium, requiring ESS revision under general anaesthesia. Two cases (2%) presented partial opacification of the maxillary sinus secondary to closure of the maxillary natural ostium, without clinical symptoms.

4. Discussion

This study retrospectively investigated 98 cases of patients with chronic OMS.

Lack of gender dominance and a mean age of 51.6 (±11.9) years were similar to findings reported in other case series Troeltzsch et al., 2015; Zirk et al. (2017); Matsumoto et al., 2015; Longhini and Ferguson (2011).

Symptoms suggestive of OMS can include sinonasal symptoms (Legert et al., 2004), anterior maxillary tenderness or maxillary pain (Brook, 2006), and dental symptoms. Lee and Lee (2010) reported that unilateral purulent rhinorrhoea was the most common symptom in 66.7% of their patients with OMS. Andric et al. (2010) reported facial pain, nasal discharge, and nasal obstruction as the most prominent preoperative symptoms. In our sample of patients the nasal symptoms were the most common (59.2%). Therefore, our data suggest that sinonasal symptoms predominate in patients with OMS. Analysis of nasal symptoms and radiological findings for our sample showed that the proportion of total maxillary sinus radiological involvement in patients with nasal symptoms was significantly higher than in patients without nasal symptoms ($p < 0.05$).

Wang et al. (2015) examined 55 patients with OMS; however, the clear presence of a positive nasal endoscopy was unclear. All the patients in our sample received preoperative nasal endoscopy, with mucopurulent discharge from the middle meatus, without oedema of the uncinate process, being observed in the majority of cases (65 cases; 66.3%). Positive nasal endoscopy correlated well with clinical symptoms in our sample, where the nasal symptoms were the most common (59.2%). Therefore, it can be concluded that about two-thirds of patients with OMS referred for surgical treatment present a positive clinical endoscopy and nasal symptoms.

Analysis of nasal symptoms and preoperative clinical endoscopy data for our sample showed that the proportion of endoscopic inflammatory signs in patients with nasal symptoms was significantly higher than in patients without nasal symptoms ($p < 0.05$).

Lechien et al. (2014) reviewed 23 publications for a total of 674 patients. The main cause of OMS was iatrogenic, accounting for 65.7% of the cases. Our sample supports these data since the majority of our patients ($n = 60$; 61.2%) had oral surgery-related OMS.

Among the teeth involved, maxillary molars (48 cases; 73.8%) were the most common. Our data were consistent with previous reports (Matsumoto et al., 2015; Andric et al., 2010; Lechien et al., 2014). These results can easily be explained by the preferential anatomical relationship between the floor of the maxillary sinus and the maxillary molars.

CT and CBCT are the methods of choice for diagnosing OMS (Shahbazian and Jacobs, 2012). The most common radiological aspect of OMS in our sample was total opacification (74.5%). An important consideration regarding examination of CT imaging for our sample was the incidence of anatomical variation of the OMC. Tomomatsu et al. (2014) studied aperture width of the OMC on the side of the maxillary sinus, and anatomical variations in 39 patients with OMS. They concluded that the OMC might be a significant predictor of the effectiveness of initial medical treatment of OMS. Results from our sample revealed that one-third of patients with OMS had concomitant anatomical variations, which may have contributed to reducing patency of the OMC and therefore clearance of the maxillary sinus.

From our point of view, radiological follow-up with a 6-month postoperative CT scan would be advisable, especially in patients with oral surgery-related OMS. In such cases, an accurate evaluation of maxillary sinus bony boundaries and mucosal thickness is useful for defining postoperative healing and to rule out relapses, particularly where there is microbiological evidence of mycotic sinusitis.

The choice of CBCT rather than traditional CT, and a careful balance of the exposition parameters according to the 'ALADA' concept, can help to reduce potential radiation risk for the patient (Jadu et al., 2018).

In our work, the definition of iatrogenic OMS, as associated with post-extraction oroantral communication, previous dental implant placement, or foreign body within the maxillary sinus, does not necessarily imply a technical pitfall during the procedure, because an inflammatory process leading to OMS could arise after a technically correct intervention due to other causes. In this study, 'iatrogenic OMS' should therefore be considered as OMS associated with previous oral surgery rather than OMS as a consequence of surgical complication.

Treatment of OMS is different from treatment of non-odontogenic sinusitis, and requires management of the dental source and management of the inflammation of the maxillary sinus. Specific management protocols for OMS have not yet been established. Akhlaghi et al. (2015) concluded that the Caldwell-Luc approach might be the best method for treating sinusitis in cases of displaced teeth, while oroantral fistula can easily be treated by endoscopy and fistula closure. The Caldwell-Luc approach is now obsolete. A transoral osteoplastic surgical approach via the anterior sinus wall should be performed for cases necessitating an open approach, as reported by Zirk et al. (2017) in a recent retrospective study. Wang et al. (2015) suggested dental surgery as first-line surgical treatment for OMS. They suggested performing ESS as the next step of treatment if the condition persists. Longhini and Ferguson (2011) evaluated clinical aspects of OMS in 21 patients. Without correction of the dental pathology, ESS was unsuccessful in their series. Longhini and Ferguson's results reinforce the concept that management of sinus inflammation without treatment of the dental source is generally unsuccessful. Kim et al. (2016) analysed treatment results for 19 patients with dental implant-related OMS. They concluded that despite appropriate medical treatment, the majority of patients with OMS related to implant placement required surgical treatment with ESS.

Albu et al. (2011) proposed treatment of OMS with drainage of the sinus by an intraoral approach involving endoscopic canine fossa puncture without endonasal surgery. Results of this study indicated that canine fossa puncture at the time of dental treatment should be sufficient for adequate treatment of OMS. Additional studies with a larger sample and a longer follow-up have been suggested to validate these results.

The presented combination of treatments is only one of several treatment options described. The retrospective nature of our clinical study does not allow conclusions to be drawn regarding timing and type of surgical procedures. However, it is our opinion that, currently, the literature is not able to indicate which patients with OMS benefit from a medical and dental approach as the first step of treatment. Therefore, it seems reasonable that clinicians treat simultaneously the dental source and the inflammation of the maxillary sinus in patients with OMS.

The role of ESS is to restore the normal patency of the natural ostium and to facilitate more rapid recovery of the sinus clearance (Costa et al., 2007). In addition, ESS allows simultaneous treatment of anatomical variation of the OMC complex, as observed in almost one-third of patients with OMS in our sample.

Several studies have emphasized the importance of collaboration between different professional figures managing patients with OMS (Felisati et al., 2013; Matsumoto et al., 2015; Wang et al., 2015; Lechien et al., 2014). In our opinion, a multidisciplinary approach to patients with OMS is related to the difficulty in identifying a professional figure able to manage both the odontogenic source of infection and the maxillary mucosal inflammation. Otolaryngologists are usually more confident with maxillary mucosal inflammation and ESS but have more difficulty in identifying and treating the odontogenic source. On the contrary, oral surgeons or dentists are able to identify and treat the odontogenic source but usually they have no confidence with ESS and pathophysiology of the maxillary sinus. We suggest that patients with OMS should be managed by a single professional figure able to treat both the source and the site of inflammation. Since oral and maxillofacial surgeons frequently treat OMS, we think that this expertise should be a requirement in these cases. Alternatively, as emphasized by Felisati et al. (2013), the ideal solution is a multidisciplinary treatment allowing a combination of different surgical skills during a single surgical procedure.

5. Conclusions

Within the limitation of this retrospective study, the following conclusions may be drawn. Sinonasal symptoms predominate in patients with OMS, and about two-thirds of patients referred for surgical treatment present a positive clinical endoscopy. Previous extractive dento-alveolar, reconstructive, and implant surgery are the most common causes of OMS. The most common radiological aspect is total opacification of the maxillary sinus involved, with one-third of patients having concomitant anatomical variations that may contribute to reduced patency of the OMC. Nasal symptoms are significantly associated with total maxillary sinus opacification and positive endoscopic clinical examination. Combining treatment of the odontogenic source of infection by an oral surgical approach and of the sinus inflammation by ESS appears to be an effective option for successfully treating patients with OMS. Since oral and maxillofacial surgeons frequently treat OMS, this expertise should be a requirement.

Acknowledgements

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

Akhlaghi F, Esmaeelinejad M, Safai P: Etiologies and treatments of odontogenic maxillary sinusitis: a systematic review. Iran Red Crescent Med J 17(12): e25536, 2015

Albu S, Baciut M: Failures in endoscopic surgery of the maxillary sinus. Otolaryngol Head Neck Surg 142(2): 196–201, 2010

Albu S, Baciut M, Opincariu I, Rotaru H, Dinu C: The canine fossa puncture technique in chronic odontogenic maxillary sinusitis. Am J Rhinol Allergy 25(5): 358–362, 2011

Andric M, Saranovic V, Drazic R, Brkovic B, Todorovic L: Functional endoscopic sinus surgery as an adjunctive treatment for closure of oroantral fistulae: a retrospective analysis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 109(4): 510–516, 2010

Brook I: Sinusitis of odontogenic origin. Otolaryngol Head Neck Surg 135(3): 349–355, 2006

Costa F, Emanuelli E, Robiony M, Zerman N, Polini F, Politi M: Endoscopic surgical treatment of chronic maxillary sinusitis of dental origin. J Oral Maxillofac Surg 65(2): 223–228, 2007

Felisati G, Chiapasco M, Lozza P, Saibene AM, Pipolo C, Zaniboni M, Biglioli F, Borloni R: Sinonasal complications resulting from dental treatment: outcome-oriented proposal of classification and surgical protocol. Am J Rhinol Allergy 27(4): 101–106, 2013

Jadu FM, Alzahrani AA, Almutairi MA, Al-Amoudi SO, Jan AM, Khafaji MA: The effect of varying cone beam computed tomography image resolution and field-of-view centralization on effective radiation dose. Saudi Med J 39(5): 470–475, 2018

Kim SJ, Park JS, Kim HT, Lee CH, Park YH, Bae JH: Clinical features and treatment outcomes of dental implant-related paranasal sinusitis: a 2-year prospective observational study. Clin Oral Implant Res 27(11): e100–e104, 2016

Konstantinidis I, Constantinidis J: Medial maxillectomy in recalcitrant sinusitis: when, why and how? Curr Opin Otolaryngol Head Neck Surg 22(1): 68–74, 2014

Lechien JR, Filleul O, Costa de Araujo P, Hsieh JW, Chantrain G, Saussez S: Chronic maxillary rhinosinusitis of dental origin: a systematic review of 674 patient cases. Int J Otolaryngol. https://doi.org/10.1155/2014/465173, 2014

Lee KC, Lee SJ: Clinical features and treatments of odontogenic sinusitis. Yonsei Med J 51(6): 932–937, 2010

Legert KG, Zimmerman M, Stierna P: Sinusitis of odontogenic origin: pathophysiological implications of early treatment. Acta Otolaryngol 124(6): 655–663, 2004

Longhini AB, Ferguson BJ: Clinical aspects of odontogenic maxillary sinusitis: a case series. Int Forum Allergy Rhinol 1(5): 409–415, 2011

Matsumoto Y, Ikeda T, Yokoi H, Kohno N: Association between odontogenic infections and unilateral sinus opacification. Auris Nasus Larynx 4(4): 288–293, 2015

Patel NA, Ferguson BJ: Odontogenic sinusitis: an ancient but under-appreciated cause of maxillary sinusitis. Curr Opin Otolaryngol Head Neck Surg 20(1): 24–28, 2012

Shahbazian M, Jacobs R: Diagnostic value of 2D and 3D imaging in odontogenic maxillary sinusitis: a review of literature. J Oral Rehabil 39(4): 294–300, 2012

Simuntis R, Kubilius R, Vaitkus S: Odontogenic maxillary sinusitis: a review. Stomatologija 16(2): 39–43, 2014

Tomomatsu N, Uzawa N, Aragaki T, Harada K: Aperture width of the osteomeatal complex as a predictor of successful treatment of odontogenic maxillary sinusitis. Int J Oral Maxillofac Surg 43(11): 1386–1390, 2014

Troeltzsch M, Pache C, Troeltzsch M, Kaeppler G, Ehrenfeld M, Otto S, Probst F: Etiology and clinical characteristics of symptomatic unilateral maxillary sinusitis: a review of 174 cases. J Craniomaxillofac Surg 43(8): 1522–1529, 2015

Wang KL, Nichols BG, Poetker DM, Loehrl TA: Odontogenic sinusitis: a case series studying diagnosis and management. Int Forum Allergy Rhinol 5(7): 597–601, 2015

Zirk M, Dreiseidler T, Pohl M, Rothamel D, Buller J, Peters F, Zöller JE, Kreppel M: Odontogenic sinusitis maxillaris: a retrospective study of 121 cases with surgical intervention. J Craniomaxillofac Surg 45(4): 520–525, 2017