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Simultaneous endoscopic endonasal sinus surgery and sinus augmentation with immediate implant placement: A retrospective clinical study of 23 patients

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ABSTRACT

Objective: The aim of this study was to evaluate the efficacy of simultaneous endoscopic endonasal sinus surgery and sinus augmentation with immediate implant placement.
Patients and methods: The study patients ($n = 23$) were partially or completely edentulous in the posterior maxilla and required maxillary sinus augmentation. All included patients had a sinus pathology confirmed clinically and radiographically. The technique of simultaneous endoscopic endonasal sinus surgery and sinus augmentation was used in 15 patients, with eight endonasal sinus surgery procedures being performed 2–3 months before sinus augmentation. Where possible, implants were placed during the same surgical procedure (with a ridge bone height of at least 4 mm).
Results: There were no any major intraoperative complications. Implants placed in the reconstructed areas were shown to integrate normally, and postoperative occlusal function and aesthetics were favorable. Of the 95 implants placed in these 23 patients, two failed to osseointegrate.
Conclusion: The method of simultaneous endoscopic endonasal sinus surgery and sinus augmentation with immediate implant placement leads to a reduction in postoperative complications, significantly shortening the rehabilitation period for patients with maxillary sinus diseases and insufficient bone tissue.

1. Introduction

Success of dental implants depends largely on the quality and quantity of available bone in the recipient site. The posterior region of the edentulous maxilla often presents insufficient bone quantity and quality for prosthetic rehabilitation with endosseous implants. The loss of the alveolar ridge due to trauma, periodontal disease, extraction of maxillary posterior teeth, or pneumatization of the maxillary sinus can make it difficult to position the implant (Sharan and Madjar, 2008; Cavalcanti et al., 2018).

In unfavorable anatomical situations, sinus augmentation procedures are required prior to, or simultaneously with, implant placement.

Over the last three decades, several surgical procedures have been proposed for maxillary sinus elevation, which differ in terms of surgical approach and bone graft materials. All the approaches have demonstrated a high level of predictability. Nowadays the most popular surgical techniques for sinus floor elevation are the external lateral window approach and the internal transalveolar approach (Beretta et al., 2015).

The sinus lift operation has been used since the early 1980s (Boyne and James) to gain vertical bone height in atrophic regions of the posterior maxilla, prior to the placement of dental implants (Boyne and James, 1980). Following the creation of a window in the buccal side of the sinus, the Schneiderian membrane is elevated prior to bone placement in order to increase bone volume.

The transalveolar technique described by Summers in 1994 is indicated for a sinus floor when residual bone height is at least 6 mm and crest bone width is adequate for implant placement (Summers, 1994). It is also known as the 'closed sinus lift'. The transcrestal sinus lift, using sinus crest, can be performed

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successfully for single or multiple sites in which bone height is insufficient.

Sinus floor augmentation with autogenus bone grafts or with biomaterials has long been the predominant procedure, and is well documented in the literature (Jensen et al., 1998; Misch, 1999; Chanavaz, 2000; Nasr et al., 2016; Antonoglou et al., 2018; Carreño et al., 2016; Esposito et al., 2010).

Various complications of sinus lift have been reported in the literature. These include: obstruction of the antronasal foramen, bleeding, infection, infraorbital nerve laceration, acute maxillary sinusitis, wound dehiscence, and Schneiderian membrane perforations, with consequent scattering of the grafting material in the sinus cavity (Jung et al., 2007; Schwartz-Arad et al., 2004; Bhattacharyya, 1999).

The presence of pathological conditions in the nasal–maxillary complex should be considered a contraindication for sinus floor elevation(Beaumont et al., 2005).

The maxillary sinus may be involved in a wide variety of disorders. Maxillary sinus diseases can be grouped as: non-neoplastic, neoplastic benign, or neoplastic malignant. Inflammatory processes, infections, cysts, polyps, and mucoceles are examples of non-neoplastic lesions. Papilloma, fibro-osseous, and mesenchymal tumors are benign neoplasms. Squamous cell carcinoma, adenocystic carcinoma, adenocarcinoma, and sarcoma are types of malignant tumor that can affect the maxillary sinus (Stephens and Saleh, 2013).

Sinus diseases and abnormalities are prevalent (40%) in patients scheduled for sinus lift procedures, and the presence of these conditions is significantly correlated with a history of indicative symptoms (Schaefer, 1998; Beaumont et al., 2005).

Sinus membrane pathology can potentially complicate the postprocedural course of sinus lift. The sinus membrane, characterized by a periosteum overlaid with a thin layer of pseudociliated, stratified respiratory epithelium, constitutes an important barrier for the protection and defense of the sinus cavity. Its integrity is essential for maintaining the healthy function of the sinus and to avoid dislocation of grafting material, local inflammation, and resorption of the bone graft. If the membrane integrity is damaged, graft particles can pass through mucosa perforation or laceration into the sinus cavity, resulting in severe or chronic sinusitis. It is well known that the presence of preoperative rhinosinusal disease is highly correlated with the development of acute sinusitis after sinus floor augmentation procedures (Tidwell et al., 1992).

To avoid the loss of the graft and inserted implants in cases of sinus pathology, surgery is necessary in order to promptly restore maxillary sinus ventilation and drainage. The removal of these lesions is recommended in order to limit intra- and postoperative complications. Chronic odontogenic sinusitis and rhinosinusitis are highly prevalent diseases of the paranasal sinus. Different treatment options exist for treatment of sinus pathology. Endoscopic sinus surgery is an effective treatment for medically recalcitrant chronic rhinosinusitis (Veloso-Teles and Cerejeira, 2017). Management of odontogenic sinusitis needs to be tailored to each individual patient, and involves varying combinations of medical management, dental surgery, and sinus surgery.

Previously, the Caldwell-Luc method was performed for the treatment of sinus pathology. Classic Caldwell-Luc surgery is characterized by radical removal of the sinus mucosa, defects of the lateral wall maxillary sinus, and establishment of a drainage channel into the lower nasal cavity. This can often lead to complications, including blood loss, facial swelling, cheek discomfort, facial asymmetry, facial paresthesia, and recurrent sinusitis (Datta et al., 2016; Schneider et al., 2015). De Freitas and Lucente reported that the Caldwell-Luc procedure had a high complication rate, in which immediate postoperative complications occurred in 89% of patients, with approximately 19% of patients having major chronic complications as a result of the operation (DeFreitas and Lucente, 1988). Several modifications have been reported in the literature, including bony wall reimplantation and sinus membrane preservation, with or without inferior meatal antrostomy (Huang & Chen, 2012; Kurokawa et al., 2002). Lindorf reported on the removal of the bone piece during surgical access, with this being immediately reusable as free bone for defect closure (Lindorf, 1984).

Revision sinus surgery for diseases of maxillary sinus has been revolutionized by endoscopic techniques used in maxillary sinus surgery. Endoscopic sinus surgery was introduced in the 1960s by Professors Messerklinger and Wigand, and was popularized by Stammberger and Kennedy (Stammberger and Posawetz, 1990; Kennedy, 1985). An endoscope is passed through the nose and provides a view of conditions such as pathological sinus mucosa, osteomeatal complex condition, and polyps. The natural ostium is widened surgically and only infected sinus mucosa is removed, leaving the basement membrane intact. Thus, natural sinus mucosa is preserved and mucocilliary clearance is not disturbed. The features of endoscopic sinus surgery allow for the restoration of the physical function of the sinus membrane and preservation of the physiological environment of the sinus. This technique is now widely accepted as the standard approach for patients who require surgical treatment of various sinus pathologies. Due to the proximity to anatomical structures such as the orbital nerve, internal carotid, and eyes, this procedure requires high experience and precision (Akhlaghi et al., 2015).

Treating maxillary sinus pathology by endoscopic approaches, prior to implant insertion and/or sinus augmentation, is crucial for a better outcome of the dental procedure. The literature suggests a surgical-endoscopic approach to remove intrasinusal lesions, in order to allow a possible sinus lift procedure and implant insertion (Costa et al., 2007; Andric, 2010; Draf, 1992). However, studies comparing the effectiveness of single-step endoscopic endonasal sinus surgery and simultaneous sinus-lifting with the results of the two-stage operation will be necessary, because scientific evidence is lacking.

The aim of this study was to assess the effectiveness of simultaneous endoscopic endonasal sinus surgery and sinus augmentation with immediate implant placement.

2. Materials and methods

This retrospective study included 23 patients (14 males and 9 females, aged 28–62 years), who needed prosthetic rehabilitation in the posterior maxillary area, and who presented with sinus pathologies on radiographic evaluation, between 2014 and October of 2018. All patients signed an informed consent form. The investigation was approved by the Yerevan State Medical University Ethics Committee (protocol N3 17.11.16).

Inclusion criteria included:

1) a residual alveolar ridge height of <5 mm;
2) sinus pathology before augmentation.

All patients were assessed preoperatively, determining both their dental and general health status. Radiographic parameters, including preoperative remaining bone height, augmented bone height, and bone density, were evaluated preoperatively and at 6 and 12 months after surgery using CT. Analysis of complex anatomy by CT helped in reducing potential complications. The CT scans were obtained to evaluate any pathology of the sinuses. Software programs were used to calculate the existing preoperative residual bone height in millimetres.

To assess the effectiveness of simultaneous endoscopic endonasal sinus surgery and sinus augmentation, patients were randomly divided in two groups:

- a basic group of 15 patients on whom endonasal sinus surgery was performed simultaneously with sinus lifting,
- a control group of eight patients on whom endonasal sinus surgery was performed 2–3 months before sinus lifting.

The surgical indications in the basic group included two patients presenting with maxillary sinus pseudocyst, 10 with chronic rhinosinusitis, and three with foreign bodies (filling material) in the maxillary sinus, resulting in sinusitis (Table 1).

In the control group, one patient presented with maxillary sinus pseudocyst, one with odontogenic cyst, four with chronic rhinosinusitis, one with chronic odontogenic sinusitis, and one with foreign bodies in the maxillary sinus, resulting in sinusitis (Table 1).

All patients signed an informed consent for surgery and participation in scientific studies.

2.1. Surgical technique

Patients were given Ceftriaxone injection (1 g once daily) for 3 days, followed by oral amoxicillin clavulanate (875 mg twice daily) and ibuprofen (600 mg three times a day), both for 7 days following surgery. All patients were instructed to rinse their mouths using 0.12% chlorhexidine gluconate three times a day for 7 days.

The first procedure was always the endoscopic endonasal sinus surgery. This was performed in all the patients through an enlarged natural sinus ostium in the middle nasal meatus. All operations were carried out under general anesthesia. Rigid 0°/30°/45°/70°/90°/2.7-mm/4.0-mm endoscopes (Karl Storz, Tuttlingen, Germany) and a monitor were used for inspection and treatment of the maxillary sinus. The middle meatus was visualized and the uncinated process was identified and medialized, with the lower two-thirds removed using backbiting forceps. The ostium was enlarged to a size that allowed access to the sinus with appropriate instruments. The cysts, fungal material, and hypertrophic mucosa within the maxillary sinus were removed and sent for pathological analysis. At the end of the procedure a haemostatic sponge was placed in the middle meatus. The packing was removed on the following day.

Sinus lifting procedures were performed using a lateral window approach. Osteotomy was performed on the lateral surface of the sinus wall using a round drill. After exposing the sinus membrane, this was dissected carefully from the sinus floor walls using a flat, blunt-edged instrument. After the elevation of the sinus membrane, the dental implant sites were prepared using low-speed calibrated burrs, specific to the implant system used. The cavity between the sinus membrane and the sinus floor was filled in with a mixture of particulate bovine bone graft (Bio-Osss, Geistlich Pharma, Wolhusen, Switzerland), autologous bone, and platelet-rich plasma (PRP), and the dental implants were inserted with a good primary stability. In the three cases of bilateral sinus lift, the graft was harvested from the anterior iliac crest; in the 14 cases of monolateral sinus lift the graft was harvested from the mandibular ramus; and in the other six cases the graft was harvested from the maxillary tuberosity using a bone scraper (safescraper twist-META, Reggio Emilia, Italy). The grafting materials used are presented in Table 2.

Table 2
Grafting materials used for sinus lifting.

Grafting material	Number
Xenograft Bio-Oss	26
Autograft from anterior iliac crest	6
Autograft from mandibular ramus	14
Autograft from maxillary tuberosity	6

Table 1
Details of individual patients and their sinus pathologies.

Patients	Age	Gender	Patient group	Sinus pathology	Sinus surgery performed simultaneously with sinus-lifting	Sinus surgery performed 2–3 months before sinus lifting
N.1	35	M	Basic	Chronic rhinosinusitis	+	–
N.2	43	M	Basic	Foreign bodies in maxillary sinus with sinusitis	+	–
N.3	46	F	Basic	Chronic rhinosinusitis	+	–
N.4	57	M	Basic	Maxillary sinus pseudocyst	+	–
N.5	41	F	Basic	Foreign bodies in maxillary sinus with sinusitis	+	–
N.6	39	F	Basic	Chronic rhinosinusitis	+	–
N.7	48	M	Basic	Maxillary sinus pseudocyst	+	–
N.8	54	M	Basic	Chronic rhinosinusitis	+	–
N.9	49	M	Basic	Foreign bodies in maxillary sinus with sinusitis	+	–
N.10	61	M	Basic	Chronic rhinosinusitis	+	–
N.11	42	M	Basic	Chronic rhinosinusitis	+	–
N.12	32	F	Basic	Chronic rhinosinusitis	+	–
N.13	59	M	Basic	Chronic rhinosinusitis	+	–
N.14	62	F	Basic	Chronic rhinosinusitis	+	–
N.15	39	M	Basic	Chronic rhinosinusitis	+	–
N.16	53	F	Control	Chronic rhinosinusitis	–	+
N.17	58	F	Control	Maxillary sinus pseudocyst	–	+
N.18	46	M	Control	Foreign bodies in maxillary sinus with sinusitis	–	+
N.19	43	M	Control	Odontogenic cyst	–	+
N.20	54	F	Control	Chronic rhinosinusitis	–	+
N.21	38	M	Control	Chronic rhinosinusitis	–	+
N.22	46	F	Control	Chronic odontogenic sinusitis	–	+
N.23	52	M	Control	Chronic rhinosinusitis	–	+

Immediate implant placement (one-stage sinus lifting protocol) was performed when a mean bone height of at least 4 mm was present on CT examination. For the one-stage protocol the implant site was prepared and the implant inserted in the residual subantral bone. The cavity between the sinus membrane and the sinus floor was filled in with a mixture of particulate bovine bone graft, autogenous bone, and platelet-rich plasma (PRP). The osteotomy window was covered with the PRP membrane before flap closure. The muco-periostal flap was sutured using 3.0 silk suture. Hospitalization after surgery varied from 1 to 2 days. The sutures were removed 10–14 days postoperatively (Figs. 1–4).

Two-stage sinus lifting protocol was performed when there was a mean bone height of less than 4mm (implant placement 5 months after sinus lifting procedure). A total of 26 sinus augmentation procedures were performed — in three out of 23 patients the sinus floor elevation was performed bilaterally. The technique of simultaneous endoscopic endonasal sinus surgery and sinus augmentation with immediate implant placement was used in 13 patients (58 implants) in the basic group and seven patients (26 implants) in the control group. Delayed implant placement was carried out in two patients (seven implants) in the basic group and in one patient (four implants) in the control group. In total there were 95 dental implants placed in conjunction with the augmented maxillary sinus. The diameters of the implants used ranged from 3.75 to 4.2 mm, with lengths of 10–13 mm, depending on the bone morphology. Postoperatively the patients were instructed to not blow their nose, to sneeze with the mouth wide open, and to avoid drinking with straws, in order not to modify the air pressure inside the maxillary sinus.

Any intraoperative and postoperative complications, such as bleeding, membrane perforation, swelling, ecchymosis, pain, nasal bleeding, and infection, were recorded clinically and radiographically. The following parameters were assessed: failure of the augmentation procedure, implant failure, and vertical bone height.

The gain in bone height was measured by comparing the preoperative and final dental CT scan cross-sections (preoperative residual ridge height and postoperative bone graft height).

Implant success was assessed clinically and radiographically. Implants were characterized as surviving by the following criteria: absence of persistent pain; absence of peri-implant infection with suppuration; absence of mobility; and absence of continuous peri-implant radiolucency (Albrektsson et al., 1986). Criteria for failure included implant mobility and radiographic bone loss (>1/3 implant height). Dental prosthetic rehabilitation was undertaken 6 months after implant insertion and submerged healing.

2.2. Statistical analysis

Statistical analysis was performed with Microsoft Office Excel 2007 and Biostat software. The Student t-test was used to correlate the mean initial residual crest height with the bone height gained by sinus lift 1 year after the operation. Mean values were calculated for the two groups. Differences were considered significant if p-values were <0.05.

3. Results

No major complications were encountered in our study. Membrane perforation 1–2 mm in diameter occurred in two patients in the basic group, and in three patients in the control group. This was closed with PRP and a resorbable membrane. Perforation of the membrane base of the maxillary sinus did not occur during sinus lifting in any patients. There was one case of bleeding in a patient in the basic group, which was controlled with a nasal pack.

On the first day after surgical treatment, 4 patients in the basic group were troubled by pain in the operation area, difficulty in nasal breathing, and bloody discharge from the nose. 2–3 days after the operation, minor swelling in the buccal and infraorbital areas was noted from the side of the intervention. By the fifth day after

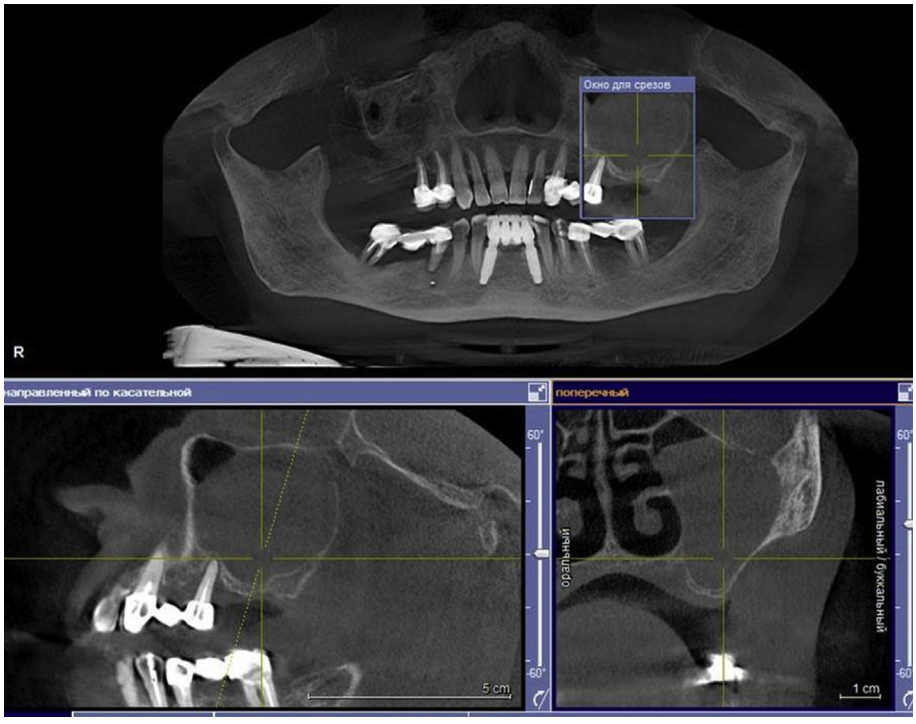

Fig. 1. Preoperative CT scan of a patient with a large maxillary sinus pseudocyst.

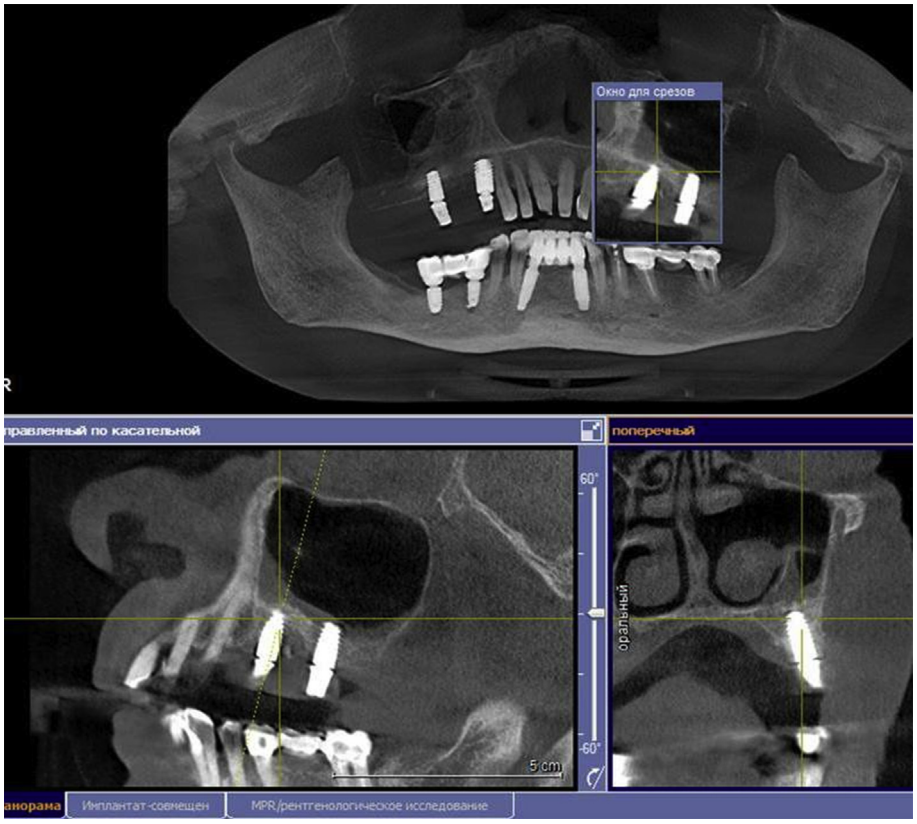

Fig. 2. Postoperative CT scan of a patient with maxillary sinus large pseudocyst following simultaneous endonasal sanitation of the maxillary sinus, sinus-lifting, and dental implantation.

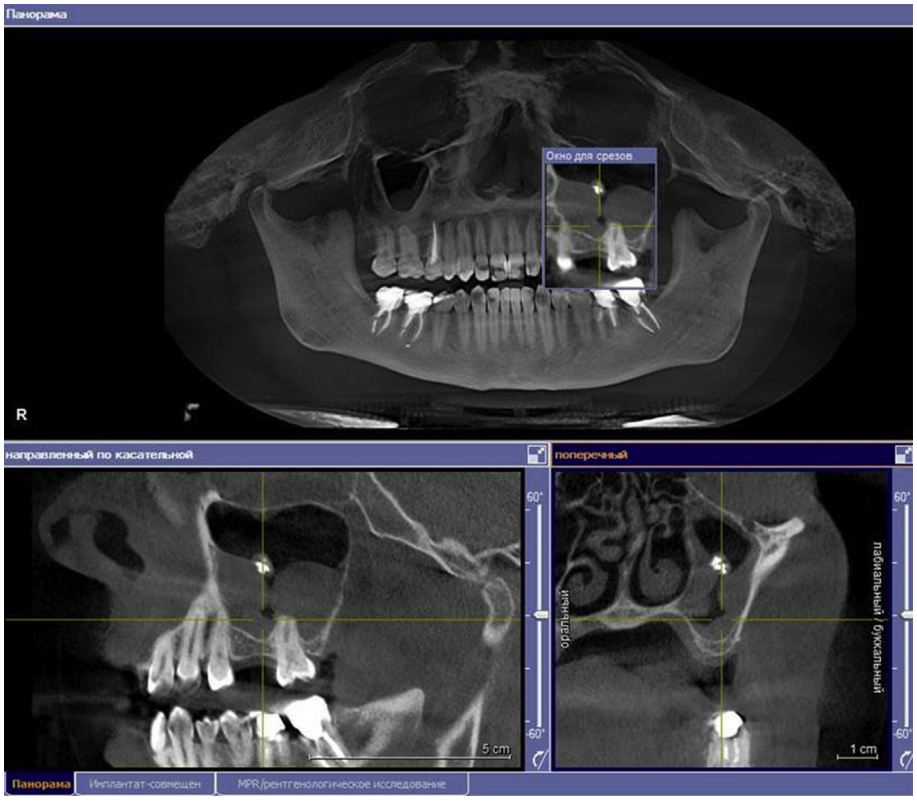

Fig. 3. Preoperative CT scan of a patient with polyposive sinusitis, showing foreign bodies in the maxillary sinus (filling material).

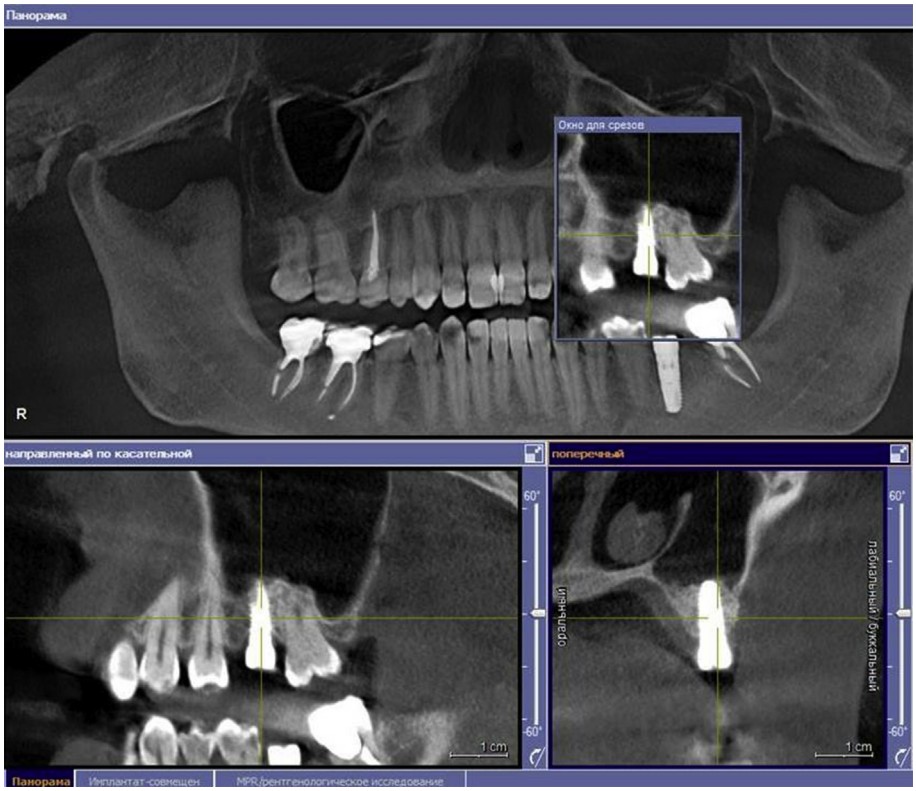

Fig. 4. Postoperative CT scan of a patient with foreign body of the maxillary sinus (filling material) with polyposive sinusitis following simultaneous endonasal sanitation of the maxillary sinus, sinus-lifting, and dental implantation.

the operation, soft tissue edema was not observed, edema of the inferior nasal concha and the oral mucosa decreased, and patients noted improvement in nasal breathing compared with the first 24 h after the operation.

For patients in the control group facial swelling and pain after surgery were mild. Nasal bleeding occurred in the membrane perforation cases on the first day after the operation. On the 10th day postoperatively, the mucosal wound had healed uneventfully in all patients. Sinusitis after sinus lifting with implantation was observed in two patients in the control group. This was managed conservatively (Table 3).

After 3 weeks, the edges of the enlarged natural ostium of the maxillary sinus were completely epithelialized, with no swelling or hyperemia. No complications, such as infection of the grafted material or acute sinusitis, were registered during the postoperative period or at follow-up in all the surgical sites. CT scans were used to assess the bone height gained with sinus lift. CT scans also showed good integration of the grafting material in all the patients. Statistical results relating to bone height achieved 1 year after the operation were as follows:

Mean initial bone height for the basic group was 3.8 mm, with mean height 1 year after the operation reaching 12.2 mm, giving a mean increase in height of 8.4 mm ($p < 0.001$).

Mean initial bone height for the control group was 4.2 mm, with mean height 1 year after the operation reaching 12.4 mm, giving a mean increase in height of 8.2 mm ($p < 0.001$) (Table 4).

There was no significant difference in vertical alveolar bone gain between the two groups. All cases showed good integration and consolidation of the graft material used for maxillary sinus floor augmentation. Loss of graft materials did not occur in any case. CT examination showed the presence of dense bone around and above the implants.

Of the 95 implants placed in these 23 patients, two were lost during the osseointegration period (one in the basic group and one in the control group), giving a final implant osseointegration rate of 97.8%. Crestal bone loss in implants was assessed using standardized periapical radiographs after 1 year. Mean crestal bone loss was 0.51 mm in the basic group and 0.54 mm in the control group; this difference was not significant (Table 5).

The surgical procedure performed on our patients involved either a 1- or 2-stage sinus lifting. No statistically significant differences were found between implants placed using either the 1- or 2-stage procedure. The patients were followed up for a mean period of 36 months after prosthetic loading implants were lost. Patients was satisfied with the esthetic and functional results.

Table 3
Complications following endoscopic sinus surgery.

Complications	Number of basic group patients ($n = 15$)	Number of control group patients ($n = 8$)
Membrane perforation	2	3
Nasal bleeding	1	3
Sinusitis	0	2
Pain in the operation area	3	2
Total	15	8

Table 4
Bone height gain following sinus lift.

	Number of basic group patients ($n = 15$)	Number of control group patients ($n = 8$)
Mean initial bone height	3.8 mm	4.2 mm
Mean height bone one year after the operation	12.2 mm	12.4 mm
Mean increase in height	8.4 mm	8.2 mm

Table 5
Crestal bone loss in implants after 1 year.

Mean crestal bone loss	Number of basic group patients ($n = 15$)	Number of control group patients ($n = 8$)
	0.51 mm	0.54 mm

4. Discussion

Maxillary sinus floor elevation is considered a safe and predictable procedure, provided that the maxillary sinus is healthy. Contraindications can be represented by several clinical conditions, such as anatomical/structural impairments of the maxillary sinus drainage pathways (for example, a concha bullosa or septal deviations) or sinus pathology (chronic rhinosinusitis, odontogenic sinusitis, odontogenic cysts, pseudocysts, mucoceles and retention cysts, and benign naso-sinusal neoplasms of limited extent). Several etiological factors contribute to the pathogenesis of sinus pathology, including allergens, inflammatory disorders, and odontogenic and rhinogenic infectious agents (viral, bacterial, and fungal) (Nolan et al., 2014).

The presence of these conditions might increase the difficulty in performing sinus augmentation surgery and the risk of developing postoperative complications. In these patients, the reduction in maxillary sinus dimensions and the potential inflammatory reaction, resulting from the sinus floor elevation procedure, could expose the patient to a high risk of obstruction of the sinus and osteo-meatal complex, with reduction of sinus ventilation, stasis of sinusal secretions, and consequent development of maxillary sinusitis and/or infection of the graft material used for sinus elevation (Manor et al., 2010; Anavi et al., 2008).

Inflammatory disease and maxillary sinus cyst are the most common pathological conditions involving the maxillary sinus. It has been reported that of all cases of maxillary sinusitis, the incidence of odontogenic maxillary sinusitis ranges between 10% and 12% (Mehra and Murad, 2004).

Odontogenic sinusitis is associated with a wide range of etiologies, including complications linked with dental treatments (dental extractions, endodontic treatments, etc.). The treatment protocol for chronic odontogenic sinusitis patients requires a surgical approach in order to achieve an acceptable success rate. This protocol differs from that for common chronic rhinogenic sinusitis mostly because of the differing etiopathogenesis. Successful management of odontogenic sinusitis involves a combination of medical treatment, dental surgery and/or endoscopic sinus surgery. Endoscopic sinus surgery can be carried out via a classic (lateral wall maxillary sinus) or endonasal approach. It is much less invasive and more physiological compared with an approach via the anterior antral wall. Endoscopic sinus surgery as an alternative to an intraoral surgical approach is now widely applied in the treatment of chronic odontogenic maxillary sinusitis, with favorable long-term outcomes.

Chronic rhinosinusitis (CRS) is a group of disorders characterized by inflammation of the mucosa of the nose and maxillary sinuses for at least 12 consecutive weeks. Chronic rhinosinusitis without nasal polyps is characterized by histological abnormalities, including basement membrane thickening (fibrosis) and goblet cell hyperplasia. The pathophysiology of chronic rhinosinusitis is specific to the type of disease perpetuating the inflammation, and is often characterized by a unique cytokine profile (Cho et al., 2016). Treatments are aimed at reducing mucosal inflammation, controlling infection, and restoring mucociliary clearance within the sinuses. Sinus surgery is generally reserved for patients who remain symptomatic despite maximal medical therapy. Functional endoscopic sinus surgery has been the most effective method in curing CRS for patients who do not satisfactorily respond to appropriate medical treatment (Bunzen et al., 2006).

Kayabasoglu et al. showed that patients who have a history of sinusitis are at a higher risk for developing postoperative sinusitis following a dental implant (Kayabasoglu et al., 2014). Timmenga et al. showed that maxillary sinusitis as a complication of sinus floor augmentation is significantly more prevalent in patients with a predisposition to sinusitis or a history of chronic sinusitis (Timmenga et al., 2003).

Dome-shaped radiopacities on the floor of the maxillary sinus are commonly interpreted as sinus cysts on radiographs during dental implant planning. Maxillary sinus lesions, including mucoceles, radicular cysts, retention cysts, and pseudocysts, located on the floor of the maxillary sinus can hinder the sinus-lifting procedure. Most cystic masses are asymptomatic, with incidental imaging findings of certain polypoid masses requiring expert consultation, histological assessment, and surgical intervention (Jorissen, 1996). Cystic lesions in the maxillary sinus have been reported as factors increasing the risk of perforation during sinus-lifting operations. This may further lead to a reduction in size of the antrum due to sinus mucosa elevation, which can result in blockage of the ostium and development of sinusitis (Chan and Wang, 2011).

The indications for sinus augmentation in patients with sinus cysts are not clearly defined in the literature. Some authors suggest that cysts of the maxillary sinus are a contraindication for sinus augmentation. They recommend sinus lifting at least 3–6 months after cyst removal (Ziccardi and Betts, 1999; Lin et al., 2010). Others suggest combining sinus lifting with aspiration or removal of maxillary sinus pseudocysts in order to shorten the healing time, or even sinus lifting without sinus pseudocyst removal (Baykul and Findi, 2014; Oh et al., 2014; Kfir et al., 2014; Kim et al., 2016; Mardinger et al., 2007; Celebi et al., 2011) (Table 6).

Recent technological advances in the field of endoscopy have resulted in substantial improvements in endoscope-controlled surgery of paranasal sinuses (Felasti, 2010).

Progress with nasal endoscopy has improved understanding of the role of the sinus mucosa and the patency of the osteo-meatal complex in preventing sinus pathologies, and emphasised the importance of a minimally invasive surgical approach. Endoscopic sinus surgery is widely used these days to remove sinus mucosa lesions and foreign bodies while preserving the physiological function of the sinus. This technique is associated with significantly lower morbidity and higher success rates than previous surgical approaches, and is continuing to evolve. Endoscopic sinus surgery is currently regarded as the gold standard treatment for sinus pathology; however, this procedure requires high experience and precision (Tajudeen and Kennedy, 2017; Chiu and Kennedy, 2004; Mattos et al., 2016; Saibene et al., 2016; Bhagwat et al., 2015; Vereanu et al., 2015; Tobita et al., 2011).

Modern trends in dental implantation aim to minimize surgical trauma and reduce rehabilitation time for patients.

In our clinical study, a comparative evaluation of the effectiveness of a one-stage surgical procedure (endonasal sinus surgery performed simultaneously with sinus lifting) and a two-stage surgical procedure (endonasal sinus surgery performed 2–3 months before sinus lifting) was conducted. Based upon in our clinical experience, single-stage endoscopic endonasal sinus surgery is highly effective, with results comparable with those of the two-stage operation.

To assess the effectiveness of functional endoscopic sinus surgery as a treatment for chronic rhinosinusitis, sinus surgery was performed simultaneously with sinus-lifting in 10 patients (seven patients with immediate implant placement) and 2–3 months

Table 6
Summary of the literature review.

Study	Number of patients (*n*)	Pathologies	Sinus lifting technique	Intraoperative complications	Postoperative complications
Mardinger et al. (2007)	8	Maxillary sinus pseudocyst	Lateral	Two membrane perforation	1 (acuta sinusitis)
Lin et al. (2010)	11	Maxillary sinus pseudocyst	Lateral	None	None
Celebi et al. (2011)	4	Maxillary sinus pseudocyst	Two lateral, two crestal	None	None
Delilbasi et al. (2014)	7	Maxillary sinus pseudocyst	Lateral	One membrane perforation	None
Baykul and Findi (2014)	1	Maxillary sinus pseudocyst	Lateral	One membrane perforation	None
Oh et al. (2014)	2	Maxillary sinus pseudocyst	Crestal	None	None
Kfir et al. (2014)	16	Maxillary sinus pseudocyst	Crestal	None	None
Kim et al. (2016)	8	Maxillary mucous retention cyst	10 lateral	None	None
Kayabasoglu et al. (2014)	94	Rhinosinusitis	155 lateral	None	Four sinusitis

before sinus-lifting in four patients (two patients with immediate implant placement). No statistically significant differences in effectiveness were found between simultaneous endoscopic endonasal sinus surgery with sinus lifting and delayed sinus lifting.

Our results show that, in the presence of an average bone height of at least 4 mm, simultaneous endoscopic endonasal sinus surgery and sinus lift with immediate implant placement are recommended. The results also show that immediate dental implant placement is possible in cases of sinus cyst, and hence this does not represent a contraindication if cautious surgical procedures are followed.

The one-step procedure proposed in this study not only avoids the patient having to undergo a second surgical procedure, but it is also more cost-effective, and significantly shortens the rehabilitation time for patients with insufficient bone tissue in the area of the maxillary sinus.

An endoscopic surgical approach is required to remove intrasinusal lesions, in order to allow the sinus lift procedure and implant insertion to be carried out.

5. Conclusion

Simultaneous endonasal endoscopic sinus surgery and sinus augmentation with immediate implant placement has proven to be both effective and safe, and has allowed patients to avoid longer waiting periods before final prosthetic rehabilitation. These methods are relatively comfortable and predictable, and able to achieve good results, provided the surgery is carried out accurately and with care.

Conflict of interest

The authors declare no conflict of interest

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Compliance with ethical standards

Disclosure

The authors claim to have no financial interest, either directly or indirectly, in the products or information listed in the paper. No financial support has been received from any oral implant manufacturer.

Protection of human and animal subjects

The authors declare that the procedures followed were in accordance with the regulations of the responsible Clinical Research Ethics Committee at Yerevan State Medical University, after M. Heratsi (protocol N3 17.11.16), and in accordance with those of the World Medical Association and the Helsinki Declaration.

Consent statement

Written informed consent was obtained from the patients for publication of this case report and accompanying images.

Role/contribution of each co-author

Khachatryan Grigor, Khachatryan Levon, and Hakobyan Gagik conceived the study and participated in its design and coordination.

Khachatryan Grigor, Khachatryan Anna, and Hakobyan Gagik made substantial contributions to data acquisition and conception of the manuscript.

Hakobyan Gagik and Khachatryan Levon drafted and finalized the manuscript.

All authors read and approved the final manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcms.2019.04.004.

References

Akhlaghi F, Esmaeelinejad M, Safai P: Etiologies and treatments of odontogenic maxillary sinusitis: a systematic review. Iran Red Crescent Med J 17: 25536, 2015

Albrektsson T, Zarb G, Worthington P, Eriksson AR: The long-term efficacy of currently used dental implants: a review and proposed criteria of success. Int J Oral Maxillofac Implant. 1: 11–25, 1986

Anavi Y, Allon DM, Avishai G, Calderon S: Complications of maxillary sinus augmentations in a selective series of patients. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 106: 34–38, 2008

Andric M: Endoscopic surgery of the maxillary sinuses in oral and maxillofacial surgery practice: a literature review. Hellenic Arch Oral Maxillofac Surg 2(2): 57–68, 2010

Antonoglou GN, Stavropoulos A, Samara MD, et al: Clinical performance of dental implants following sinus floor augmentation: a systematic review and meta-analysis of clinical trials with at least 3 years of follow-up. Int J Oral Maxillofac Implant. 33(3): 45–65, 2018

Baykul T, Findi Y: Maxillary sinus perforation with presence of an antral pseudocyst, repaired with platelet rich fibrin. Ann Maxillofac Surg 4(2): 205–207, 2014

Beaumont C, Zafiropoulos GG, Rohmann K, Tatakis DN: Prevalence of maxillary sinus disease and abnormalities in patients scheduled for sinus lift procedures. J Periodontol 76: 461–467, 2005

Beretta M, Poli PP, Grossi GB, Pieroni S, Maiorana C: Long-term survival rate of implants placed in conjunction with 246 sinus floor elevation procedures: results of a 15-year retrospective study. J Dent 43: 78–86, 2015
Bhagwat H, Sheikh S, Wadhwania A, Patil N, Ahmed Z: Endoscopy in oral and maxillofacial surgery. Int J Oral Health Med Res 2(4): 98–101, 2015
Bhattacharyya N: Bilateral chronic maxillary sinusitis after the sinus lift procedure. Am J Otolaryngol 20(2): 133–135, 1999
Boyne PJ, James RA: Grafting of the maxillary sinus floor with autogenous marrow and bone. J Oral Surg 38: 613–616, 1980
Bunzen DL, Campos A, Leão FS, Morais A, Sperandio F, Caldas Neto S: Efficacy of functional endoscopic sinus surgery for symptoms in chronic rhinosinusitis with or without polyposis. Braz J Otorhinolaryngol 72(2): 242–246, 2006
Carreno JC, Aguilar-Salvatierra A, Gomez-Moreno G, García Carreño EM, Menéndez López-Mateos ML, Perrotti V, et al: Update of surgical techniques for maxillary sinus augmentation: a systematic literature review. Implant Dent 25(6): 839–844, 2016
Cavalcanti MC, Guirado TE, Sapata VM, Costa C, Pannuti CM, Jung RE, et al: Maxillary sinus floor pneumatization and alveolar ridge resorption after tooth loss: a cross-sectional study. Braz Oral Res 32: 64, 2018
Celebi N, Gonen ZB, Kilic E, Etoz O, Alkan A: Maxillary sinus floor augmentation in patients with maxillary sinus pseudocyst: case report. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 112: 97–102, 2011
Chan HL, Wang HL: Sinus pathology and anatomy in relation to complications in lateral window sinus augmentation. Implant Dent 20(6): 406–412, 2011
Chanavaz M: Sinus graft procedures and implant dentistry: a review of 21 years of surgical experience. Implant Dent 3: 197–203, 2000
Chiu AG, Kennedy DW: Surgical management of chronic rhinosinusitis and nasal polyposis: a review of the evidence. Curr Allergy Asthma Rep 4(6): 486–489, 2004
Cho SH, Kim DW, Gevaert P: Chronic rhinosinusitis without nasal polyps. J Allergy Clin Immunol Pract 4(4): 575–582, 2016
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
Datta RK, Viswanatha B, Shree Harsha M: Caldwell Luc surgery: revisited. Indian J Otolaryngol Head Neck Surg 68: 90–93, 2016
DeFreitas J, Lucente FE: The Caldwell-Luc procedure: institutional review of 670 cases: 1975–1985. Laryngoscope 98: 1297, 1988
Delilbasi C, Gokhan Gurler G, Burgaz I: Sinus lifting in the presence of pseudocyst: case series. OHDM 13(4): 259–262, 2014
Draf W: Endonasal surgery of the paranasal sinuses. HNO Praxis H Eute 12: 59–80, 1992
Esposito M, Grusovin MG, Rees J, Karasoulos D, Felice P, Alissa R, et al: Effectiveness of sinus lift procedures for dental implant rehabilitation: a Cochrane systematic review. Eur J Oral Implantol 3(1): 7–26, 2010
Felasti G: Maxillary sinus elevation in conjunction with transnasal endoscopic treatment of rhino-sinusal pathoses: preliminary results on 10 consecutively treated patients. Acta Otorhinolaryngol Ital 30(6): 289, 2010
Huang YC, Chen WH: Caldwell-Luc operation without inferior meatal antrostomy: a retrospective study of 50 cases. J Oral Maxillofac Surg 70: 2080–2084, 2012
Jensen OT, Shulman LB, Block MS, Iacono VJ: Report of the sinus consensus conference of 1996. Int J Oral Maxillofac Implant. 13(l): 11–45, 1998
Jorissen M: Recent trends in the diagnosis and treatment of sinusitis. Eur Radiol 6: 170–176, 1996
Jung JH, Choi BH, Jeong SM, Li J, Lee SH, Lee HJ: A retrospective study of the effects on sinus complications of exposing dental implants to the maxillary sinus cavity. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 103(5): 623–625, 2007
Kayabasoglu G, Nacar A, Altundag A, Cayonu M, Muhtarogullari M, Cingi C: A retrospective analysis of the relationship between rhinosinusitis and sinus lift dental implantation. Head Face Med 10: 53, 2014
Kennedy DW: Functional endoscopic sinus surgery. Arch Otolaryngol 111: 643–649, 1985
Kfir E, Goldstein M, Abramovitz I, Kfir V, Mazor Z, Kaluski E: The effects of sinus membrane pathology on bone augmentation and procedural outcome using minimal invasive antral membrane balloon elevation. J Oral Implantol 10(30): 286–293, 2014
Kim Seong-Beom, Yun Pil-Young, Kim Young-Kyun: Clinical evaluation of sinus bone graft in patients with mucous retention cyst. Maxillofac Plast Reconstr Surg 38(1): 35, 2016
Kurokawa H, Takeda S, Yamashita Y, Nakamura T, Takahashi T: Evaluation of a modified method for maxillary sinus surgery — reimplantation of the anterior bony wall of the maxillary sinus. Asian J Oral Maxillofac Surg 14: 144–147, 2002
Lin Y, Hu X, Metzmacher AR, Luo H, Heberer S, Nelson K: Maxillary sinus augmentation following removal of a maxillary sinus pseudocyst after a shortened healing period. J Oral Maxillofac Surg 68(11): 2856–2860, 2010
Lindorf HH: Osteoplastic surgery of the sinus maxillaris — the 'bone lid'-method. J Maxillofac Surg 12: 271–276, 1984
Manor Y, Mardinger O, Bietlitum I, Nashef A, Nissan J, Chaushu G: Late signs and symptoms of maxillary sinusitis after sinus augmentation. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 110: 1–4, 2010
Mardinger O, Manor I, Mijiritsky E: Maxillary sinus augmentation in the presence of antral pseudocyst: a clinical approach. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 103: 180–184, 2007
Mattos JL, Ferguson BJ, Lee S: Predictive factors in patients undergoing endoscopic sinus surgery for odontogenic sinusitis. Int Forum Allergy Rhinol 6: 697–700, 2016
Mehra P, Murad H: Maxillary sinus disease of odontogenic origin. Otolaryngol Clin North Am 37(2): 347–364, 2004
Misch CE: The maxillary sinus lift and sinus graft surgery. In: Contemporary implant dentistry. St Louis: Mosby, 469–495, 1999
Nasr S, Slot DE, Bahaa S, Dörfer CE, Fawzy El-Sayed K M: Dental implants combined with sinus augmentation: what is the merit of bone grafting? A systematic review. J Craniomaxillofac Surg 44(10): 1607–1617, 2016
Nolan PJ, Freeman K, Kraut RA: Correlation between Schneiderian membrane perforation and sinus lift graft outcome: a retrospective evaluation of 359 augmented sinus. J Oral Maxillofac Surg 72: 47–52, 2014
Oh JH, An X, Jeong SM, Choi BH: Crestal sinus augmentation in the presence of an antral pseudocyst. Implant Dent 26(6): 951–955, 2014
Saibene AM, Pipolo C, Maccari A, Lozza P, Chiapasco M, Scotti A, et al: One-step maxillary sinus augmentation in association with endoscopic sinus surgery: case series and review of the literature. Implant Dent 25(5): 698–702, 2016
Schaefer SD: Rhinology and sinus disease: a problem-oriented approach. St Louis: Mosby, 1998
Schneider JS, Day A, Clavenna M, Russell PT, Duncavage J: Early practice: external sinus surgery and procedures and complications. Otolaryngol Clin North Am 48: 839–850, 2015
Schwartz-Arad D, Herzberg R, Dolev E: The prevalence of surgical complications of the sinus graft procedure and their impact on implant survival. J Periodontol 75(4): 511–516, 2004
Sharan A, Madjar D: Maxillary sinus pneumatization following extractions: a radiographic study. Int J Oral Maxillofac Implant. 23(1): 48–56, 2008
Stammberger H, Posawetz W: Functional endoscopic sinus surgery, concept, indications and results of the Messerklinger technique. Eur Arch Otolaryngol 247: 63–76, 1990
Stephens JC, Saleh HA: Evaluation and treatment of isolated maxillary sinus disease. Curr Opin Otolaryngol Head Neck Surg 21(1): 50–57, 2013
Summers RB: A new concept in maxillary implant surgery: the osteotome technique. Compendium 15: 152–162, 1994
Tajudeen BA, Kennedy DW: Thirty years of endoscopic sinus surgery: what have we learned? World J Otorhinolaryngol — Head Neck Surg 2(3): 115–121, 2017
Tidwell JK, Blijdorp PA, Stoelinga PJ, Brouns JB, Hinderks F: Composite grafting of the maxillary sinus for placement of endosteal implants. A preliminary report of 48 patients. Int J Oral Maxillofac Surg 21(4): 204–209, 1992
Timmenga NM, Raghoebar GM, Weissenbruch van RVissink A: Maxillary sinus floor elevation surgery: a clinical, radiographic and endoscopic evaluation. Clin Oral Implant Res 14(3): 322–328, 2003
Tobita T, Nakamura M, Ueno T, Sano K: Sinus augmentation surgery after endoscopic sinus surgery for the treatment of chronic maxillary sinusitis: a case report. Implant Dent 20(5): 337–340, 2011
Veloso-Teles R, Cerejeira R: Endoscopic sinus surgery for chronic rhinosinusitis with nasal polyps: clinical outcome and predictive factors of recurrence. Am J Rhinol Allergy 31(1): 56–62, 2017
Vereanu AD, Savu MA, Patrascu E, Sarafoleanu C: Transnasal endoscopy — evaluation and treatment method for patients with sinus lift and dental implants indications. Rom J Rhinology 5(9): 179–184, 2015
Ziccardi VB, Betts NJ: Complications of maxillary sinus augmentation. In: Jensen OT: the sinus bone graft. Carol stream, Il. Quintessence Publishing, 201, 1999