Abstract. This study retrospectively analyses paranasal sinus complications following displacement of oral implants in the maxillary sinus treated according to clinical situation by functional endoscopic sinus surgery (FESS), an intraoral approach, or a combination of both procedures. Over 5 years, 27 patients (13 male; 14 female), aged 27–73 years (mean 53.9 years), underwent treatment for postoperative complications involving the paranasal sinuses following displacement of oral implants in the maxillary sinuses. According to the complication (implant displacement, implant displacement with or without reactive sinusitis and/or with or without associated oro-antral communication), patients were treated with FESS, intraoral approach to the sinus, or FESS associated with an intraoral approach. Follow up lasted for at least 1 year with clinical and radiographic controls. 26 patients recovered completely; one patient underwent re-intervention with FESS and an intraoral approach 2 years after implant removal, due to persistent signs and symptoms of maxillary sinusitis and oro-antral communication. Postoperative recovery after the second procedure was followed by complete recovery. The results demonstrate that a rational choice of surgical protocol for the treatment of complications involving the paranasal sinuses following displacement of implants in the maxillary sinuses may lead to reliable results.

Keywords: maxillary sinus; ethmoidal cells; sphenoid sinus; paranasal sinuses; sinusitis; oral implant; FESS; complications; oral surgery procedure; migration; infection; oro-antral communication.
Since 2003, two oral surgery units and one otolaryngology unit, located in university hospitals in Milan, Italy, have been treating these patients with integrated surgical planning in order to optimize the treatment outcome. The aim of this retrospective study is to report the authors’ experience concerning the surgical management of complications related to implant displacement in the paranasal sinuses and to propose different surgical approaches for the rational treatment of these problems.

**Patients and methods**

In a 5-year period (2002–2006) 27 patients (13 male; 14 female), aged 27–73 years (mean age 53.9 years), presenting with displaced/migrated oral implants in the paranasal sinuses with or without associated oro-antral communication and/or paranasal sinusitis, were referred for treatment.

The patients were evaluated and baseline data collected. The visit included: a general health evaluation; analysis of signs and symptoms related to paranasal sinus infection, such as mucopurulent rhinorrhea, chronic or intermittent cephalgia, pain in the area corresponding to the infected sinus; and analysis of the oral status, to evaluate the presence of oro-antral communications. A preoperative radiographic evaluation was carried out with panoramic radiography and computed tomography (CT) of the maxilla, to evaluate the condition of the paranasal sinuses and the location of the displaced implants in the sinuses.

26 patients presented with displaced implants in the maxillary sinuses. 1 patient presented with an implant that was originally displaced in the maxillary sinus, but due to delay in treatment, underwent spontaneous migration toward the sphenoid sinus and penetrated its ostium. In 14 of 27 patients the implants did not cause any relevant foreign body reaction/infection in the involved maxillary sinus; in 13 patients the displaced implants were associated with signs and symptoms of chronic paranasal sinusitis. Of these 13 patients, 7 presented with relevant obstruction of the maxillary ostium. Of 27 patients, 19 presented with oro-antral communications, while 8 had undergone spontaneous closure of oro-antral communications before being referred. Anagographic data and the patients’ clinical features are reported in Table 1. All patients gave signed informed consent before the start of treatment.

**Surgical protocols**

Patients underwent removal of displaced/migrated oral implants in the paranasal sinuses in association with treatment of sinusitis and/or oro-antral communications (if present) in one surgical session performed 1–24 months after the primary surgery responsible for these complications. One of the following surgical protocols was used: functional endoscopic sinus surgery (FESS); intraoral approach to the sinus; and FESS plus intraoral approach. The choice of surgical approach was dictated by the specific clinical indications.

FESS alone was used in case of displacement of implants in the maxillary sinus in association with or without signs and symptoms of paranasal sinusitis and/or obstruction of the natural maxillary ostium, but with no oro-antral communications (6 patients). An intraoral approach alone, with the creation of a bony window in the anterior-lateral aspect of the maxillary sinus, was used in cases of displacement of implants in the maxillary sinus in association with or without oro-antral communications, but with no signs and symptoms of paranasal sinusitis and in case of patency of the maxillary ostium (17 patients). FESS was associated with an intraoral approach whenever implant displacement in the paranasal sinuses was associated with signs and symptoms of sinusitis, obstruction of the maxillary ostium, and oro-antral communications (4 patients).

FESS was always performed under general anesthesia with oral intubation. The endoscopic technique always consisted of a partial uncinctomy and in a middle meatal antrostomy with enlargement of the maxillary sinus ostium. This procedure permitted easier access to the maxillary sinus for removal of the displaced implant, and the recreation of adequate patency of the maxillary ostium. If other paranasal sinuses presented with concomitant secondary infection/inflammatory reaction, the procedure could include an ethmoidectomy (anterior and/or posterior), a sphenoidecomy, or the opening of the frontal recess. Haemostasis was obtained with diathermy during surgery and by means of anterior nasal tamponade at the end of surgery.

The basic surgical procedure in the case of an intraoral approach consisted in raising a full thickness buccal flap with a horizontal incision following the margins of the oro-antral communications (if present), extended distally and mesially with vertical releasing incisions. Access to the
Table 1. Anagraphic data and clinical features of patients.

<table>
<thead>
<tr>
<th>Pt</th>
<th>Sex</th>
<th>Age</th>
<th>Site</th>
<th>Sinusitis</th>
<th>Oronal communication</th>
<th>Ostium obstruction</th>
<th>Other sinuses involved</th>
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<td>No</td>
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Maxillary Sinus = M.S.; Sphenoidal Sinus = S.S.; Frontal Sinus = F.S.; Ethmoidal sinus = E.C.; Functional Endoscopic Sinus Surgery = F.E.S.S.; Oral Approach = O.A.
maxillary sinus was obtained either with the removal of a bony window from the lateral aspect of the sinus (including the mucoperiosteum attached to the window), or with the creation of a bony window that was left pedicled to the antral mucoperiosteum as described by Biglioli and Goisiss2. In this latter case, the bony window was created with a small diamond round bur on a low speed straight handpiece, taking care not to tear the antral mucosa. Once the mobility of the bony window was checked, the antral mucosa was incised with a blade along the inferior, mesial, and distal aspect, but leaving the mucoperiosteum on the superior side of the window intact, to create a mobile bony window pedicled to the antral mucoperiosteum. The window was gently pushed inward and upward to permit sinus exploration. The implant was removed with thin suctioning devices and/or with Klemmer pliers. In case of oro-antral communication, the epithelium of the oro-antral fistula was removed at the same time.

In cases in which the bony window was not preserved (17 patients), primary closure of the intraoral access was obtained after adequate periosteal releasing incision of the flap and watertight suture. In cases in which the bony window was preserved (2 patients), the first step was repositioning of the pedicled window in its initial position and its stabilization with two resorbable stitches. Finally, the buccal flap was sutured as described before. Patients were treated under local anesthesia (14 patients), under local anesthesia in association with intravenous sedation (2 patients), or under general anesthesia with nasotracheal intubation (1 patient). The choice of anesthesia depended on surgical needs, patient compliance and expected duration of the procedure.

When FESS was associated with an intraoral approach (4 patients), the operation was always performed under general anesthesia with oro-tracheal intubation and began with the removal of the displaced implant, revision of the maxillary sinus mucosa/ostium, and revision of other paranasal sinuses (if involved) using an endoscopic approach. Once FESS was completed, the intraoral approach consisted in closing the oro-antral communication with a buccal mucoperiosteal flap, as described before. All patients treated with FESS received anterior nasal tamponade to control haemostasis postoperatively.

Results
Hospitalization after surgery varied from 1 to 3 days for patients treated with sedation or general anesthesia (mean 1.5 days). Patients treated under local anesthesia were discharged within 1 hour of surgery. Postoperative recovery was uneventful in 26 of 27 cases. In one patient treated with FESS, a relevant nasal haemorrhage occurred a few hours after completion of the surgical procedure, despite anterior nasal tamponade. The patient had to return to the operating room and the haemorrhage was controlled under general anesthesia with diathermy. No other adverse events occurred. Nasal tamponade in patients treated with FESS was removed 2–4 days after surgery. Intraoral sutures were removed 7–10 days after surgery.

Patients were followed clinically 1, 6, and 12 months after surgery, and annually thereafter, to exclude signs and symptoms of relapsing sinusitis and/or oro-antral communication. Patients treated with FESS underwent endoscopic control (without local anesthesia) 6 and 12 months after surgery.

Complete recovery of paranasal sinus function and the disappearance of signs and symptoms of sinusitis, as demonstrated clinically, endoscopically and radiographically, occurred in 26 patients. One patient, who underwent implant removal and closure of oro-antral communication with an intraoral approach, presented 2 years after surgery with a relapse of maxillary sinusitis and purulent secretion from the nose and the oral cavity. Radiographic control demonstrated complete radiopacity of the previously treated sinus. The patient was re-operated under

Fig. 1. (a, b) Preoperative radiographs demonstrating migration of an endosseous implant in the maxillary sinus in association with sinusitis and inflammatory obstruction of the ostium. (c) Endoscopic view of the left maxillary sinus after extended debridement of inflamed and hypertrophic mucosa (4 mm, 45° endoscope): the implant is removed with forceps. (d) Endoscopic control 1 year after treatment: the sinus mucosa appears healthy.
general anesthesia using FESS in association with closure of the oro-antral communication with a buccal flap. After re-intervention, recovery was uneventful and no other episodes of paranasal sinusitis occurred.

26 of 27 patients were treated successfully (96% success rate). The success rate of FESS (6 patients) and FESS in association with an intraoral approach (4 patients) was 100%, while the success rate of the intraoral approach (17 patients) was 94%. Two clinical cases treated with FESS or the intraoral approach are presented in Figures 1 and 2.

Discussion

Implant displacement/migration in the maxillary sinus and related infectious complications are apparently low and sporadic, but it is the authors’ opinion that such problems are underestimated. As the number of surgical procedures to place implants in the posterior maxilla is rapidly expanding, such complications will probably increase in the future.

A thorough preoperative evaluation of the posterior maxilla to exclude an unfavorable anatomical situation and/or a pre-existing asymptomatic pathologic paranasal sinus remains the key factor to avoid postoperative problems. In cases in which a complication occurs, the surgical protocols presented by the authors might be a rational treatment proposal.

The traditional Caldwell-Luc approach has not been used in any of the reported cases. This approach is frequently followed by partial or no recovery of maxillary sinus functions (in particular, inferior antrostomy in the nose is of little use in permitting normal ventilation of the maxillary sinus).

The key factor for successful recovery of maxillary sinus function, beyond the removal of a foreign body from the maxillary sinus, is recreation of adequate patency of the maxillary ostium. This can be obtained with FESS, which has the following advantages: less invasive procedure; possibility of endoscopic control and treatment of the maxillary antrum, the nasal mucosa, ethmoid cells, frontal sinus, and sphenoidal sinus, which can be secondarily involved by infections starting from the maxillary sinus; surgical ‘toilette’ and enlargement of the obstructed maxillary ostium, to allow the quick recovery of maxillary sinus functions.

There is ample literature demonstrating that the severe complications linked to traditional FESS, which includes uncinctomy and enlargement of the natural ostium, are absent or extremely limited (less than 0.1%) and generally consequent to technical errors. The only side-effect reported in the literature is the formation of ‘synechias’ due to scar formation between the inferior turbinate and the nasal septum. This complication, which can be considered of limited clinical relevance, may be a consequence of the surgical trauma induced by the endoscopic instruments used for the FESS procedure. It is worth noting, that no significant stenosis with interference with normal ventilation has been described in the literature and that none of the cases presented in this case series presented such a complication.

If oro-antral communication is present, FESS alone may not be able to treat a chronic sinusitis following implant displacement in the paranasal sinuses. In these cases, a combination of FESS and an intraoral approach allows removal of the foreign body from the sinuses with a non-invasive procedure and closure of the communication with local flaps. In the case of migrated implants in the maxillary sinus in association with or without oro-antral communication, with no signs and symptoms of maxillary sinus mucosa infection and, most important, in the case of absence of maxillary ostium obstruction, an intraoral approach with removal of the implant through the preexisting communication or by creating a bony window in the lateral aspect of the maxilla with no inferior antrostomy, followed by watertight closure of the access flap, may be
the treatment of choice. This procedure can be performed easily under local anesthesia and the patients can be discharged immediately after surgery, making it economical.

In conclusion, results from this study seem to demonstrate that FESS, an endonasal approach, or a combination of these procedures can be used safely for the treatment of complications following displacement/migration of grafting materials and/or oral implants in the paranasal sinuses. Each procedure presents specific indications that must be evaluated carefully in order to optimize results.

Funding
No sources of funding

Competing Interests
We do not have any type of financial personal relationship with other people or organizations that inappropriately influence our clinical studies/researches.

Ethical Approval
Informed consent was given by each patient. No ethical committee was involved as it was a retrospective clinical study and not an experimental prospective study.

References
8. EL-HAKIM IE, EL-FAIKARANY AM. The use of the pedicled buccal fat pad (BFP) and palatal rotating flaps in closure of oroantral communication and palatal defects. J Laryngol Otol 1999; 113: 834–838.

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