Position paper

ENT assessment in the integrated management of candidate for (maxillary) sinus lift

Il ruolo dello specialista ORL nella gestione integrata del paziente candidato al rialzo del seno (mascellare)

L. PIGNATARO[1], M. MANTOVANI[1], S. TORRETTA, G. FELISATI[2], G. SAMBATARO
Department of Otorhinolaryngological and Ophthalmological Sciences, University of Milan, Fondazione IRCCS Maggiore Policlinico Mangiagalli and Regina Elena Hospital, Milan; [2] ENT Clinic "San Paolo" Hospital, University of Milan, Milan, Italy; [1] LP and MM contributed equally to this study

SUMMARY

As stated at the 1996 Consensus Conference at Babson College, a (maxillary) sinus lift is a "safe and predictable" procedure for increasing alveolar bone height in the postero-superior alveolar regions in order to allow oral rehabilitation and restore masticatory function by means of the insertion of a dental implant even in the case of an atrophic maxilla. However, the procedure has a well-known impact on the delicate homeostasis of the maxillary sinus: the concomitant presence of systemic, naso-sinusal or maxillary sinus disease may favour the development of post-operative complications (particularly maxillary rhino-sinusitis), which can compromise a good surgical outcome. On the basis of these considerations, the management of sinus lift candidates should include the careful identification of any situations contraindicating the procedure and, if naso-sinusal disease is suspected, a clinical assessment by an ear, nose and throat specialist, which should include nasal endoscopy and, if necessary, a computed tomography scan of the maxillo-facial district, particularly the ostio-meatal complex. This first preventive-diagnostic step should be dedicated to detect presumably irreversible and potentially reversible contraindications to a sinus lift, whereas the second (preventive-therapeutic) step is aimed at correcting (mainly with the aid of endoscopic surgery) such potentially reversible ear, nose and throat contraindications as middle-meatal anatomical structural impairments, phlogistic-infective diseases and benign naso-sinusal neoplasms the removal of which achieves naso-sinusal homeostasis recovery, in order to restore the physiological drainage and ventilation of the maxillary sinus. The third (diagnostic-therapeutic) step is only required if mainly infective and sinusal complications arise after sinus lift surgery, and is aimed at ensuring early diagnosis and prompt treatment of maxillary rhino-sinusitis in order to avoid, if possible, implant loss and, in particular, the related major complications. The purpose of this report is to describe these three steps in detail within the context of a multidisciplinary management of sinus lift in which otorhinolaryngological factors may be the key to a successful outcome.

KEY WORDS: Paranasal sinus • Sinus surgery • Sinus lift • Functional endoscopic sinus surgery • Rhino-sinusitis • ENT contraindications

RIASSUNTO

Il rialzo del seno (mascellare), attualmente, rappresenta una tecnica diffusa e di successo per ottenere un incremento dell'altezza dell'osso alveolare nei settori postero-superiori, così da permettere la riabilitazione orale con il ripristino della funzionalità masticatoria, tramite l'apposizione di impianti dentari, anche in presenza di atrofia mascellare. Tuttavia questa procedura esercita un ben noto impatto sulla delicata omeostasi del seno mascellare e la concomitante presenza di patologie sistemiche, naso-sinusali o di processi disventilatori a carico del seno mascellare può favorire la comparsa di complicanze post-operatorie, tra cui, prima fra tutte, la rinosinusite mascellare, con possibile compromissione del buon esito della procedura. Sulla base di questa considerazione la gestione del paziente candidato al rialzo del seno dovrebbe includere l'accurata identificazione di quelle situazioni che sono state indicate come potenziali controindicazioni alla procedura e, nel sospetto di una patologia rinosinusale, una valutazione otorinolaringoiatrica comprensiva di endoscopia nasale, oltre, se indicata, l'esecuzione di una tomografia computerizzata del distretto maxillo-facciale con acquisizione del complesso ostio-meatale. Ciò si verifica durante un momento preventivo-diagnostico (primo momento), grazie al quale vengono identificate, in campo otorinolaringoiatrico, le controindicazioni presumibilmente irreversibili e potenzialmente reversibili all'esecuzione del rialzo del seno. Successivamente, il momento preventivo-terapeutico (secondo momento) prevede, per lo più attraverso il trattamento chirurgico endoscopico, la risoluzione delle controindicazioni otorinolaringoiatriche potenzialmente reversibili, quali alterazioni anatomico-strutturali della regione medio-metale, processi infettivo-flogistici e neoplasie benigne del distretto rino-sinusale la cui rimozione permetta il ritorno all'omeostasi naso-sinusale, così da ripristinare il fisiologico drenaggio e la ventilazione del seno mascellare. L'ultima situazione nella quale è richiesto il coinvolgimento dello specialista otorinolaringoiatra riguarda la gestione delle complicanze iatrogene fra cui, prima fra tutte, la rinosinusite mascellare e si esplica nel momento diagnostico-terapeutico (terzo momento). Esso è finalizzato ad ottenere una precoce diagnosi e ad instaurare un sollecito trattamento della rinosinusite mascellare, così da scongiurare, quando possibile, la perdita degli impianti e soprattutto lo sviluppo delle complicanze sinusitiche più gravi. Il presente lavoro si sofferma sui tre momenti, all'interno della gestione multidisciplinare del rialzo del seno, in cui il ruolo dello specialista in otorinolaringoiatria si rivela veramente determinante per il successo chirurgico della procedura.

PAROLE CHIAVE: *Seni paranasali • Chirurgia dei seni paranasali • Rialzo del seno mascellare • Chirurgia funzionale endoscopica dei seni paranasali • Rinosinusiti • Controindicazioni*

Introduction

The use of dental implants is now an extremely widespread and highly successful means of ensuring oral rehabilitation. Over the last few years, these have been employed for the upper dental arch, which had, for decades, been considered inviolable by implantologists because of the nearness of the maxillary sinus and the unpleasant complications arising from its surgical assault. In this context, the surgical sinus lift introduced by Boyne and James, in 1980 [1], makes rehabilitation of the upper dental arch feasible even in the case of maxillary bone atrophy [2-4] due to increased osteoclastic activity and bone resorption following the inferior expansion of the maxillary sinus after the loss of tooth roots [5]. Sinus lifting involves creating a mucoperiosteal pocket over the maxillary floor and beneath the Schneider membrane in which to place graft material (allograft, xenograft, alloplast) capable of promoting bone thickening by inducing osteoinduction and osteoconduction in order to increase alveolar bone height without compromising the inter-alveolar space. On the basis of good surgical outcomes reported in the literature [2-7], which led to sinus lifting being described as an "efficacious procedure" during the Sinus Consensus Conference in 1996 [8], there has been a considerable increase in the number of edentulous candidates for this procedure seeking the complete restoration of masticatory function. However, before undertaking a sinus lift, surgeons need to consider its impact on sinus physiology in order to avoid unwelcome complications that may compromise a positive outcome. An ear, nose and throat (ENT) specialist should be a primary figure in the approach to any sinus lift procedure as his/her collaboration will be precious during the various steps necessary to ensure success of surgery:

1. a first preventive-diagnostic step aimed at excluding any naso-sinusal diseases that may lead to failure of surgery;
2. a second preventive-therapeutic step aimed at correcting any pathological findings that represent reversible contraindications to a sinus lift;
3. a third diagnostic-therapeutic step (if necessary) aimed at ensuring the prompt diagnosis and appropriate treatment of any possible sinus lift-related naso-sinusal complications.

The management of candidates for a sinus lift should be shared by a dental surgeon and ENT specialist. Furthermore, the availability of a multidisciplinary surgical team makes it feasible to attempt experimental surgical strategies such as the combined two-steps procedure in which the ENT specialist first restores maxillary sinus ventilation endoscopically by resolving the pathological process or anatomical alteration contraindicating implant surgery, and then (after a period of at least 3-4 weeks) the oral surgeon performs the sinus lift and places the implants. As an expert in naso-sinusal physiology, the ENT specialist should also play a useful role in defining, with the implantologist, a prophylactic regimen for the candidate to sinus lift in order to reduce the risk of complications: stop smoking, avoid dehydration, pollutant inhalation, exposure to low temperature or dry air and assumption of atropine-like drugs are only a few examples of the hygienic rules indicated for the patient. This article will concentrate on the role of an ENT specialist in managing candidates for a sinus lift, and include a brief description of the anatomo-physiology of the maxillary sinus and the effect of sinus elevation on maxillary homeostasis.

Anatomo-physiology of the maxillary sinus

The maxillary sinus is the widest paranasal sinus, pyramidal in shape and varies remarkably in size, although the average in adulthood is: base 35 x 35 millimeters (mm) and height 25 mm [9]; its pneumatisation is related to age of the patient and the presence of teeth. The maxillary sinus walls most involved during sinus lift surgery are the mesio-vestibular wall, the inferior wall (or floor) and the medial wall. The first consists of a thin cortical layer containing the neurovascular bundle; the second may present septa or ridges; and the third houses the natural ostium antero-superiorly and sometimes (25%) an accessory ostium in the mucosal area called the anterior and posterior fontanelles [10]. Maxillary secretions converge into the middle meatus exclusively through the natural ostium. The maxillary ostium is a 7-11 mm long and 2-6 mm wide elliptical opening [11] that does not open directly into the nasal cavity as it is shielded medially by the uncinate process, which represents the medial bony wall of a slit called the infundibulum that extends from its inlet (the hiatus semilunaris) to the maxillary sinus. The inner layer of the maxillary sinus consists of a 0.13-0.5 mm thick mucosal membrane (Schneider's membrane) upholstered by a multi-stratified and columnar epithelium (100-150 cilia per columnar cell, with a frequency of 1000 beats per minute) that continues into the nasal mucosa and contains basal, columnar and globet cells resting over the basal membrane [10 12 13]. Some serous and mucous glands that thicken near the ostial opening are located in the underlying lamina propria. In addition to acting as an immunological barrier, directly exposed to inspired air, the ciliated respiratory epithelium transports, towards the natural ostium of the maxillary sinus, the viscous gel layer [14]. The ~2 litres of maxillary secretions per day [9] consist of water (96%), glycoproteins (3-4%), immunoglobulins, lactoferrin, prostaglandins, lysozyme, leukotrienes and histamine, and are discharged into the middle meatus at a flow rate of 1 cm/min so that the antral mucous can be entirely changed in ~20-30 minutes [15]. Mucous production is influenced by sympathetic and parasympathetic control, neuropeptide release, physical environmental factors, and drugs [15], and maxillary drainage depends on sinus oxygenation, which is mainly provided by direct gaseous exchange as the amount of blood oxygen is not enough [15]. Maxillary secretions can only be removed via the active transport system of drainage because they cannot take advantage of the force of gravity: in fact, the natural ostium, in the adult population, is located high up in the medial wall, several millimeters over the sinusal floor. Findings emerging from some experimental studies suggest that muco-ciliar transport runs along genetically determined star-shaped pathways [16] from the maxillary floor towards the natural ostium, which is the exclusive discharge point even in the presence of other naturally or surgically made openings. Mucous flow also seems to adapt to the shape of the inside of the sinus as the secretions thicken at the rising bony edge and the gel phase slides over the serous phase in order to cross the narrowest passages by means of the so-called "bridging phenomenon" [15]. The pathophysiology underlying maxillary sinus disease is impaired sinus secretion drainage related to ostial patency, impaired epithelial function or altered nasal secretions [17]. Sinusal homeostasis is

compromised in the presence of pathogenic *noxae*, such as environmental factors (pollution, impaired inspired air humidity), systemic diseases interfering with mucous composition or ciliar movements (cystic fibrosis, Kartagener's and Mounier-Kuhn's syndrome, dehydration, ciliostatic drugs), or anatomical variations that hinder physiological maxillary

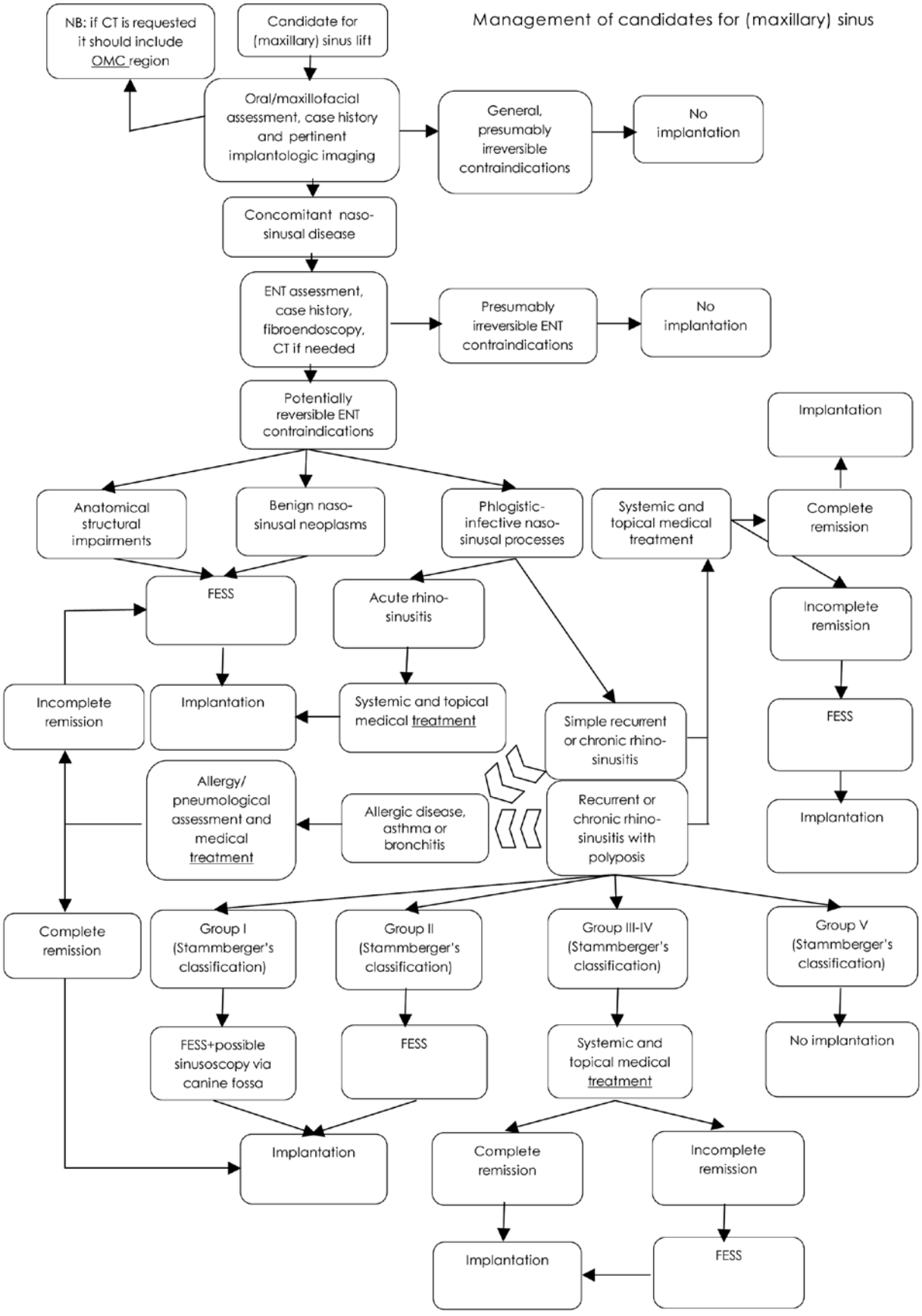

Fig. 1. Flow chart. Management of candidates for (maxillary) sinus lifting.

ventilation and drainage (such as a hyperplastic uncinate process, *concha bullosa*, maxillary ostium stenosis, septal deviations or nasal polyposis obstructing the medio-meatal region). This leads to impaired maxillary drainage and ciliar activity, with decreased oxygen and increased carbon dioxide concentrations, and is followed by epithelial dysfunction, which predisposes to infections causing oedema and mucosal hypertrophy of the ostio-meatal complex (OMC), with deterioration in sinusal ventilation and drainage [15].

Effect of sinus lifting on maxillary sinus homeostasis

Any surgical treatment of the maxillary sinus activates cellular inflammatory mediators and promotes transient sinusitis, and the larger the exposed area, the more likely it is that there will be a post-surgical inflammatory reaction. In the case of a sinus lift, the development of a secondary infection leads to possible bone graft loss [18]. Maxillary sinusitis is, in fact, the most frequent post-lifting complication and, although the diagnostic criteria used are not always clear [18], it has been reported in 0-27% of cases in clinical studies [19-26]. In a more recent study that used standard diagnostic ENT criteria, subacute maxillary sinusitis developed in 4.5% of the patients undergoing sinus lifting, and post-elevation chronic maxillary sinusitis in 1.3% [27]. Sinus lifting can obstruct physiological maxillary drainage into the middle meatus in various ways. The traumatic lifting of Schneider's membrane to above the maxillary floor may transiently and unpredictably inhibit ciliar activity [15] and also predispose to altered mucus composition due to bacterial infections [15], as may perforating the membranous sinusal lining during detachment (which may occur in up to 56% of cases) [24 25]. Furthermore, OMC patency may be impaired by:

1. transient inflammatory peri-ostial swelling;
2. excessive raising of the maxillary mucosal floor, especially in the presence of antral cysts lining the sinusal floor [18], which may be observed in 1.6-22% of cases [28-32];
3. graft fragments passing through mucosal lacerations into the maxillary sinus and obstructing the natural ostium, especially if these are > 5 mm [15 33].

However, it is well known that the sinusal mucosa can promptly repair tears due to surgery [34], and, therefore, it must be assumed that every sinus lifting procedure temporarily impairs maxillary sinusal physiology and sometimes prevents the post-operative restoration of normal sinusal homeostasis, which can lead to maxillary bacterial sinusitis and thus compromise surgical outcome and patient well-being. In this regard, and confirming other reports [8 35], a prospective study by Timmenga et al. [36] showed that the maxillary mucosa can recover after sinus lifting, especially if sinus drainage is normal. The finding, in that study, of a mild post-operative inflammatory reaction, upon the histomorphological examination of maxillary sinus mucosal biopsies [36], should, therefore, be interpreted as a physiological expression of the mucosal airway defense system, which can also be seen in healthy subjects who have not undergone surgery [36 37]. The rapid return of the maxillary sinus to a post-operative sterile state is also well known [36 38]. This intrinsic potential of the sinus mucosa to resume its homeostatic status after the surgical trauma caused by sinus lifting is known as sinus compliance: the better the starting conditions (high compliance), the lower the risk of complications. On the other hand, an excessive risk should be considered a contraindication to the procedure. An ambitious target is to identify sufficient objective parameters to create a "sinus compliance index" that could be used to assess the suitability of sinus lifting in individual patients.

Step 1. The first preventive/diagnostic ENT assessment

Given the above considerations, sinus compliance of each individual patient (or the presence of risk factors for post-elevation sinusitis) should be evaluated pre-operatively in order to define a relative risk threshold based on the probability of post-operative complications (Flow chart). This involves taking a careful case history in order to identify any previous nasal trauma or surgery, nasal respiratory obstruction, or recurrent or chronic naso-sinusal diseases [12], as well as the presence of any systemic diseases that may interfere with implant integration, such as uncompensated diabetes mellitus, immunodeficient disease, voluptuous habits (smoking, alcohol abuse, cocaine use), odontoiatric diseases (periapical diseases, parodontopathies), or maxillary irradiation [5 9 15 25]. Furthermore, all patients with radiological or anamnestic evidence suggesting maxillary sinusal dysventilation should undergo otorhinolaryngological examination with nasal endoscopy and, if indicated, computed tomography (CT) of the maxillo-facial district (including the OMC) in order to identify any possible contraindications to sinus lifting. This will lessen the risk of post-operative complications, thus providing relief for the patient and a good medico-legal guarantee for the oral surgeon.

Radiological assessment

It has been shown that conventional radiographic imaging is only 73% reliable, in the case of maxillary sinus mucosal diseases [18]. However, this diagnostic gap has now been filled by the introduction of high resolution axial and coronal paranasal CT [39], and pre-operative CT of the maxillo-facial district (with acquisition of the OMC), especially the new multi-slice CT with sub-millimetric acquisitions, has become almost mandatory in managing implant surgery when naso-sinusal diseases are suspected [40-42]. CT imaging is extremely useful as it can assess maxillary bone height [41] and thus make it possible to determine the best surgical approach, the timing of implant placement (simultaneous *vs*. delayed), and the most suitable type of graft. As many implantologists routinely request CT-maxillary DENTASCAN in order to prepare the implant positioning, it is very important, in our opinion, that the radiologist studies also the OMC, if a sinus lift is programmed. It has also been suggested that maxillary sinus volume can be pre-operatively measured by means of the three-dimensional reconstruction of the CT images in order to choose the best donor site when autogenous bone grafts are needed [43], however, this application does not seem to be routinely practicable [43]. CT can pre-operatively detect the presence of a narrow maxillary sinus [44], or aberrant sinus anatomy and Underwood's septa, which have been reported in 20-58% of cases [45-48]. Studying sinus morphology, by means of CT scans, provides precious information since when septa are present in the sinus floor, they can complicate sinus elevation by hampering bone plate inversion and lifting

of the sinus membrane [22]. CT scans with acquisition of OMC also play a primary role in managing sinus lift, from the ENT point of view, as they very precisely indicate the position and patency of the maxillary ostium, and detect any associated middle-meatal anatomical alterations or concomitant sinus diseases [12] that should be corrected before attempting sinus elevation, because the risk of developing post-operative sinusitis is increased in patients with impaired sinus clearance [3]. Other radiological investigations that have become increasingly important in assessing sinus diseases include magnetic resonance imaging (MRI) [49], although it is not useful for bone evaluation.

Endoscopy

Nasal endoscopy is a widely accepted means of assessing the middle meatus [3] because, by directly visualising the OMC, it can pre-operatively detect the factors impairing maxillary sinus drainage that may be responsible for a negative surgical outcome. Furthermore, it is particularly useful in managing their surgical correction before attempting sinus elevation. The main purpose of an endoscopic examination is to evaluate the condition of the infundibulo-meatal area, which is sometimes compromised by spatial competition between its foremost components (the uncinate process, the ethmoidal bulla and the *agger nasi*) [50 51] and other anatomical structures, such as the septal crests, the *concha bullosa* of the middle turbinate or its paradoxical bending, or a massive ethmoidal polyp [12]. A relationship has been documented between the post-operative development of sinusitis and pre-existing maxillary sinus diseases [22] as well as a correlation between sinusitis and the size of the maxillary ostium [52]. On the grounds that the cranial position of the maxillary ostium makes its mechanical blocking unlikely [3], a number of Authors [3] recommend nasal endoscopy before maxillary sinus elevation only in the case of patients with previous maxillary pathological processes or a documented history of impaired maxillary clearance, and it has also been suggested that an endoscopic finding of mild mucosal inflammation does not strictly contraindicate sinus lifting [37].

Otorhinolaryngological contraindications to a maxillary sinus lift

Any otorhinolaryngological contraindications should be detected pre-operatively and, if possible, corrected before undertaking a sinus lift procedure.

These contraindications can be divided into those presumably irreversible and those that are potentially reversible [15 53 54]. The former include:

1. anatomic-structural permanent and not correctable impairments of the nasal walls and/or naso-sinus mucosa that may seriously interfere with normal homeostatic naso-sinusal physiology (e.g., post-traumatic or post-surgical scars, sequelae of radiotherapy);
2. inflammatory-infective processes, including recurrent or chronic sinusitis (with or without concomitant naso-sinusal polyps), that cannot be resolved because associated with congenitally impaired muco-ciliar clearance (e.g., cystic fibrosis, Kartagener's syndrome, Young's syndrome), acetylsalicylic acid hypersensitivity (as defined by the distinguishing clinical triad of naso-sinus polyposis, asthma and acetylsalicylic acid hypersensitivity), or immunological defects (e.g., acquired immunodeficiency deficit syndrome, pharmacological immunosuppression);
3. naso-sinusally located aspecific systemic granulomatosis diseases (e.g., Wegener's granulomatosis, sarcoidosis);
4. benign naso-sinusal neoplasms (e.g., inverted papilloma, myxoma, ethmoido-maxillary fibromatosis), and malignant naso-sinus neoplasms involving the maxillary sinus and/or the adjacent anatomic structures (e.g., metastases and primary neoplasms originating from the epithelium, neuroectoderma, bone, soft tissue, dental tissue or lymphatic system tumours) that seriously interfere with naso-sinusal homeostasis, both before and after treatment.

However, there are many more otorhinolaryngological contraindications that are potentially reversible by means of appropriate medical or surgical treatment:

1. limited anatomic-structural impairments of the maxillary sinus drainage pathways (e.g., septal deviation, paradoxical bending of the middle turbinate, *concha bullosa*, hypertrophy of the *agger nasi*, the presence of Haller cells, post-surgical endonasal scars, synechiae of the OMC);
2. phlogistic-infective processes (e.g., acute viral or bacterial rhino-sinusitis, non-invasive mycotic rhino-sinusitis, recurrent and chronic rhino-sinusitis favoured by one of the above-mentioned anatomic alterations conditioning a stenosis of the maxillary drainage pathways), allergic rhino-sinusitis, naso-sinusal polyposis group I-IV (Stammberger's classification);
3. antro-ethmoidal foreign bodies;
4. oro-antral fistula not associated with a wide bone gap and after a definitive surgical closure;
5. benign naso-sinusal neoplasms that impair the maxillary drainage pathways before or would do after the sinus lift procedure, removal of which can restore naso-sinusal homeostasis and not damage the muco-ciliar transport system (e.g., mucous cysts, cholesterinic granulomas, choanal polyps).

Many of these potentially reversible otorhinolaryngological sinus lift contraindications are electively amenable to functional endoscopic sinus surgery (FESS).

Step 2. Prevention and therapy: the role of endoscopic surgery

The potentially reversible otorhinolaryngological contraindications to sinus lift surgery need to be corrected by means of conservative medical therapy or functional endoscopic sinus surgery – FESS – (the current gold standard for many naso-sinusal conditions amenable to surgery) in order to restore physiological maxillary sinus clearance and ventilation, after which it is possible to perform the sinus lift procedure to begin oral rehabilitation. Some Authors [55-57] have also proposed endoscopically controlled sinus floor augmentation procedures in order to check the positioning of graft material intra-operatively and assess the integrity of Schneider's membrane by directly observing its elastic deformation until the maximum elevation has been reached. However, this cannot be considered a standard procedure, the use of which should be confined to scientific trials as it is still technically demanding and requires considerable additional equipment. Furthermore, although it can prompt-

ly visualize perforations of the sinus membrane, it cannot avoid their occurrence [57].
Herewith, a brief description of the current therapeutic options for the treatment of some of the potentially reversible otorhinolaryngological contraindications to sinus lifting.

Rhino-sinusitis and benign naso-sinus neoplasms
As far as concerns acute rhino-sinusitis, which affects up to 16% of the US population [58 59] and 8% of Europeans [60], the medical treatment should be established by an ENT specialist. This may involve orally administered non-steroidal anti-inflammatory drugs [61] and the use of topical decongestants (for a maximum of 3 days) in order to restore sinusal ostial patency and provide symptomatic relief [61 62]. If acute viral rhino-sinusitis is suspected, antibiotics are not recommended [63], and patients with non-severe acute bacterial rhino-sinusitis should be considered candidates for clinical observation if follow-up is guaranteed [64]. If a patient's condition fails to improve within 7 days of diagnosis, or worsens at any time [61], antibiotics, such as amoxicillin [65-67] or extended spectrum cephalosporins [68] should be started and given for at least 7 days [69]. There is no evidence supporting the effectiveness of systemic steroids for acute rhino-sinusitis, and only weak evidence supports the use of topical nasal steroids in patients with acute viral rhino-sinusitis or allergic rhinitis (these may reduce mucosal swelling) [61 70]. A number of (mainly industry supported) clinical trials have shown the efficacy of topical corticosteroids in cases of acute bacterial rhino-sinusitis [71 72], but the use of decongestants and corticosteroids in addition to saline irrigation and mucolytics has not been approved by the American Food and Drug Administration for acute rhino-sinusitis. The clinical impact of antihistamine therapy on viral rhino-sinusitis has not yet been assessed [61], but it does not seem to be substantial in non-atopic patients with acute bacterial rhino-sinusitis [64].
In addition to eliminating the infection, the current treatment of chronic rhino-sinusitis also involves identifying and correcting the underlying predisposing factor (anatomical alterations of the OMC, allergopathy, nasal polyposis). Endoscopic surgery has become the common means of ensuring functional rehabilitation as it allows precise and decisive therapeutic intervention with minimal negative effects on delicate naso-sinusal physiology [73] and good patient outcome. In the most advanced centres, the traditional approaches to maxillary sinus surgery have been replaced by endoscopic uncinectomy, middle meatal antrostomy, and anterior and posterior ethmoidectomy [73]. A description of the surgical treatment of the structural anomalies conditioning impaired maxillary sinus drainage is given in the next section. In the case of allergic rhino-sinusitis or concomitant asthma, medical treatment should first be established with topical or systemic antihistamines [74], disodium chromoglycate and specific immunotherapy [73] and, if necessary, the patient should be referred for an allergy assessment. In the case of recurrent bronchitis, a pneumological evaluation may also be useful. Patients with concomitant nasal polyposis, which has a general population incidence of 0-86% among males and 0-39% among females [75] should be classified into treatment groups on the basis of the extent of the pathology. Patients in Stammberger clinical group I (with antrochoanal polyposis, ACP) [76] should undergo surgery as first-line therapy [77 78]: the ACP is resected using an endoscopic trans-nasal approach, and then a middle meatal antrostomy is performed in order to remove the base from the maxillary sinus [79 80]. The use of powered FESS instrumentation has also recently been described to be effective in completely removal of an ACP including its antral portion [81 82]. When the antral portion cannot be reached trans-nasally, a combined approach through the canine fossa may be used [79]. Any other benign naso-sinus neoplasms, such as maxillary mucous cysts, should also be surgically removed or aspirated before [33] or at the time of sinus augmentation [53]. Patients in Stammberger's group II (with spheno-choanal or ethmoido-choanal polyps) [76] should undergo polypectomy together with sphenoidotomy by means of the direct paraseptal route or selective posterior ethmoidotomy using FESS [79]. Stammberger group III and IV patients (with nasal polyposis associated with chronic rhino-sinusitis without or with eosinophilia) [76] should undergo endoscopic surgical treatment if complete recovery cannot be achieved by means of medical treatment with antibiotics and systemic steroids [83], and post-operative topical steroid treatment should be used to avoid recurrences [79]. In the case of non-invasive fungal sinusitis, the fungal ball should be removed by means of trans-nasal endoscopy [84], whereas the current therapy, for allergic fungal sinusitis, is endoscopic sinus surgery with topical administration of corticosteroids and antimycotic drugs [85].

Anatomical alterations of the OMC and oro-antral fistulas
In the case of sinus diseases associated with anatomical alterations that impair physiological maxillary drainage and are responsible for sinus dysventilation, FESS should be used to restore OMC patency before the sinus lifting is performed. Nasal septum deviations, which in the general population reach an incidence of 56.4% [86], are some of the most frequent findings requiring surgical correction. In addition to the traditional headlight technique, endoscopic – and now powered functional endoscopic [87] – septal surgery is considered a safe and efficacious approach, especially in the case of posterior and superior deformities which are difficult to access using the traditional technique, and can be performed at the same time as FESS [88 89]. Large *agger nasi* cells, which are found in up to 52% of the population [86 90 91], are endoscopically opened [12], whereas true *conchae bullosae* or pneumatisations of the middle turbinate, with an incidence of 8.3-42.5% in the general population [86 90-94] require surgical resection of the lateral bony lamella of the pneumatised middle turbinate [12]. Any other naso-sinusal anatomic variations, such as paradoxical bending of the middle turbinate (general population incidence 5.3-24.2%) [86 90-93], or infra-orbital ethmoidal (Haller) cell (general population incidence 1-9.4%) [86 90 91], as well as post-surgical synechias of the OMC, which occur in 0.4-44% of the patients undergoing nasal surgery depending on the surgical technique [95-98], need to be endoscopically corrected before attempting sinus lifting if they are associated with anamnestic, clinical or instrumental findings of sinus disease. Oro-antral fistulas, which have a reported incidence of 5-25% after upper teeth extraction [99 100] are clear contraindications to a sinus lift. They must, therefore, be treated first by means of surgical correction and adequate medical treatment [101] in order to obtain a disease-free sinus environment [102]. The successful long-term closure of an oro-antral fistula depends on the physiological status of the maxillary sinus [103].

Once the alveolo-antral areas have stably and completely healed, the possibility of a sinus lift can be considered depending upon the local situation and residual bone gap.

Step 3. Diagnosis and therapy: the management of post-operative complications

The postoperative complications of sinus lift may be distinguished between early and late complications: the former include tearing Schneider's membrane, intra-surgical displacement of implants into maxillary sinus, dehiscence of the oral surgical wound with oro-antral fistula formation, hematomas and acute maxillary sinusitis; the latter include chronic maxillary sinusitis and bone sequestration sometimes leading to bone graft and implant loss [12 33]. Tearing of Schneider's membrane may occur if the pouch is overfilled, especially with sharp-angled grafting material, or if intra-operative membrane detachment is inadequate [48 104]. Maxillary sinusitis is the most frequent post-operative complication [19-26], although its post-lifting occurrence is not always defined using precise ENT criteria [18]. It may be caused by:

1. lack of asepsis during the surgical procedure [38];
2. dysventilation of the maxillary sinus, due to ostial obstruction, as a result of mucosal oedema [105];
3. infection of non-vital bony fragments floating into the sinus [106];
4. a previously undetected disease impairing maxillary drainage.

Small intra-operative perforations of the sinus membrane do not seem to be responsible for maxillary sinusitis in healthy subjects [18], but larger perforations expose more of the grafted bone surface to the sinusal environment, and, therefore, lead to a greater risk of penetration of bony fragments into the sinus lumen and the development of post-lifting rhino-sinusitis [18 106]. The pathogenic mechanism may start with the protrusion of debris-covered implants into the sinus lumen where, as foreign bodies, they may give rise to inflammation impairing the muco-ciliar system; the subsequent mucosal swelling leads to maxillary ostial obstruction, infection, and rhino-sinusitis [107]. General guidelines for the prevention of transient and chronic maxillary rhino-sinusitis, after sinus lifting, include peri-operative antibiotic prophylaxis and post-operative administration of topical corticosteroids in order to ensure the patency of the maxillary ostium [3 21 25 108 109]. The use of decongestants is controversial because, by inducing vasoconstriction, they may further compromise the already low oxygen tension in the sinus [110]. The role of ENT specialists, in the case of post-elevation maxillary rhino-sinusitis, is to guarantee early diagnosis and treatment. Early medical or (in advanced stages) surgical treatment, able to promptly restore maxillary sinus ventilation and drainage, would not only avoid the loss of graft and implants, but also prevent major complications, such as venous septic thrombosis, especially in the case of acute purulent events [12 34]. For a correct and prompt diagnosis, in addition to nasal and sinus endoscopy, the ENT specialist can proceed with aspiration of sinus contents for cytological examination and microbiological assessment [111]. CT is also an extremely useful means of detecting pathological processes. If medical therapy alone fails to control the sinus infection, the guidelines for the treatment of transient rhino-sinusitis suggest the use of trans-nasal endoscopy to establish maxillary drains for sinus irrigation and, if this fails to bring about complete recovery within three weeks (or in the presence of exposed and sequestered endosinusal grafts), surgical curettage, by means of FESS, should be taken into consideration [3 12 35 102 108 109]. In the case of chronic maxillary rhino-sinusitis, endoscopic surgical treatment should be used in addition to medical treatment [3 35 102 108 109]. Published data and our own experience show that infected graft material and implants should be removed because eliminating the source of infection will avoid recurrences of rhino-sinusitis [102 112]; however, some Authors [107] have successfully used alternative treatments consisting of partial resection of the grafts. Inappropriate positioning or accidental displacement of dental implants, inside the maxillary sinus, have been also reported as late complications after sinus lifting [5 25]. If such events are confirmed by means of diagnostic nasal endoscopy and radiology, the migrated implants should be surgically removed in order to prevent the development of rhino-sinusitis due to interrupted muco-ciliary clearance or a tissue reaction [113-115]. In the case of nasal or sinusal diseases, FESS should be considered the option of choice but, in the absence of sinus infection and if the OMC is normal, the implants can be retrieved using:

1. the traditional Caldwell-Luc surgical approach, which consists of retrieving them through a window created in the antero-lateral maxillary sinus wall [25];
2. more conservative maxillary anterior wall resection [116];
3. the endoscopic insertion of a trocar through the canine fossa [10 11];
4. the endoscopic insertion of a new type of trocar that improves the ergonomy of the operation by allowing simultaneous endoscopic vision and the use of surgical instruments (e.g., aspirator, grasping forceps, etc.) (Fig. 2);
5. endoscopic access through the naso-antral wall [118-120].

It is worthwhile pointing out that these surgical approaches can be used under local anaesthesia if the patient is compliant and the surgeon is experienced. All the above-mentioned considerations indicate that the cooperation of an ENT specialist is also useful in the management of this post-lifting complication, as trans-nasal endoscopic retriev-

Fig. 2. New trocar for endoscopic trans-canine approach conceived by M.M. and L.P. and presented at IV National Congress of ENT University Association (5 December 2007, Mestre, Italy).

al of migrated implants allows the simultaneous treatment of the concomitant mucosal disease related to implant displacement and any associated ostial obstruction with minimal invasiveness and less morbidity than that related to the standard approach [119].

Conclusions

Whenever concomitant dysventilatory naso-sinusal diseases are suspected, ENT specialists are primary figures in the management of candidates for sinus lifting. Their involvement in all three preventive-diagnostic, preventive-therapeutic and diagnostic-therapeutic steps makes it possible to identify any presumably irreversible or potentially reversible contraindications to sinus lifting and resolve (when possible) the pathological processes or anatomical impairments potentially leading to surgical failure, as well as ensure the early detection and treatment of any post-operative complications that may compromise good surgical outcome. The availability of a multi-disciplinary surgical team, including a well-trained ENT specialist, not only increases the likelihood of a better procedural outcome, but also provides a good medico-legal guarantee for the oral or maxillofacial surgeons attempting a sinus lift.

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Address for correspondence: Prof. L. Pignataro, Dipartimento di Otorinolaringoiatria e Scienze Oftalmologiche, Università di Milano, Fondazione I.R.C.C.S., Ospedale Maggiore Policlinico "Mangiagalli e Regina Elena", via F. Sforza 35, 20122 Milano, Italy. Fax +39 02 50320248. E-mail: lorenzo.pignataro@unimi.it