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ORIGINAL ARTICLE

Mucosal cyst aspiration in conjunction with maxillary sinus elevation: A clinical cohort study

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Abstract

Introduction: Patients with mucosal cysts in the maxillary sinus require special consideration in patients who require implant therapy for the restoration when undergoing implant therapy for the restoration of the posterior maxillary dentition. Treatment strategies for these clinical situations remain controversial in the literature. Thus, this study seeks to describe a safe and effective therapeutic strategy for sinus augmentation in patients with pre-existing maxillary antral cysts.

Methods: A total of 15 patients and 18 sinuses were consecutively enrolled in this cohort study and underwent maxillary antral cyst treatment by needle aspiration and simultaneous maxillary sinus augmentation (MSA). During surgical procedures, threeimplants (Zimmer Biomet, Indiana, USA) were positioned in 11 sinuses and two implants (Zimmer Biomet, Indiana, USA) were positioned in 5 sinuses.

Results: Overall implant success and survival rates were 100% and 97.8%, respectively at 1 year and 5-year follow-ups. Crestal bone resorption averaged 0.3 ± 0.2 mm 5-year post-loading, showing bone stability. Implant survival rate at 5-year follow-up expressed predictability of the technique comparable to historical data

Hom-Lay Wang and Massimo Del Fabbro share the last position.

when MSA was performed alone. Crestal bone resorption averaged 0.3 ± 0.2 mm 5 years post-loading and shows bone stability utilizing mucosal cyst aspiration with concomitant MSA procedures. Quality of life evaluation at 1-week post-op showed similar results to published historical data. In 81% (13 sinuses), the CBCT examination at 5-year follow-up showed no cyst reformation, in 19% (3 sinuses) cyst reformation was visible, but smaller in size when compared to the pre-op CBCT evaluation, and all the patients were asymptomatic.

Conclusions: Maxillary sinus mucosal cyst aspiration with concomitant MSA, may be a viable option to treat maxillary sinus cyst.

KEYWORDS

cysts, maxillary sinus, mucocele, mucus retention cysts, sinus floor augmentation

Summary Box

What is known

The presence of maxillary cysts may incur additional intraoperative challenges and/or complications during sinus augmentation procedures. Several approaches have been proposed for the management of such conditions, with controversial results.

What this study adds

This study presents a safe and effective therapeutic strategy for sinus augmentation in patients with pre-existing maxillary antral cysts. It presents mucosal cyst aspiration concomitant to maxillary sinus surgery as a viable treatment option.

1 | INTRODUCTION

Posterior atrophic maxillary rehabilitation supported by the placement of endosseous dental implants can be challenging, especially in cases of severe sinus pneumatization and compromised residual ridge height.[1] Maxillary sinus augmentation (MSA), both by crestal and lateral approaches, restores the alveolar ridge height to a therapeutic dimension for proper placement of adequately sized endosseous implants.[2] Notably, the implants placed in grafted sinuses exhibit a similar survival rate to those placed in native bone,[3] and both crestal and lateral sinus augmentation procedures report similar clinical outcomes.[4] However, the presence of sinus pathologies (i.e., antral cysts) could represent a contraindication to MSA.[5] MSA in the presence of such pathologies may lead to reduced sinus lumen and increased risk of ostium obstruction, stasis in mucous secretions, and—eventually—to sinus infection. Antral cysts occur with a prevalence of 21%.[6] These antral cysts are common, asymptomatic, and diagnosed under routine radiological examinations as a dome-shaped cyst-like radio-opacity protruding into the antrum.[7]

Antral cysts are classified into three types: mucoceles, retention cysts, and pseudocysts. A mucocele is characterized by a thickly lined cyst, which may sometimes involve bony erosions. Mucoceles are a rare finding and represent an absolute contraindication for MSA unless properly removed. The other two types of antral cysts, namely retention, and pseudocysts, are the most common antral cyst phenotypes and are often incidentally identified on routine radiographic examination. The presence of the latter does not contraindicate MSA procedures, but requires awareness and caution, as displacement of the cyst apically during MSA could result in blockage of the ostium. To this end, pseudocysts and retention cysts rarely require any invasive procedure for removal.[8] Some clinicians surmise that the presence of a cystic lesion alone is a contraindication for sinus augmentation, because it might lead to future complications and potential failure.[8] A study reported that 29.4% of maxillary sinus cysts were found to increase in size after follow-up for 38–102 months, indicating the potential for increasing obstruction rates of the ostium and thus possibly an increased risk of bone graft and implant failure in the future.[9] Other studies recommend minimizing risk through identification and treatment of these antral cysts via a Caldwell-Luc operation or endoscopy, followed by a 6-month healing period prior to sinus augmentation.[10,11] The latter two clinical protocols are subject to complications and their use is often limited by a potentially high rate of injuries and adverse effects. In contrast to these reports, other studies concluded that sinus augmentation can be safely performed with no consequences in patients with pre-existing maxillary antral cysts.[12,13] As of the time of this study, there is limited clinical evidence, prohibiting the establishment of a standard treatment protocol, and MSA in the presence of antral cysts remains controversial. As such, the aims of our clinical cohort study were:

- To present the outcome of MSA in conjunction with needle aspiration of antral cysts in terms of implant survival and post-operative quality of life.
- To evaluate the incidence of cyst relapse or sinus mucosal thickening during a five-year follow-up period.

2 | MATERIALS AND METHODS

This cohort study is reported according to the STROBE guidelines for observational studies.[14] All patients were treated following the Ethical Principles for Medical Research Involving Human Subjects described in the Helsinki World Medical Association Declaration in 1975, as revised in 2000. Ethical approval was not required due to the nature of the study, which involved patients who were treated and rehabilitated according to a standard procedure. The IRCCS Istituto Ortopedico Galeazzi Institutional Review Board approved the protocol (No. L2057).

2.1 | Patient selection

A total of 15 patients and 18 sinuses (6 women and 9 men) ranging in age from 45 to 72 years (mean, 60.3 years) were consecutively enrolled in this cohort study. They underwent maxillary antral cyst treatment by needle aspiration and simultaneous sinus augmentation at the Dental Clinic of the IRCCS Istituto Ortopedico Galeazzi, Milan, Italy. There were no specific inclusion criteria since we included all the patients requiring MSA with mucosal cysts in the area of the augmentation independent of the residual alveolar bone height. The maxillary cysts were identified on cone beam computer tomography (CBCT) performed for routine diagnostic assessment. All patients were asymptomatic both at the time of examination and at the time of surgery. Patients with a spherical or dome-shaped radiopacity in the sinus were included. Informed consent was obtained from each patient. During surgical procedures were positioned three implants (Zimmer Biomet, Indiana, USA) in 11 sinuses and two implants (Zimmer Biomet, Indiana, USA) in five sinuses. CBCT was taken before and after surgery, at 1-year and 5-year follow-ups. Periapical radiographs were taken immediately after implant placement, at the prosthetic phase, and at each follow-up visit (scheduled after 6, 12 months of prosthesis function and yearly up to 5 years).

2.2 | Surgical procedure

The same surgical team performed all the surgical procedures. Local anesthesia (1:100 000 Articaine 4% Omnia s.p.a. Fidenza, Italy) was administered at the operation site. A trapezoidal, full-thickness mucoperiosteal flap was raised, following a crestal and two vertical releasing incisions in the area of edentulism. The lateral access window was made carefully using a piezo-surgical unit (Mectron Carasco, Genova, Italy). Only the cysts that were in the area of the future MSA were treated via 21 gauge needle aspiration mounted on a 10cc disposable syringe. After having performed the antrostomy that includes the area of the mucosal cyst, the needle is inserted in the mucosal cyst itself. The mucosal cyst is located by taking measurements on the CBCT. The method does not differ from the method that a clinician uses to clinically locate the position of the antrostomy. Cysts located far from the area of intervention, for example, the posterior maxillary wall and not involved in the MSA, were left untreated. The aspirated cysts contained a yellow liquid (Figure 1A–D). Once the clinician punctures the cyst wall the needle is firmly held in the same position without going any further toward the medial wall. The needle is retrieved once all aspirant have been removed. The needle aspiration technique is designed not to perforate the sinus membrane, as the puncture is precisely positioned between the ciliated columnar epithelium cells and the periosteum of the sinus membrane, as demonstrated in a recently published clinical study.[15] No bone graft was used in this study, however, a collagen membrane (Evolution membrane, Tecnoss Dental Giaveno Italy) was used to repair and protect small puncture site.

Two cysts in which it was impossible to aspirate any liquid were surgically removed and showed a caseous or a gelatinous content (Figure 2A, B). Those cysts were removed from the dataset of the study.

Subsequently, a conventional lateral sinus elevation technique with simultaneous implant placement (3I Biomet West Palm beach Florida) was performed. The sutures were removed 10 days postoperatively. Second-stage surgery was performed 6 months later. Prosthetic loading was performed 8 months later.

2.3 | Clinical and radiological parameters

At each visit, the following variables were recorded.

Primary variables were:

- Implant survival, number and type of surgical or postsurgical complications, and marginal bone level change.
- Implant success according to conventional criteria.[14,15]
- Patients' satisfaction for mastication, function, phonetics, and aesthetics, evaluated by means of questionnaires.

Secondary variables were prosthesis success when the prosthesis was in function, without mobility, even in the face of the loss of one or more implants. Prosthesis stability was tested by means of pressure from two opposing instruments.

2.4 | Quality of life evaluation

All subjects were asked to complete an Oral Health Impact Profile (OHIP) and an SF36 questionnaire pre- and post-treatment. Questionnaire Responses to each of the 49 OHIP statements are based on the Likert scale (i.e., 0: never, 1: hardly ever, 2: occasionally, 3: fairly often, and 4: very often).

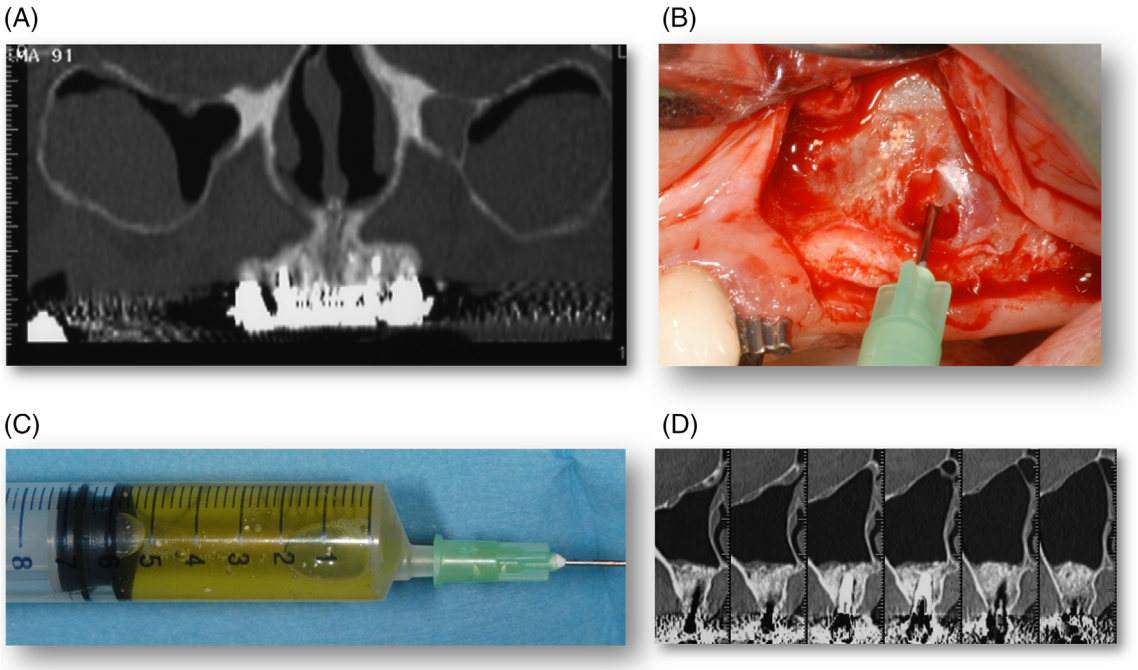

FIGURE 1 (A) Pre-op CBCT, (B) Cyst needle aspiration, (C) the content of the cyst was 6 cc of a yellow liquid, (D) 5-years post-op CBCT showing no cyst reformation.

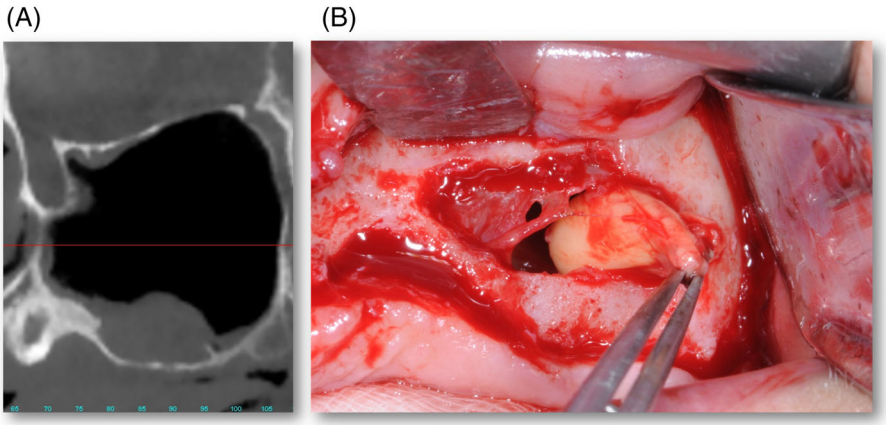

FIGURE 2 (A) Pre-op CBCT, (B) Solid "cheese-like" cyst surgically removed.

The SF36 consists of 35 statements divided into eight subscales, namely: physical functioning, social functioning, role limitation-physical, role limitation-emotional, mental health, vitality, pain, and general health perception. There is also a self-assessed global transition statement asking respondents to compare their general health status with that of 1-year previously. Subjects also completed an assessment of satisfaction with their prostheses pre- and post-treatment.

These scales have been validated and used in an implant-related study by Feine.[16] Subjects were asked to rate, on a Likert scale, their satisfaction with the following aspects of both maxillary and mandibular conventional dentures: general satisfaction, retention, comfort, stability, appearance, the ability to speak, and occlusion.

2.5 | Radiographic evaluation

Radiographic evaluation was performed through CBCT and standardized intraoral radiographs. CBCT were taken before MSA, after surgery, and at 5 years follow-up. Periapical radiographs were taken immediately after implant placement (at baseline), at the prosthetic phase, and at each follow-up visit (scheduled after 6 and 12 months of prosthesis function and yearly thereafter up to 5 years).

Radiographs were taken using a long-cone paralleling technique and individual trays to ensure reproducibility.

A dedicated image analysis software (UTHSCSA Image Tool version 3.00 for Windows, University of Texas Health Science Center, San Antonio, TX, USA) was used to perform measurements of marginal bone levels around implants at both mesial and distal aspects.

The implant neck was the reference point for each measurement. Mesial and distal values were averaged to have a single value for each implant.

3 | RESULTS

Following mucosal cyst aspiration during MSA, the overall implant survival rates were 100% at 1 year and 97.8% at the 5-year follow-up. All prosthetic rehabilitations were successful and remained in function. After 5 years of loading, the peri-implant bone loss averaged 0.3 ± 0.2 mm.

Two patients were excluded from the study due to the presence of solid cysts. The finalized cohort for this study consisted of 13 patients with a total of 16 sinuses. Notably, neither immediate nor late post-operative complications were reported in any of these cases.

Upon conducting a 5-year follow-up CBCT examination on 13 sinuses, no cyst reformation was observed however, in 3 sinuses, there was evidence of cyst reformation, albeit with smaller dimensions compared to the pre-operative CBCT evaluation. Importantly, it is noteworthy that all these patients remained asymptomatic (as depicted in Figure 3A, B, and Figure 4).

In a short-term (1-week post-op) evaluation of quality of life, patient responses were found to be similar to the published historical data on MSA without cyst aspiration.[17]

4 | DISCUSSION

MSA is generally considered a safe and predictable procedure, providing substantial prosthetic rehabilitations for patients with a high degree of predictability. Despite its efficacy, the MSA procedure alone may have intra-operative and post-operative complications.

Toward this end, additive risk to the baseline probability of complications during an MSA procedure can be further assessed based on anatomical variations. Thus, first ensuring a precise diagnosis of all principal components for this surgery is paramount to fundamentally minimize both intra- and post-operative complications and optimization of clinical success. However, when patients present with otolaryngological contraindications to MSA, such as mucosal cysts, the literature provides conflicting guidance regarding timing and therapeutic strategy.

Cyst-like opacities in the maxillary sinus, while often asymptomatic, are typically identified through routine radiographic examinations that were conducted for various reasons. These include both for planning dental rehabilitations and for assessing the alveolar ridge width and height for implant placement. Literature reveals variations in antral cyst prevalence based upon the type of examination performed.[18] In one radiological study using orthopantomographs, a sample of 5021 participants was evaluated. The authors reported mucosal thickening in 12% of cases and mucosal cysts in 7% of cases,

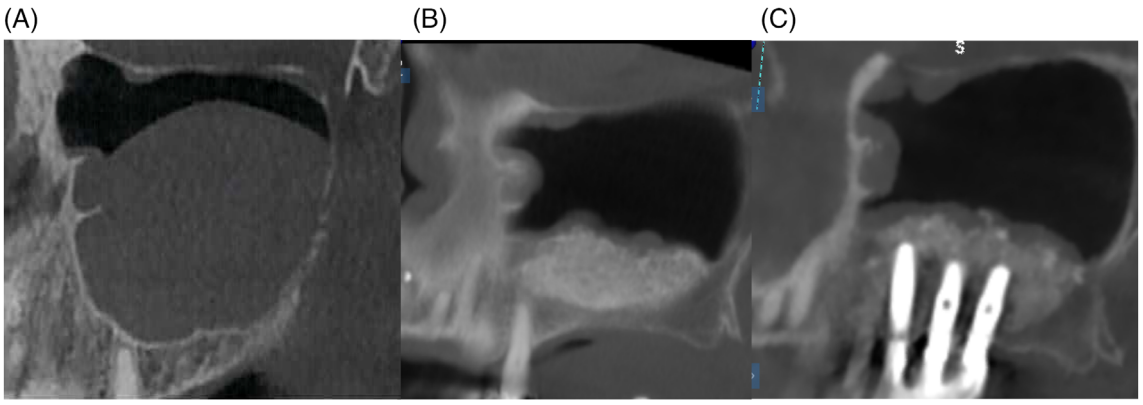

FIGURE 3 (A) Pre-op CBCT, (B) Post-Op CBCT, (C) 5 years follow up a minimal thickening of the sinus membrane is visible.

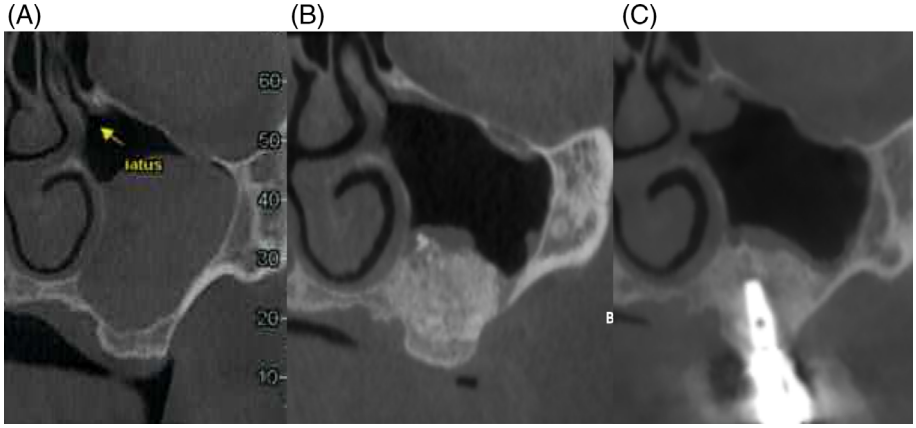

FIGURE 4 Cross sections view of the same case shown in Figure 3 (A) Pre-op CBCT, (B) Post-Op CBCT, (C) 5 Years follow up a minimal thickening of the sinus membrane is visible.

demonstrating that mucosal abnormalities require diagnosis and can often present in the absence of symptoms.[18]

Another study evaluated panoramic radiographs of two sets of 1000 consecutive patients attending the University of Hong Kong Dental School in 1981 and 1990. This study revealed the mean prevalence of mucosal cysts to be 5.2%, being twice as frequent in males.[19]

Another study, in an effort to discern sinus pathology detection efficacy using different diagnostic imaging modalities, one group compared the maxillary sinus in 30 patients using panoramic radiography and computed tomography. The authors stratified their cohort into four groups: (1) no pathology, (2) mucosal thickening, (3) mucous cyst, or (4) complete sinus occupation. Demographics of their cohort included 17 women and 13 men, averaging 50.9 years of age. Radiographic abnormalities were present in 38.3% of cases. Of these abnormalities, 23.3% were mucosal thickenings, 10% were mucous cysts, and 5% were full sinus opacifications. Out of the 23 sinuses showing radiographic pathology, only one (4.3%) was accurately identified using panoramic radiography,[20] suggesting that computed tomography is a better diagnostic tool for maxillary sinus surgical preparation.

Differentiating between an antral pseudo-cyst and other sinus lesions is vital for effective treatment planning since maxillary sinuses can be affected by numerous conditions. These include chronic rhinosinusitis, benign and malignant neoplasms, and dental disorders. Prior to any intervention, a meticulous diagnosis, involving radiological evaluation (Panoramic exam and CT scan) and eventually otolaryngological examination when needed.[21]

In general, when considering utilization of MSA, the contraindications in the field of otolaryngology pertain to conditions or anatomical variations that either currently or potentially obstruct the natural drainage of the maxillary sinus through its natural opening. Both medical conditions that affect ciliary function (such as rhinosinusitis and cystic fibrosis) and physical obstructions (like polyps and neoplasms) can hinder sinus drainage, increasing the risk of infection after a sinus graft. Specifically, in the context of MSA, antral cysts that occupy at least two-thirds of the maxillary sinus can pose a potential risk of blocking the ostium during the procedure. This blockage might occur due to the cyst's elevation caused by the graft or by the temporary enlargement of the cyst due to local inflammation after the graft. Therefore, the risk of MSA failure associated with cysts is primarily linked to the space occupied by the cyst during the acute phase and not solely to the presence of the cyst itself.[22]

The negligible risk of sino-nasal complications related to maxillary cysts per se is well known so that these lesions are rarely addressed surgically outside the MSA context.[23]

In a clinical study involving 52 maxillary sinuses in 46 patients, Nosaka et al. demonstrated that cysts might form due to the obstruction of the excretory duct, located in the ciliated columnar epithelium, while the cysts themselves located between the lamina propria and the periosteal layer.[15]

However, when mucosal cysts are detected in a candidate for MSA, a common occurrence in the maxillary sinus, there is an ongoing debate about the appropriate treatment approach when performing sinus floor augmentation in the presence of these cysts. This is particularly true since mucosal cysts are typically not removed in asymptomatic patients. Some authors argue for the radical removal of the cyst, fearing a recurrence and potential blockage of the ostium, while others prefer more conservative methods. These authors take advantage of the thickening of the maxillary floor lining caused by the cyst to reduce the risk of damage to Schneider's membrane during membrane elevation. A conflicting study by Inshua demonstrated that a thickened but inflamed membrane is weaker than a thinner non inflamed membrane.[24]

As there are no comprehensive studies addressing this issue, a more cautious approach is somewhat supported by histological analyses of maxillary cysts.

Maxillary cyst cavities lie in a "safe space," potentially minimally replenished by epithelial secretions after deflation and clearly distinct from the periosteum below. Such a histological structure favors, in the opinion of the authors, a conservative approach that avoids breaching the periosteum toward the sinus lumen, thus minimizing the risk for ensuing sinusitis. Furthermore, the low replenishment rate is such that any significant cyst relapse following MSA takes place well after the osteoinduction and osteoconduction process is finished and the graft is consolidated, resulting in an excellent safety profile. In the aforementioned study by Nosaka et al.[15] the authors employed various methods for treating the cysts, including aspiration and complete cyst removal. Although total cyst removal was considered the most reliable treatment plan, it was associated with complications, such as large perforations, in most cases. Consequently, the authors identified a two-stage surgery (cyst removal followed by re-entry at 3 months) as a more risk-free procedure. This approach, however, imposed a greater burden on patients. In contrast, our minimally invasive approach involved cyst aspiration only, allowing for one-stage procedures. Given the low rate of cyst reformation and the understanding that cyst formation results from duct obstruction and the absence of a secretory epithelium, our study further supported the infrequent recurrence of cysts in our approach.

5 | CONCLUSIONS

Maxillary sinus mucosal cyst aspiration with concomitant MSA therapy would appear to be a viable treatment option. Implant survival rates, up to the 5-year follow-up, are comparable to historical data when MSA is performed alone. Limited crestal bone resorption, and a relatively low cyst relapse or mucosal thickening incidence, appear to affirm the predictability of the technique.

These results should be interpreted with caution since there are limitations due to the small sample size. Further randomized clinical trials are warranted to draw final conclusions.

AUTHOR CONTRIBUTIONS

Conceptualization: T.T. and R.S. *Methodology*: M.D. and M.D.F. *Software*: R.R. and S.T. *Validation*: F.Z., A.D., A.M.S., S.S.W., and T.T. Data analysis: G.F., M.S., and M.D.F. *Investigation*: T.T., L.T., M.D.F., R.S., and R.R. *Resources*: L.T. *Data curation*: M.D., M.S., and

F.Z. *Writing—original draft preparation*: R.S., G.F., and S.S.W. *Writing—review and editing*: H.L.W., A.D., A.M.S., and M.D.F. *Visualization*: S.T. and L.T. *Supervision*: L.F. All authors have read and agreed to the published version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

This study was funded by Italian Ministry of Health—Current research IRCCS.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

INFORMED CONSENT STATEMENT

Informed consent was obtained from all subjects involved in the study.

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