

Five cases of postoperative maxillary cysts treated using direct approach to the anterior and lateral part of the maxillary sinus with an endoscope (DALMA)*

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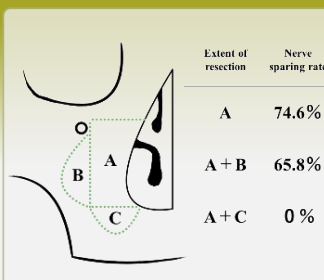
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Five cases of postoperative maxillary cysts treated using direct approach to the anterior and lateral part of the maxillary sinus with an endoscope (DALMA)

Postoperative maxillary cysts (POMCs)

- More prevalent following Caldwell-Luc surgery
- Distance of cyst from nasal cavity results in incomplete opening of cyst wall in conventional approaches, possibly increasing risk of recurrence



Approaches

From inferior nasal passage

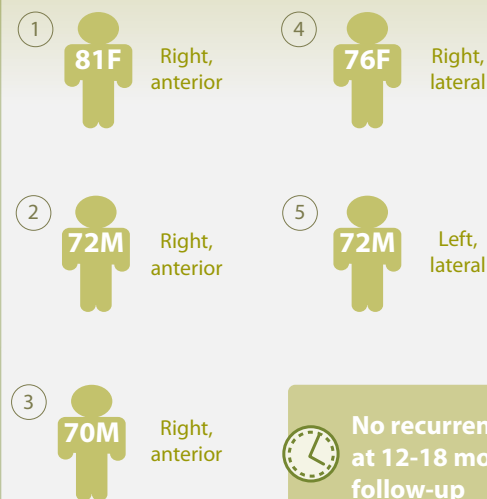
- Damage risk to infraorbital nerves (ION) and arteries



DALMA

- ✓ Maximal opening of cyst wall
- ✓ Performed without external incision
- ✓ Preserves ION

Cases



• All 5 patients are recurrence free following DALMA

• Further research with larger sample sizes needed

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Abstract

Postoperative maxillary cysts (POMCs), which are late complications of sinus surgery, are more prevalent in patients who have undergone Caldwell-Luc (CL) surgery. The incidence of these diseases has recently decreased; however, some cases remain refractory and pose an ongoing problem for patients and surgeons. Postoperative re-occlusion of the cyst wall was the main reason for recurrence. The risk of recurrence after conventional endoscopic surgery is high, probably because cysts that are distant from the nasal cavity, such as those in the lateral maxillary sinus and anterior descending region, result in an incompletely open cyst wall. Maximal opening of the cyst wall is the most effective surgical approach to prevent recurrence. However, approaching cysts from the inferior nasal passage has limited usefulness because of the risk of damage to the infraorbital nerves (ION) and arteries, as previous CL surgeries change these anatomical positions with bone augmentation. A direct approach to the anterior and lateral part

of the maxillary sinus with an endoscope (DALMA) was proposed in 2019. Using the DALMA, the anterior wall of the maxilla and ION were placed under a clear view, overcoming the limitations of the conventional approach. The DALMA approach was applied to five patients with recurrent refractory POMCs. Here, we describe its value in the treatment of recurrent refractory POMCs and provide a literature review.

Key words: maxillary sinus, cyst, surgical endoscopy, infraorbital nerve

Introduction

Sinus cysts can be primary, postoperative, or caused by trauma. Among postoperative cysts that occur (in 80-90% of cases), approximately 70% occur in the maxillary sinus⁽¹⁾.

Postoperative maxillary cysts (POMCs) develop late as a complication of Caldwell-Luc (CL) surgery and other procedures⁽²⁾. Although various theories have been proposed regarding the POMCs, their principles are generally the same. This is believed to be caused by secretions produced by the residual postoperative mucous membranes in the sinus, which roughly peel off during CL surgery. This is due to cyst formation in the postoperative wound or adhesive healing of the wound with bone thickening. Despite this speculation, the exact cause remains unknown.

POMC incidence has been decreasing owing to the development of endoscopic techniques that have remarkably reduced the need for CL surgery⁽³⁾. The treatment strategy for POMC is a wide opening of the cyst and connection to the nasal cavity. Furthermore, the recurrence rate is related to whether the POMC wall is membranous or bony.

The preferred indication for endoscopic endonasal surgery is the presence of a membranous cyst wall that is in contact with the nasal cavity. Restenosis of a bony or laterally located cyst wall, in which the nasal cavity and cyst wall are not fully opened, leads to recurrence⁽⁴⁻⁶⁾. Endoscopic modified medial maxillectomy (EMMM) is effective in these situations because the maxillary sinus is treated with a 0° endoscope while preserving the inferior turbinate and nasolacrimal duct⁽⁷⁻¹⁰⁾. However, patients still experience recurrence when the infraorbital nerve (ION), companion vessels, and other tissues or the entire cyst are not visible and when only the cyst itself can be partially opened. The Direct approach to the Anterior and Lateral part of the Maxillary sinus with An endoscope (DALMA)⁽¹¹⁾ is practical because the ION can be identified in the anterior wall of the maxilla and all surrounding tissues of the POMC can be visible. So, under a clear view of ION, cyst can be opened as wide as possible. The DALMA method was invented by Omura⁽¹¹⁾. Although this approach differs from endoscopic sinus surgery (ESS), DALMA remains an endoscopic procedure for the maxillary sinus, as it is essentially an extended ESS. This approach is particularly useful when the cyst is in contact with the ION or lateral or anterior to the maxillary sinus.

Here, we describe a patient with a recurrent refractory cyst located anterolaterally from the ION to a part of the bony cyst wall and discuss the cases of four other patients who were treated using the DALMA method. All cases were considered difficult to treat using the usual approach, for which the DALMA method would be useful on preoperative computed tomography (CT) scans. This study demonstrated that the DALMA method will be a viable option in cases that are difficult to approach using the usual ESS technique.

Case presentation

An 81-year-old woman presented with pain and swelling in the right buccal region. She had undergone CL surgery for chronic sinusitis 50 years previously and right ESS and endoscopic septoplasty for POMC 20 years previously at our hospital and had been followed up postoperatively as an outpatient. However, she experienced repeated symptoms of nasal obstruction and the right buccal region. The patient underwent further surgery for swelling in the right buccal region associated with four episodes of postoperative recurrence and repeated infections. Physical examination revealed that the right buccal region was slightly more swollen and tender than the left buccal region. No eye movement disorders or hypoesthesia in the buccal region were observed. Endoscopy revealed that the ethmoid sinus was open, but the inferior nasoantral window was swollen and drained. A soft-tissue density shadow in the anterior-inferior region of the right maxillary sinus was observed on the CT images of the paranasal sinuses. A cystic lesion with soft-tissue density extended beyond the maxillary sinus to the buccal area inferiorly away from the ION (Figure 1).

Surgery was performed under general anesthesia. Figure 2a shows the findings before the right endonasal surgery using a 0° rigid type endoscope. The mucous membrane was swollen, and pus drained into the medial inferior part of the inferior meatus. The mucosa of the pyriform aperture was pulled outward using an exfoliator, and the mucosa posterior to the pyriform aperture was incised using a needle electrocautery scalpel (Figure 2b). The mucosa of the pyriform aperture was dissected on the side of the inferior turbinate and the anterior wall of the maxilla (Figure 2c). The nasolacrimal duct was identified (Figure 2d), followed by the ION (Figure 2e). The anterior wall of the maxilla was treated from lateral and medial ports to avoid a pyriform

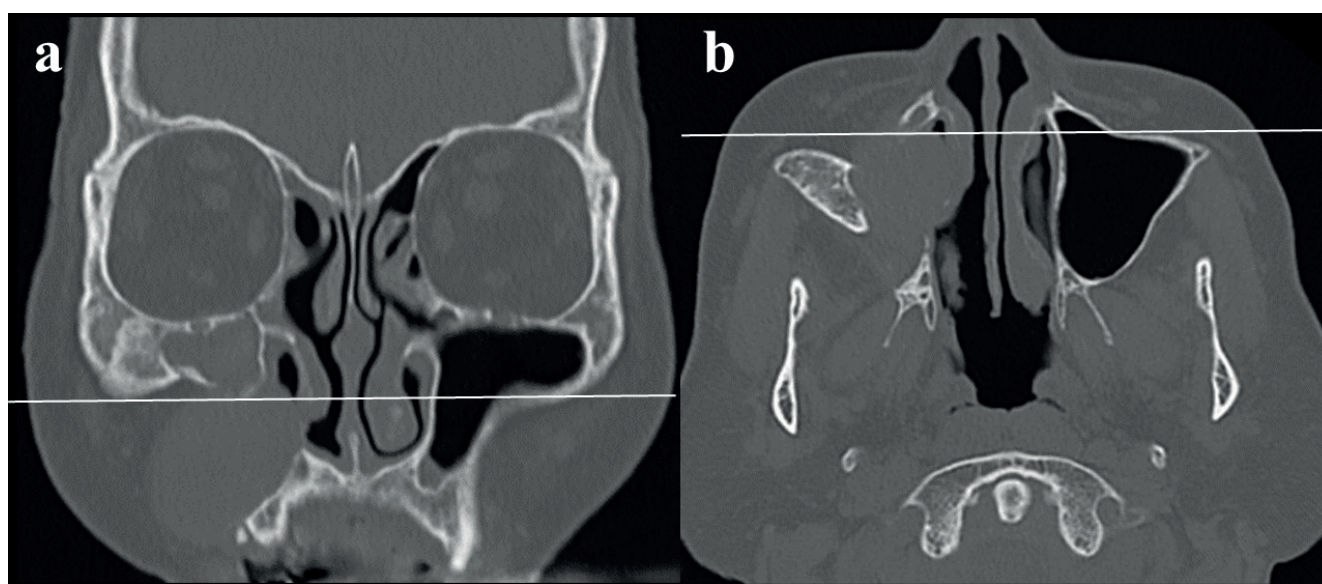


Figure 1. Computed tomography (CT) findings of paranasal sinuses showing a soft-tissue density shadow in the anterior inferior region of the right maxillary sinus. Cystic lesions with soft-tissue density extend beyond the maxillary sinus to the buccal area and are located inferiorly away from the infraorbital nerve. White lines: corresponding positions of the coronal (a) and axial (b) views on the CT images.

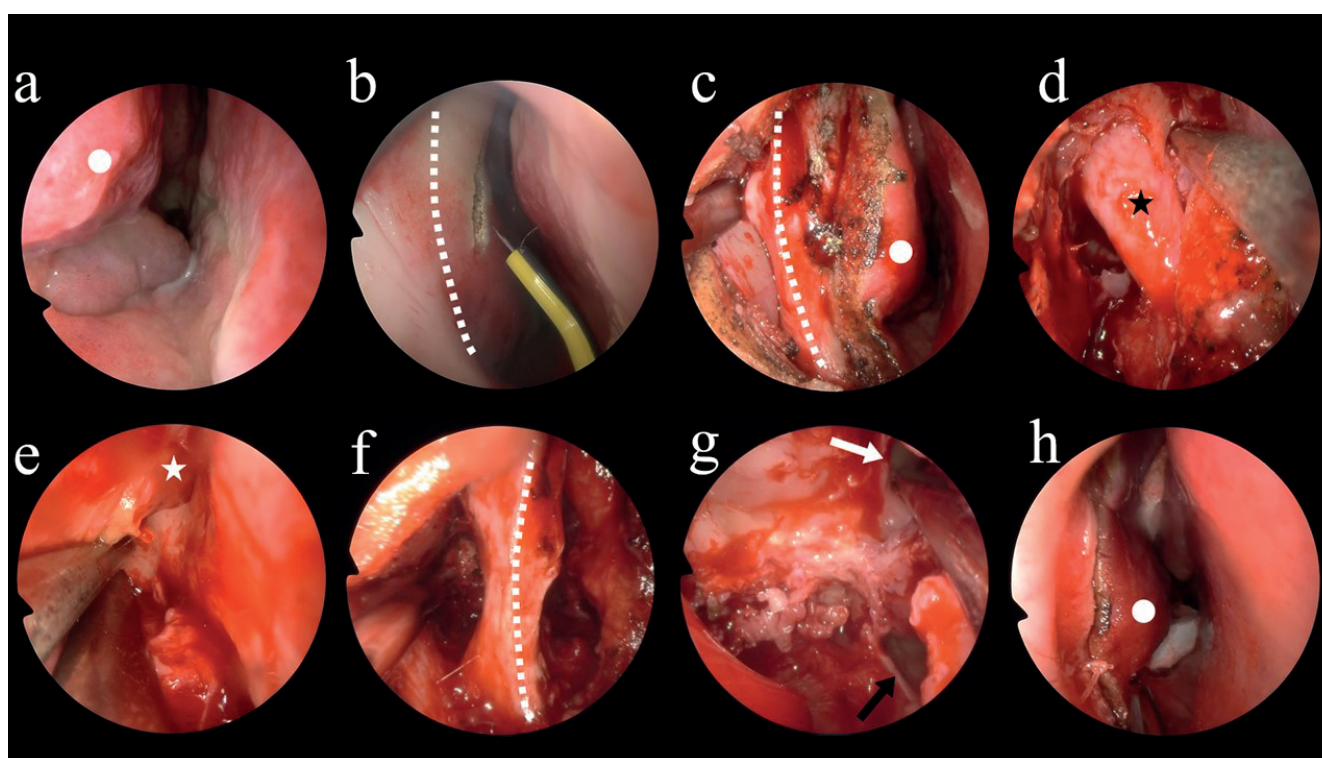


Figure 2. Right endonasal surgery using a 0° rigid type endoscope. a) White dot indicates swollen mucous membrane and pus drainage in the medial inferior part of inferior turbinate. b) White dotted line shows an incision of mucosa posterior to the pyriform aperture using needle electrocautery scalpel. c) Mucosa of pyriform aperture dissected on the side of the inferior turbinate and the anterior wall of the maxilla. d) and e) Black and white stars indicate the nasolacrimal duct and infraorbital nerve, respectively. f) Anterior wall of maxilla treated via the lateral and medial ports avoiding the pyriform aperture in the field of view of direct approach to anterior and lateral part of maxillary sinus with an endoscope (DALMA) method. g) Black and white arrows indicate the open cyst wall at the inferior and middle meatus, respectively. h) Wound surface sutured with 5-0 Vicryl®.

aperture in the field of view of the DALMA method (Figure 2f). This enabled the 0° endoscope to reach the cyst from the right

external nostril on the affected side via the anterior wall of the right maxillary sinus. This opened the wall of the cyst into the

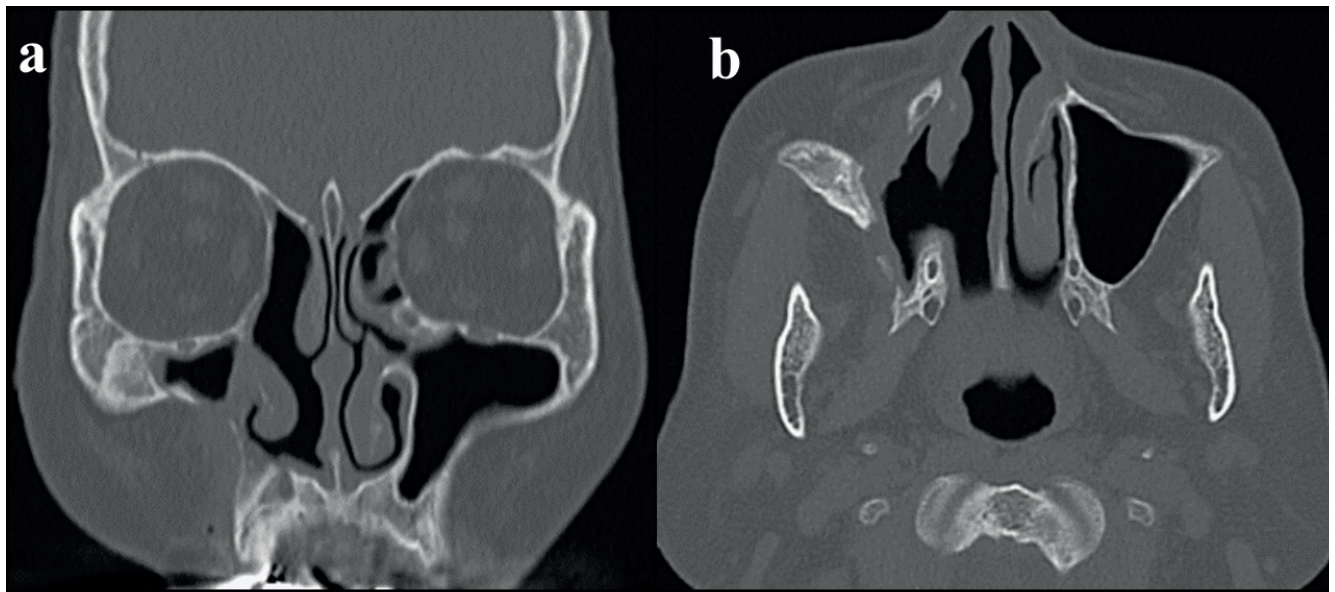


Figure 3. Postoperative follow-up computed tomography images of paranasal sinuses at 6 months confirm the absence of postoperative recurrence. Coronal (a) and axial (b) sections of the paranasal sinuses show air in the right maxillary sinus and preserved pyriform aperture, respectively.

Table 1. Summary of five cases of POMC treated using the DALMA method.

Case no.	Age	Sex	Chief complaint	Side	Location	Follow-up (mo.)	Opening ratio (%)	Postoperative symptoms
1	81	F	Cheek pain, swelling	R	Anterior	18	130	-
2	72	M	Nasal blockage, cheek pain	R	Anterior	17	54.1	-
3	70	M	Cheek pain	R	Anterior	14	78.9	-
4	76	F	Bloody phlegm	R	Lateral	12	82.8	-
5	72	M	Rhinorrhea, post-nasal drip	L	Lateral	12	73.6	-

The maxillary sinus was opened owing to a sufficiently open cyst wall. All patients remained recurrence-free for 12–18 months. Cyst opening rate = $B/A \times 100$ (%). A. Maximum vertical cyst diameter; B. Cyst opening part. In addition to the cyst diameter, the distance of the part parallel to the cyst opening was used. F, female; M, male; R, right; L, left; mo., months.

nasal cavity (Figure 2g). The incision anterior to the right inferior turbinate was closed with three 5-0 Vicryl® sutures and returned to its original position so that the bony surface of the pterygoid margin was not exposed. A Merocel hemoX® sponge was inserted in the right ethmoid sinus and in the maxillary sinus wound lateral to the right inferior turbinate for compression and hemostasis, and the surgery was completed (Figure 2h). The surgical duration was 72 min, with minimal blood loss. Postoperative pathology revealed that the nasal mucosa was coated with an atypical multilineage linear columnar epithelium and squamous metaplasia in some areas. No malignancy was found, and the patient was diagnosed with a postoperative maxillary cyst. The Merocel hemoX® sponge was removed, and the patient was discharged with instructions to apply nasal rinses at home. No recurrence was noted in the endoscopic findings of the nasal cavity or in the CT images of the paranasal sinuses obtained 6 months postoperatively (Figure 3). There was no evidence of lacrimal duct stenosis, lacrimal tears, sensory disturbances of

the right buccal region or upper gingiva, or facial deformities based on the symptoms and endoscopic findings. The patient remained on outpatient follow-up for approximately 18 months postoperatively.

Other cases of POMC with a history of CL surgery were treated in the same manner as those with DALMA. In all the cases, preoperative CT revealed no specific anatomical variations in the maxillary sinus. These cases are summarized in Table 1. No patient experienced recurrence or sensory disturbances within the buccal or supragingival regions.

Discussion

Restenosis after POMC surgery is caused by inadequate opening of the cyst wall connected to the nasal cavity⁽⁴⁾. An insufficient cyst wall opening is caused by difficulty in identifying the ION and companion vessels. This occurs even with the pre-lacrimal or EMMM approaches (Figure 4).

Only the DALMA technique can be used to identify the ION

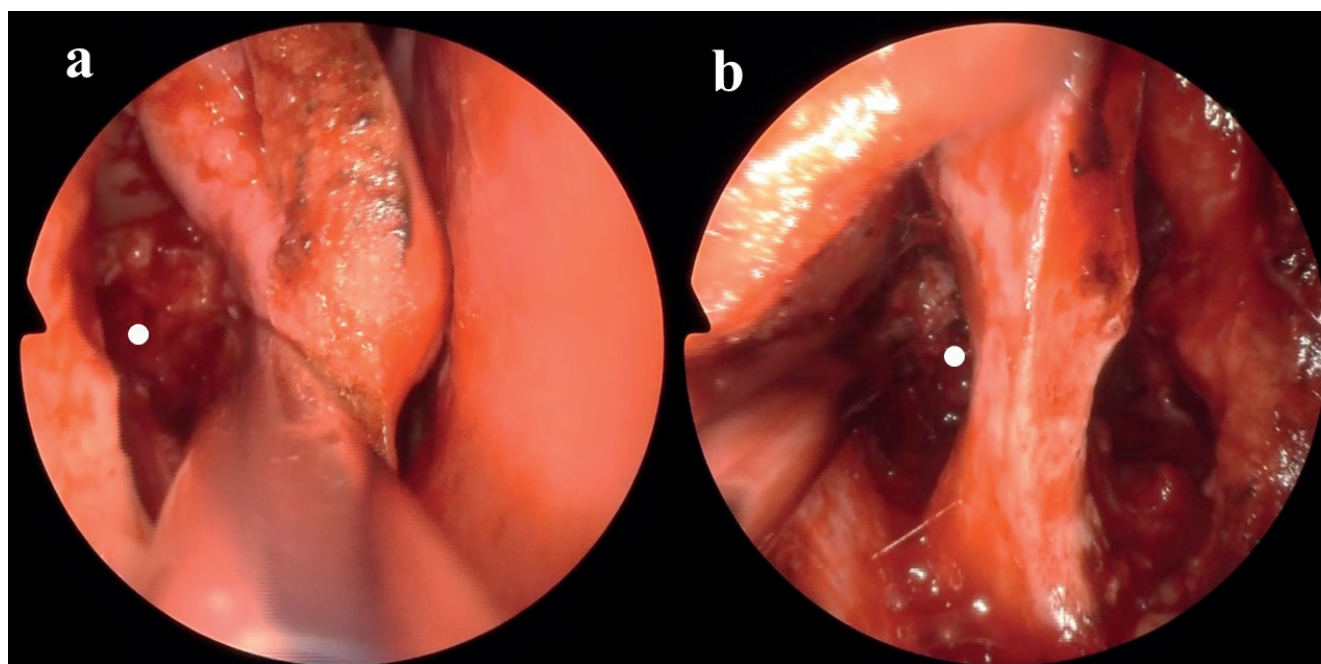


Figure 4. Endonasal surgery with a 0° rigid type endoscope field of view in endoscopic modified medial maxillectomy (EMMM) and direct approach to anterior and lateral part of maxillary sinus with an endoscope (DALMA). a) Field of view in EMMM showing a cyst (white dot) outside the endoscope, but forceps interfere with vision due to the one-port approach. b) Field of view in DALMA showing a cyst (white dot) in the center of the endoscope view, with which the forceps do not interfere because the approach is via outer and inner ports across the pyriform aperture.

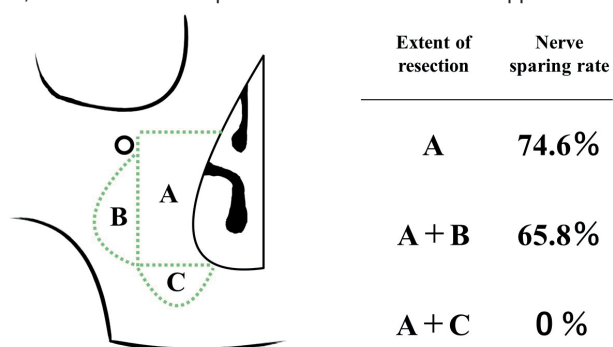


Figure 5. Schematic view of the right nasal cavity, right buccal region, and right maxillary sinus. Relationship between the extent of osteotomy of the anterior maxillary wall and the ratio (%) of nerve preservation. The extent of maxillary sinus resection during surgery was previously reported⁽¹³⁾. The range above the nasal floor medial to the infraorbital nerve (A), above the nasal floor and lateral to the infraorbital nerve (B), and below the nasal floor (C).

outside the cyst (Figure 2e) during the surgical evaluation of the anterior buccal tissue from the anterior wall of the maxillary bone.

To enhance the advantages of the DALMA technique, the preservable structures and reachable areas during pre-lacrimal surgery, endoscopic medial maxillectomy (EMM), DALMA, and endoscopic Denker's approach are listed in Tables 2 and 3. The modified Denker procedure⁽¹²⁾ approaches the anterior wall of the maxillary sinus, similar to the DALMA; however, it involves resection of the pyriform aperture, resulting in an external nasal

deformity and functional deficits such as nasal stenosis due to alar collapse.

The DALMA approach⁽¹¹⁾ allows visualization of the entire maxillary cyst and the ION located around the cyst while preserving the pyriform aperture, inferior turbinate, and nasolacrimal duct. This approach has changed the concept of surgery, particularly for lesions in the entire maxillary sinus that involve the ION and those outside the anterior wall of the maxillary sinus.

Furthermore, because the anterior wall of the maxilla is drilled during the DALMA, damage to the anterior superior alveolar nerve (ASAN) running through the area may cause pain and numbness in the nasolabial and buccal regions⁽¹³⁻¹⁶⁾.

The ASAN runs through this area, and the rate of nerve damage during surgical resection has been previously described⁽¹⁶⁾.

Although the present report provides detailed classifications, the patients are classified as A, B, or C according to whether the location of the POMC was above or below the nasal floor and, if so, whether they were lateral or medial to the ION (Figure 5). If bone resection proceeds below the nasal floor in A + C, postoperative symptoms (e.g., pain and numbness in the nasolabial and buccal regions) due to nerve damage occur. However, bone resection proceeds A or A+B, nerve sparing in 74.6% or 65.8%. The risk of postoperative complications can be decreased by implementing the DALMA method based on an understanding of the anatomical characteristics of the nerve trajectory.

Table 1 shows the clinical data of the five patients included in this study. The mean age of the patients at the time of surgery

Table 2. Preservable structures during surgical steps of pre-lacrimal, EMM, DALMA, and eDenker's approaches.

	Inferior turbinate	Lacrimal duct	Pyriform aperture	Anterior wall of MS
Pre-lacrimal	○	○	○	○
EMM	×	×	○	○
DALMA	○	○	○	×
eDenker's	×	×	×	×

DALMA, direct approach to the anterior and lateral part of the maxillary sinus with an endoscope; eDenker's, endoscopic Denker's; EMM, endoscopic medial maxillectomy; MS, maxillary sinus.

Table 3. Reachable areas during surgical steps of pre-lacrimal, EMM, DALMA, and eDenker's approaches.

	Medial to ION	Lateral to ION	Inferomedial part of MS	Anterior wall of MS
Pre-lacrimal	○	×	×	×
EMM	○	×	×	×
DALMA	○	○	○	○
eDenker's	○	○	○	○

DALMA, direct approach to the anterior and lateral part of the maxillary sinus with an endoscope; eDenker's, endoscopic Denker's; EMM, endoscopic medial maxillectomy; ION, infraorbital nerve; MS, maxillary sinus.

was 74.2 years. Three patients (60%) were male. Four patients (80%) had a cyst on the right side, and one patient (20%) had a cyst on the left side. All patients had previously undergone CL surgery. The cysts were grouped according to their location as follows: anterior to the maxillary sinus (Cases 1–3) and lateral to the ION (Cases 4 and 5).

The ratio of the distance between the maximum vertical diameter of the cyst (A) and the cyst opening part (B) on postoperative CT was defined as the cyst opening rate as follows: cyst opening rate = $B/A \times 100$ (%). In addition to the cyst diameter, the distance of the part parallel to the cyst opening was used. The mean cyst opening rate was 83.8% (54.1–130%) (Table 1)⁽⁷⁾. All patients were followed up for 12–18 months postoperatively.

No cases of recurrence or sensory disturbances in the buccal or supragingival regions were noted.

The DALMA method may be a viable option in cases that are difficult to approach using ESS techniques^(11,13–17). For example, the area is located lateral to the ION, the inferior medial part of the maxillary sinus, and the anterior wall of the maxillary sinus. However, sufficient data are currently lacking owing to the paucity of surgeries using the DALMA method at our hospital. Therefore, further investigations with large sample sizes are required to confirm the validity of our findings.

Conclusions

Here, we describe the effective treatment of five cases of recurrent refractory POMC using the DALMA method. These patients had repeated recurrences and infections due to incomplete surgery for the maxillary sinus lesions after CL surgery. DALMA is performed without an external incision, preserves the ION, and maximally opens the cyst wall. Although various durations have passed since surgery and follow-up has continued, all patients remain recurrence-free.

Abbreviations

ASAN, anterior superior alveolar nerve; CT, computed tomography; DALMA, direct approach to anterior and lateral part of maxillary sinus with an endoscope; EMM, endoscopic modified medial maxillectomy; ESS, endoscopic sinus surgery; ION, infraorbital nerve; POMC, postoperative maxillary cyst.

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Authorship contribution

TA wrote the protocol and collected the patient data, as well as analyzed and interpreted the patient data; all authors read and approved the final manuscript.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Consent was obtained from the patients.

Availability of data and material

The datasets used and/or analyzed in the current study are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declare that they have no competing interests.

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