



Comparison Between Endoscopic Prelacrimal Medial Maxillectomy and Caldwell-Luc Approach for Benign Maxillary Sinus Tumors

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Objectives. Endoscopic prelacrimal medial maxillectomy (EPMM) was previously reported to treat maxillary inverted papilloma. This study aimed to compare prelacrimal recess approach with the conventional Caldwell-Luc approach (CLA) to remove benign maxillary sinus tumors and to evaluate the usefulness of this approach based on our experience.

Methods. Ten patients who underwent EPMM at our hospital from January 2013 to December 2017 were reviewed. We also reviewed 30 patients who underwent benign maxillary sinus tumor resection via CLA during the same period. From medical records, postoperative pathological results, complications due to surgery, and recurrence rate were evaluated.

Results. There were eight inverted papilloma, one ameloblastoma, and one ossifying fibroma in the EPMM group. In the CLA group, all 30 cases were inverted papilloma. There were no cases of failure at gross total removal during surgery, and no recurrences were observed during follow-up in either groups. Mean follow-up period was 13.0 months in CLA group and 10.8 months in EPMM group. Regarding postoperative complications, 11 patients of the CLA group (37%) and three patients of the EPMM group (30%) had numbness around the cheek and upper lip area after surgery ($P=0.715$). In the CLA group, there were eight patients who had numbness lasting more than 3 months after surgery, and two patients had numbness for more than 1 year. However, facial numbness disappeared within 3 months in all patients in the EPMM group, in which epiphora was not observed.

Conclusion. EPMM is the effective surgical approach for resecting benign maxillary sinus tumor compared with CLA. Although facial numbness was reported in EPMM, the duration of numbness was shorter than CLA.

Keywords. Prelacrimal Recess Approach; Maxillary Sinus Neoplasms; Caldwell-Luc Approach; Inverted Papilloma; Endoscopy

INTRODUCTION

Endoscopic sinus surgery has been widely used for most sinonasal disease including that in the maxillary sinus. There are vari-

ous lesions that can be present in the maxillary sinus such as chronic inflammation, odontogenic infection, and neoplastic disease. In cases with sinus inflammation or infection are controlled by functional endoscopic sinus surgery to reestablish ventilation and mucociliary clearance of the sinuses [1]. However, in cases of benign sinonasal tumor such as inverted papilloma, resection of its attachment site should be performed through elevation of a mucoperiosteal flap surrounding the lesion with safe macroscopic margins. Incomplete removal can lead to early recurrence of the tumor [2]. It is common to perform middle meatal antrostomy first to remove maxillary sinus-occupying lesions. Considering the position of the maxillary sinus although we can visualize lesions in the maxillary sinus with a 70° or 90° endoscope, it is often difficult to remove the lesion completely because the

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limited reach of the instrument. In particular, when the lesion is located on the inferior or anterior side of the maxillary sinus, it is usually hard to remove through the natural ostium. Such removal can be performed using the traditional Caldwell-Luc approach (CLA) or by way of a canine fossa puncture [3,4]. Complications of the canine fossa approach have occurred in up to 75% of patients and include cheek swelling, dental numbness, facial numbness, tingling, and pain [5,6].

Zhou et al. [7,8] proposed the intranasal endoscopic prelacrima recess approach to the maxillary sinus. This procedure is performed by removal of the medial wall of the prelacrima recess, preserving the inferior turbinate and nasolacrimal duct. Many cases have been reported using this approach to remove unilateral maxillary sinus diseases such as inverted papilloma and chronic inflammation [9], tumor of pterygopalatine fossa [10], and tumor located at the infratemporal fossa [11]. Endoscopic prelacrima medial maxillectomy (EPMM) has the advantage of avoiding an external incisional wound.

However, many surgeons are reluctant to use this approach because they consider its limitations relative to CLA. Comparison between CLA and EPMM is also not well established. This study compared EPMM with conventional CLA to remove benign maxillary sinus tumor and to evaluate the usefulness of these approaches based on our experience.

MATERIALS AND METHODS

This retrospective study was approved by the Institutional Review Board of Samsung Medical Center (IRB No. 2018-05-129). The informed consent was exempted because the risk to the study subjects was extremely low.

Subjects

We reviewed 10 patients who underwent EPMM at a Samsung Medical Center from January 2013 to December 2017. Ten patients using EPMM had a benign maxillary sinus tumor with a lesion difficult to approach despite using angled instruments with 30°, 70°, and 90° endoscopy. These patients were required to do CLA because it was hard to manipulate tumor through middle meatal antrostomy site. However, EPMM was used to

avoid the external approach. We also reviewed 30 patients who underwent benign maxillary sinus tumor resection through CLA because the operation could not be completed with middle meatal antrostomy during the same period. To compare EPMM and CLA in resection of benign maxillary sinus tumor, 10 EPMM and 30 CLA patients were evaluated. The mean age of these 40 patients was 53.7 ± 13.3 years (range, 24 to 72 years), and the mean follow-up period was 12.4 ± 11.7 months. All the patients had a preoperative assessment including endoscopic examination and computed tomography (CT).

EPMM was performed by one junior rhinologist (SDH), and CLA was performed by three other experienced rhinologists (SKC, HJD, and HYK). Approach selection was based on surgeon preference. From the medical record, patient features were extracted for analysis and included age, sex, previous operation history, and surgical record of tumor attachment sites. Postoperative pathological result, complications due to surgery, and recurrence rate were evaluated.

Surgical technique for EPMM

EPMM involves removing the medial wall of the prelacrima recess, which is the bone between the pyriform aperture and nasolacrimal duct. This approach can avoid the external incision used in CLA. We used EPMM for cases of maxillary sinus-occupying benign tumor or retromaxillary lesion. In the surgical procedure of chronic sinusitis, middle meatal antrostomy is well established for functional treatment. We think that EPMM is unsuitable for treatment of chronic inflammation as a primary choice. If a malignant tumor is suspected in preoperative radiological imaging test with bony invasion, this technique is unsuitable because en bloc resection of the tumor would be difficult. Therefore, we used EPMM only for sinonasal benign tumors in our study population.

Many previous papers have described surgical procedures of EPMM. We briefly describe the surgical procedure for our case (Fig. 1): (1) mucosal incision of the lateral nasal wall at the inferior turbinate anterior margin, (2) elevation of the lateral nasal wall mucosa posteriorly, (3) identification of the lacrimal bone by navigation, (4) after removing the lacrimal bone and identifying the lacrimal duct, (5) drilling the medial wall of the prelacrima recess, (6) full exposure of the maxillary sinus, (7) after tumor removal, mucosal flap repositioning and suturing an incision site, (8) endoscopic finding of postoperative 1 month.

Statistical analysis

Descriptive analysis was performed, and the results are presented as mean \pm standard deviation. The comparison between CLA and EPMM was evaluated using chi-square test. Statistical significance was set at $P < 0.05$. All statistical analyses were performed using IBM SPSS ver. 20.0 (IBM Corp., Armonk, NY, USA).

HIGHLIGHTS

- Endoscopic prelacrima medial maxillectomy is the effective surgical approach for benign maxillary sinus tumors.
- Endoscopic prelacrima medial maxillectomy provide a wide surgical field of all maxillary sinus walls despite preservation of the nasolacrimal duct and inferior turbinate.
- The duration of facial numbness after prelacrima approach was shorter than that for Caldwell-Luc approach.

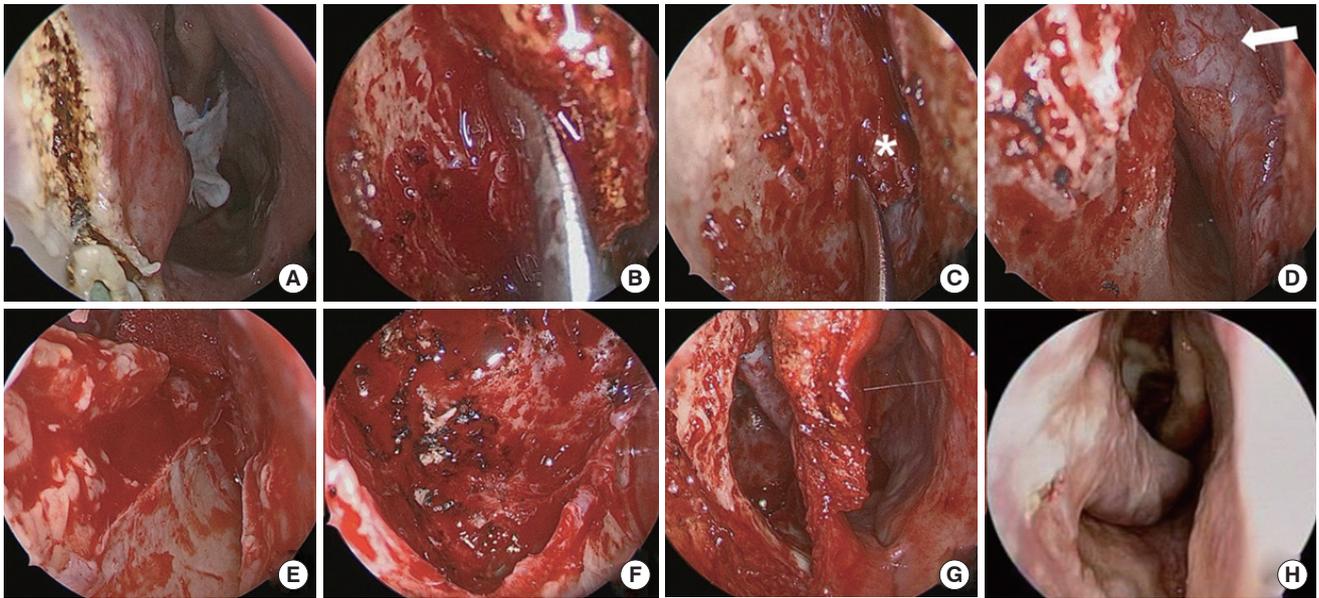


Fig. 1. Surgical procedures for prelacrimal recess approach medial maxillectomy. (A) Mucosal incision of the lateral nasal wall at the inferior turbinate anterior margin. (B) Elevation of the lateral nasal wall mucosa posteriorly. (C) Identification of the lacrimal bone by navigation (asterisk). (D) Identification of the lacrimal duct (arrow) after removing the lacrimal bone. (E) Drilling the medial wall of the prelacrimal recess. (F) Full exposure of the maxillary sinus. (G) Reposition of mucosal flap and suture an incision site after tumor removal. (H) Endoscopic finding at postoperative 1 month.

Table 1. Patient characteristics between groups according to surgical approach

Variable	Caldwell-Luc	Prelacrimal
No. of patients	30	10
Age (yr), mean \pm SD	53.7 \pm 14.2	53.6 \pm 10.7
Male:female	25:5	7:3
History of previous operation (no, %)	12 (40)	4 (40)
Mean follow-up period (mo)	13.0	10.8
Pathological result (no. of cases)	Inverted papilloma, 30	Inverted papilloma, 8; ameloblastoma, 1; ossifying fibroma, 1

SD, standard deviation.

RESULTS

Demographic data of benign maxillary sinus tumor patients in this study is presented in Table 1. A total of 40 patients (32 males and eight females) diagnosed with maxillary sinus-occupying benign tumor by radiological imaging modality were enrolled. We divided the study population according to surgical approach—CLA and EPMM. The mean age of the CLA group was 53.7 years, and that of the EPMM group was 53.6 years. The proportion of previous operation history was 40% in both groups. Mean age ($P=0.978$) and follow-up period ($P=0.618$) between the two groups were not significantly different. Pathological results showed that all 30 CLA group cases were inverted papilloma, and EPMM comprised eight inverted papilloma, one

Table 2. Surgical outcomes according to surgical approach for benign maxillary sinus tumors

Variable	Caldwell-Luc (n=30)	Prelacrimal (n=10)
Operation time (min)	116.8 \pm 31.3	105.3 \pm 33.3
Bleeding amount (mL)	141.0 \pm 106.6	143.0 \pm 92.2
Failure of gross total removal	0	0
Hospital stay (day)	4.1 \pm 0.3	4.1 \pm 0.5
Recurrence	0	0
SCC from IP	0	1
Complication	Numbness, 11 (37) facial pain, 2 (7) Epistaxis, 0	Numbness, 3 (30) Epiphora, 0 Epistaxis, 0
Duration of facial numbness (mo)		
<3	3	3
≥ 3 – <12	6	0
≥ 12	2	0

Values are presented as mean \pm standard deviation or number (%). SCC, squamous cell carcinoma; IP, inverted papilloma.

ameloblastoma, and one ossifying fibroma case.

Comparison of surgical outcomes according to surgical approach is presented in Table 2. There were no cases of failure of gross total removal during surgery, and no recurrences were observed during the follow-up period for either group. The operation time ($P=0.825$), bleeding amount ($P=0.999$), and hospital stay ($P=0.397$) were also not significant between two approaches. Squamous cell carcinoma was seen in one patient in the EPMM group. This patient underwent additional postoperative

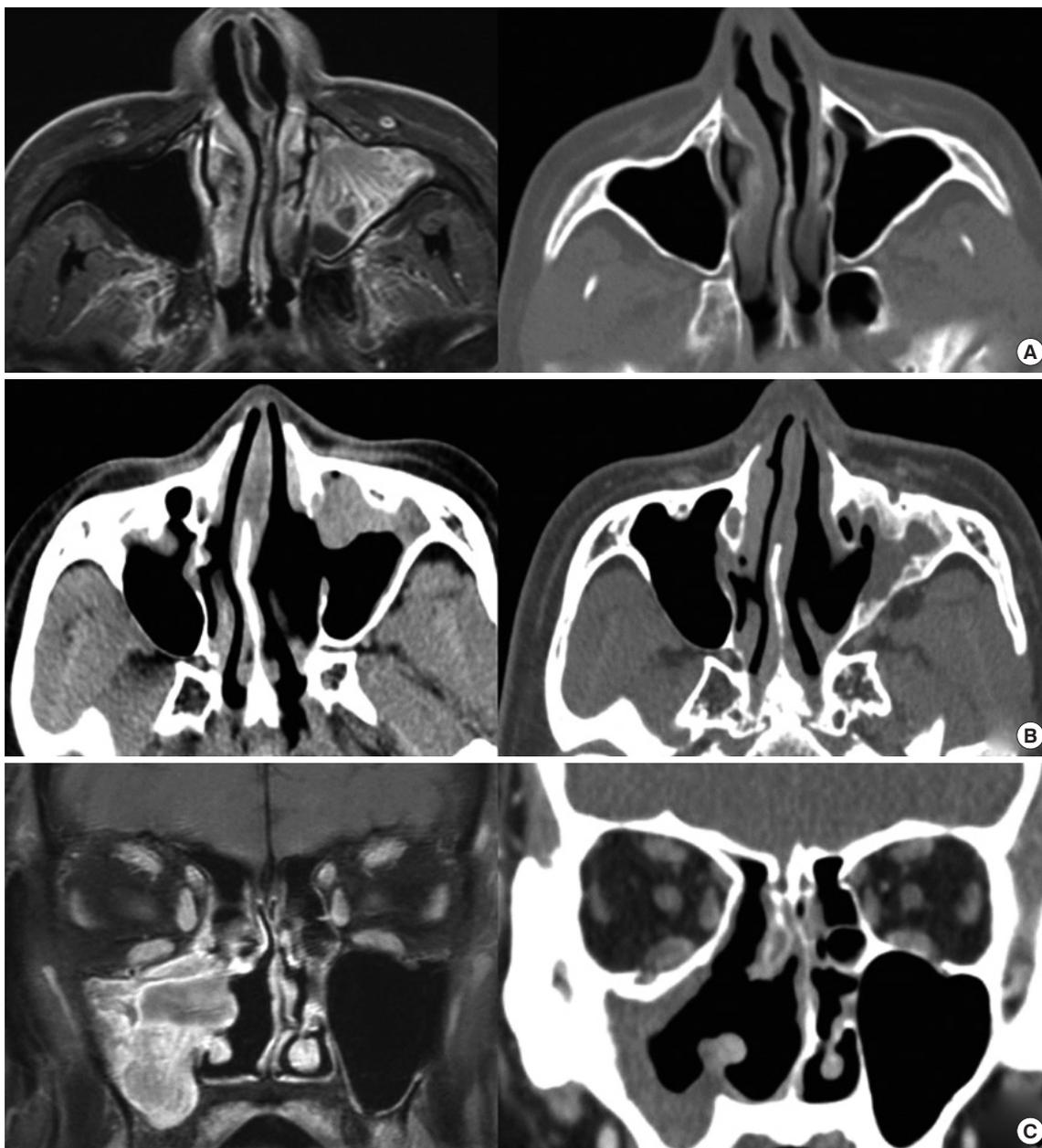


Fig. 2. Three cases using the prelacrimar recess approach for maxillary sinus inverted papilloma. Left shows preoperative radiological finding, and right is postoperative follow-up image. (A) Medial wall-attached inverted papilloma. (B) Anterior wall-attached inverted papilloma. (C) Inverted papilloma of diffuse attachment to the maxillary sinus.

radiation therapy and had regular follow-up at outpatient clinic. Eleven CLA patients (37%) and three EPMM patients (30%) had numbness around the cheek and upper lip area ($P=0.715$). Two CLA patients had facial pain after surgery. Epiphora was not been observed in the EPMM group. In the CLA group, there were eight patients who had numbness lasting more than 3 months and two patients for more than 1 year. However, facial numbness disappeared within 3 months in all EPMM patients.

The attachment site of the benign maxillary sinus tumor is shown in Table 3. Evaluation of attachment site was performed

Table 3. Attachment sites in the maxillary sinus

Variable	Caldwell-Luc (n=30)	Prelacrimar (n=10)
Anterior wall	8	3
Posterior wall	2	0
Lateral wall	2	1
Medial wall	6	2
Superior wall	5	0
Inferior wall	4	1
Diffuse type	3	3

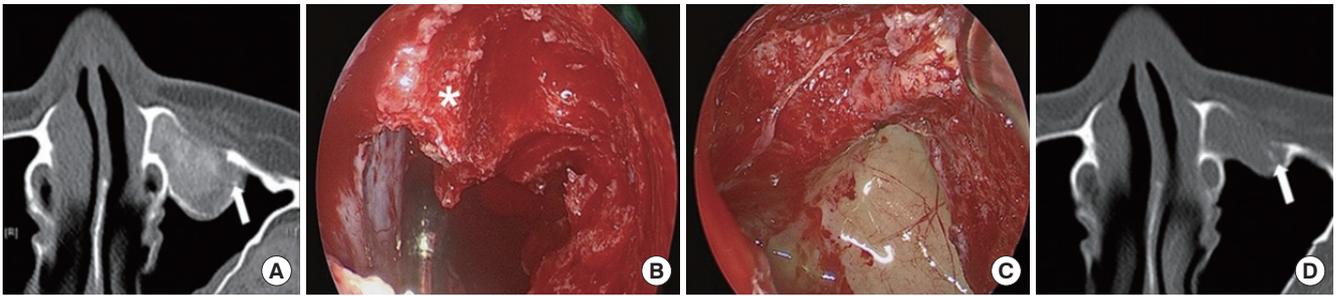


Fig. 3. Ossifying fibroma excision case using endoscopic prelacrimal medial maxillectomy. (A) Fibro-osseous lesion in the anterior wall of the left maxillary sinus shown on preoperative computed tomography (CT) scan (arrow: infraorbital nerve). (B) Bony tumor in the maxillary sinus anterior wall encasing the infraorbital nerve (asterisk). (C) Decompressed infraorbital nerve was defined. (D) Postoperative 6-month CT scan showed removal of bony tumor and only a small amount of soft-tissue lesion remaining (arrow: infraorbital nerve).

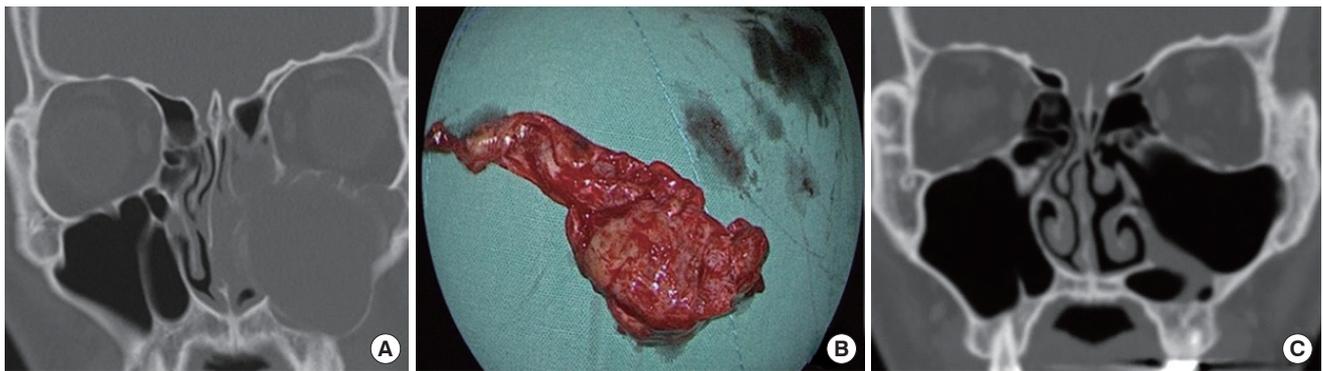


Fig. 4. Ameloblastoma excision case using endoscopic prelacrimal medial maxillectomy. (A) Computed tomography (CT) scan showed a large expansile mass in the left maxillary sinus. (B) A well-capsulated round mass was successfully removed. (C) Postoperative 18-month CT scan showed absence of tumorous lesion and well-pneumatized maxillary sinus.

through surgical procedures. In the CLA group, the attachments in 30 cases of benign maxillary sinus tumor were found at the anterior wall (n=8), posterior wall (n=2), lateral wall (n=2), medial wall (n=6), superior wall (n=5), inferior wall (n=4), and diffuse attachment to the maxillary sinus (n=3). In the EPMM group, the attachments in 10 cases of benign maxillary sinus tumor were found at the anterior wall (n=3), lateral wall (n=1), medial wall (n=2), inferior wall (n=1), and diffuse type (n=3). Fig. 2 shows three cases using EPMM for maxillary sinus inverted papilloma. Tumors were successfully removed. Fig. 3 shows another case using EPMM. A 48-year-old female patient visited for left cheek tingling sensation of 4-year duration. CT scan showed a fibro-osseous lesion encasing the infraorbital nerve at the maxillary sinus anterior wall. We performed tumor removal and infraorbital nerve decompression through EPMM, and her symptoms resolved after surgery. Ameloblastoma removal via EPMM is presented in Fig. 4.

DISCUSSION

Endoscopic sinus surgery is frequently performed for sinonasal disease, and middle meatal antrostomy is the most basic tech-

nique in the surgical procedure. We focused on benign maxillary sinus tumors in using EPMM as originally described by Zhou et al. [7]. In many cases of inflammation or infectious disease such as odontogenic sinusitis, fungal sinusitis, chronic sinusitis, and nasal polyp, we do not usually remove attached mucosa with a free margin. Because the purpose of surgery in these diseases is to reestablish ventilation, mucociliary clearance of the sinuses with removal of irreversibly changed tissue. Therefore, in assessing whether it is a suitable surgical procedure for maxillary sinus disease, it would be better to confine the study population to tumorous lesions. We also excluded cases of malignancy because an external approach should be considered when there is bony invasion. Finally, we reviewed 40 patients who needed an additional surgical approach for benign maxillary sinus tumor removal and among these patients; 10 patients underwent surgery through EPMM.

There are many types of benign tumor originating from the sinonasal cavity including inverted papilloma, hemangioma, fibrous dysplasia, and angiofibroma. Of these, inverted papilloma, which accounted for most of our study population, has a high recurrence rate and a chance of malignant transformation. These tumors are also well known to exhibit centrifugal growth pattern [12,13]. Even though such a tumor usually occupies the na-

sal cavity with large volume, the origin is often located in a focal area. Therefore, it is important to predict the attachment site of the tumor through preoperative radiological imaging, and the tumor must be completely removed around the attachment site. Lee et al. [14] reported that focal hyperostosis on CT could be considered a predictor of inverted papilloma origin. In our study population, 40% of all patients had a previous operation history at another hospital and visited our center for recurred lesions. In most cases, only middle meatal antrostomy was performed as primary surgery. Therefore, the lesions could not be removed from the attached origin site properly. There was no difference in proportion of patients with previous operation history between the two groups.

The maxillary sinus is a pyramidal shaped chambered space that is usually the largest sinus of the paranasal space, and its natural ostium is formed at the superior and medial areas of the maxillary sinus. Because of these anatomical characteristics, the inferior and anterior walls of the maxillary sinus are difficult to approach despite using angled microdebrider and endoscopy. It has been reported that even the experienced sinus surgeon can have trouble accessing all walls of the maxillary sinus [15,16]. Historically, the difficult-to-approach area of the maxillary sinus was accessed via the CLA [17].

In 2007, Zhou et al. [8] first reported performing operation using EPMM for maxillary sinus disease. Since then, many surgeons have reported cases using this approach. However, comparison between CLA and EPMM has not been presented. The indications for and limitations of this approach are also not well established. In our experience, there are two important advantages in using EPMM. One is to avoid nasolacrimal duct injury when opening a lacrimal bone surrounding a nasolacrimal duct. Second point is to remove the medial wall of the prelacrima recess widely to facilitate instrument use. EPMM is basically performed by removing the maxillary sinus medial wall of the prelacrima recess, which is the bone between the pyriform aperture and nasolacrimal duct. However, after full exposure of the nasolacrimal duct and medialization with lateral nasal wall mucosa can be done, we perform bony removal of maxillary sinus medial wall to the natural ostium, which is the anterior margin of the middle meatal antrostomy. This allows a wide surgical field, making it easier to use the instruments. We used these tips in some cases with widely attached tumor of the maxillary sinus.

In our study, three patients of the EPMM group (30%) had facial numbness around the cheek and upper lip area after surgery. Although our study showed no significant difference in incidence of facial numbness between the two groups, the duration of numbness was significantly shorter with EPMM than with CLA. These neurologic complication is thought to be caused by injuries to the branches of the infraorbital nerve, principally the anterior superior alveolar nerve and less commonly the middle superior alveolar nerve [3]. When drilling the pyriform aperture, we can damage the nerve. However, nerve transection is merely

happened during the EPMM and transient numbness could be happened because of thermal injury by cauterization or drilling. However, when making antral window in CLA, we can make damage to the main branch of infraorbital nerve. When elevating periosteum up to the infraorbital canal, infraorbital nerve could be in risk. If the infraorbital artery injured, cauterization could also make permanent damage to infraorbital nerve.

Even when compared with endoscopic medial maxillectomy as a transnasal surgical approach, EPMM has an advantage of reducing complications by preserving the inferior turbinate and lacrimal duct. Osguthorpe and Weisman [18] performed medial maxillectomy in 35 patients and reported that all patients complained of nasal crusting, which is a symptom of empty nose syndrome. Another study reported a 30% incidence of epiphora after medial maxillectomy [19]. Our patient did not complain of persistent nasal crusting or epiphora. In our EPMM cases, we performed one or two sutures at incision site using 4-0 vicryl and there was no adverse event such as necrosis or detachment of inferior turbinate. During the follow-up period, it was difficult to exam the tumor recurrence through the inferior meatus in EPMM because the lateral nasal wall mucosa of inferior meatus was preserved. However, because all the EPMM cases were performed after middle meatal antrostomy was conducted in advance, we were able to exam the recurrence of tumor through the middle meatal antrostomy site using 30°, 70°, and 90° endoscopy.

The main advantages of EPMM is a wide surgical field for all maxillary sinus walls without violation of the nasolacrimal duct and inferior turbinate. Our study showed that benign maxillary sinus tumors attached to various sites of the maxillary sinus could be removed, and gross total resection is possible even for diffuse-type tumors with this approach. In addition, since EPMM is performed via a transnasal method, it can preserve the periosteum of the canine fossa area, which is the manipulated site of the CLA. Periosteum plays a role as a primary barrier to prevent maxillary sinus disease from invading the skin of the cheek. When CLA is performed for maxillary sinus inverted papilloma, if the final pathology result is confirmed as squamous cell carcinoma, the approach site could become a spreading route. Therefore, EPMM has an advantage that the periosteum of the canine fossa area can be left as a barrier. There are some limitations of EPMM. Beyond the standard complications of endoscopic sinus surgery, potential complications of EPMM include damage to the nasolacrimal apparatus, nasal dryness, and facial numbness [20]. Additionally, in patients with a narrow nasal cavity due to a septal deviation or maxillary sinus hypoaeration, it can be difficult to perform EPMM based on our experience.

If there is no reluctance to sublabial incision, both approaches can be used for all maxillary benign tumor according to surgeon's preference. However, based on our experiences, we would like to discuss the strengths and weaknesses of EPMM and CLA. Anterior wall of maxillary sinus tumor is more efficiently managed by EPMM than CLA. On the contrary, supero-

medial wall is relatively difficult to be manipulated by EPMM compared with CLA. Although anteroinferior wall is also difficult to approach by both approaches, there is more chance to damage of anterior inferior alveolar nerve when drilling anteriorly in performing EPMM.

This study has some limitations. First, the sample size of the EPMM group was too small to establish the effectiveness of this approach. Second, the range of maxillary sinus disease between the two groups was not the same. However, this study showed that all walls of the maxillary sinus can be accessed and total gross removal of tumor can be performed through EPMM. The follow-up period is quite short in our study. Because they were mostly asymptomatic patients, the rate of follow-up over 1 year was not high. Although further study of a large population is needed to establish definite indications and limitations of EPMM, our study offers a comparison between the two approaches, showing that tumor control is comparable. EPMM is also a useful method for diverse benign sinonasal tumors in maxillary sinus.

EPMM is a useful approach for benign maxillary sinus tumors. This approach can be used for benign tumors of the entire wall of the maxillary sinus without lacrimal duct or inferior turbinate injury. Tumor control is comparable with that of CLA. The duration of facial numbness after surgery was also significantly shorter than that with CLA.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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AUTHOR CONTRIBUTIONS

Conceptualization: SDH. Data curation: JLL, DK. Formal analysis: JLL, AMAZ, GR. Methodology: JLL, SDH. Project administration: SDH. Visualization: AMAZ. Writing - original draft: JLL. Writing - review & editing: HJD, SKC, HYK, SDH.

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