

“TuNa-saving” endoscopic medial maxillectomy: a surgical technique for maxillary inverted papilloma

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Abstract The maxillary sinus is the most common site of sinonasal inverted papilloma. Endoscopic sinus surgery, in particular endoscopic medial maxillectomy, is currently the gold standard for treatment of maxillary sinus papilloma. Although a common technique, complications such as stenosis of the lacrimal pathway and consequent development of epiphora are still possible. To avoid these problems, we propose a modification of this surgical technique that preserves the head of the inferior turbinate and the nasolacrimal duct. A retrospective analysis was performed on patients treated for maxillary inverted papilloma in three tertiary medical centres between 2006 and 2014. Pedicle-oriented endoscopic surgery principles were applied and, in select cases where the tumour pedicle was located on the anterior wall, a modified endoscopic medial maxillectomy was carried out as described in this paper. From 2006 to 2014 a total of 84 patients were treated. A standard endoscopic medial maxillectomy was performed in 55 patients (65.4%), while the remaining 29 (34.6%) had a modified technique performed. Three recurrences (3/84; 3.6%) were observed after a minimum follow-up of 24 months. A

new surgical approach for select cases of maxillary sinus inverted papilloma is proposed in this paper. In this technique, the endoscopic medial maxillectomy was performed while preserving the head of the inferior turbinate and the nasolacrimal duct (“TuNa-saving”). This technique allowed for good visualization of the maxillary sinus, good oncological control and a reduction in the rate of complications.

Keywords Inverted papilloma · Endoscopic sinus surgery · Medial maxillectomy · Epiphora · Nasolacrimal duct · Maxillary sinus

Introduction

Sinonasal inverted papilloma (IP) is one of the most common benign neoplasms of the nasal and paranasal sinus tract [1–4]. Several recent publications cite the maxillary sinus as the most frequent site of tumour growth (Vancouver 49%, Varese–Brescia 43.4%, Tel-Aviv 39%, Philadelphia 31%), followed by other sinonasal areas [5–8]. In accordance with these published frequencies, we found that 45% of our cohort had maxillary localization [9, 10]. IP can be locally aggressive; it has both the ability to recur after removal and carries a risk of converting into a malignant squamous cell carcinoma (SCC). For these reasons, the goal of surgical treatment is to completely remove the lesion by direct, visual surgery and to reduce the morbidity rate of this treatment [11–13]. IP usually presents itself as a pedicle with a single site of attachment to the sinonasal region. Investigation of the pedicle’s attachment site can be facilitated by preoperative radiological examinations [14–17]. However, confirmation of the tumour attachment site and its extent can only be accurately determined during surgery. Based on all of these data, we codified the

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principles needed for treatment of sinonasal IP as “pedicle-oriented endoscopic surgery” (POES) [10].

Endoscopic medial maxillectomy (EMM) was developed to treat IP on the maxillary sinus [18–21]. EMM can be divided into “simple” EMM and “extended” EMM. In the former type, the medial maxillary wall is resected into its posterior two-thirds. In the latter type, resection is extended anteriorly to include the lacrimal pathway along with the anterior third of the inferior turbinate (IT), removing the entire medial maxillary wall; in doing so, the nasolacrimal duct (NLD) is exposed and incised at its proximal end (Fig. 1). In some cases, the anterior extension is mandatory to gain control of the anterior portion of the maxillary sinus. In fact, without excision of this area, a part of the maxillary sinus would be inaccessible for surgical exploration [22, 23]. Moreover, the NLD itself or the IT are sometimes involved in the IP and, in these cases, require resectioning. EMM is a safe and effective procedure that has been considered the mainstay treatment for IP originating inside the maxillary sinus. However, this technique also carries the risk of some complications, particularly with “extended” EMM, such as epiphora or dacryocystitis related to postoperative stenosis of the lacrimal pathway. Moreover, complete resectioning of the IT can impair its normal functions in temperature adjustment and alteration of nasal airflow, thus leading to persistent crusting and lack or reduction of warming and humidifying of inhaled air [24, 25].

To avoid these potential complications, we propose a modification of the EMM procedure to gain adequate antero-inferior access to the maxillary sinus based on the supposed origin and extent of the IP. In this procedure, the IT body is not completely resected; the head is preserved

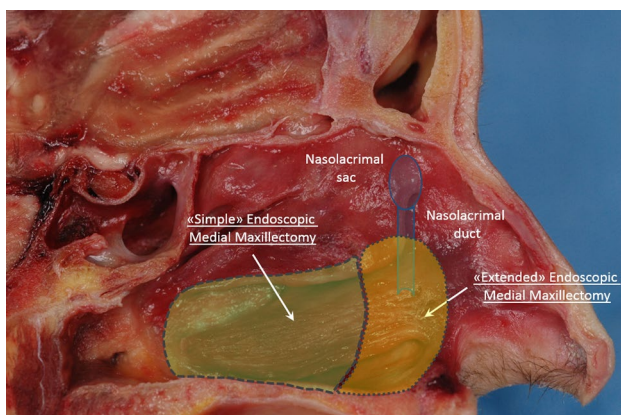


Fig. 1 Anatomical scheme of a *left* lateral nasal wall showing in green the limits of resection of a “simple” EMM. The area to be further resected to perform an “extended” EMM is represented in orange; in this latter case, a complete removal of IT and a section of NLD should be performed

and the inferior meatus is drilled anteriorly until the pyriform aperture is reached, which spares the entire nasolacrimal unit. This technique, developed by the leading authors of this work (F.P. and G.L.T.), has been named “TuNa-saving EMM” (“Tu” for “Turbinate” and “Na” for “Nasolacrimal duct”). In this report, we present the surgical details of this technique and the treatment outcomes in a group of patients with IP of the maxillary sinus.

Materials and methods

A retrospective case study is presented in this paper. After obtaining Local Ethics Committee approval, we retrospectively reviewed the medical files and data from patients who had been endoscopically treated for maxillary IP at three tertiary medical centres in Italy between January 2006 and June 2014. Patients with a minimum follow-up of 24 months were included in this study. The diagnosis of IP was confirmed in all cases with a preoperative endoscopic biopsy, and all patients were assessed with imaging studies (both CT and MRI scans). For this paper, only adult patients with maxillary localization of the disease were selected. Other sinonasal localizations of IP were excluded; moreover, patients with concomitant SCC were not considered. In all cases, POES principles were applied during surgery as described in our previous study [10]. Analysed data included patients’ age and gender, location of the tumour pedicle inside the maxillary sinus, surgical technique, intra- and postoperative complication rates, follow-up and recurrence rate of IP.

In this paper, we propose a modification of EMM that preserves the head of the IT as well as the lacrimal drainage system for IPs originating on the antero-inferior and infero-lateral walls of the sinus (Fig. 2). The approach was called “TuNa-saving EMM”. In this technique, surgery was performed under general anesthesia in a slightly reversed Trendelenburg position (30°). Decongestion of the nasal mucosa was accomplished with pledgets soaked in a 0.1% xylometazoline hydrochloride + 0.01% oxybutrocaine chlorhydrate solution and an injection of 1% lidocaine with 1:100,000 epinephrine at the head of the middle turbinate and the lateral nasal wall. After tumour debulking, a partial inferior uncinectomy and a middle antrostomy were performed to identify the maxillary ostium and to explore the maxillary sinus. Subsequently, the posterior part of the IT was resected while preserving the anterior third of the former. An incision on the medial wall of the maxillary sinus at the nasal floor in the inferior meatus was performed and the medial wall of the sinus was removed. Resection of the anterior portion of the medial wall was extended anteriorly into the inferior meatus to the pyriform aperture, with its upper limit at Hasner’s valve. By this method, the

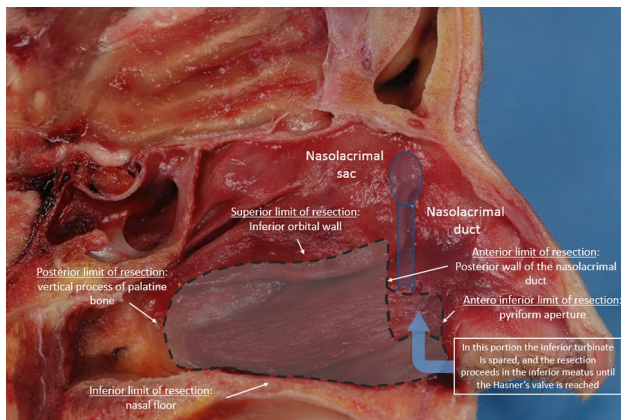


Fig. 2 Anatomical scheme of a *left* lateral nasal wall showing the limits of resection when performing a “TuNa-saving” EMM (in grey). In this case, the anterior extension is obtained through the inferior meatus, without the sacrifice of IT and lacrimal pathways

infero-lateral and antero-inferior portion of the maxillary sinus could be explored and the site where the neoplasm originated could be adequately identified and treated without removing the head of the IT and preserving the lacrimal pathway (Fig. 3). When the NLD or the IT were involved with the tumour they were resected, and in these cases an “extended” EMM was performed.

Results

From January 2006 to June 2014, 181 patients were treated in our departments for sinonasal IP; among them, 84 patients who had this disease localized to their maxillary sinus (46.4%) were enrolled in the present

study. This group consisted of 53 men (63.1%) and 31 women (36.9%), with a mean age of 66.6 years (range 21–89 years). An “extended” EMM was carried out for 38 cases (45.2%), a “simple” EMM for 17 cases (20.2%), and in the remaining 29 cases (34.6%) a “TuNa-saving” EMM was performed according to the technique described in this paper. In latter group, the tumour pedicle was located on the antero-inferior or infero-lateral wall of the maxillary sinus; therefore, the resection would have required an anterior extension. A direct tumoural invasion of NLD and IT was observed in nine patients (10.7%); in all of these cases, an “extended” EMM was performed and the IT head and NLD were completely removed. During the follow-up period (minimum 24 months), three patients (both belonging to the “extended” EMM group) developed a recurrence of IP (3/84, 3.6% global recurrence rate; 3/38, 7.9% recurrence rate in the “extended” EMM group; 0/29, 0% recurrence rate in the “TuNa-saving” EMM group).

No major postoperative complications were observed in our group of patients. Regarding minor complications, in patients who underwent the “extended” EMM procedure, we observed three cases (3/38; 7.9%) of transient, mild-to-moderate facial paresthesia in the area innervated by the V2 cranial nerve branches, one case of maxillary mucocele (1/38; 2.6%) and five cases (5/38; 13.2%) of postoperative stenosis of the NLD. Among the patients with postoperative stenosis of the NLD, in three cases the epiphora resolved itself spontaneously after 20 days, and the other two patients had an endoscopic dacryocystorhinostomy performed after 13 and 15 months. No complications were observed in the patients that had the “TuNa-saving” EMM procedure. Table 1 describes these results, including the site of tumour origin within the maxillary sinus (Table 1).

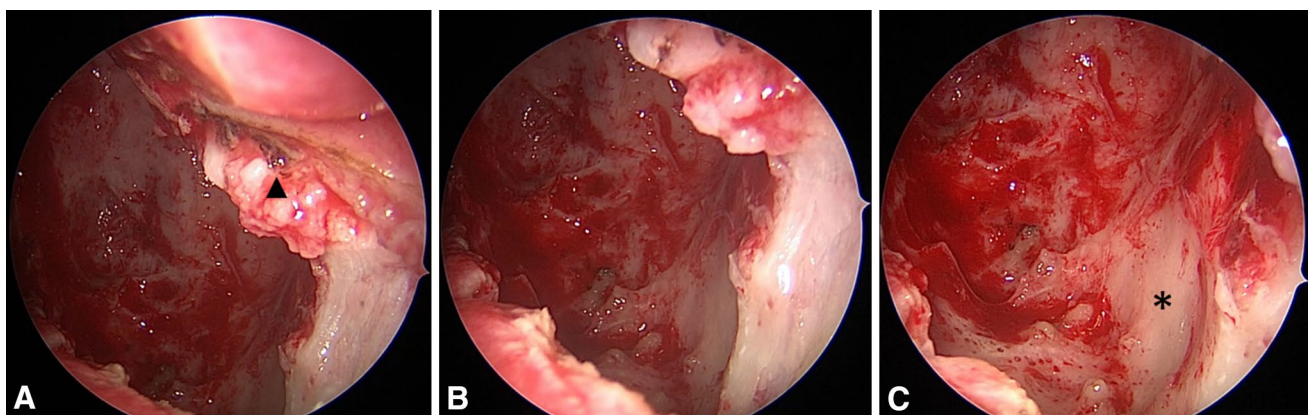


Fig. 3 Intraoperative sequence showing a *left side* “TuNa-saving” EMM for a maxillary sinus IP. **a** The inferior meatus is drilled until the pyriform aperture without the removal of the head of IT and with preservation of the Hasner’s valve (marked with a black triangle). **b**,

c The maxillary sinus is explored with 70° angled scopes to check the complete treatment of the site of implant (marked with a black asterisk) of the tumour located in the antero-inferior wall of the sinus

Table 1 Table comparing patients based on the surgical procedures (“Extended” EMM, “Simple” EMM and “TuNa-saving” EMM)

	“Extended” EMM group	“Simple” EMM group	“TuNa-saving” EMM group	Total
No. of patients	38 pts	17 pts	29 pts	84 pts
Gender				
Male	24 pts (63.2%)	11 pts (64.7%)	18 pts (62.1%)	53 pts (63.1%)
Female	14 pts (36.8%)	6 pts (35.3%)	11 pts (37.9%)	31 pts (36.9%)
Place of attachment				
Medial wall	1 pts (2.6%)	3 pts (17.6%)	2 pts (6.9%)	6 pts (7.1%)
Lateral wall	8 pts (21.1%)	1 pts (5.9%)	4 pts (13.8%)	13 pts (15.5%)
Posterior wall	2 pts (5.3%)	11 pts (64.7%)	8 pts (27.6%)	21 pts (25%)
Anterior wall	7 pts (18.4%)	0 pts (0%)	4 pts (13.8%)	11 pts (13.1%)
Superior wall	5 pts (13.2%)	1 pts (5.9%)	3 pts (10.3%)	9 pts (10.7%)
Inferior wall	1 pts (2.6%)	1 pts (5.9%)	8 pts (27.6%)	10 pts (11.9%)
Not identified	14 pts (36.8%)	0 pts (0%)	0 pts (0%)	14 pts (16.7%)
Type of disease				
Primary	28 pts (73.7%)	14 pts (82.4%)	23 pts (79.3%)	65 pts (77.4%)
Recurrence	10 pts (26.3%)	3 pts (17.6%)	6 pts (20.7%)	19 pts (22.6%)
Recurrence at follow-up (minimum 24 months)	3 pts (7.9%)	0 pts (0%)	0 pts (0%)	3 pts (3.6%)
Complications				
Intraoperative	0 pts (0%)	0 pts (0%)	0 pts (0%)	0 pts (0%)
Postoperative (NLD)	5 pts (13.2%)	0 pts (0%)	0 pts (0%)	5 pts (6%)
Postoperative (other)	4 pts (10.5%)	0 pts (0%)	0 pts (0%)	4 pts (4.8%)

Discussion

As previously reported, the maxillary sinus is the most common site of IP [9, 10]. We recently codified the POES principles for the treatment of these lesions: this technique was based on tumour pedicle research, subperiosteal dissection of the tumour-attachment site and bone drilling [10]. When dealing with the maxillary sinus, it is essential to effectively reach and remove the pedicle area. For tumours involving the posterior, postero-lateral, medial, and superior (its posterior half) walls of the maxillary sinus, a “simple” EMM is usually the treatment of choice. In our experience, this approach was feasible in only 17 patients (20.2%), when the IP was attached to the posterior part of the maxillary sinus that could be easily reached and managed with a “simple” EMM. The anterior part of the sinus (antero-lateral and antero-superior walls, alveolar recess and supero-medial angle) was the most difficult to expose and consequently treat; thus, the “extended” EMM permitted a safe and effective approach for these subsites [9]. Although the endoscopic technique reduced the rate of surgical complications relative to an external approach, there was still a 30% chance of epiphora and dacryocystitis, particularly during the “extended” EMM, due to resectioning of the NLD [26]. Moreover, complete resection of the IT could result in persistent crusting and lack or reduction

in warming and humidifying of inhaled air [24, 25]. For these reasons, some authors have proposed new surgical techniques that preserve the NLD and IT. Weber et al. proposed preserving the IT during an EMM by dissecting it at the anterior insertion and reinserting it after the tumour was completely removed [27]. Nakamaru et al. proposed separating the entire NLD from the bony component of the nasolacrimal canal [28]. Suzuki et al. developed a procedure in which the preserved IT and NLD were shifted medially allowing for a complete resection of the IP inside the maxillary sinus [29]. Wang et al. and Nakayama et al. proposed preserving the IT (by making a mucosal incision in the lateral nasal wall behind the pyriform aperture and elevating the nasal mucosa to allow direct visualization of the bone) and isolating the NLD before entering the maxillary sinus by drilling through the bone [11, 26]. A transnasal prelacrimal approach has also been described for the treatment of maxillary sinus diseases; this approach provides a wide, clear surgical view and easy access to the maxillary sinus to resect tumours and adjacent structures together [30–33]. In our opinion, problems related to these techniques include the risk of direct invasion of the NLD, which is no longer protected by its bony canal (in the case of tumour recurrence), and the impossibility of visually observing the IP point of origin in the maxillary sinus in postoperative follow-ups due to repositioning of the

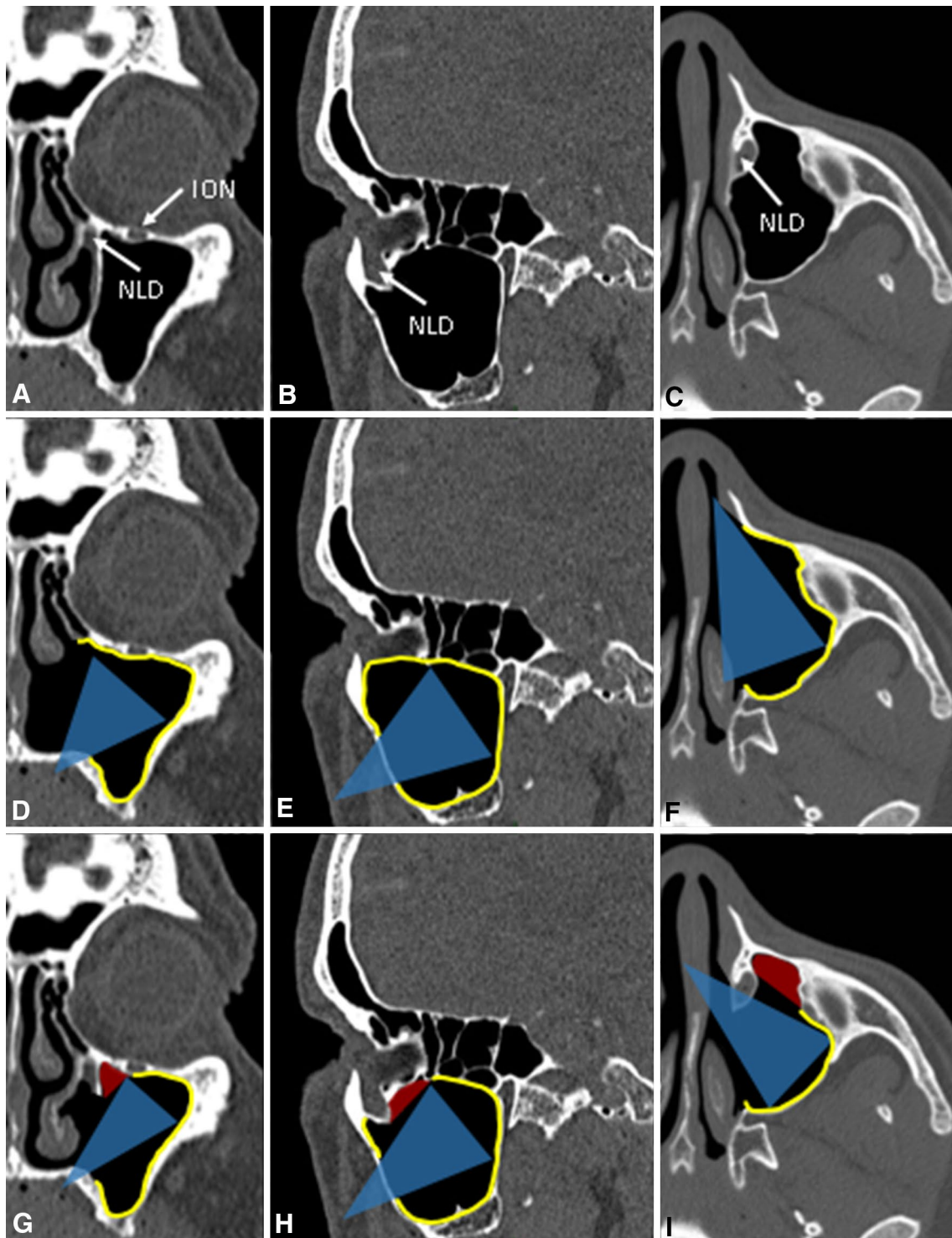


Fig. 4 Coronal, sagittal and axial CT scans showing the concepts of the resections and the surgical area that can be explored inside the maxillary sinus. **a–c** *NLD* nasolacrimal duct, *ION* infraorbital nerve. **d–f** An “extended” EMM is shown: in this approach, almost all

areas inside the sinus can be reached. **g–i** A “TuNa-saving” EMM is shown: in this case, about 95% of the maxillary sinus can be treated, leaving only part of the anterior and superior walls of the maxillary sinus (demonstrated in *red*) hidden behind and laterally to the NLD

mucosa at the end of the surgery. Moreover, there is currently no data available regarding the function of postoperatively replaced IT and NLD [34].

We propose a modification of EMM, which includes partial removal of the IT while preserving both its head and the entire nasolacrimal unit, and drilling the inferior

meatus only to the pyriform aperture. Tanna et al. demonstrated that 64% of the maxillary sinus volume is below the IT insertion on the lateral nasal wall, and only 5% of the total maxillary sinus volume lies anterior to the NLD [22]. Therefore, a “TuNa-saving” EMM guarantees an almost complete visualization of the maxillary sinus (about 95% of its volume), leaving only part of the anterior and superior walls of the maxillary sinus hidden (anterior and lateral to the NLD) (Fig. 4) [22, 35]. With this technique, a good and safe exposure of the maxillary sinus can be obtained, and a satisfactory control of the disease is guaranteed in most cases. Moreover, the physiology of the nasolacrimal unit and of the nasal airflow is preserved, reducing the risk of postoperative complications such as epiphora or dacryocystitis.

The retrospective nature of this study potentially introduced the following limitations: our results did not include IP cases that were attached to more than one wall (only the main attachment site was reported in Table 1); however, it is possible for this to happen. Moreover, different IP attachment sites were managed with different approaches, which weaken the direct comparison between different approaches.

Based on our experience, we codified four approaches to treat a maxillary sinus IP (types A–D). If the tumour pedicle was identifiable, a POES could be performed (types A–C): in these cases, an EMM was carried out to locate the pedicle and focus treatment to this area with selective demucosization and selective bone drilling. A “simple” EMM (type A) was the approach of choice when the IP originated in the posterior or postero-lateral areas of the maxillary sinus, a “TuNA-saving” EMM (type B) was chosen if the IP originated in the infero-lateral or antero-inferior areas of the sinus, and an “extended” EMM (type C) was reserved only for pedicles in the supero-lateral or antero-superior areas of the sinus. Finally, if the pedicle was not identifiable (for example in revision surgeries), an “extended” EMM with a complete maxillary subperiosteal dissection and an extended drilling of the underlying bone (type D) was the approach of choice.

Conclusions

A modification of EMM to treat selected cases of maxillary sinus IP is proposed in this report. The “TuNa-saving” EMM permits preservation of the NLD and the IT head. This approach provides almost complete surgical control of the maxillary sinus, as well as its anterior aspect, reduces the invasiveness of the surgery and preserves important physiological structures, which consequently reduces the complication rate, particularly for epiphora and dacryocystitis. Moreover, the

“TuNa-saving” EMM has demonstrated good oncological control in IP surgery. In conclusion, based on our experience, this endoscopic endonasal technique has been demonstrated to cure 96% of patients with maxillary sinus IP, and, in most cases, EMM can be performed without interruption of lacrimal pathways.

Compliance with ethical standards

Funding This study was not funded.

Conflict of interest The authors declare no conflict of interests.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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