TAILORED ENDOSCOPIC SURGERY FOR THE TREATMENT OF SINONASAL INVERTED PAPILLOMA

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Abstract: Background. This retrospective study was designed to evaluate the efficacy of tailored endoscopic surgery. Tailored endoscopic surgery aims at resecting the inverted papilloma completely with a customized surgical approach, especially when an en-bloc excision cannot be comprehensively or routinely achieved because of the immense extent of the tumor.

Methods. Between November 1991 and March 2002, 43 patients with sinonasal inverted papillomas were treated by tailored endoscopic surgery. The average duration of follow-up for this population was 25.3 months (range, 9–150 months). A staging system developed by Krouse was adopted for tumor grading. On the basis of tailored endoscopic surgery, 15 localized lesions and 12 smaller extensive lesions (Krouse stages 1 and 2) were treated by ordinary endoscopic resection, whereas 16 larger extensive lesions (Krouse stages 3 and 4) in which the tumors were immense were subjected to sequential segmental endoscopic surgery (SSES). Seven of these 16 larger extensive lesions combined with endoscopic medial maxillectomy because of extensive encroachment of maxillary sinus antrum.

Results. Four patients (9.3%) had residual disease, each requiring one revision surgery. All tumors were successfully resected. No patient required lateral rhinotomy or midfacial degloving procedure. No major complications were encountered in any of the patients. None of the patients had residual disease at the time of this writing.

Conclusions. Tailored endoscopic surgery is a safe and effective treatment that obviates the need for more extensive surgery for the management of inverted papilloma. Proper preoperative evaluations, intraoperative determination of extent and attachment of the tumor, close endoscopic follow-up, and expert application of endoscopic techniques are the keys to the successful use of tailored endoscopic surgery.

Keywords: endoscopic surgery; sinonasal; inverted papilloma

Nasal inverted papilloma was first described by Ward in 1854 and Billroth in 1855. It is an uncommon neoplasm, arising primarily in the nasal cavity but often extending to the surrounding paranasal sinuses and even into the intracranial space. Sinonasal inverted papilloma is renowned for its high recurrence rate and malignant transformation potential. Therefore, most authors advocate radical surgery to remove the tumor. The surgical treatment has evolved from limited intranasal removal to radical en bloc resection by lateral rhinotomy and medial maxillectomy. With the rapid development of endoscopic instrumentation and the advanced imaging techniques of CT and MRI, many surgeons have begun to manage sinonasal inverted papillomas endoscopically, and several clinical series demonstrating the effectiveness of endoscopic treatment of the tumor have been reported. The advantages of endoscopic surgery include assurance of safety margins after
the tumor removal, preservation of normal tissue, and avoidance of cosmetic injuries. However, an algorithmic approach of the surgical treatment is irrational. Localized lesions are manageable and can be treated by ordinary endoscopic resection. In more extensive lesions for which en bloc excision is not practical or when the tumor has invaded the maxillary, frontal, or sphenoid sinus so that regular endoscopic dissection is problematic, a tailored surgical approach should be devised. We report our experience in treating inverted papilloma in a single institution over an 11-year period.

MATERIALS AND METHODS

From November 1991 to March 2002, 43 patients with inverted papillomas of the nose and paranasal sinuses underwent endoscopic surgery, excluding two patients with loss of follow-up. The average duration of the follow-up period was 23.3 months (range, 9–150 months). All the patients were initially seen with nasal polypoid masses and were assessed preoperatively by endoscopic examination and CT routinely. The diagnosis was also based on MRI in some extensive lesions to preliminarily delineate tumor extent and differentiate between tumor and sinusitis.

The patients were categorized as having localized ($n = 15$) and extensive ($n = 28$) lesions. The former indicates that tumors were confined to the nasal cavity, middle meatus, with limited expanse to the anterior ethmoid sinus. The latter comprised 12 smaller extensive lesions restricted within the nasal cavity or ostiomeatal complex (OMC) and 16 larger extensive lesions that overstepped the confines of OMC with extension to the maxillary sinus antrum, frontal sinus, sphenoid sinus, orbital cavity, or skull base bone. Fifteen localized lesions and 12 smaller extensive lesions were categorized in stage 1 and 2 of the Krouse staging system (Table 1).

Before general anesthesia was administered, topical decongestion of the inferior turbinate, middle meatus, and inferior meatus with 2% oxymetazoline-soaked cotton pledgets was applied. Infiltration of 1% lidocaine and 1:100,000 epinephrine was performed, mainly into the tumor attachment or origin and surrounding polypoid tissue after general anesthesia had been induced.

Under general anesthesia, 15 localized lesions that involved either the septum, turbinate, or ethmoid sinus were endoscopically resected (septectomy, turbinectomy, or ethmoidectomy), and 12 smaller extensive lesions lacking maxillary sinus antrum involvement were excised en bloc from the identified tumor attachment with safety margins by ordinary endoscopic resec-

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<th>Localized lesions</th>
<th>Extensive lesions</th>
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<td>No. of patients</td>
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<td>Sphenoid sinus</td>
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<td>Krouse stage</td>
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<td>II (24;55.8%)</td>
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* Endoscopic medial maxillectomy (seven patients).
** Complicated by orbital cavity invasion.
† One local recurrence in middle turbinate (one patient).
‡ One local recurrence in maxillary sinus ostium (two patients).
§ One extensive recurrence in maxillary sinus antrum (one patient).
¶ Complicated by skull base invasion.
¶¶ With associated squamous cell carcinoma.
tions (Figure 1). The residual suspicious mucosa and margins were sampled and sent individually for frozen pathologic section. The tailoring of the endoscopic approach to surgical dissection was performed on the basis of the tumor extent and location.

Because of the characteristic of the tumor, the maxillary sinus and posterior ethmoid sinus were routinely opened to make sure there was no residual tumor. Frontal or sphenoid sinusotomy was performed when indicated. If the tumor was too bulky, making en bloc resection inconceivable, SSES was performed. On the basis of this modified endoscopic technique, the other 16 larger extensive lesions (Krouse stages 3 and 4) (Table 1) were “sequentially” excised into massive “segments” (regularly three segments). The removal of the segments of tumor mass was done in lesions within the (1) common nasal cavity; (2) middle meatus, including portions of the OMC (medial to uncinate process and maxillary ostium, lateral to middle turbinate, inferior to frontal recess, and anterior-superior to basal lamella or sphenoid recess, depending on the tumor extent); (3) maxillary sinus ostium and antrum (along with maxillary sinus medial wall if endoscopic medial maxillectomy10,13 was performed); and (4) frontal sinus or sphenoid sinus. After the removal of the first two segments, with a rigorous hemostasis and recognition of the tumor margins under precise endoscopic control, the remaining third bulk of the tumor mass was dissected and meticulously separated from the surrounding normal tissue along with uncinectomy, maxillary sinus antrostomy, frontal sinusotomy, ethmoidectomy, and sphenoidotomy as indicated. When endoscopic medial maxillectomy was not combined, the third main bulky segment of the tumor mass was then rotated and twirled out of the sinus ostium after the accurate resection of tumor attachment with a safety margin of the surrounding mucoperiosteum and bony structure. In patients who received SSES combined with endoscopic medial maxillectomy, the maxillary sinus medial wall was cautiously dissected and removed superiorly to the orbital floor, inferiorly to the inferior meatus or inferior turbinate, anteriorly to the nasolacrimal duct, and posteriorly to the maxillary sinus posterior wall. The third segment of the tumor mass along with the maxillary sinus medial wall was then removed as one entire specimen. A 90° or 110° upturned Giraffe forceps and a 70° or 90° endoscope were used to help manage tumors whose attachment not only overstepped the confines of the maxillary sinus medial wall but extensively invaded the antrum. Because nasolacrimal ducts were not found to be stringently involved by the inverted papilloma and because the orifices were kept wholly identifiable and taken care of throughout the operation, dacryocystorhinostomy was not required at the end of the procedure.

A frontal curette or a frontal probe, as well as upturned Giraffe sinus forceps, were used to gently dissect the tumor attachment or origin near the frontal recess (within the OMC). The tumor was then removed from the frontal sinus along with the third main bulk of the tumor mass. All segments of the specimen were sent for pathologic evaluation. After thorough irrigations with warm normal saline, several pieces of aseptic petroleum jelly gauze were placed and

FIGURE 1. An inverted papilloma in a 49-year-old male patient, which involved the middle turbinate, uncinate process, and ethmoid sinus, was excised with the ordinary endoscopic technique. Left: Preoperative CT; right: 25 months’ postoperative follow-up.
packed for less than 48 hours. The patients were discharged with oral antibiotics for 14 days and were followed every 7 days after surgery with meticulous endoscopic assessments and debride-
ments of the wound. CT or MRI follow-up was performed in cases of suspected recurrence and associated malignancy.

RESULTS
A total of 43 patients with sinonasal inverted papillomas were treated by tailored endoscopic surgery over an 11-year period. There were 34 male and nine female patients (male predomi-
nance). The average age at the onset of symptoms was 45 years, with a range of 16 to 77 years. There were 23 patients with left-sided lesions and 20 with right-sided lesions (no preferential lateral-
ity). There were no cases of bilateral disease. These lesions were primary disease in 26 patients (60.5%) and recurrent disease in 17 patients (39.5%), who had undergone previous operations in other institutions. The average interval be-
tween prior operation and recurrence of tumor was 13.7 months. Involvement of the middle turbinate was found in most patients (24 patients; 55.8%) (Table 1). SSES combined with endoscopic medial maxillectomy was performed in seven of the 16 larger extensive lesions, whose tumor attachments were all found to extend from the maxillary sinus antrum. Although tumor masses exceedingly invaded the maxillary sinus medial wall and even occupied the antrum, endoscopic medial maxillectomy was not required in the other nine of 16 larger extensive lesions, whose tumor attachments did not extend into the maxillary sinus antrum. Four (9.3%) of the 43 patients had recurrence after one surgical procedure. Three of them were local recurrences, comprising two lesions that occurred in the maxillary sinus ostia and one lesion that occurred in the middle turbinate. Another lesion of recurrence was found to extend into the maxillary sinus antrum. All four recurrences were the lesions categorized as Krouse stage 3, and three of them occurred in the maxillary sinus. One additional procedure
(a revision endoscopic surgery in three patients and a Caldwell-Luc operation in one patient) was required for these four patients to achieve complete resection of the recurrent tumor.

Under meticulous and skilled endoscopic control, the tumors involving the frontal sinus could always be traced to have originated from the OMC and to have spread out to the frontal sinus. All five lesions with frontal sinus involvement revealed no recurrence at follow-up of at least 15 months (Figure 2). There was no isolated lesion of the frontal sinus in this series. One patient had skull base bone erosion (cribriform plate) with cerebrospinal fluid (CSF) leakage caused by an inverted papilloma that was repaired with a surgical membrane by way of an endoscopic approach. No recurrence of tumor or CSF leak was found during a follow-up period of 68 months in this case. Two patients who were initially seen with orbital invasions (erosion and perforation of lamina papyracea) caused by inverted papillomas had neither tumor recurrence nor orbital sequelae during 33 and 57 months of follow-up, respectively. One patient with synchronous squamous cell carcinoma in an inverted papilloma had no evidence of recurrence 26 months after operation (Figure 3). There were no major postoperative complications in this series.

**DISCUSSION**

Inverted papilloma remains an uncommon tumor of the nose and paranasal sinuses whose treatment is renowned for its difficulty. The possibility of associated malignancy, high recurrence rate, local aggressive behavior, and tendency for multicentric involvement should be taken into consideration when devising a treatment plan for these patients. Many authors have stressed the need for adequate excision, such as medial maxillectomy by means of lateral rhinotomy.3–6,8 Although debate still exists as to whether less extensive procedures result in incomplete excision of the lesion, leading to a higher recurrence rate,3,4,14–16 and as to what extent of tumor can be managed properly endoscopically, present investigations support the role of endoscopic surgery in treating inverted papillomas.6–11,13,17–19 Most articles on this subject recommend that the endoscopic approach should be restricted to selected lesions such as those confined to the lateral nasal wall or that extend only minimally into the adjacent paranasal sinuses. However, with gradual improvement in endoscopic instrumentation and surgical technique, the number of authors who apply the endoscopic approach to extirpate the tumor is increasing, and the results are encouraging and favorable even in patients with more extensive disease. McCary et al,9 Waitz and Wigand7 agree with the rationale that even larger inverted papillomas extending further into the paranasal sinuses can often be excised endoscopically. The key to the success of this treatment is locating the specific site of tumor origin or attachment, defining its extent, and completely removing all disease.9,10,18 On the basis of the consensus that inverted papillomas most commonly originate from the lateral nasal wall,15,20 Kamel10 and Sukenik and Casiano13 were the first surgeons to suggest the potential for endoscopic medial maxillectomy in treating extensive inverted papillomas. In determining the location and extension of the tumor, radiographic studies (CT or MRI) and preoperative nasal endoscopy allow the surgical approach to be more accurately planned before
surgery. The usefulness of MRI to delineate inverted papilloma from sinusitis in particular cases has been reported. However, radiographic studies are restricted in the ability to delineate the areas of tumor attachment, especially in a larger lesion. The only way to determine the areas of tumor attachment is to perform endoscopic control during operation. Kamel characterized and illustrated that inverted papillomas involving the maxillary sinus in association with the lateral nasal wall originate from the maxillary sinus medial wall, fill the antrum, and then extend medially to the nasal cavity. Therefore, it is essential to initiate the surgical procedure by localization of the tumor attachment, especially for lesions with multiple areas of attachment. In this series more than two areas of tumor attachment were found in all five cases with frontal sinus involvement, and these tumors extended into circumferential sinuses such as the frontal, maxillary, and sphenoid sinus. Although endoscopic treatment of inverted papilloma aims at removal of the mass as a whole, its use is impractical for en bloc excision of larger tumors such as the 16 larger extensive lesions (Krouse stages 3 and 4) in this series. If the tumor is so large that en bloc excision is not practical, instead of piecemeal removals of the tumor, a faultless way of dissection that is dissimilar to ordinary endoscopic approach should be developed as a fitting mode of surgical dissection. In the larger extensive lesions of this series, the incisions were designed to separate the tumor bulk into three segments (four at the most). After the excision of the first two segments of the tumor mass, the areas of tumor attachment associated with the main bulk of the tumor mass were exposed. The resection of this third segment with or without endoscopic medial maxillectomy was then conducted. With SSES, the removal of three “segments” of the tumor mass follows in regular “sequence.” There were seven larger extensive lesions that needed to be treated by SSES in combination with endoscopic medial maxillectomy (Figure 4). Besides the medial wall of the maxillary sinus, the areas of tumor attachment identified within maxillary sinus antrum in these seven patients were superior wall in one patient; anterior wall in one patient; inferior wall in two patients; posterior wall in two patients; and both inferior and lateral wall in one patient. On the basis of the modified endoscopic technique, SSES, we believe that, in treating extensive inverted papillomas, the combination of endoscopic medial maxillectomy should only be taken into consideration for tumors whose origins or attachments trespass on the lateral, inferior, superior, anterior, or posterior wall of the maxillary sinus antrum. In the other nine larger extensive lesions whose main tumor bulk was located in the OMC, SSES was performed without endoscopic medial maxillectomy. Although the tumor masses in these patients overstepped the maxillary sinus medial wall extensively on radiographic studies, endoscopic medial maxillectomy was not required in these patients because of lack of evidence that the tumor attachment trespassed on the maxillary sinus antral wall (Figure 5). The areas of tumor attachment of these nine lesions were identifiable and limited to the vicinity of the maxillary sinus ostium. As another example, although the only lesion with associated malignancy in this series seemed to be exceedingly widespread and bulky on

FIGURE 4. SSES combined with the endoscopic medial maxillectomy was carried out in a 45-year-old man in whom the tumor attachment was extended to the medial and posterior wall of the maxillary antrum. He had undergone Caldwell-Luc operation at another institution 15 months before this visit. Left: preoperative CT; right: 18 months' postoperative follow-up.
preoperative radiographic studies, no evidence of the spread of tumor attachment into the maxillary sinus antrum was found during endoscopic management. SSES without endoscopic medial maxillectomy was thus sufficient in this patient, who had no evidence of recurrence during 26 months’ follow-up. The main bulk of the tumor might extend from the tumor attachment into the maxillary sinus, frontal sinus, or sphenoid sinus. According to our observation, these three circumferential sinuses were seldom invaded by inverted papilloma simultaneously. The ethmoid sinus was the most commonly involved sinus in this series (46.5%), and only one patient (2.3%) had a lesion that simultaneously invaded the frontal sinus and maxillary sinus. Another patient (2.3%) was found intraoperatively to have an ethmoid sinus lesion with extension to the frontal and sphenoid sinus, which was evaluated and proved in histopathologic studies. The exceptional concurrence indicates the characteristics of local aggressiveness and multicentric tendency of the inverted papilloma. None of the 43 patients in this series had maxillary sinus and sphenoid sinus encroachment simultaneously. None of these lesions was disclosed to occur concurrently in the maxillary sinus, frontal sinus, and sphenoid sinus at the time of surgery. We suggest that, although simultaneous involvement of multiple sinuses was rare and the opacification of the sinus was always mild on preoperative radiographic studies in this series, the potential for concurrent encroachment of the tumor should not be ignored, especially when a massive lesion is encountered.

Inverted papilloma involving the frontal sinus was thought to be one of the limitations of the endoscopic approach and should hence be precluded. Stankiewicz and Girgis reported a case of inverted papilloma with frontal sinus involvement, in which an endoscopic modified Lothrop procedure was applied. Han et al experienced two cases of frontal sinus inverted papilloma also treated by endoscopic modified Lothrop procedures. Neither of their patients had recurrence during a follow-up of 33 months. In our study, the tumor attachment in five accompanying

FIGURE 5. A 33-year-old man had an extensive inverted papilloma. Although tumor mass overstepped the maxillary sinus medial wall exceedingly, SSES, not combined with the endoscopic medial maxillectomy, was performed because of lack of tumor attachment within the maxillary sinus antrum. Up: preoperative CT; down: 34 months’ postoperative follow-up.
Frontal sinus lesions were recognized on endoscopy to originate from the vicinity of the frontal recess and then emanate superiorly to the frontal sinus. One of these extensive lesions was subjected to SSES with endoscopic medial maxillectomy because of its extensive nature and the concurrent finding that an area of the tumor attachment emanated from the superior and medial wall of the maxillary sinus antrum. Because none of the tumors had isolated tumor attachment to the frontal sinus, the Lothrop procedure was not performed in this series.

Orbital and skull base bone invasions are uncommon in inverted papilloma, but Sukenik and Casiano13 noted that 32% of their patients had bony erosion of lamina papyracea or fovea ethmoidalis. In this series, bony destruction of the lamina papyracea without intraorbital extension was found in only two patients (4.7%), and skull base bone invasion with CSF leak was found in only one patient (2.3%).

The association of inverted papilloma with malignancy has varied considerably in previous studies, ranging from 0%6,8–11,16,19 to 53%.21 Most malignancies are squamous cell carcinoma (SCC). Concurrent benign and malignant processes were first noted by Hyams22 and Weissler et al.15 Because of this association, many authors regard inverted papilloma as a premalignant condition.3 Several associations between inverted papilloma and SCC have been reported, including (1) synchronous SCC within an inverted papilloma, (2) focal areas of carcinoma in situ within an inverted papilloma, (3) areas of inverted papilloma inside an SCC, (4) metachronous SCC not associated with the original site of the inverted papilloma, and (5) metachronous SCC at the original site of the inverted papilloma, otherwise known as malignant transformation.20,23 Benninger et al24 described SCC as being a synchronous lesion in most cases. It is therefore extremely important to evaluate the entire specimen for possible malignant associations. Although no author is presently suggesting the use of endoscopic resection for malignancy of the nose and paranasal sinuses and none of the articles related the result between synchronous and metachronous tumor, our results indicate that with tailored endoscopic surgery, certain associated malignancies such as synchronous SCC or carcinoma in situ within an inverted papilloma are endoscopically manageable diseases when there is no intracranial extension or metastasis, and adequate safety margins of the tumor can be ensured under endoscopic control (Figure 3). However, an inverted papilloma inside an SCC and metachronous lesions are limitations of endoscopic surgery and are eligible for a more extensive operation (eg, lateral rhinotomy and midfacial degloving).

The recurrence rate was 9.3% (four of 43) in this series. All four recurrent lesions were categorized as Krouse stage 3, and three of them occurred in the maxillary sinus. The lack of recurrences in lesions in other Krouse stages suggests that the maxillary sinus might be the most common site of recurrence compared with the nasal cavity and other sinuses. These data thus suggest that Krouse stage 3 tumors are more suitable for a radical operation than are the tumors in other Krouse stages.

Compared with those patients managed endoscopically by other authors,7–11,13,17–19 which demonstrates the recurrence rates of 0% to 27%, the 9.3% recurrence rate in the 43 patients of this study further indicates that inverted papilloma can be treated successfully by the tailored endoscopic approach when performed by a skilled surgeon.

CONCLUSION

Our results show that all tumors were treated successfully with varied extents of surgical dissection. Initiated by proper clinical judgment and a thorough endoscopic assessment, tailored endoscopic surgery can provide successful complete resection of the tumor by means of ordinary endoscopic resection, SSES, endoscopic medial maxillectomy, or combinations of these techniques. However, unskilled or indiscriminate application of endoscopy might result in incomplete resection and complications. Tailored endoscopic surgery obviates the need for a more extensive operation in certain cases and is an effective treatment for sinonasal inverted papilloma. Close postoperative endoscopic surveillance is still mandatory to ensure early recognition of recurrent disease and malignant transformation.

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