ORIGINAL CONTRIBUTION

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Preservation of the nasolacrimal duct during endoscopic medial maxillectomy for sinonasal inverted papilloma*

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SUMMARY

Background: *To assess the efficacy of a new endonasal medial maxillectomy technique (EMM) for the treatment of inverted papilloma (IP).*

Methodologies: *A prospective series of 55 consecutive patients diagnosed with IP between March 2002 and April 2009 were entered into this study. The new surgical technique was applied to tumours arising from the anterior part of the maxillary sinus. After conventional EMM, the entire nasolacrimal duct was separated from the bony component of the nasolacrimal canal and preserved. Schirmer's test and a visual analog scale (VAS) score were used to assess the lacrimal duct function after surgery.*

Results: *Ten of the 55 patients underwent the new surgical procedure. All patients were categorized with stage T3 or T4 tumours. No patient suffered tumour recurrence. There was no difference in lacrimal duct function between the diseased and healthy side of the nasolacrimal duct. The mean VAS score was 2.8/100.*

Conclusions: *This new surgical technique preserves the whole length of the nasolacrimal unit. It also offers several advantages including good visualization, nasolacrimal function after surgery and fewer adverse effects such as facial numbness and epiphora.*

Key words: inverted papilloma, maxillary sinus, nasolacrimal duct, video-assisted surgery

INTRODUCTION

Sinonasal inverted papillomas (IP) are one of the most common benign neoplasms of the nasal and paranasal sinus lesions [(1)]. The tumours originally have a benign entity but they can be locally aggressive and have a high potential of recurrence: up to 71 % following local excision [(2)]. Additionally, IPs are associated with an 8-10% risk of malignancy [(2,3)].

Due to the high recurrence rate after non-endoscopic endonasal resection of this type of tumour (4), the former gold standard of treatments for IP was the external approach of medial maxillectomy via a lateral rhinotomy (LR) or midfacial degloving [(5)]. However, this led to a high incidence of complications such as epiphora, dacrocystitis, mucocele, facial neuralgia and external scarring, and there remained a high chance of recurrence [(6)].

Waitz and Wigand reported that endoscopic transnasal resection of IPs achieved a similar success rate as the external approach [(7)]. In the 1990s, a new surgical technique, transnasal endoscopic medial maxillectomy (EMM), was developed for the treatment of IP tumours. It involves the intranasal resection of the medial wall of the maxillary sinus, inferior turbinate and nasolacrimal duct [(8,9)]. The development of powered instruments for intranasal surgery enabled improved visualization and the means to thoroughly resect the tumour intranasally.

Although EMM reduces the rate of surgical complications compared to the external approach of medial maxillectomy, there remains the possibility of epiphora and dacryocystiits occurring due to resection of the nasolacrimal duct. Indeed, we have observed two IP patients treated with EMM and transnasal endoscopic dacryocystorhinostomy (DCR) with silicone intubation who suffered from epiphora immediately after the tube was removed, and whose symptoms still persist.

To avoid these side effects, we have developed a new surgical technique. Tumours at the anterior wall of the maxillary sinus and the nasolacrimal duct that prevent an internasal approach are treated by separating the bone surrounding the nasolacrimal duct from the entire lacrimal passage (lacrimal sac to nasolacrimal duct opening at the inferior nasal meatus). The preserved duct is then swigged upwards to the agger nasi

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to offer a clear surgical view. In the present study, we report on the surgical details of this new technique and the treatment outcomes.

MATERIALS AND METHODS

Patients

Fifty-five patients with sinonasal inverted papillomas (IPs) who were treated between March 2002 and April 2009 at the Department of Otolaryngology, Head and Neck Surgery, Hokkaido University Hospital, a referral centre of Hokkaido prefecture, Japan, were enrolled in the study. Patients diagnosed with squamous cell carcinoma (SCC) at the preoperative pathological examination were excluded from this study. Data from these patients were reviewed retrospectively.

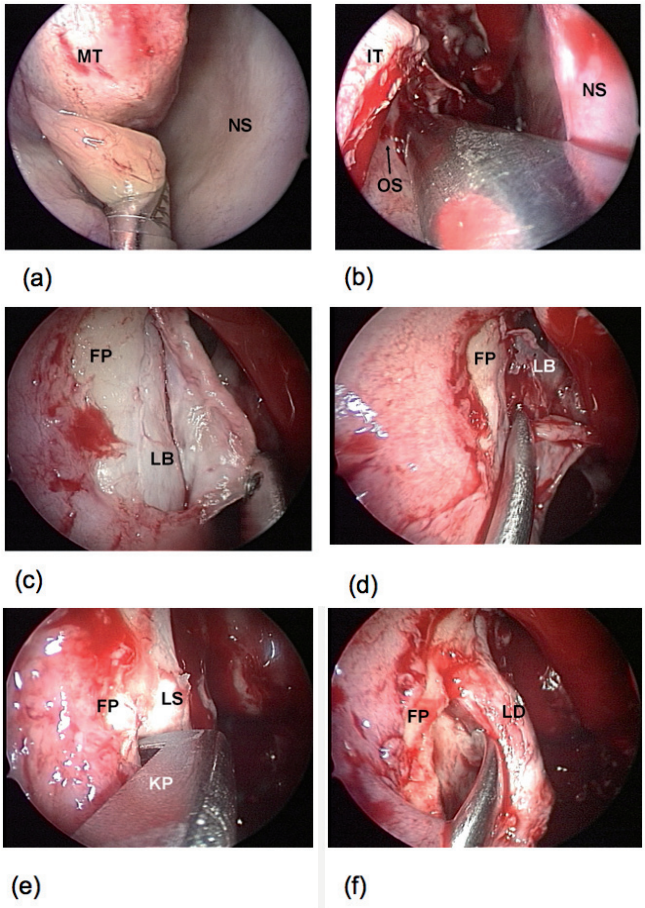

Figure 1. a) Debulking the tumour using powered microdebrider. MT: middle turbinate, NS: nasal septum. b) Resection of medial wall of maxillary sinus with chisel. IT: resected inferior turbinate, NS: nasal septum, OS; natural ostium of nasolacrimal duct. c) Muco-periosteum flap at frontal process of maxilla elevated with suction elevator. Lacrimal bone (LB) identified as thin bone just behind frontal process of maxilla (FP). d) Lacrimal bone (LB) taken away with suction elevator. e) Osteotomy of frontal process of maxilla performed with Smith–Kerrison punch forceps (KP). Lacrimal sac (LS) detected beneath lacrimal bone. f) Entire nasolacrimal duct (LD) separated from bony component of nasolacrimal canal. Nasal mucosa surrounding natural ostium of nasolacrimal duct cut away.

Staging of patients

We preoperatively staged IPs by magnetic resonance imaging (MRI) and chose the surgical procedure according to the stage [10]. Grading was carried out according to the Krouse staging system with some modifications [10,11]. For Krouse stage T1 and T2 patients, standard endoscopic sinus surgery (ESS) was chosen. ESS combined with an endoscope-assisted transantral approach (TA) or EMM was indicated for most T3 patients. The remaining T3 patients with tumours located at the frontal sinus or supraorbital recess were treated with an external approach to surgery as such tumours do not offer easy intranasal access for endoscopic procedures and are frequent sites of recurrence [12,13]. T3 diseases were divided into subgroups T3-A and T3-B; the latter group contained tumours extending into the frontal sinus or supraorbital recess, and the remaining T3 tumours were categorized as T3-A. T4 patients were treated on a case-by-case basis [10].

The candidates for this new surgical technique were therefore T3-A or more severe patients whose tumours had invaded the anterior, lateral and/or inferior wall of the maxillary sinuses. All patients were informed about our treatment policy, and patients who underwent endoscopic surgery were informed in advance that external surgery would be required if the tumour could not be completely excised intranasally.

Surgical details (Figure 1)

All surgery was performed under general anesthesia. The nasal cavity was packed with 4% Xylocaine and adrenaline to reduce mucosal swelling. The tumour was debulked using a powered microdebrider until its origin could be identified (Figure 1a). If the tumour arose from the medial or superior wall of the maxillary sinus (T2 patients), a large middle antrostomy was performed and the tumour was resected with surrounding normal mucosa. If the tumour was attached to the anterior, lateral and inferior part of the maxillary sinus, an EMM was performed. In particular, if the tumour arose from the anterior part of the maxillary sinus, we selected the new surgical technique with EMM.

After debulking the tumour and locating the maxillary ostium, the inferior turbinate was cut off at the superior site. The natural ostium of the nasolacrimal duct can be found at the inferior meatus. The medial wall of the maxillary sinus was then resected with a chisel and a backbiting forceps paying attention not to damage the ostium of the nasolacrimal duct (Figure 1b). An incision was made in the nasal mucosa of the lateral nasal wall just above the insertion of the middle turbinate onto the frontal process of the maxilla to beneath the insertion of the inferior turbinate.

The mucosa and periosteum of the maxilla frontal process behind the incision were elevated with a suction elevator (Figure 1c). The lacrimal bone was easily detected behind the frontal process of the maxilla. Almost every patient had a very thin lacrimal bone that was easily removed with the suction elevator (Figure 1d). The lacrimal sac was detected under the lacrimal bone and was separated from the frontal process of

the maxilla using a right-angled elevator. An osteotomy of the frontal process of the maxilla was performed with straight Smith–Kerrison punch forceps (Figure 1e). The osteotomy was continued downwards into the natural ostium of the nasolacrimal duct.

After the entire nasolacrimal duct was separated from the bony component of the nasolacrimal canal using a suction elevator, the nasal mucosa surrounding the natural ostium of the nasolacrimal duct was cut away (Figure 1f). The duct was swung upwards towards the roof of the ethmoid sinus to improve visualization of the maxillary sinus. After preservation of the nasolacrimal duct, the frontal part of the maxillary sinus medial wall was resected with a chisel towards the limb of the anterior nasal aperture.

By using curved instruments such as curved curettes, microdebrider blades and burrs, the tumour could be removed with a margin of normal mucosa and direct visualization of the entire maxillary sinus with a 70 degree scope. The bone where the tumour had been attached was then drilled until all soft tissues were cleared away. All unaffected mucosa and sinuses were preserved. Frozen sections were examined when tumour involvement was suspected in tissues around the surgical margin. We used an intraoperative image-guided system (StealthStation, Medtronic Sofamor Danek, Co. Ltd, Minneapolis, MN, USA) to assist in excising the tumour around high risk areas such as the lamina papyracea, the tegmen of the ethmoid sinus, and the nasofrontal duct.

Although tumours attached to most of the maxillary sinus could be resected with this method, those attached to the bottom of the maxillary sinus with irregular prominences were difficult to manage intranasally. Therefore, they were resected with the use of an additional transantral approach of the canine fossa. After resecting the tumour, the lacrimal duct was returned to its original position. Post-surgery, all patients were followed up as outpatients with endoscopic analysis every 1 to 3 months during the first year and every 6 months thereafter.

Lacrimal duct function

Three months after surgery, the lacrimal duct function was estimated by Schirmer's test I and lacrimal duct function was assessed by the visual analog scale (VAS) score. Schirmer's test I was carried out using 5 × 35 mm Whatman's filter paper without prior instillation of topical anaesthetic drops. The filter paper was folded 5 mm from one end and inserted into the middle third of the lower eyelid. The patient was allowed to blink as necessary. The paper was removed after 5 min and the length of wetting was measured from the fold.

Patients estimated the degree of dacryorrhea by putting a mark on a 100 mm horizontal VAS ranging from 0 = "no watering of eye" to 100 = "very irritated watering eye".

Statistics

Results are expressed as the mean ± SEM. Comparisons between experimental groups were performed using the Mann-Whitney U test.

RESULTS

Of the 55 IP patients enrolled in the study, 10 underwent the new procedure, EMM with preserved nasolacrimal duct. Six of these patients were male and 4 were female, with an age range of 29 - 74 years (median age, 55 years old). The mean duration of follow up was 13.1 months (range 6-32 months). All patients were categorized as stage T3 or T4 as the tumours were attached to the anterior part of the maxillary sinus. One T3 patient was re-categorized as stage T4 when the post operative pathological examination revealed that the tumour was IP plus SCC in situ. Two patients had an additional canine fossa transantral approach to surgery as their tumours were attached to the prominences of teeth roots. Out of the 55, 10 patients had an external approach such as LR and skull base surgery. They were the recurrent cases (with the tumour in the scar) or the cases in which the tumour extended into the frontal sinus or the supraorbital recess.

Nasolacrimal duct function

The Schirmer's test after surgery revealed that there was no difference between lacrimal duct function of the diseased side and healthy side of the nasolacrimal duct. The mean length of the affected side was 16.30 ± 6.75 mm and that of the healthy side was 17.40 ± 5.66 mm. There was no significant difference

Table 1. Clinical characteristics of IP patients.

Case	Age (years)	Sex	T Stage	Tumour origin	Procedure	Recurrence	Follow-up (months)	VAS
1	33	F	3a	A, M, L, P	EMM	(-)	32	0
2	64	F	3a	A, M	EMM	(-)	19	0
3	38	M	3b	A, M, L, P, I	EMM	(-)	14	10
4	74	F	3a	A	EMM	(-)	13	0
5	71	F	3a	A, M	EMM	(-)	12	0
6	29	F	3a	A, M	EMM	(-)	9	0
7	71	M	3a	A, M	EMM	(-)	9	0
8	48	F	3a	A, M	EMM	(-)	9	18
9	70	M	3a	A, M, L, P, I	EMM+TA	(-)	8	0
10	54	M	4	A, L, I	EMM+TA	(-)	6	0

A: anterior wall of maxillary sinus, M: medial wall of maxillary sinus, L: lateral wall of maxillary sinus, P: posterior wall of maxillary sinus, I: inferior wall of maxillary sinus.

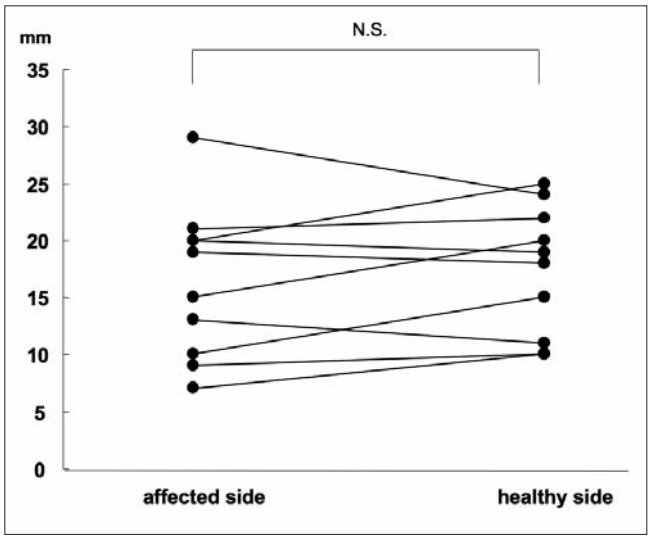

Figure 2. Nasolacrimal duct function post-surgery by Schirmer's test. No difference in lacrimal function between affected or healthy sides. Mann-Whitney U test used to test for correlation between variables. N.S.; not significant.

between the two categories (Figure 2). The mean score of the VAS was 2.8/100, with most patients recording 0 mm, one recording 10 mm, and a second recording 18 mm (Table 1).

Recurrence and complications

None of the 10 patients have suffered tumour recurrence to date (Table 1). There were no major complications in any cases, according to the classification advocated by May et al. [14].

As minor complication, numbness of the cheek was reported by 3 patients. Two patients who underwent EMM and TA suffered facial numbness, as well as 1 out of 8 patients treated with EMM. In the latter case, the tumour was located just beneath the infraorbital nerve of the superior wall of the maxillary sinus. It is conceivable that when the bones where the tumour was attached were drilled, the nerve was injured. However, the patient fully recovered from the numbness 8 months after surgery.

DISCUSSION

In this study, we describe a new surgical technique for IP patients whose tumours are attached to the anterior wall of the maxillary sinus. Critical to the management of IP was location of the tumour attachment area to the sinus mucosa, and excision of the tumour with a margin of macroscopically normal mucosa. After removal of the tumour, the bone underlying it was drilled to ensure that no mucosa was retained [9]. The risk of recurrence was low if the surgical methods were enforced and because IP is a benign tumour.

EMM is suited to this attachment-oriented policy for IP surgery, as it enables good visualization of the maxillary sinus and provides sufficient working space for surgical instruments. Two recent meta-analysis reports concluded that the recurrence rate with intranasal endoscopic surgery was less than that of sinus surgery via an external approach. The authors of these reports speculated that the improved visibility of endoscopic surgery may reduce the recurrence rates [2,3]. However, in cases where tumours are attached to the anterior wall of the maxillary sinus, it is not possible to perform EMM without sacrificing the nasolacrimal duct. To do this without reconstruction may mean loss of the lacrimal duct function and long lasting epihora. We therefore developed this new surgical technique with similarly good surgical visibility and the possibility of resecting the tumour around the duct.

Alternative methods to prevent loss of nasolacrimal duct function after sacrificing the duct include the endoscopic DCR for nasolacrimal duct stenosis with a reported success rate of 70 - 95% [15]. However, the technique requires silicon tube insertions which can take a long time to insert and can cause granulation formation and stenosis around the duct [15]. With our new technique, there was no observed granulation formation or stenosis after surgery, because we preserve the whole lacrimal structures and there is no trauma in the lacrimal passage from the lacrimal punctum to the opening of the nasolacrimal duct at the inferior meatus. In addition, there was no difference between the affected and healthy side of the nasolacrimal duct according to the Schirmer's test, and the VAS score was very low. Moreover, patients in the present study maintained normal lacrimal function 3 months after surgery, none reported discomfort after blowing their nose.

EMM plus TA that does not sacrifice the lacrimal duct is a good method for resecting the tumour, as it offers better visualization and increased working space than EMM alone. However, although the combined technique leaves no external scar on the patient's face, numbness of the cheek occurs in a large percentage of TA cases and can be long-lasting [16]. For this reason, TA should be avoided if the tumour is completely resected by an intranasal approach, and restricted to cases in which the tumour is attached to the inferior wall of the maxillary sinus with involvement of teeth roots, as these can be difficult to manage intranasally.

The extent of tumour involvement can be predicted by preoperative MRI and recently it was reported that preoperateive CT scan can also predict the site of attachment of IP at high rates [17]. However, the exact area of tumour attachment is difficult to identify prior to surgery, especially when the maxillary sinus is filled with the tumour [10,18]. In these cases, if the location of attachment is unknown until surgery, it can be difficult to treat without sacrificing the nasolacrimal duct, so the surgeon will decide whether to change the type of operation to LR or TA. Our new method is suitable for patients if the procedure is changed during surgery because it has no major side effects and conditions after surgery are similar to those after conven-

tional EMM. As the follow-up period was relatively short, longer-follow up might be needed to clarify the long term prognosis of nasolacrimal duct.

CONCLUSION

This new technique of preservation of the nasolacrimal duct when performing EMM during treatment for IP has several advantages including good visualization, maintenance of nasolacrimal function after surgery, and fewer adverse effects such as facial numbness and epiphora. As the present study is relatively small and included only short follow-up periods, a long-term follow-up study is required to assess this technique.

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AUTHORSHIP CONTRIBUTION

Conception and design: Yuji Nakamaru, Yasushi Furuta. Provision of study patients: Yuji Nakamaru, Dai Takagi, Nobuhiko Oridate. Manuscript Writing: Yuji Nakamaru, Yasushi Furuta. Final approval of the manuscript: Yuji Nakamaru, Satoshi Fukuda.

CONFLICT OF INTEREST

The authors declare they have no conflict of interest.

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ERRATUM

In the publication: “The Agger Nasi cell and uncinate process, the keys to proper access to the nasolacrimal drainage system” by M.B. Soyka et al. (Rhinology 2010; 48: 364-367), the affiliation of the second author T. Treumann should be: [2]Department Radiology, Luzerner Kantonsspital, Lucerne, Switzerland. This erratum is to indicate that fact.

ERRATUM

In the publication: “In reference to the use of race and demographic variables in clinical research” by N.A. Al shaikh, and J. Kanagalingam (Rhinology 2010; 48: 379-380), the name of the first author is cited incorrectly. It was spelled as: Ali Alshaikh N. The proper spelling should be: Al shaikh NA. This erratum is to indicate that fact.