ORIGINAL ARTICLE

Contributing Factors to Prevent Prolonged Epiphora After Maxillectomy

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Objective: To analyze the incidence of prolonged epiphora after maxillectomy according to transected nasolacrimal duct management technique, type of tumor, radiotherapy, and timing of tube removal and performance of dacryocystorhinotomy.

Design: Retrospective medical record review.

Settings: University hospitals.

Patients: We studied 89 patients (90 cases) who underwent nasolacrimal duct transection during maxillectomy with preservation of orbital contents for the management of sinonasal tumors between July 1, 1996, and January 31, 2008.

Main Outcome Measures: The incidence of prolonged epiphora was analyzed according to 4 different transected nasolacrimal duct management techniques: simple transection without any additional procedure, silicone tube stenting, transcanalicular Silastic stenting, and marsupialization without stenting. We also analyzed the relationship between other factors (type of tumor, radiotherapy, and timing of tube removal) and the incidence of prolonged epiphora. Prolonged epiphora was defined as persistent if it lasted longer than 6 months.

Results: The overall incidence of prolonged epiphora was 15.6% (14 of 90 cases). The prolonged epiphora rates differed according to the management technique (no procedure, 27.3% [3 of 11 cases]; silicone tube, 7.0% [4 of 57 cases]; transcanalicular Silastic stenting, 66.7% [4 of 6 cases]; marsupialization, 18.8% [3 of 16 cases]; $P=.002$). The silicone tube technique showed the lowest rate (odds ratio=0.20, $P=.06$). In contrast, the incidence of prolonged epiphora was not affected by the type of tumor, postoperative radiotherapy, or timing of tube removal.

Conclusion: Silicone tube stenting can be used as the effective and convenient transected nasolacrimal duct reconstructive technique to prevent prolonged epiphora.

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While transection of the nasolacrimal duct (NLD) is required during maxillectomy for benign and malignant tumors involving the sinonasal tract, this procedure can result in troublesome epiphora and dacryocystorhinitis.[1] Reported rates of postoperative epiphora vary greatly. Previous studies have reported early NLD obstruction in 32% and late NLD obstruction in 63% of all patients following radical maxillectomy with orbital preservation.[2,3]

Techniques for transected NLDs include simple transection without any additional procedure, silicone tube stenting, transcanalicular Silastic stenting, and marsupialization without stenting.[1,4-6] Reconstruction of the integrity of the lacrimal sac after transection is not absolutely essential, but to obviate epiphora and the need for secondary dacryocystorhinostomy (DCR), it seems appropriate to repair the continuity of this drainage system at the time of the ablative surgery.[7] Sessions and Humphreys[7] reported a persistent epiphora rate of 6.25% when using a silicone tube placed in the sac, while Osguthorpe and Weisman[8] reported a rate of 5.7% when using a Silastic transcanalicular stenting tube. Recently, Habib and Har-El[6] observed a lower postoperative epiphora rate (1.9%) using the method of primary marsupialization of the duct without stenting. However, no study has compared different transected NLD management techniques within one institution. In addition, little information is available about other factors that may affect the development of prolonged epiphora, such as the type of tumor, radiotherapy, or tim-

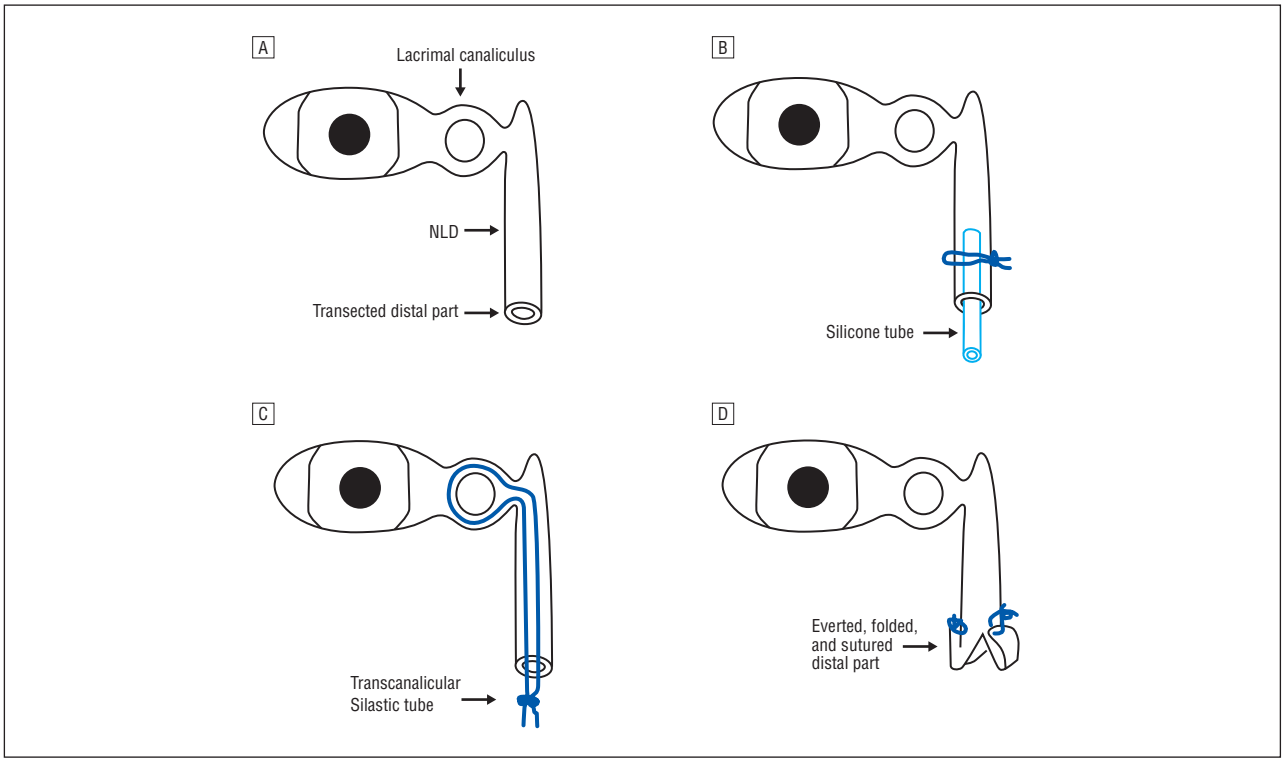

Figure 1. Schematic drawing of 4 different transected nasolacrimal duct (NLD) management techniques used during maxillectomy. A, Simple transection without any additional procedure. B, Silicone tube stenting, in which a 10- to 15-mm silicone tube with a 4-mm diameter tip was placed in the end of the transected NLD. A purse-string of absorbable suture was then placed in the NLD tissue and tightened securely about the tube. C, Transcanalicular Silastic stenting in which a Silastic dacryocystorhinostomy stent was inserted by passing each end down each canaliculus. D, Marsupialization without stenting in which 2 opposing cuts at the distal end of the transected NLD were everted, folded, and sutured to the proximal end duct or surrounding mucosa using 5-0 absorbable sutures without stenting.

ing of tube removal. The present single-institution study analyzed prolonged epiphora for transected NLD management technique, type of tumor, radiotherapy, and timing of tube removal.

METHODS

We retrospectively analyzed 89 patients (90 cases) who underwent NLD transection during maxillectomy with preservation of the orbital contents for the management of sinonasal tumors between July 1, 1996, and January 31, 2008. Patients with primary lacrimal system tumors or tumors extended directly into the NLD were excluded from this study. All surgical procedures were performed by us. The follow-up period ranged from 12 to 114 months, with a mean follow-up of 40 months. Medical records were NLD management techniques, reviewed for the type of tumors, radiotherapy, timing of tube removal, and performance of DCR. We analyzed the relationship between the aforementioned factors and the incidence of prolonged epiphora. Epiphora was diagnosed based on symptoms and examination by rhinologic surgeons and ophthalmologists. Prolonged epiphora was defined as persistent if it lasted longer than 6 months.[6]

SURGICAL TECHNIQUES

Four different transected NLD management techniques were used during maxillectomy (**Figure 1**). They are as follows: (1) Simple transection without any additional procedure. (2) Silicone tube stenting, in which a 10- to 15-mm long silicone tube with a 4-mm diameter tip (T-drainage tube; Sewoon Medical Co Ltd, Seoul, South Korea) was placed in the end of the transected NLD. A purse-string of absorbable suture material was then placed in the NLD tissue and tightened securely about the tube (**Figure 2**). (3) Transcanalicular Silastic stenting in which a Silastic DCR stent (Crawford lacrimal intubation set; JEDMED Instrument Co, St Louis, Missouri) was inserted by passing the stainless steel bodkins at each end down each canaliculus. The bodkins were then maneuvered down the NLD, leaving a loop of silicone at the medial canthus and free ends in the nasal cavity. (4) Marsupialization without stenting in which 2 opposing cuts at the distal end of the transected NLD were everted, folded, and sutured to the proximal end duct or surrounding mucosa using 5-0 absorbable sutures without stenting.

Each surgeon managed the duct using all of the various approaches according to their preferences or the condition of the transected NLD. There were no obligate criteria to determine how the duct would be managed. Usually, when the length of the remnant NLD was enough, a silicone tube or marsupialization was used, because both of the techniques needed the procedure to suture the distal stalk. On the other hand, if the length of the remnant NLD was short, the transcanalicular Silastic tube was inserted or no additional procedure was done.

STATISTICAL ANALYSIS

Results were statistically analyzed using SPSS software (version 12; SPSS Inc, Chicago, Illinois). Differences in the incidence of prolonged epiphora according to NLD management technique, type of tumor, radiotherapy, and immediate epiphora were analyzed using the Fisher exact test. The incidence of pro-

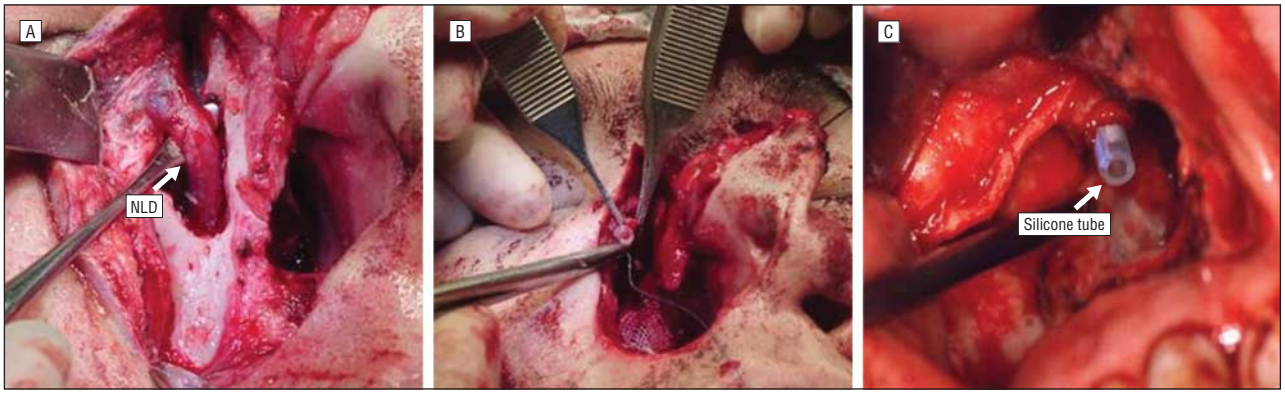

Figure 2. Transected nasolacrimal duct (NLD) management using silicone tube stenting. A, Freer elevator used to dissect the nasolacrimal duct. B and C, Silicone tube stenting, in which a 10- to 15-mm silicone tube with a 4-mm diameter tip was placed in the end of the transected NLD. A purse-string of absorbable suture was then placed in the NLD tissue and tightened securely about the tube.

longed epiphora according to tube removal time was analyzed using the Mann-Whitney test. Logistic regression analysis was used to compare odds ratios according to management techniques. $P<.05$ was considered statistically significant.

RESULTS

The patient population comprised 61 men and 28 women, with a median age of 59 years (age range, 25-82 years). During the study period, one male patient had one further maxillectomy due to tumor recurrence. The 90 cases comprised 37 benign and 53 malignant tumors. In the malignant tumor group, 37 patients (37 of 53 [69.8%]) received postoperative irradiation. No patient underwent preoperative radiotherapy or chemotherapy.

The tumor histological types are listed in **Table 1**. The largest subgroup included 31 patients with inverted papillomas, followed by squamous cell carcinomas comprising 23 patients. Medial maxillectomy was performed in 75 patients, total maxillectomy in 11 patients, and radical maxillectomy in 4 patients. Transected NLD management techniques included no additional procedure in 11 cases (12.2%), silicone tube stenting in 57 cases (63.3%), transcanalicular Silastic stenting in 6 cases (6.7%), and marsupialization without stenting in 16 cases (17.8%).

Immediate transient epiphora was observed in 22 patients and lasted a mean of 22 days. The overall incidence of prolonged epiphora was 15.6% (14 of 90 cases). Five patients showed persistent epiphora from the immediate postoperative period, and others showed delayed persistent epiphora during follow-up.

We analyzed the relationship between variable factors and prolonged epiphora (**Table 2**). The type of NLD management technique applied was found to have an effect on the incidence of prolonged epiphora ($P=.002$). Prolonged epiphora developed in 27.3% of the patients who underwent no procedure (3 of 11 cases), 7.0% of the patients who underwent silicone tube placement (4 of 57 cases), 66.7% of the patients who underwent transcanalicular Silastic stenting (4 of 6 cases), and 18.8% of the patients who underwent marsupialization (3 of 16 cases). The silicone tube approach had the lowest rate, which was 5 times lower than the technique with no procedure (odds ratio = 0.20, $P=.06$). Statistical analysis showed that the type of tumor (malignant vs benign), undergoing radiotherapy, or experiencing immediate postoperative epiphora had no effect on the incidence of prolonged epiphora. Silicone tubes or transcanalicular Silastic tubes were removed at postoperative weeks 2 to 30 (mean, 10.8 weeks), and the tube was maintained to the end of radiotherapy in patients receiving postoperative irradiation. The timing of tube removal had no effect on the incidence of prolonged epiphora.

Table 1. Tumor Histology for the Overall Study Group

Tumor Histology	Patients, No. (%)
Benign tumor	37 (41.1)
Inverted papilloma	31 (34.4)
Hemangioma	3 (3.3)
Juvenile nasopharyngeal angiofibroma	1 (1.1)
Osteoclastoma	1 (1.1)
Ossifying fibroma	1 (1.1)
Malignant tumor	53 (58.9)
Squamous cell carcinoma	23 (25.6)
Adenoid cystic carcinoma	6 (6.7)
Malignant melanoma	6 (6.7)
Inverted papilloma with squamous cell carcinoma	5 (5.6)
Nasal cavity sarcoma	5 (5.6)
Adenocarcinoma	4 (4.4)
Olfactory neuroblastoma	2 (2.2)
Mucoepidermoid carcinoma	1 (1.1)
Undifferentiated carcinoma	1 (1.1)

Fourteen patients with prolonged epiphora underwent endoscopic or external DCR between 6 and 48 months (mean, 12 months) after the original surgery. Dacryocystorhinostomy was successful in all patients except one, who experienced a wound infection at the DCR site and required admission for dressing and intravenous antibiotics. Methicillin-resistant *Staphylococcus aureus* infection was cultured at the DCR site. After the infection improved, DCR was performed again, which resulted in significant symptom improvement, although not complete resolution.

Table 2. Incidence of Persistent Epiphora

Incidence of Persistent Epiphora	Cases, No./Total No. (%)	*P* Value	Logistic Regression	
			Odds Ratio (95% CI)	*P* Value
Techniques for the transected NLD		.002		
No additional procedure	3/11 (27.3)		1 [Reference]	. . .
Silicone tube	4/57 (7.0)		0.20 (0.04-1.07)	.06
Transcanalicular Silastic tube	4/6 (66.7)		5.33 (0.62-45.9)	.13
Marsupialization without stenting	3/16 (18.8)		0.61 (0.09-3.82)	.60
Type of tumor		.09	. . .	. . .
Benign tumor	3/37 (8.1)			
Malignant tumor	11/53 (20.8)			
Postoperative radiotherapy		.82	. . .	. . .
Received	8/37 (21.6)			
Not received	3/16 (18.8)			
Immediate postoperative epiphora		.41	. . .	. . .
Yes	5/24 (20.8)			
No	9/66 (13.6)			
Timing of tube removal (mean), wk	2-30 (10.8)	.77	. . .	. . .

Abbreviations: CI, confidence interval; ellipsis, not applicable; NLD, nasolacrimal duct.

COMMENT

Of the 4 methods examined for transected NLD management during maxillectomy, the present study found that silicone tube stenting was associated with the lowest incidence of prolonged epiphora. The type of tumor, radiotherapy, existence of immediate epiphora, and timing of tube removal did not affect the incidence of prolonged epiphora.

Previous studies reported diverse methods and results for transected NLD management.[1-3,6-8] Initial results following simple transection of the duct showed high epiphora rates (36% to 63%).[2,3] Routine stenting or marsupialization at the primary resection lowered complication rates to 1.9%.[6-8] Some articles[3,5,6,8] discussed the relationship between orbital complications and postoperative radiotherapy. While early articles[3,8] showed that postoperative radiotherapy increased the rate of epiphora, recent articles[5,6] found that radiation had no effect. Our findings support the latter data. However, information is lacking about whether the type of tumor, the existence of immediate epiphora, and timing of tube removal affect prolonged epiphora rates. Our study found that none of these factors influenced prolonged epiphora development.

In addition to having the lowest prolonged epiphora rate, silicone tube stenting has several other advantages over other reconstructive bypass techniques of the lacrimal drainage system. One is avoiding the entrance into the caruncle area of the medial conjunctiva as described in the transcanalicular Silastic tube stenting technique.[1] Dilatation of the lacrimal punctum and canaliculus for insertion of a Silastic DCR tube can cause injury. Indeed, our study found that the highest incidence of prolonged epiphora was in patients undergoing the transcanalicular Silastic tube stenting technique. Additionally, silicone tube stents can be easily removed, and sometimes exit spontaneously through the nasal cavity. However, when the transcanalicular Silastic tube is removed, care must be taken not to injure the conjunctiva or medical canthus. Lastly, the surgical technique of silicone tube stenting is simpler than other bypass techniques. Marsupialization requires the creation of semicircular flaps, which are then everted and sutured to the proximal duct, periorbita, or around the nasal mucosa,[6] and, therefore, usually takes longer than silicone tube stenting. Transcanalicular Silastic tube stenting also requires more effort and time due to the passing of the stainless steel bodkins at each end down each canaliculus.

Therefore, we used silicone tube stenting for the reconstruction of the transected NLD more frequently because of the aforementioned advantages. For this reason, the wide variance in the number of cases managed using each specific method could not be unavoided, and this variance might work as selection bias. However, 4 cases of prolonged epiphora in silicone tube stenting were not limited to the earliest procedures performed but were scattered throughout the entire study period. So, the lower incidence of prolonged epiphora using this technique might not be caused by the adaptation. Silicone tube stenting may have associated with the lowest prolonged epiphora rate by itself.

A limitation of silicone tube stenting is that it cannot be easily used on all of the transected NLD. If there is not enough length of the remnant NLD, it is difficult to insert the silicone tube in the duct and to fix it using sutures. Therefore, a silicone tube can be easily used in cases with sufficient remnant end of the NLD after transection. Marsupialization can also be performed when there is a long remnant end of the NLD for eversion and fixation of mucosal fold. On the other hand, transcanalicular silicone tube insertion can be used when there is a short remnant end of the NLD. However, transcanalicular silicone tube insertion did not show more advantage than no additional procedure.

In conclusion, each technique for transected NLD can induce the different incidences of the prolonged epiphora

after maxillectomy. We suggest that silicone tube stenting be used as the effective and convenient transected NLD reconstructive technique to prevent prolonged epiphora. The incidence of prolonged epiphora is unaffected by immediate epiphora, type of tumor, postoperative radiotherapy, or timing of tube removal.

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