Injury to the lacrimal apparatus after endoscopic sinus surgery: Surgical implications from active transport dacryocystography

H. HALIS UNLU, MD, CIHAN GOKTAN, MD, ASIM ASLAN, MD, and SERDAR TARHAN, MD, Manisa, Turkey

In order to evaluate the lacrimal drainage system injury after functional endoscopic sinus surgery, surgical records and postoperative active transport dacryocystography imaging of 31 patients were analyzed. Presence of the lacrimal bone dehiscence and no passage of the contrast material into the inferior meatus were noted as the signs of injury to the lacrimal canal on active transport dacryocystography. Bony dehiscence was detected in 53.2% of the operated sides but 20% of the nonoperated sides. No passage of the contrast material into the inferior meatus was observed in 14.9% of the operated sides. There were no cases of epiphora postoperatively. The lacrimal drainage system injury was more frequently observed on the left sides operated. We conclude that lacrimal drainage system injury might occur in various extents during functional endoscopic sinus surgery. However, it does not necessarily result in postoperative epiphora. Performing the middle meatal antrostomy in posteroinferior direction, and uncinectomy with backbiting forceps or a shaver might help in reducing the lacrimal injury. Active transport dacryocystography can be adopted as an alternative diagnostic tool in detection of the lacrimal injury. (Otolaryngol Head Neck Surg 2001;124:308-12.)

Functional endoscopic sinus surgery (FESS) has gained popularity among otorhinolaryngologists since its first introduction in mid-70s. The primary reason is probably that it enables direct visualization of intranasal anatomic structures and pathologies. Although the procedure seems to be easy to perform, it is indeed a delicate operation, and surgical injury to the neighboring structures does still occur. Various important complications such as cerebrospinal fluid leak and blindness have been reported following FESS.[1] Nevertheless, lacrimal injury is frequently overlooked. Lacrimal drainage system (LDS) is one of the most vulnerable structures to the surgical trauma in the course of FESS due to its intimate anatomic localization. Epiphora after LDS injury has been reported to range from 0.3 to 1.7%.[2-4] However, LDS injury does not necessarily result in epiphora. Asymptomatic cases, which had the intraoperative occult damage, have also been reported in 15% of the patients undergoing endoscopic ethmoidectomies.[3] Therefore, assessing the anatomic integrity and function of the LDS is important. Several methods have been used for evaluation of the LDS.[5,6] However, none of these can demonstrate the anatomic patency and physiologic pump function of the LDS concomitantly. Recently, a new imaging method, active transport dacryocystography (ATD), has been proposed in evaluating the LDS after rhinoplastic surgery.[7]

In this study, we aimed at presenting our experience with LDS injury after FESS by evaluating with postoperative ATD.

METHODS AND MATERIALS

In order to examine the degree and type of possible injury to the LDS, 31 patients who underwent FESS at the otorhinolaryngology department of Celal Bayar University School of Medicine in Manisa, Turkey, were postoperatively evaluated with ATD. Clinical records regarding the age and gender of the patients, diagnosis, type of operation, and surgical findings as well as the period between the operation and ATD evaluation were retrospectively analyzed. Patients who had preoperative epiphora or previous dacryocystorhinostomy operation were excluded from the study. The parameters studied on ATD examination for the evaluation of the LDS injury were the integrity of the bony lacrimal canal and its patency, which was indicated by observation of the nonionic contrast material in the inferior meatus. Operative and ATD findings were analyzed separately on the left and right sides in each patient. In unilateral cases, ATD findings on the nonoperated side were also recorded as a control group. The side differences in all surgical interventions and differences in findings between the operated and the nonoperated sides in unilateral cases were statistically analyzed. A *t* test was used in statistical analysis for the comparison of the percentages.

All patients were operated on using the technique of FESS described by Stammberger[1] and Kennedy et al[2,8] with minor

From the Otorhinolaryngology Department (Drs Unlu and Aslan) and the Radiodiagnostic Department (Drs Goktan and Tarhan), Celal Bayar University, School of Medicine, Manisa, Turkey
Reprint requests: H. Halis Unlu, MD, Posta Kutusu 141, 45010, Manisa, Turkey; e-mail, asimas98@yahoo.com.

0194-5998/2001/$35.00 + 0 **23/77/112433**
doi:10.1067/mhn.2001.112433

Table 1. Documentation of surgical procedures

Operation type	Number	Percentage
Uncinectomy	47/47	100%
Maxillary ostioplasty	46/47	97.8%
Anterior ethmoidectomy	39/47	82.9%
Posterior ethmoidectomy	30/47	63.8%
Sphenoidotomy	13/47	27.6%
Frontal recess surgery	12/47	25.5%
Middle turbinectomy	21/47	44.7%
Mini Caldwell	2/47	4.2%
Septoplasty	8/31	25.8%

Table 2. Indications for FESS

Diagnosis	Number (%)
Chronic sinusitis	13 (41.9)
Nasal polyps	13 (41.9)
Antrochoanal polyps	4 (12.9)
Allergic fungal sinusitis	1 (3.3)

Table 3. ATD findings in all operated sides

	Total (n = 47)	Right (n = 23)	Left (n = 24)	*P*
Bony canal				
Normal	22 (46.8%)	15 (65.2%)	7 (29.2%)	<0.05
Defect	25 (53.2%)	8 (34.8%)	17 (70.8%)	<0.05
Patency				
Normal	40 (85.1%)	21 (93.3%)	19 (79.2%)	>0.05
Absent	7 (14.9%)	2 (8.7%)	5 (20.8%)	>0.05

Table 4. Comparison of ATD findings between operated and nonoperated sides in unilateral cases

	Operated	Nonoperated	*P*
Bony canal			
Normal	9 (60%)	12 (80%)	>0.05
Defect	6 (40%)	3 (20%)	>0.05
Patency			
Normal	13 (86.7%)	15 (100%)	<0.05
Absent	2 (13.3%)	0 (0%)	<0.05

modifications. Surgical procedures performed are documented in Table 1. Uncinectomy and middle meatal antrostomy was the minimal endoscopic procedure in all but one patient in whom only uncinectomy was performed. The uncinate process was resected by inserting a curved knife blade carefully into the uncinate process just below the insertion of the middle turbinate. The insertion of the uncinate process on the lateral wall of the nose was transected in a convex arch from anterosuperior to posteroinferior. Middle meatal antrostomy was performed in a posteroinferior direction after identification of the natural ostium of the maxillary sinus. All patients were operated on by the same surgeon (H.H.U.). Karl-Storz endoscopes and surgical instruments were used in all operations.

ATD Technique

Thirty minutes and 10 minutes before computerized tomography (CT) scanning, 5 drops of nonionic contrast media (Iopamidol, Iohexol) were applied to both eyes of patients. This was followed by scanning in axial planes, and, by using zoom, optimum demonstration was achieved. The equipment used in this study was Hitachi 1000. Imaging parameters were the following: slice thickness = 2 mm, KV = 120, mAs = 290, matrix = 512 × 512, resolution = high, Filter = C. The images were acquired in 43.5 seconds. Patients were imaged in supine position. The sections started from the infraorbitomeatal line with 4 consecutive axial slices every 5 mm (Fig 1). The first section approximates to the inferior part of lacrimal fossa (Fig 1*A*). In the second and third axial sections, the lumen of the duct filled with contrast material and the bony canal around the duct can be clearly evaluated (Fig 1*B* and *C*). In the fourth section, the free passage of the contrast material into the inferior meatus and the detailed image of the neighboring structures can be identified precisely (Fig 1*D*).

RESULTS

Of 31 patients, 18 (58%) were women and 13 (42%) men. Forty-eight sides of 31 patients were operated on. In 1 patient with bilateral disease, FESS was only performed on 1 side and simple nasal polypectomy was carried out on the other side. Therefore, a total of 47 sides in which FESS was performed, was included for analysis. There was no epiphora either preoperatively or postoperatively in any patients. Operations were carried out bilaterally in 16 (51.6%) and unilaterally in 15 (48.4%) patients. Of 47 endoscopic surgeries, 23 (48.9%) were performed on the right side and 24 (51.1%) on the left side. Local anesthesia was applied in 20 (64%) patients, and general anesthesia was given in 11 (36%) patients. The indications for FESS are presented in Table 2.

The mean period for ATD examination after surgery was 59.7 days (range, 12 to 247 days). The findings in ATD evaluation for operated sides are demonstrated in Table 3. The posteromedial bony plate of the nasolacrimal duct was radiologically detected as either thinner or absent in each patient. The uncinate process also was attached to the posteromedial bony plate (Fig 1*A*). On the contrary, the anteromedial bony plate was thicker and defined as the lacrimal beak (Fig 2*A*). The dehiscences in the bony lacrimal canal were detected in the posteromedial bony plate in both the control and operated groups (Fig

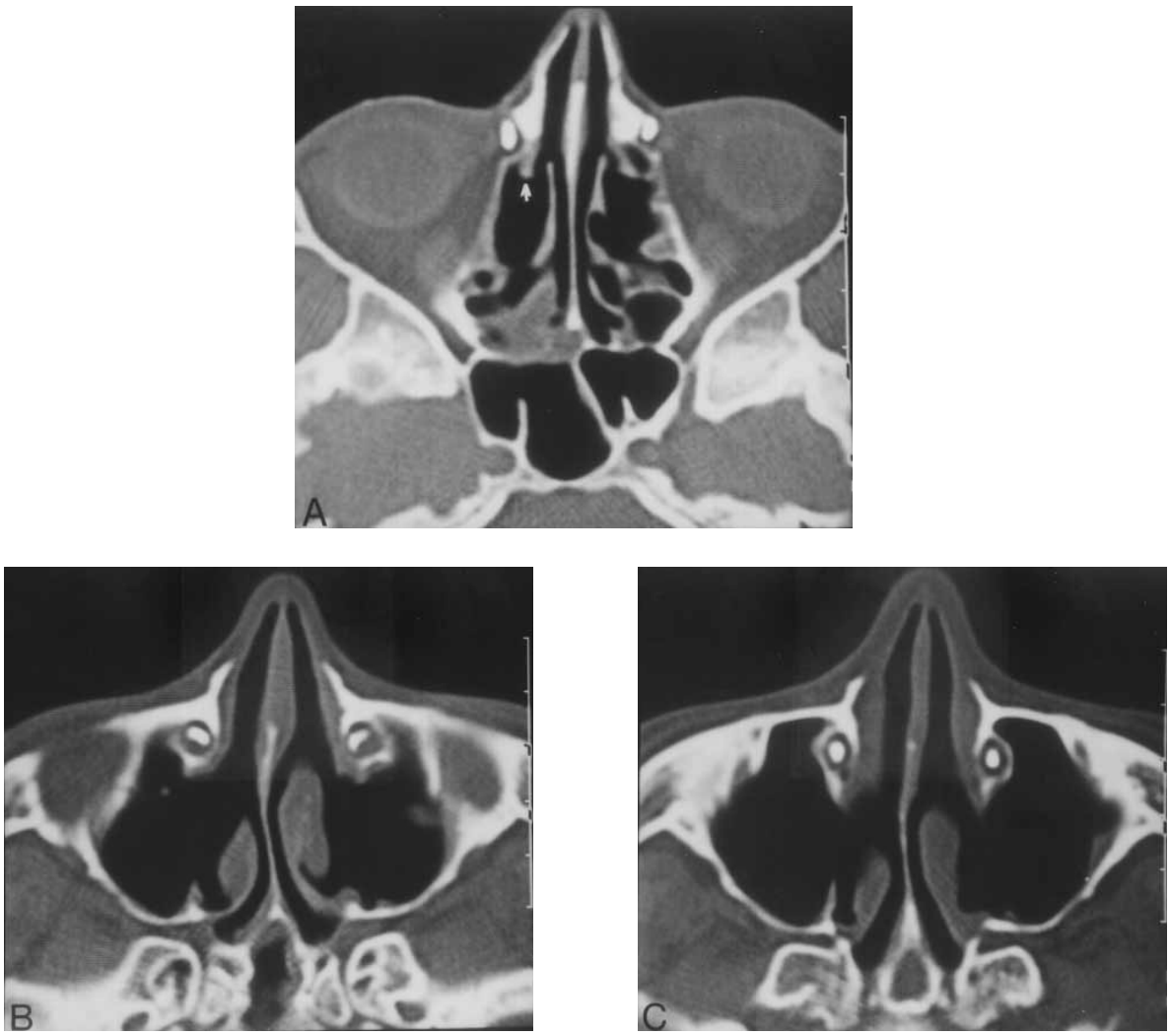

Fig 1. ATD imaging of normal lacrimal drainage starting from lacrimal fossa (**A**) (*white arrow*, uncinate process) to nasolacrimal duct (**B**), and into the inferior meatus (**C**) in a patient bilaterally operated.

2*B* and *C*). In 1 patient, the contrast material was observed inside the maxillary sinus (Fig 2*D*). Table 4 demonstrates the comparative ATD findings in operated and nonoperated sides of the unilaterally operated cases.

DISCUSSION

Any surgery on the lateral nasal wall such as FESS or rhinoplasty carries a potential risk for the LDS damage. Although FESS enables direct visualization of the intranasal anatomic structures, injury to the LDS might not have been avoided as reported in the literature.[1-4,8,9] The trauma might occur as either severe injury resulting in postoperative epiphora or occult injury without any postoperative functional loss. Anatomic intimate relationship of the lacrimal bone with the uncinate process is a major contributing factor for surgical trauma (Fig 1*A*). In addition, the thickness of the lacrimal bone allows its easy penetration with most surgical instruments. Hartikainen et al[10] reported that in 67% of the patients the mean thickness of the lacrimal bone was less than 100 μm and in 4% it was more than 300 μm. Furthermore, it has been reported that the bony wall separating the mucous membrane of the ethmoidal cells and the lacrimal bone frequently is absent.[3] Even Bolger et al[3] credited Flecker with reporting that total absence of the lacrimal bone was in 0.9% of specimens. Our ATD findings regarding bony dehiscences on the lacrimal canal corroborate these observations in the literature. We observed a radiologic bony dehiscence in 53.2% of the operated sides and 20% in the control group. The dehiscences in the control group indicate that these cases carry a high risk for indirect trauma to

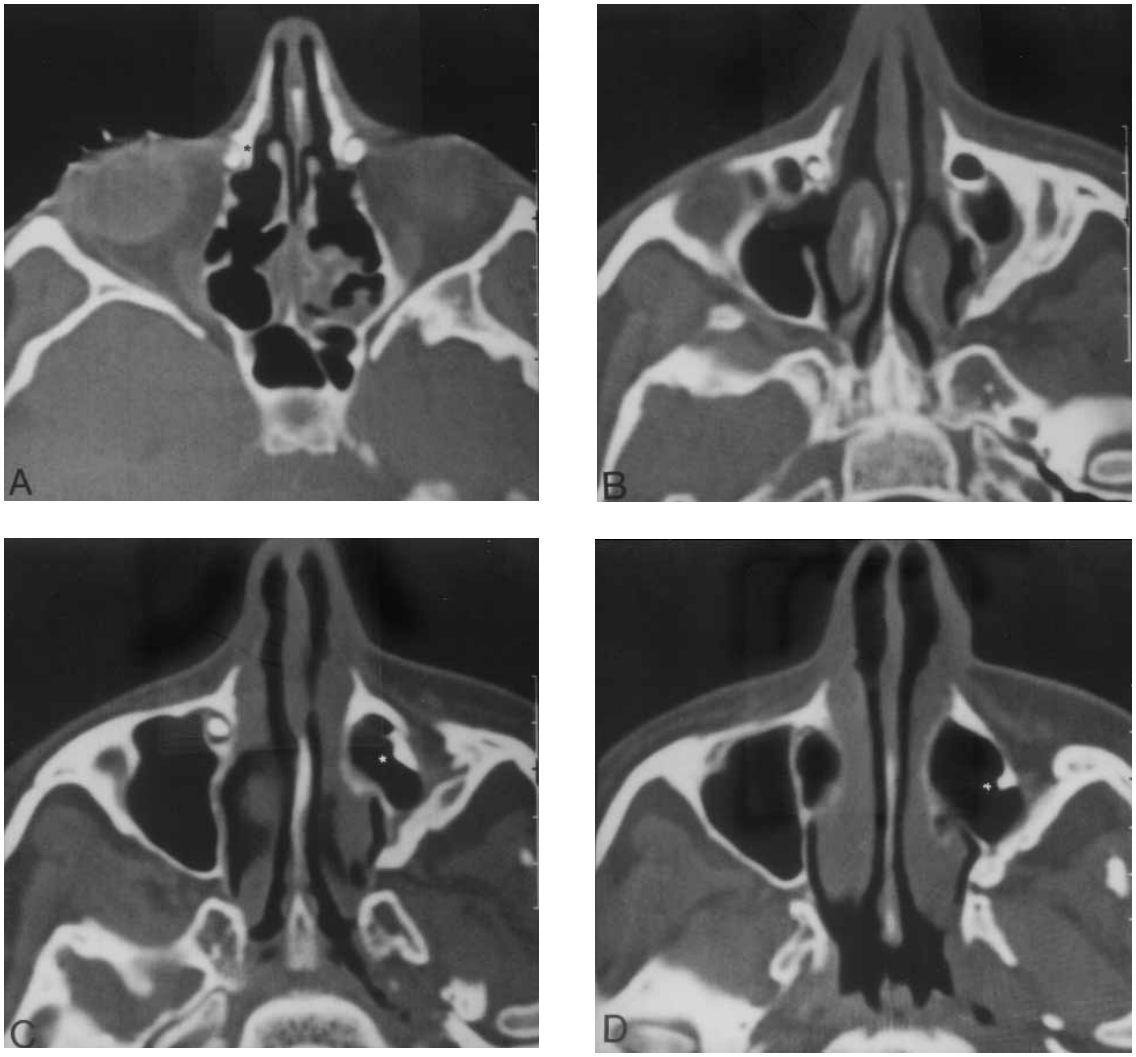

Fig 2. Patient has undergone bilateral sinus operations, ATD shows lacrimal fossa filled with contrast material in first slice (**A**). A defect on the posteromedial wall of the nasolacrimal canal can be easily detected on the second (**B**), and third slices (**C**). Although the contrast material can not be seen in the second slice (**B**), it is observed within the right maxillary sinus in the next slices (**C** and **D**). (*Black star*, lacrimal beak; *white star*, contrast material.)

the LDS during any surgical manipulation in the ostiomeatal region. However, a higher rate (53.2% vs 20%) of bony dehiscence in the operated sides suggests that the lacrimal injury occurs as a result of the surgical trauma. Moreover, we observed that the dehiscences were located in the posteromedial wall in all cases (Fig 2*B* and *C*). The main reason for this, which we discovered on the ATD examination in the control group, was that the posteromedial bony wall of the nasolacrimal duct was thinner than the anteromedial wall. We also observed that the thicker anteromedial wall appeared as an "lacrimal beak" in the postoperative axial CT scans (Fig 2*A*). If the anatomic localization of the uncinate process with the lacrimal bone and aforementioned findings regarding the thickness and dehiscence of the lacrimal bone are taken into consideration, it is obvious that the frequently performed surgical procedures associated with FESS, such as uncinectomy and middle meatal antrostomy, are the primary reasons for the lacrimal damage. Because the uncinate process is inserted into the posteromedial bony wall of the nasolacrimal duct, doing the uncinectomy with a sickle knife might lead to easy penetration and damage to the LDS.

In order to avoid and minimize trauma to the lacrimal apparatus, Bolger et al[3] suggested a modification of the classical uncinectomy method. They suggested that

Otolaryngology–
Head and Neck Surgery
March 2001

the uncinate process be mobilized anteriorly and medially with a seeker and then be removed with backbiting forceps. They also advocated performing the middle meatal antrostomy in a posteroinferior direction. We agree with them adding that uncinectomy can also be performed safely with a shaver.

Using the intraoperative flourescein dye test, Bolger et al detected an occult lacrimal trauma in 7 (15%) of 46 operations.[3] They defined the occult trauma when the contrast material was observed in the middle meatus. However, this test failed in detecting the presence and localization of the bony dehiscence on the lacrimal drainage system. Due to the localization of the bony dehiscence, it is possible to see the contrast material within maxillary sinus (Fig 2*D*). The dye test can not demonstrate such a finding. In addition, because the contrast material is injected with a lacrimal irrigation catheter, it does not allow testing the physiologic pump mechanism of the LDS. In our study, the possible effects of FESS on the LDS were evaluated with the ATD method. ATD was suggested by Unlü et al[7] in 1996 for evaluation of the lacrimal injury after rhinoplasty. We believe that ATD has several advantages over other conventional methods used in the evaluation of the LDS, such as dacryocystography and Jones test:

1. It is preferred to apply drops rather than syringing, as it is a physiologic pattern and the passage is evaluated in an objective manner.
2. It is possible to gain the maximum information on the bony detail.
3. A standard level (infraorbitomeatal line) is established for all patients. This line approximates the junction of the nasolacrimal duct and sac. From this junction, the length of the duct varies between 14 and 20 mm. Therefore, the axial sections taken at every 5-mm enable all patients to be assessed and compared at almost the same levels.
4. ATD has the potential of establishing both the anatomic patency and the function at the same time, as well as the anatomic parameters surrounding the lacrimal system, such as ostiomeatal complex disease, bone abnormalities, intrasac disease and stones.

The major disadvantage of the ATD is that it is not a cost-effective method. However, we recommend it for the evaluation of the LDS in cases of postoperative epiphora after FESS. We believe that information provided by ATD is more valuable than the conventional methods in such cases.

In ATD evaluation, the radiologic findings of the lacrimal trauma were bony dehiscence and absence of radioopaque material in the inferior meatus. We noted the bony dehiscences in 53.2% of all operations. The radioopaque material could not be observed in the inferior meatus in 14.9% of the operated sides. However, there were no cases of postoperative epiphora. These 2 findings seem to be conflict with each other. We consider that the reason was rapid emptying of the contrast material, which could not be detected during imaging.

We also noticed that the lacrimal trauma occurred mainly on the left side. All operations were carried out by the same surgeon (HHU) , who is right handed. In the literature, orbital complications in FESS were reported usually in the right side.[9]

In conclusion; in evaluation with ATD, although there is a thick bony plate (lacrimal beak) anteriorly to the nasal side of the LDS, the posteromedial bony plate is thinner in all cases and absent in 20%. This predisposes the lacrimal injury during either anterior enlargement of the maxillary sinus ostium with backbiting forceps or uncinectomy with a sickle knife. It would be safer to perform uncinectomy with a shaver and middle meatal antrostomy posteroinferiorly. Postoperatively asymptomatic cases might be encountered in a considerable number despite traumatization of the LDS. Lacrimal trauma should be suspected to occur more frequently on the left side in the course of FESS performed by a right-handed surgeon.

REFERENCES

1. Stammberger H. Functional endoscopic sinus surgery. 1st ed. Philadelphia: B.C. Decker; 1991. p. 282.
2. Kennedy DW, Zinreich SJ, Kuhn F, et al. Endoscopic middle meatal antrostomy: theory, technique and patency. Laryngoscope 1987;97(Suppl.43,part 3).
3. Bolger WE, Parsons DS, Mair EA, et al. Lacrimal drainage system injury in functional endoscopic sinus surgery. Arch Otolaryngol Head Neck Surg 1992;118:1179-84.
4. Serdahl CL, Berris CE, Chole RA. Nasolacrimal duct obstruction after endoscopic sinus surgery. Arch Ophtalmol 1990;108:391-2.
5. Hunink MG, Vries-Knoppert WA, Balm AJ, et al. Dacryocystography after paranasal sinus surgery. Br J Radiol 1988;61: 362-5.
6. Caldemeyer KS, Stockberger SM, Broderick LS. Topical contrast-enhanced CT and MR dacryocystography: Imaging the lacrimal drainage apparatus of healthy volunteers. AJR 1998; 171:1501-4.
7. Unlü HH, Çaylan R, Kutlu N, et al. Active transport dacryocystography in evaluating lacrimal drainage system after rhinoplasty. Am J Rhinology 1996;10:87-91.
8. Kennedy DW. Functional endoscopic sinus surgery: technique. Arch Otolaryngol Head Neck Surg 1985;111:643-649.
9. Silva AB, Stankiewicz JA. Perioperative and postoperative management of orbital complications in functional endoscopic sinus surgery. Op Tech Otolaryngol Head Neck Surg 1995;6:231-6.
10. Hartikainen J, Aho HJ, Seppa H, Grenman R. Lacrimal bone thickness at the lacrimal sac fossa. Ophthalmic Surg Lasers 1996; 27:679-8.