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Powered Endoscopic Dacryocystorhinostomy

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Endoscopic dacryocystorhinostomy (DCR) was first described by McDonogh and Meiring[1] in 1989. In that article, they describe the identification of the frontal process–lacrimal bone junction as the key landmark for identification of the lacrimal bone. The technique involved the removal of as much of the bone of the frontal process as possible before opening the lacrimal sac. There was no attempt to achieve full lacrimal sac exposure or nasal and lacrimal sac mucosal apposition. The sac was then carefully sutured to the mucosa of the lining of the nose, achieving apposition of the lacrimal and nasal mucosa.

Other authors subsequently have described the use of punches and chisels for bone removal.[2,3] The success rate for these techniques was approximately 80%.[1–4] If the literature is reviewed, it is apparent that external DCR by dedicated oculoplastic surgeons could achieve success rates of between 90% and 95%.[3,5] It is also apparent with review of the literature that one of the keys to success for external DCR surgery is the creation of the largest possible bony ostium with full exposure of the lacrimal sac.[6,7]

To enable these principles to be achieved via an endoscopic route, the intranasal relationships of the lacrimal sac and nasal anatomy needed to be better understood.[8] This was achieved by a study in our department using computed axial tomography dacryocystography (CT DCG) to define the limits of the lacrimal sac and to establish the relationship of the lacrimal sac with the middle turbinate.[8] Descriptions in the past have shown that the lacrimal sac sits anterior to the middle turbinate and the fundus of the sac ends just above the insertion of the middle turbinate onto the lateral nasal wall.[1–4] This insertion is termed the axilla of the middle turbinate.[8] The CT study showed that the lacrimal sac extended between 8 and 10 mm above the axilla of the middle turbinate.[8] In addition, the axial scans revealed that the bone of the frontal process of the maxilla progressively thickened toward the fundus of the sac and reached up to 15 mm in some patients. Initial cadaver dissections indicated it was not possible in the majority of patients to remove the bone above the axilla with a

punch. Chisels were not reliable and could damage the underlying skin.

Fortunately, the understanding of the anatomy of the lacrimal sac and the need for precise bone removal coincided with the development of the powered instruments for standard sinus surgery. Powered instruments were first used for sinus surgery in the late 1980s. As the technology improved and the torque of the motor driving the instruments improved, drills were implemented. Initially, cutting burrs were used, and although they quickly and aggressively removed the bone overlying the lacrimal sac, any contact between the burr and the mucosa of medial lacrimal sac wall tended to damage the wall. Often, this resulted in a significant defect of the medial wall of the sac.

The goal of the new surgical technique is to preserve all sac mucosa so that the sac can be marsupialized into the lateral nasal wall. To avoid such damage, a rough diamond DCR burr was developed for powered endoscopic DCR surgery.[9] The technique, described below, has been specifically designed to duplicate the external DCR technique with complete exposure of the lacrimal sac so that the sac stands above the lateral nasal wall.[9,10] The sac is opened by an H-incision which preserves all the lacrimal sac mucosa and allows approximation of the lacrimal mucosa with the preserved mucosa of the nasal cavity. This achieves first intention healing rather than secondary intention healing, which is similar to that achieved with an external DCR with suturing of the lacrimal flaps.[9,10]

Surgical Technique[9,10]

A decongestant solution is prepared with 2 mL of 10% cocaine solution, 1 mL of 1:1000 epinephrine, and 4 mL of 0.9% saline. Half of this solution is used to soak six neurosurgical cottonoids (2 × 1 cm) and the other half placed on four cottonoids for use during the surgery if bleeding is problematic. After the patient has been anesthetized but before the patient has been draped, one of the six cottonoids is placed between the middle turbinate and septum, one under the middle turbinate, one above the middle turbinate, and the remaining three anterior to the middle turbinate. If the procedure is to be done under local anesthetic, these packs are placed for 10 minutes before infiltration of the anesthetic is performed.

Local anesthetic infiltration is done using a dental syringe with 2% lidocaine and 1:800,000 epinephrine. If the patient is under general anesthetic, 2 mL is used to infiltrate the lateral nasal wall above and anterior to the middle turbinate and the anterior end of the middle turbinate. If the procedure is to be performed under local anesthetic, the lacrimal sac, nasal septum, and upper lip are also infiltrated.

After nasal decongestion but before surgery, the surgeon needs to assess the access to the region anterior and above the insertion of the

middle turbinate. The less experienced the surgeon, the larger amount of space required. If the septum is deviated toward this region and compromises access, a limited septoplasty should be performed before the DCR. The septum is accessed via a Killian's incision placed about a centimeter behind the anterior mucocutaneous junction. A mucoperichondrial flap is raised, and the cartilaginous bony junction of the septum identified. The suction Freer is used to separate the cartilage from the bone and a mucoperiosteal flap is formed on both sides of the bone. The deviated bony septum is resected until sufficient access to the middle turbinate insertion on the lateral nasal wall is achieved. After the DCR has been completed, a 3-0 Vicryl Rapide® (Ethicon, Somerville, NJ) plication suture is placed through the septum. This obliterates the potential space created by raising the flaps and prevents a postoperative septal hematoma from forming.

The first and one of the most important steps in powered endoscopic DCR is the mucosal incision. The incision is performed with a number 15 blade on a number 7 handle and starts 8–10 mm above and behind the insertion of the middle turbinate into the lateral nasal wall (the so-called "axilla of the middle turbinate"). The incision is brought horizontally forward 8–10 mm anterior to the axilla of the middle turbinate. The blade is turned vertically and the incision is carried down the prominent frontal process of the maxilla until the insertion of the inferior turbinate into the lateral nasal wall. This is about two-thirds of the way down the anterior edge of the middle turbinate (Figure 21.1A).

The blade is turned horizontally and the insertion continued posteriorly until the insertion of the uncinate process is reached (Figure 21.1B). If this incision is properly placed, it provides accurate margins for the correctly sized bony ostium and for complete exposure of the lacrimal sac. A 30° endoscope is turned so that the view captures the lateral nasal wall. The endoscope is pushed high into the nasal vestibule and all instruments are passed under the endoscope. At no time should the endoscope and instruments cross.

A suction Freer is used to elevate the mucosal flap, making sure that the tip of the Freer is on bone at all times during this process. The frontal process is rounded and its posterior aspect falls away, and if care is not taken to maintain contact between the bone and the elevator, the surgical plane will be lost. The 30° endoscope allows the tip of the Freer to be visualized as the dissection proceeds around the frontal process of the maxilla toward the insertion of the uncinate. The flap is elevated up to the insertion of the uncinate but no further. The thin lacrimal bone is sought between the insertion of the uncinate and the posterior aspect of the frontal process of the maxilla. A round blade is used to palpate the hard bone of the frontal process of the maxilla until the soft lacrimal bone is clearly identified. This palpation is best done in the region directly above the insertion of the inferior turbinate into the lateral nasal wall in the inferior aspect of the raised flap. The round blade is used to elevate the thin lacrimal bone over the posterior inferior aspect of the lacrimal sac. This allows the forward

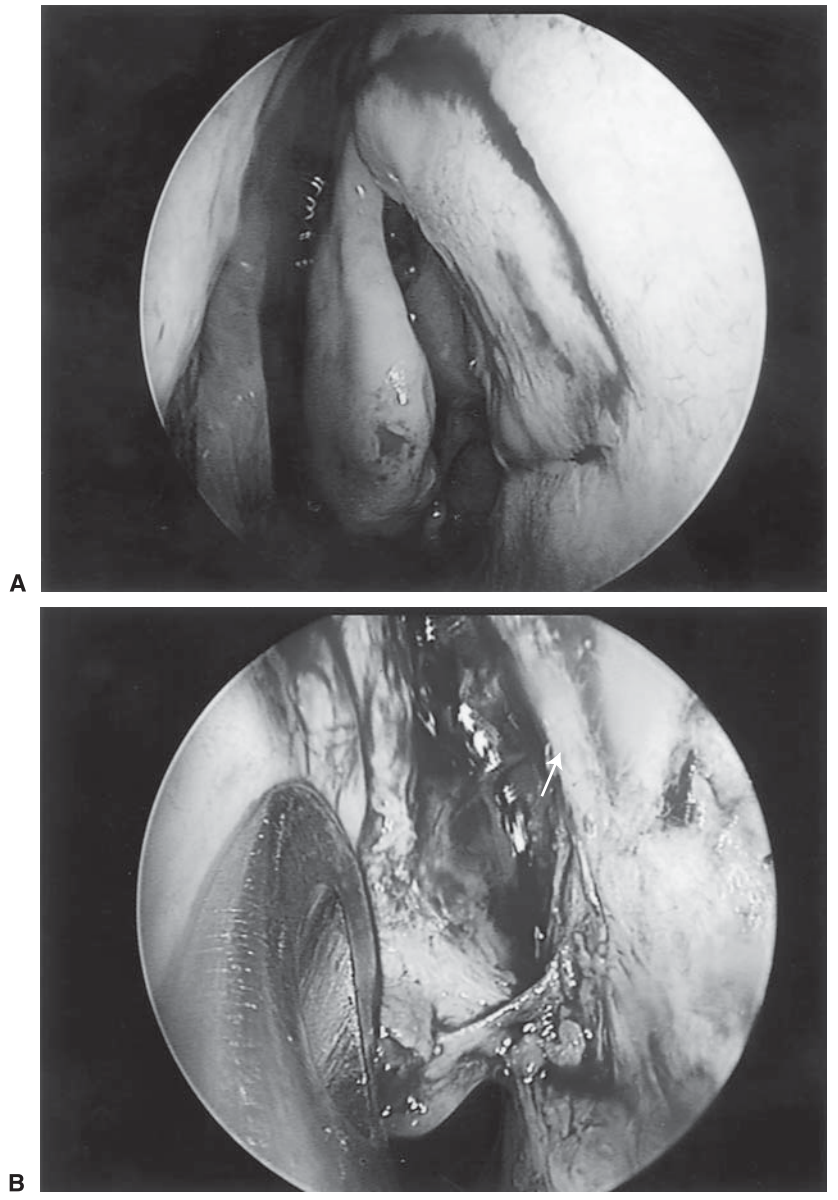

FIGURE 21.1. (A) The mucosal incisions on the left lateral nasal wall are shown for endoscopic DCR. **(B)** The nasal mucosal flap is elevated by a suction dissector with exposure of the lacrimal bone (white arrow).

biting Hajek-Kofler punch (Karl Storz, Tuttlingen, Germany) to be inserted. The tip of this instrument is placed on the exposed sac where the lacrimal bone had been removed, and as the instrument is engaged, the tip pushes the lacrimal sac away. This allows the bone over the anterior inferior aspect of the lacrimal sac to be removed (Figure 21.2).

Removal of bone is continued superiorly until the punch can no longer be seated. At this point (about halfway up toward the superior incision), the bone becomes too thick for the punch to be able to grip. A powered 15° endoscopic DCR burr is attached to a microdebrider handpiece (Medtronic Xomed, Jacksonville, FL) and used to remove the residual bone covering the lacrimal sac (Figure 21.3).

First, the residual bone exposed by elevation of the flap is thinned. Once the bone is thin, then the burr is moved to the bone–lacrimal sac

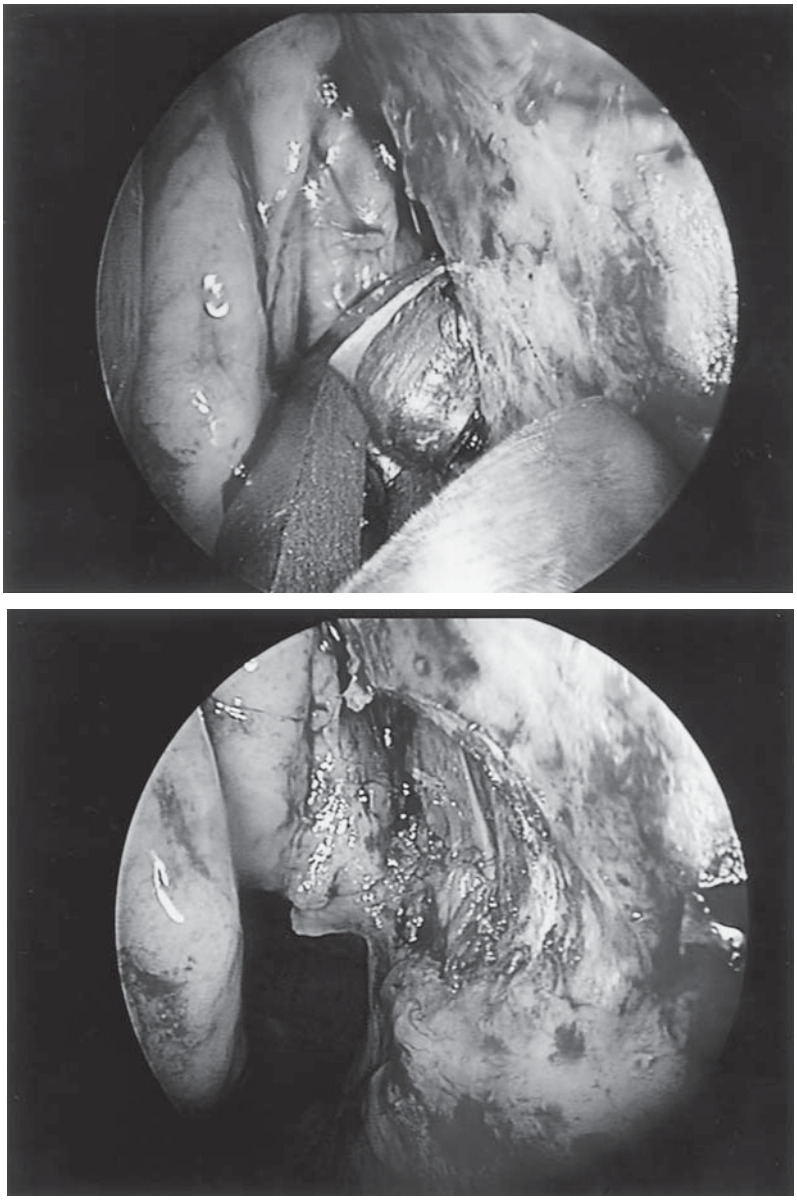

FIGURE 21.2. (A) The Hajek Koefler punch is used to remove the bone over the anterior inferior aspect of the lacrimal sac. **(B)** After the first bite, the anteroinferior lacrimal sac is seen.

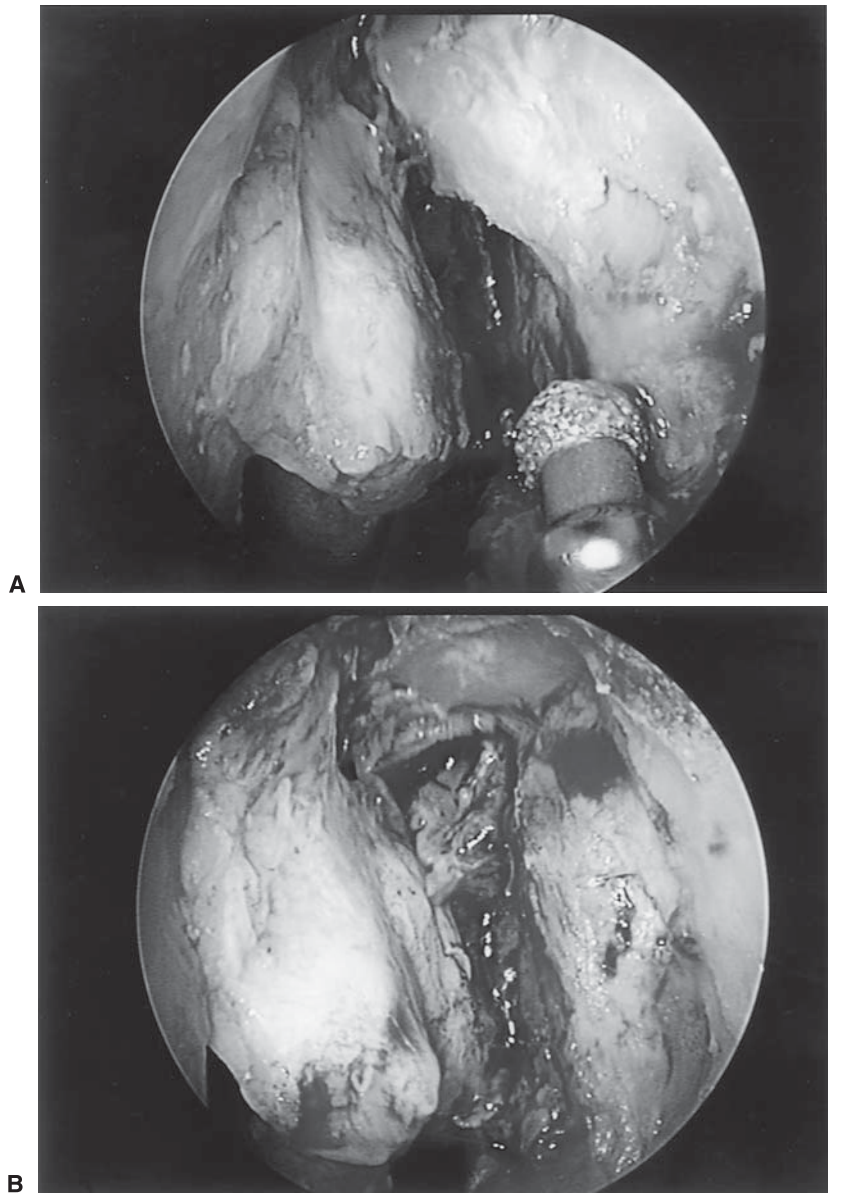

FIGURE 21.3. (A) A rough diamond DCR burr is used to remove all bone over the remaining lacrimal sac up to the superior incision. **(B)** Bowman lacrimal probe is used to tent the medial wall of the lacrimal sac.

junction and the remaining lacrimal sac is exposed. Care should be taken not to push the burr too far under the edge of the bone because this creates significant pressure on the lacrimal sac and the burr will create a hole in the sac. However, the sac wall is able to withstand light pressure as long as the entire burr can be visualized during the dissection. As the bone is removed in the region of the posterior superior region, the underlying mucosa of the agger nasi cell is exposed. This is routinely done as the superior portion of the lacrimal sac is con-

stantly related to the agger nasi cell. In addition, a small amount of skin is routinely exposed just anterior to the lacrimal sac indicating complete bony removal and defining the anterior aspect of the lacrimal sac. Once the bony removal is complete, the lacrimal sac should stand above the lateral nasal wall. This allows the sac to be completely marsupialized into the lateral nasal wall. A Bowman's lacrimal probe is placed into the lacrimal sac and the medial wall of the sac is tented (Figure 21.4).

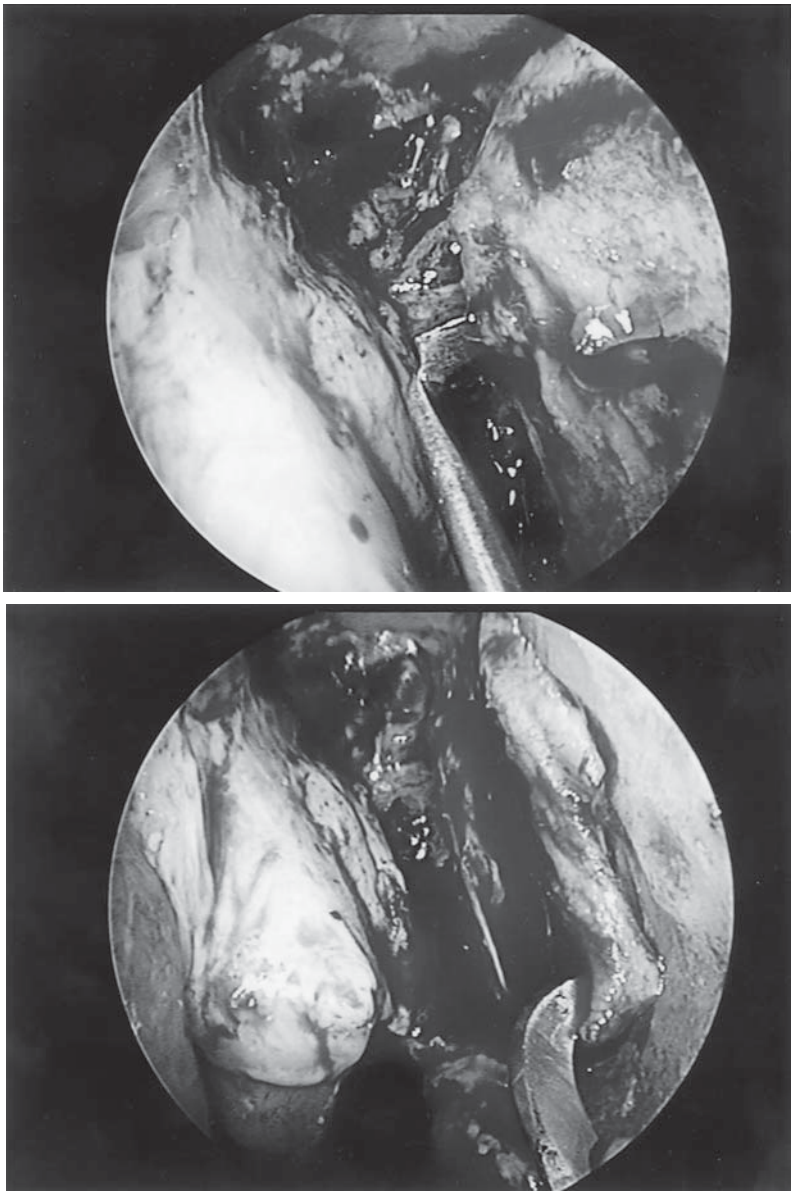

FIGURE 21.4. (A) The DCR spear knife is used to make the initial incision into the lacrimal sac. Note the Bowman's probe tenting the sac wall. **(B)** The mini-sickle knife is used to make anterior superior and inferior releasing incisions to enable the anterior lacrimal mucosal flap to be rolled out.

The tip of the probe should be clearly visualized before incision of the sac is attempted. If the tip of the probe is at the common canaliculus entry to the sac, it may appear as if the probe is in the sac, as the sac will still move when the probe is moved. Incision in this scenario can potentially injure the common canaliculus' opening into the sac. The sac is opened using a DCR spear knife (Medtronic Xomed). The knife is introduced into the sac lumen directly under the tip of the probe and the sac opened by rotating the spear knife. The whole blade should not be inserted into the sac lumen, rather only the cutting edge should be inserted. The sac is opened from top to bottom. The DCR mini-sickle knife (Medtronic Xomed) is used to create a releasing incision at the superior and inferior extent of the vertical incision, allowing the anterior lacrimal mucosal flap to be rolled anteriorly toward the anterior nasal mucosal incision. Microscissors are used to make posterior releasing incisions at the top and bottom of the vertical incision. This allows the posterior lacrimal flap to be rolled posteriorly with complete marsupialization of the lacrimal sac. A standard sickle knife is used to make a vertical incision into the mucosa of the agger nasi cell and to roll this mucosa anteriorly until it meets the mucosa of the posterior lacrimal flap with mucosa to mucosa apposition. The original nasal mucosal flap is trimmed with pediatric through-biting forceps, creating a superior limb of mucosa the same size as the space between the superior incision and the lacrimal mucosa (Figure 21.5).

In addition, the nasal mucosa is trimmed until it approximates the posterior lacrimal flap. An inferior limb can also be created if there is a space between the lower portion of the opened lacrimal sac and the inferior incision. This should allow approximation of nasal mucosa and lacrimal mucosa superiorly, posteriorly, and inferiorly. The only area where lacrimal and nasal mucosa will usually not be approximated is anteriorly, where the anterior lacrimal mucosa will often fall a few millimeters short of the anterior incision. Silastic O'Donaghue lacrimal intubation tubes are placed through the upper and lower canaliculus into the nose. A 4-mm silastic tube cut to 1.5 cm is slid over the O'Donaghue tubes to act as a spacer (Figure 21.6A). A loop of silastic tubing is pulled in the medial canthal region to ensure that there is no tension on the tubing. If the tubes are tight, they can cheese-wire through the superior and inferior puncta. Once the silastic tubing is tension-free, Ligar clips are placed endoscopically behind the 4-mm silastic spacer. A rectangular piece of Gelfoam® (Pharmacia & Upjohn, Kalamazoo, MI) is slid up the tubes onto the lacrimal mucosa. The silastic tubes are cut. Gelfoam® is lifted and the position of the flaps verified before the Gelfoam® is replaced (Figure 21.6B). The operation is complete.

Postoperative Care

All patients receive systemic antibiotics (amoxicillin/clavulanic acid or cefuroxime) for 5 days as well as antibiotic eye drops (Chloromycetin), one drop four times per day for 3 weeks. Nasal saline spray and douche

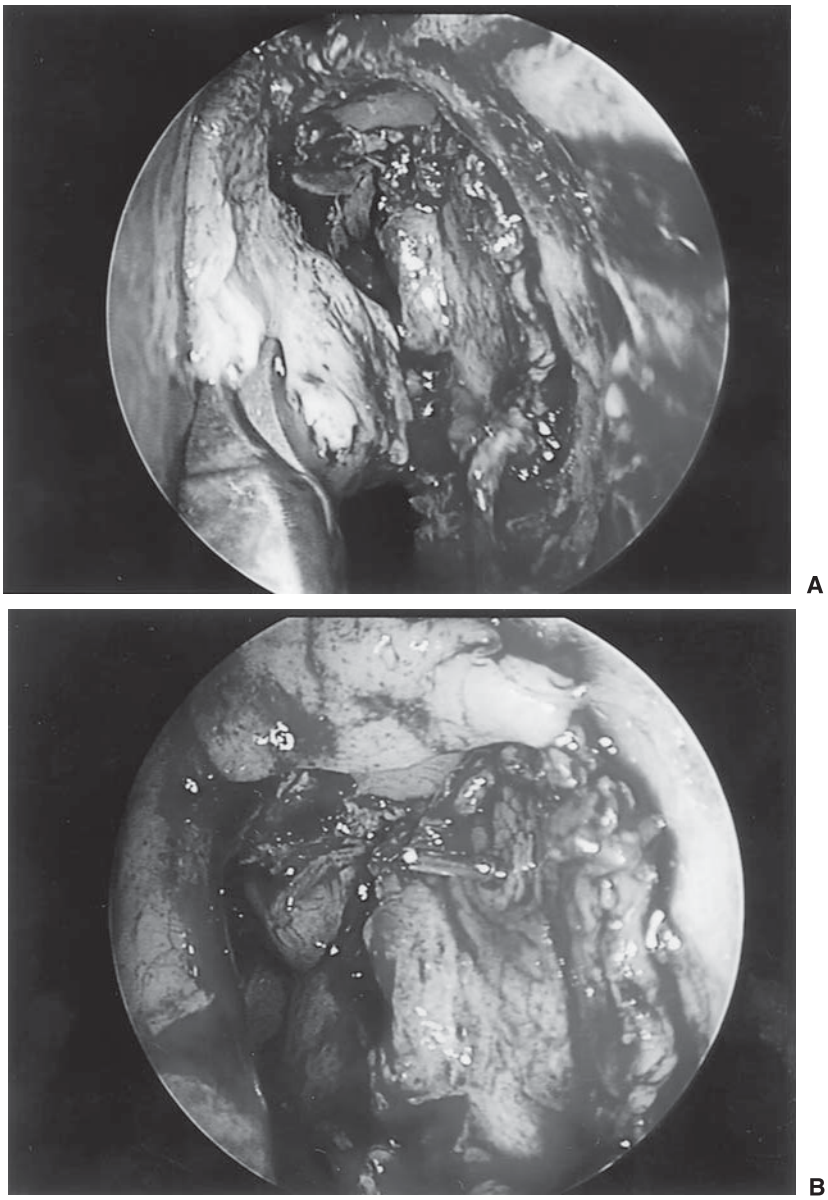

FIGURE 21.5. (A) The pediatric through-biting Blakesley is used to trim the nasal mucosal flap to allow apposition with the lacrimal sac mucosa. **(B)** Mucosal apposition is achieved superiorly between the nasal mucosa and lacrimal mucosa, posterosuperiorly between the agger nasi cell mucosa and lacrimal mucosa, posteroinferiorly and inferiorly between the nasal and lacrimal mucosa. A small gap will often remain anteriorly.

are started within 24 hours of surgery. This helps to remove blood clots from the nose and creates a clear nasal passage. It also prevents mucous from accumulating around the O'Donaghue tubes, which can create a medium for secondary infection. The patient is reviewed at 4 weeks

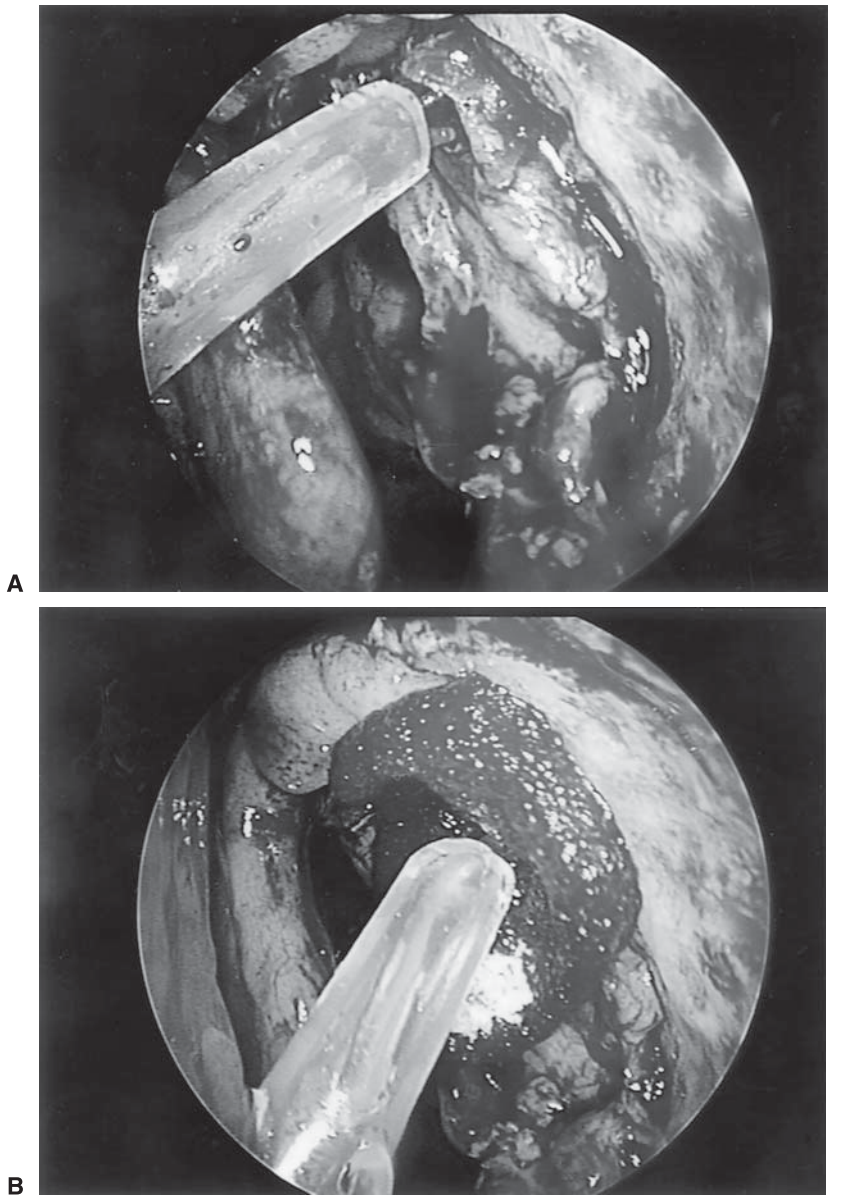

FIGURE 21.6. (A) Silastic tubes are in place and the spacer (silastic tubing) has been secured. **(B)** Gelfoam® is slid over the silastic tubes, and the position of the flaps is checked before the Gelfoam® is replaced.

and the O'Donaghue tubes are removed. A nasal endoscopy is performed and the lacrimal ostium observed. In most cases, it is well healed. However, if there are any granulations present, these are removed. Fluorescein is placed in the conjunctiva and nasal penetration is confirmed.

Results

The results of lacrimal surgery should be reported with reference to patient symptoms as well as to the anatomic surgical success of creating a functioning pathway between the conjunctiva and the nose. For a patient to be deemed to have a successful powered endoscopic DCR in our department, the patient needs to be asymptomatic with a functioning patent lacrimal ostium. This is confirmed endoscopically by the immediate draining of fluorescein from the conjunctiva into the healed lacrimal ostium. These criteria classify any patient with residual symptoms as a failure irrespective of an improvement in symptoms or the state of the lacrimal ostium. In addition, if the patient was completely asymptomatic and did not have an endoscopically visible ostium and if there was no fluorescein visible in the nose, the procedure was considered a failure. Using these strict outcome criteria, the results of powered endoscopic DCR have been reported in several publications.

Primary Dacryocystorhinostomy[9–11]

In the most recent analysis of 128 consecutive DCRs, the overall success rate was 95%. Of the failures, there were three DCRs that had no visible lacrimal ostium and no fluorescein in the nose. Four of the failures had a patent lacrimal sac with a free flow of fluorescein from the conjunctiva to the nose but were still symptomatic. All these patients said that their symptoms had improved after surgery. If the patients are divided into patients who had an anatomic nasolacrimal obstruction as defined by an obstructed DCG and scintigraphy (n = 87), the success rate was 98%.[11] Only two patients in this group failed with obstruction of the lacrimal ostium. Those patients with a functional patent had stenosis of the lacrimal ostium and four had a patent ostium with free flow of fluorescein nasolacrimal obstruction, defined by a patent system on DCG and impeded or absent nasal penetration on scintigraphy (n = 41), had a success rate of 88%.[11] Five of these patients failed. Of the four patients who had a patent lacrimal ostium, all believed that their symptoms had significantly improved. One patient with an anatomic failure was asymptomatic but was classified as a failure. The other anatomic failures all had significant symptoms and went on to have revision surgery.

Revision Dacryocystorhinostomies

If the results of patients undergoing powered endoscopic revision DCR are reviewed (n = 17), we note that the success rate decreases to 76.5%. We also found that the failures in this group were largely those patients who had undergone two or more previous DCRs. This is thought to result from the scarring and cicatrization of the lacrimal sac and the increased difficulty of achieving a marsupialized lacrimal sac with good nasal and lacrimal mucosa apposition.

Pediatric Dacryocystorhinostomies

Pediatric DCR was defined as a patient younger than 13 years of age undergoing an endoscopic powered DCR. The average age of the patients was 6.5 years (range, 2–13 years, standard deviation, 3.3). All patients had been diagnosed as having congenital nasolacrimal duct obstruction. The success rate was 14 of 16 (89%). The two failures occurred in a patient who had bilateral congenital nasolacrimal duct obstruction and had undergone three previous external DCRs on each side.

Conclusion

Powered endoscopic DCR allows the lacrimal sac to be fully exposed so that it stands proud of the lateral nasal wall after dissection. By fully preserving all the lacrimal mucosa during opening of the sac, the sac can be marsupialized into the lateral nasal wall, becoming part of the lateral nasal wall. This marsupialization is different from creating an ostium into the sac. Complete marsupialization decreases the likelihood of closure of the sac. In addition, preservation of the nasal mucosa allows this mucosal flap to be trimmed so that the nasal and lacrimal mucosa can be opposed to ensure primary intention healing rather than secondary intention healing and potentially lessens the risk of fibrosis and subsequent closure of the lacrimal ostium. Results of this procedure have proved to be reliable in primary, revision, and in pediatric DCRs.

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