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Primary External Dacryocystorhinostomy

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The watering eye may be the result of excessive tear production, abnormalities of lid position or movement, lacrimal canalicular pump failure, or obstruction of the outflow tract. With external dacryocystorhinostomy (DCR), the lacrimal sac is directly incorporated into the lateral wall of the nose, so that the canaliculi drain directly into the nasal cavity.

The aims of surgery are twofold: to eliminate fluid and mucus retention within the lacrimal sac and prevent sac enlargement (as a mucocele) – the latter leading to intermittent viscous ocular discharge – and to bypass the higher hydraulic resistance of the nasolacrimal duct, thereby increasing tear conductance and aiding the relief of epiphora.

Indications for Surgery

1. Primary acquired nasolacrimal duct obstruction
2. Secondary acquired nasolacrimal duct obstruction attributed, for example, to dacryolithiasis, endonasal surgery, inflammatory nasal or sinus disease, or prior midfacial injury
3. Persistent congenital nasolacrimal duct obstruction, often after unsuccessful probing or intubation of the nasolacrimal duct
4. Functional obstruction of lacrimal outflow with decreased tear conductance as a result of:
   (a) Stenosis, but not occlusion, of the nasolacrimal duct
   (b) Lacrimal canalicular pump failure from age-related laxity of the lower eyelid, or after facial nerve palsy
5. Acute or chronic dacryocystitis; the former group requiring initial treatment with systemic antibiotics

Surgical Principles

External DCR should establish a low-resistance drainage pathway between the conjunctival tear sac and the nasal cavity, by conversion of the lacrimal sac into part of the lateral nasal wall.

Advantages of the external approach to DCR include:

1. Sutured apposition and primary intention healing of mucosal flaps
2. Preparation of a large osteotomy that facilitates future closed placement of glass canalicular bypass tubes, should this be required
3. Direct visualization of abnormalities of the lacrimal sac – including stones, foreign bodies, or tumors
4. Provides ready access for the surgical management of canalicular disease; this includes canaliculo-DCR, retrograde canaliculostomy and intubation, or open placement of a canalicular bypass tube

Anesthesia

External lacrimal surgery may be performed under local or general anesthesia, usually as a day-case admission, and both the patient and surgeon may have a preference for either technique.[1]

Local Anesthesia

The anterior nasal space is sprayed with 4% lignocaine and packed with approximately 2′ (60 cm) of 1/2″ (12.5-mm) ribbon gauze presoaked in 2 mL of a 4% (or 10%) solution of cocaine; this pack provides effective nasal anesthesia and mucosal vasoconstriction. Using angled nasal-packing forceps, successive loops of ribbon gauze are stacked anteriorly to each of the previously placed loops and the packing should be deliberately placed above, and in front of, the anterior end of the middle turbinate.

A mixture of 0.5% bupivacaine with 1 : 100,000 to 1 : 200,000 epinephrine is used for local anesthesia: 2–3 mL of this solution is placed in the orbicularis muscle of the medial one-third of the lower eyelid and approximately 2–3 mL infiltrated medially within the orbit, around the anterior ethmoidal branch of the nasociliary nerve. The intraorbital injection is given by passing a 27-gauge needle through the skin at a point 5 mm above the medial canthus, and heading about 20° caudally from the axial plane – thereby reducing the risk of piercing the anterior ethmoidal vessels.

Giving the infiltrative local anesthesia before the surgeon scrubs allows enough time for the epinephrine-mediated vasoconstriction to occur before the start of surgery and topical anesthesia, such as amethocaine 0.5% drops, instilled into both eyes at the time of skin preparation.

Anxiolytic drugs or intravenous sedation – such as a benzodiazepine (oral or intravenous) or low-dose propofol infusion – may be provided as required throughout the procedure.

Advantages of local anesthesia include:

(a) Hemostasis because of the vasoconstriction from injection of local anesthetic solutions containing epinephrine
(b) Avoidance of general anesthetic risk in the elderly, or in patients with multiple medical problems

General Anesthesia

General anesthesia traditionally signaled a need for inpatient care but, with development of short-acting anesthetic drugs, it has become possible to perform day-case surgery under general anesthetic. Rapidly reversible anesthesia and hypotension are beneficial for lacrimal surgery, especially in the day-case setting, and a well-tested technique is described.

After placement of electrocardiogram leads, noninvasive blood pressure monitoring and pulse oximetry, general anesthesia is induced with a bolus dose of propofol and an intravenous infusion of remifentanil. After receiving a small dose of the muscle relaxant rocuronium (e.g., 400 μg per kg), the patient is ventilated with oxygen-enriched air and isoflurane until relaxed; the low-dose of rocuronium is possible because of the respiratory depression caused by the remifentanil and, if the patient has a significant tachycardia, a bolus dose of remifentanil may be given. Endotracheal intubation is undertaken and a pharyngeal pack inserted, which is only done when the patient is sufficiently relaxed to prevent coughing, because an increase in venous pressure at this stage encourages subsequent bleeding during surgery. With a surgeon well-versed in open lacrimal surgery (where bleeding might be minimal), the experienced anesthetist may choose to place a laryngeal mask airway (LMA) because emergence from anesthesia is smoother; LMA should be avoided, however, where there is greater risk of hemorrhage – as with revisional surgery or in hypertensive patients – or where problems might arise in the maintenance of a patent airway.

Some practitioners use total intravenous anesthesia throughout surgery, with continuous infusions of both propofol and remifentanil, and no volatile anesthetic agent, whereas others believe that the following technique allows a more rapid adjustment of blood pressure. A remifentanil infusion, adjusted to maintain relative bradycardia, is used for maintenance of anesthesia and the lungs are ventilated with a mixture of oxygen in air and volatile isoflurane at 0.5 MAC (minimum alveolar concentration).

The patient is placed on the operating table with a head-up tilt to reduce venous congestion at the operative site. Although the intraoperative blood pressure should be related to both the normal status of the patient and the condition at the operative field, bleeding with external lacrimal surgery is typically light with systolic pressures in the region of 80–90 mm Hg. The pulse oximeter trace can, to an experienced anesthetist, give a good indication of tissue blood flow. Local anesthetic infiltration of the operative site before skin incision will reduce the noxious stimulation that normally increases systemic blood pressure. After preparation of the sterile field, vasoconstriction of the nasal mucosa may be encouraged by the placement of three cotton-tip buds, moistened with 0.1% epinephrine solution, anterior to the middle turbinate.

At about 10 minutes before the end of the operation, the remifentanil infusion is stopped and the isoflurane increased to 1.0 MAC. An intra-

venous dose of ketorolac (10–30 mg) may be given to provide postoperative analgesia and only rarely will a patient require opiates in the postoperative period; in most cases, oral paracetamol provides adequate postoperative analgesia. If required, an antiemetic, such as intravenous ondansetron 4 mg, may be given.

At the end of surgery, the pharyngeal pack is removed and suction is applied with special attention given to the posterior nasopharynx. The patient is recovered in a semirecumbent position and is extubated – or the LMA removed – once he or she is breathing spontaneously.

Advantages of general anesthesia include:

(a) Controlled intraoperative hypotension with good control of operative bleeding
(b) Preferred by many patients, who do not wish to be conscious during surgery, and helpful for the teaching of these procedures

Vasoconstriction and Hemostasis

Successful lacrimal surgery depends on a good, blood-free visualization of tissues to permit accurate bone removal, mucosal apposition, and careful attention to the common canalicular opening to remove obstructive membranes or negotiate a retrograde canaliculostomy.

Several techniques help to encourage vasoconstriction and improve hemostasis:

1. With local anesthesia:
   (a) A nasal pack moistened with a 4% or 10% cocaine solution produces mucosal vasoconstriction; best if pack is left in place until the time of nasal mucosal suturing
   (b) Supplementary intramucosal injection of local anesthetic with 1:200,000 epinephrine may be used, but is rarely necessary during the procedure
2. With general anesthesia:
   (a) Three intranasal cotton-tip buds moistened with 1:1,000 epinephrine and placed at, and above, the anterior end of the middle turbinate produces mucosal vasoconstriction in the operative field
   (b) Infiltration of local anesthetic at the site of the skin incision
   (c) Controlled systemic hypotension, with typical pressures of 90/60 mm Hg
3. General measures:
   (a) Head-elevated (reverse Trendelenburg) posture reduces venous congestion
   (b) Use of a continuous suction device in the nondominant hand helps maintain a blood-free field, viewing of tissues, and the displacement and protection of neighboring structures during surgery
   (c) The careful handling of tissues, gentle diathermy of cut edges, suturing of mucosal flaps, and respect for surgical planes
   (d) The judicious use of bone wax for persistent hemorrhage from the cut edges of bone

Surgical Technique

A standard surgical skin cleansing and sterile draping is performed with access to the eye and nose; for local anesthesia, the whole face can be exposed after complete facial cleansing.

Using a no. 15 blade to cut skin alone, a 1/2″ (12-mm) incision – slightly shorter in children – is placed on the flat area alongside the nasion, beginning just above the level of the medial canthal tendon (MCT); positioning of a straight incision in the thicker paranasal skin helps prevent the late scar contracture and bridging often seen with posteriorly placed incisions. Lifting the lateral skin-edge anteriorly, the skin is separated from the underlying orbicularis muscle using blunt-tipped scissors until the MCT is evident (Figure 11.1A). The union

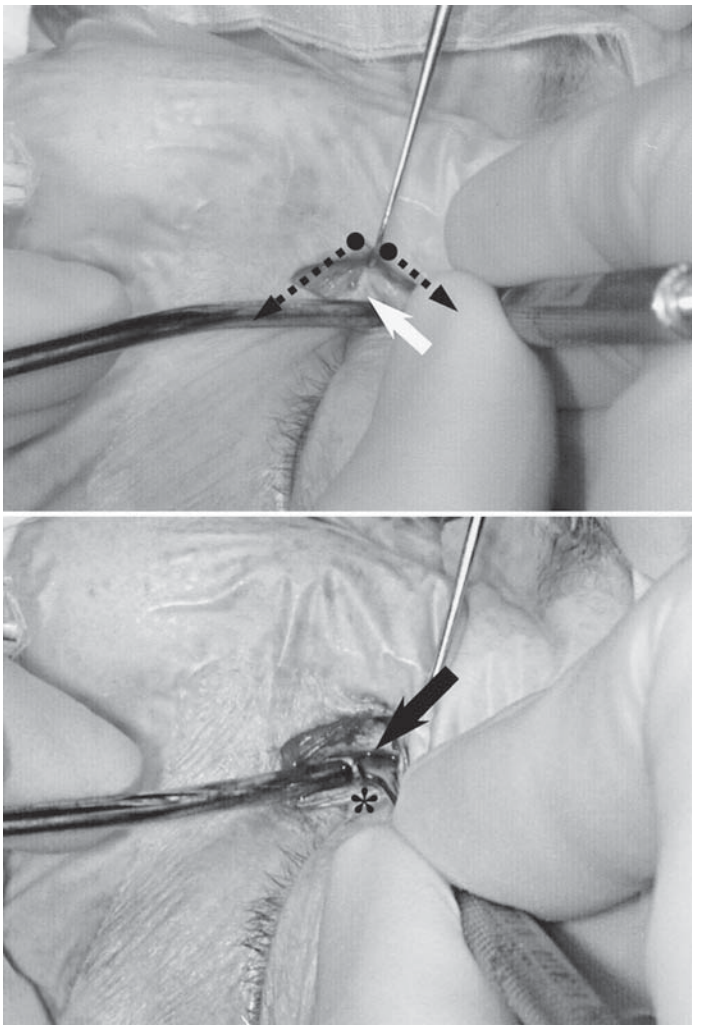

FIGURE 11.1. (A) The left MCT is readily evident (white arrow) after undermining the skin and the pretarsal and preseptal orbicularis fibers are separated superolaterally and inferolaterally (broken arrows). **(B)** A rougine is passed behind the anterior lacrimal crest (arrow) to displace the lacrimal sac (*) laterally from its bony fossa.

between preseptal and pretarsal orbicularis fibers is evident at the bony attachment of the anterior limb of the MCT, lateral to the angular vessels, and the two groups of fibers should be separated along this avascular junction using a Rollett's rongine (Figure 11.1A). The surgical assistant should use a squint hook to anteriorly retract the preseptal orbicularis and angular vessels, while the surgeon uses the rougine to incise the periosteum – starting by disinsertion of the anterior limb of the MCT and continuing down the anterior lacrimal crest, using the sharp bone edge as a cutting edge beneath the instrument. The periosteum is raised widely – anteriorly alongside the nose – and posteriorly to elevate the lacrimal sac laterally within the lacrimal sac fossa (Figure 11.1B). Using a right-angled periosteal elevator, the thin bone between the sac and anterior ethmoids is perforated at the suture line between the lacrimal bone and the frontal process of the maxilla. Occasionally, the bone in the fossa is exceptionally strong and it may be necessary to thin the bone with a drill, trephine, or hammer and chisel before perforation; an alternative in this situation is to raise the periosteum to beyond the posterior lacrimal crest and then perforate the very thin lamina papyracea just behind the posterior lacrimal crest.

Once bone has been breached, bone removal should proceed anteriorly across the anterior lacrimal crest and this can be most readily achieved with a Kerrison-style rongeur, crossing the crest close to the skull base – this being the thinnest bone on the crest and also reducing the chance of damage to the nasal mucosa (Figure 11.2A); a periosteal elevator should be swept around the bone edge (every 2 or 3 bites) to separate the nasal mucosa from underlying bone. Nasal mucosa is reached as the anterior lacrimal crest is crossed and, at this point, it is best to slightly withdraw the epinephrine-moistened cotton buds. They may be readvanced to the apex of the nasal space once the bone removal is complete. Once across the anterior crest, bone removal should be directed inferiorly to the level of the inferior orbital rim – creating an "L"-shaped rhinostomy. The remaining bone of the frontal process of the maxilla is removed, either with down-cutting rongeurs or straight (Jensen) bone-nibblers, while the lacrimal sac tissues are protected by displacing them laterally with the sucker held in the nondominant hand. The thin hamular process of the lacrimal bone, between the upper part of the nasolacrimal duct and nasal mucosa, is removed with bone nibblers and the upper part of the rhinostomy is extended to the skull base, although care should be taken here to avoid shearing forces that may fracture the cribriform plate and cause a cerebrospinal fluid leak. At this stage, the rhinostomy should be approximately 1/2"–3/4" (12–18 mm) in diameter and extend from the fundus of the sac at the skull base, approximately 1/4"–1/2" (up to 10 mm) in front of the anterior lacrimal crest, and inferiorly to expose the upper part of the nasolacrimal duct (Figure 11.2B). Anterior ethmoidectomy should be performed, using nontoothed forceps or a fine artery clip to palpate and avulse the fragment of bone and mucosa, because this creates a wide-open space that facilitates easy apposition and suture of the posterior mucosal anastomosis.[2]

A "00" Bowman probe is passed into the lacrimal sac through the lower canaliculus, and the assistant maintains gentle medial pressure to "tent" the medial wall of the sac while the medial face of the sac is opened with a no. 11 blade; this blade should be directed away from the internal opening of the common canaliculus (Figure 11.3A). Once in the sac, the closed blades of a Westcott spring scissor should *easily* pass into the lumen of the sac and duct (Figure 11.3B); difficult passage

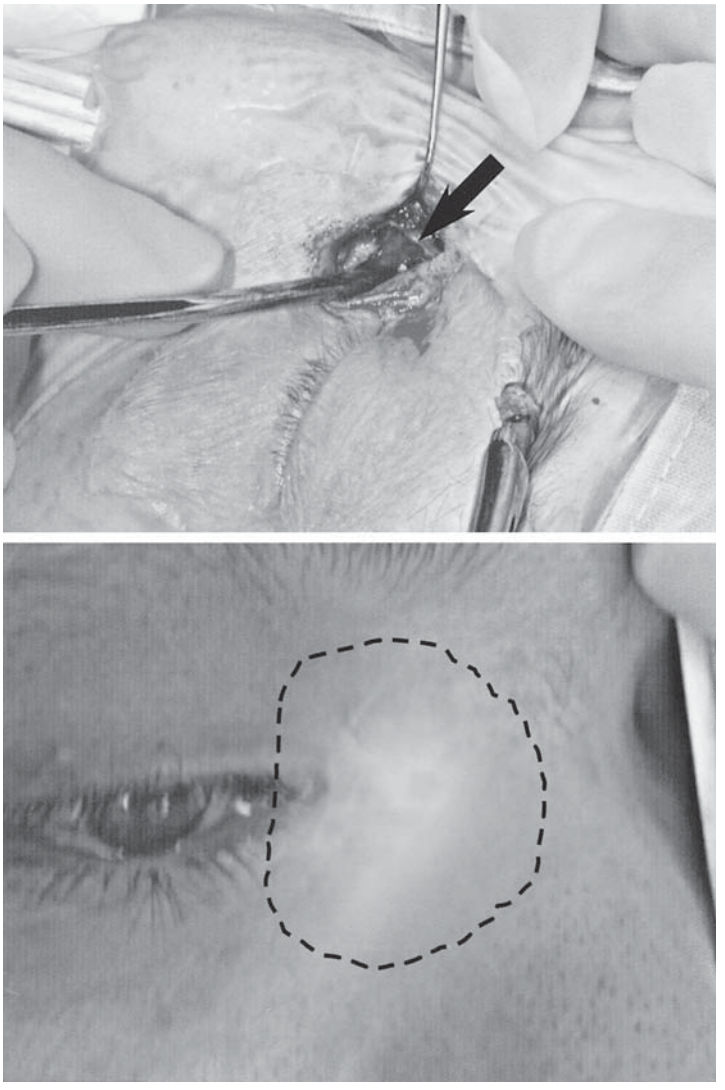

FIGURE 11.2. (A) A large rhinostomy is being created during left DCR, after having creating a defect across the anterior lacrimal crest; the anterior cut edge of bone is evident (arrow). Note the presence of epinephrine-moistened cotton tips in the nasal space. **(B)** The final size of a typical osteotomy is outlined by endonasal transillumination.

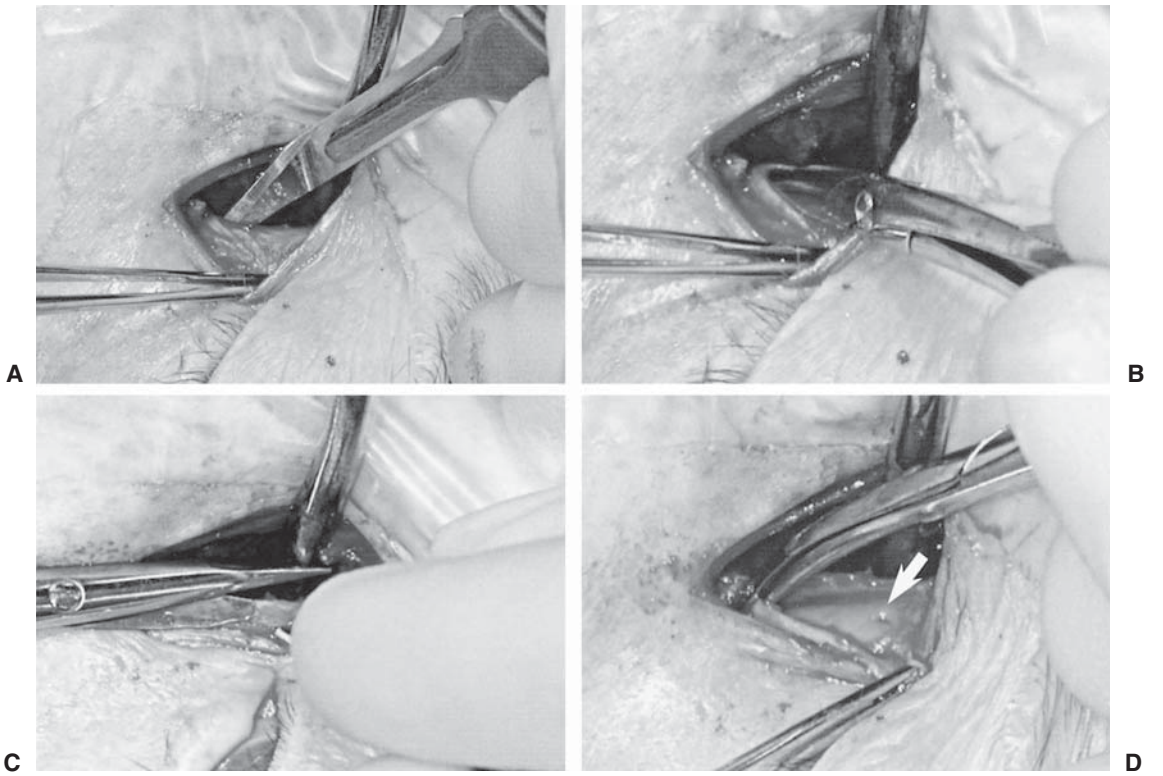

FIGURE 11.3. (A) A no. 11 blade is used to make a small incision, below the level of the common canalicular opening, during left DCR. **(B)** The nasolacrimal duct is "sounded" with the closed spring scissors and the mucosal incision continued inferiorly into the upper end of the duct. **(C)** After likewise "sounding" upward to the fundus of the sac, the mucosa is incised up to the skull base. **(D)** Relieving incisions are performed at the sac–duct junction and at the skull base, which leaves the sac opened widely and the internal opening of the common canaliculus readily evident (arrow).

frequently indicates that lacrimal fascia alone has been opened and the blades have entered the resistant submucosal (extraluminal) plane. The entire sac is opened by extension of the blade incision in both directions (Figure 11.3C) – from the fundus down to the duct, and the sac is further opened with relieving incisions at the skull base above and the nasolacrimal duct below (Figure 11.3D); cautery of the sac–duct junction is advisable before the relieving incisions, because there is a rich vascular plexus at this site.

The internal opening of the common canaliculus should be clearly visible and deliberately inspected (Figure 11.3D): Where membranous obstruction is present, the adherent valve of Rosenmüller should be excised by grasping it with a pair of fine, toothed forceps and excising approximately 1 mm^2 using a no. 11 blade. Likewise, biopsy of suspicious lesions within the sac, or removal of any debris (such as stones), is readily accomplished with the sac opened widely.

Using the no. 11 blade with the cotton buds protecting the nasal septum, the nasal mucosa is opened in a superior–inferior direction and the incision placed 3–4 mm anterior to the "arch" formed by the inflexion of the nasal mucosa into anterior insertion of the middle turbinate; this arch is only evident after anterior ethmoidectomy. The anterior flap is created by superior- and inferior-positioned relieving incisions (Figure 11.4A) and the posterior flap is similarly created after

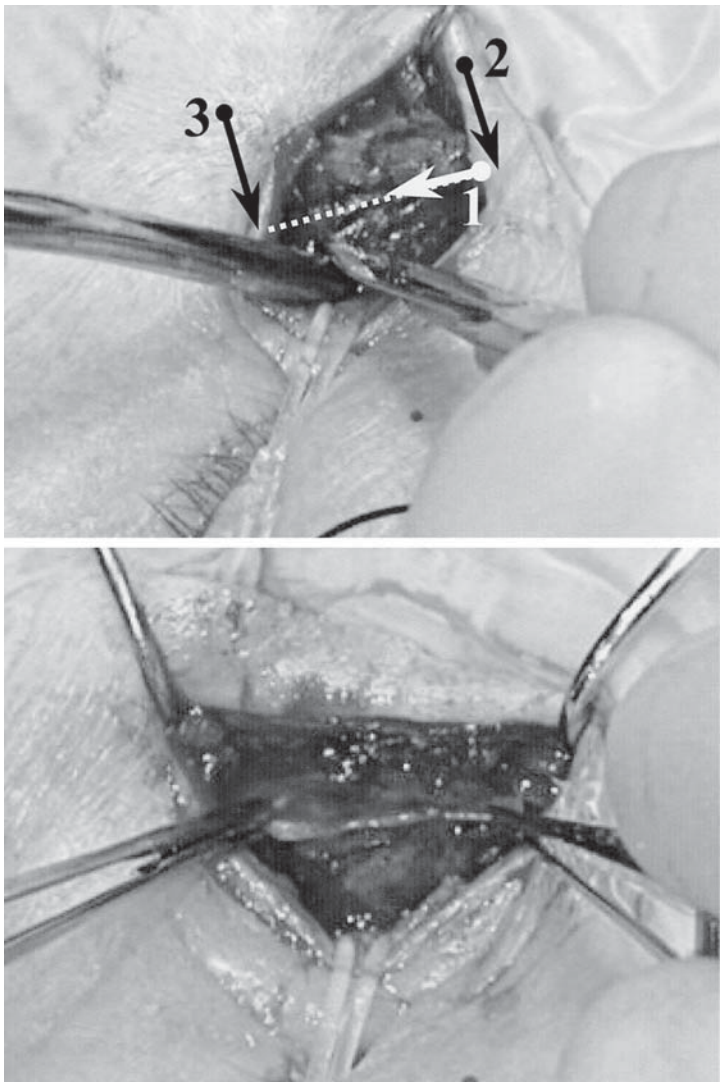

FIGURE 11.4. (A) Fashioning a large anterior flap of nasal mucosa: the first incision – made using a no. 11 blade against intranasal cotton tips – is (anatomically) vertical, and the other two incisions pass anteroposteriorly along the edges of the osteotomy. **(B)** The resulting large nasal mucosal flap should be hung aside by a weighted suture placed across the nasal bridge.

mucosal cautery. A 6-0 soluble suture (e.g., Vicryl W9756; Ethicon) is passed through the orbicularis muscle on the anterior lip of the incision and then through the middle of the free edge of the anterior nasal flap (Figure 11.4B), the suture is clipped and draped across the nasal bridge – this keeps the anterior flaps out of the surgical field during posterior suturing.

The posterior mucosal flaps are apposed – from the skull base (Figure 11.5) to the entrance of the nasolacrimal duct – with a locked continu-

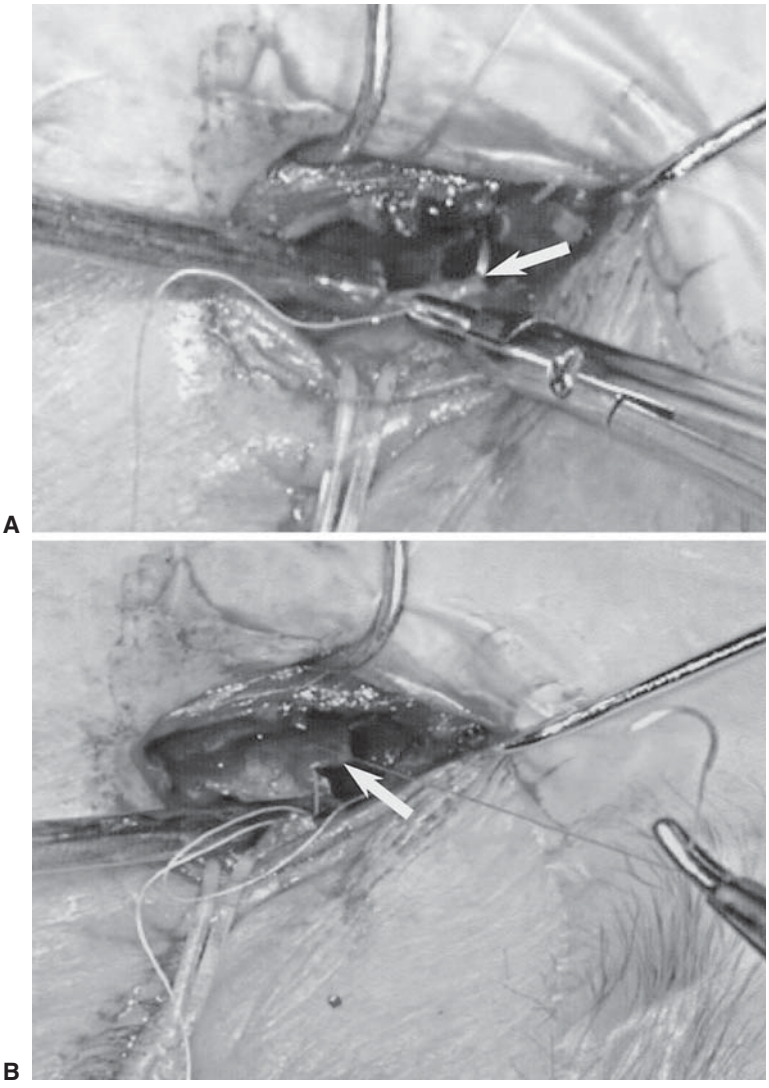

FIGURE 11.5. (A) Prior anterior ethmoidectomy facilitates suturing of the posterior mucosal flaps using an 8-mm diameter, half-circle needle – here being passed through the upper end of the posterior sac flap (arrow). **(B)** The posterior nasal flap (arrow) has just been engaged to start the sutured anastomosis that should extend from the skull base to the sac–duct junction.

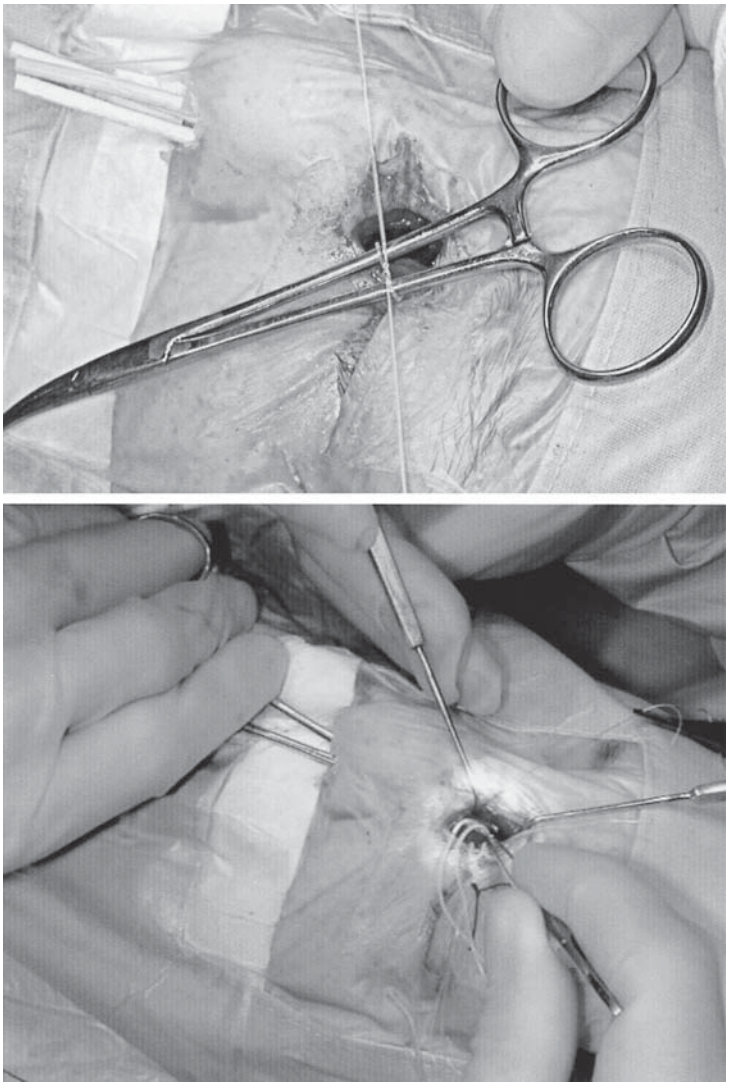

FIGURE 11.6. (A) Postoperative ride-up of intubation is almost unknown if the intubation is passed through the section and tied over the shank of an instrument. **(B)** The tied tubes are then retrieved in the jaws of an artery clip passed into the anterior nasal space.

ous 6-0 Vicryl suture and the suture secured by a triple locking throw. Silicone tubes are passed through the upper and lower canaliculi, retrieved through the incision using a curved hemostat, the metal bodkins removed, and the tubes tied over the shank of the closed hemostat resting across the incision (Figure 11.6A). While the assistant holds both tubes elevated, a 2–0 silk ligature is tied just above the silicone knot and the ends are left approximately 15 mm long to facilitate identification within the nose; the tube ends are then passed into the

nose and retrieved with a curved hemostat passed from the nasal entrance (Figure 11.6B).

Closure of the anterior mucosal flaps is best accomplished with three 6-0 Vicryl sutures using "suspension" from the orbicularis fibers: The most superior suture is passed successively through the medial orbicularis (avoiding the angular vessels), the edge of the anterior nasal flap, the edge of the anterior sac flap, and finally through the anterior limb of the MCT (Figure 11.7A); the middle suture has already been

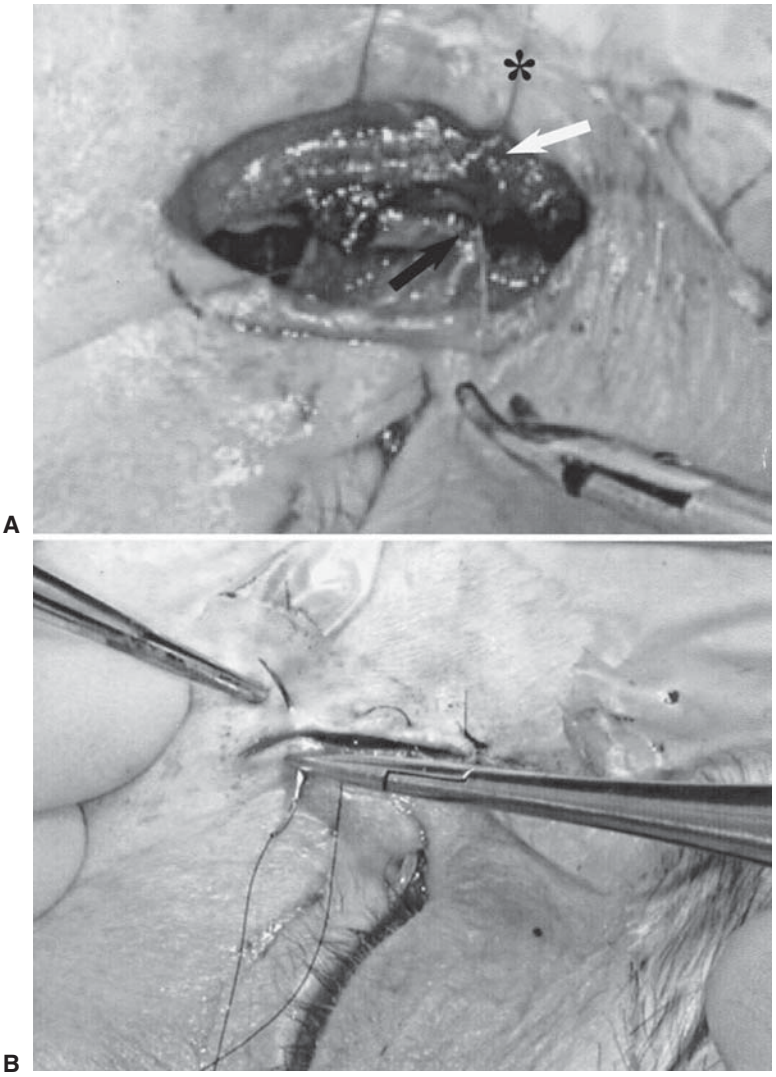

FIGURE 11.7. (A) Three sutures are used to suspend the anterior mucosal union from the orbicularis muscle fibers: here the uppermost suture (*) has been passed through the anterior, preseptal orbicularis (white arrow), through the upper end of the anterior nasal and sac mucosa (dark arrow), and finally through the MCT. **(B)** After suture of the deep tissues, the skin is closed with mattress 6-0 nylon.

passed through the anterior structures and only needs to be passed through the anterior sac mucosa; the inferior suture is finally passed through the various layers and the sutures are all tied to close both the mucosa and the orbicularis in one maneuver. The skin is then closed with a running mattress 6-0 nylon suture (Figure 11.7B), antibiotic ointment is instilled in the eye, and a firm, nonadhesive pad is placed on the incision for 12–24 hours. The silicone tubes are left long and taped to the dressing, until trimmed just before hospital discharge – this permits easier nasal packing if necessary in the unlikely event of primary hemorrhage.

If no contraindications exist, cefuroxime (typically 750 mg) is given intravenously during surgery to reduce the risk of postoperative wound infection.

Postoperative Care

The patient should rest for a few hours after surgery, seated half-reclining to reduce nasal venous congestion, and hot drinks and food should be avoided for approximately 12 hours to reduce the chance of epistaxis caused by heat-induced nasal vasodilation.

The dressing may be removed at home on the first postoperative day and a combined topical antibiotic/steroid, such as prednisolone-neomycin, should be used 3–4 times a day. To reduce the low risk of secondary hemorrhage, the patient is asked to avoid nose blowing for a week. The skin sutures are removed at approximately 1 week and the silicone stent at approximately 4–5 weeks, when epithelial healing is complete (Figure 11.8).[3,4]

Complications

1. Intraoperative
   (a) Hemorrhage
      i. For troublesome intraoperative hemorrhage, use cautery to soft tissues and wax on the cut edge of bone
      ii. If persistent, try pressure packing the operative site for 5 minutes with an epinephrine-moistened gauze
      iii. Consider packing the nasal space with an absorbable surgical cellulose sponge
   (b) Canalicular injury
      i. May be avoided by gentle handling of probes and stents during surgery
      ii. When passing a probe or tube, ensure that the eyelid is held taut, to avoid a "concertina" effect in the canaliculus and creation of a false passage
   (c) Cerebrospinal fluid leak
      i. Inadvertent fracture of the cribriform plate may rarely result in cerebrospinal fluid leak

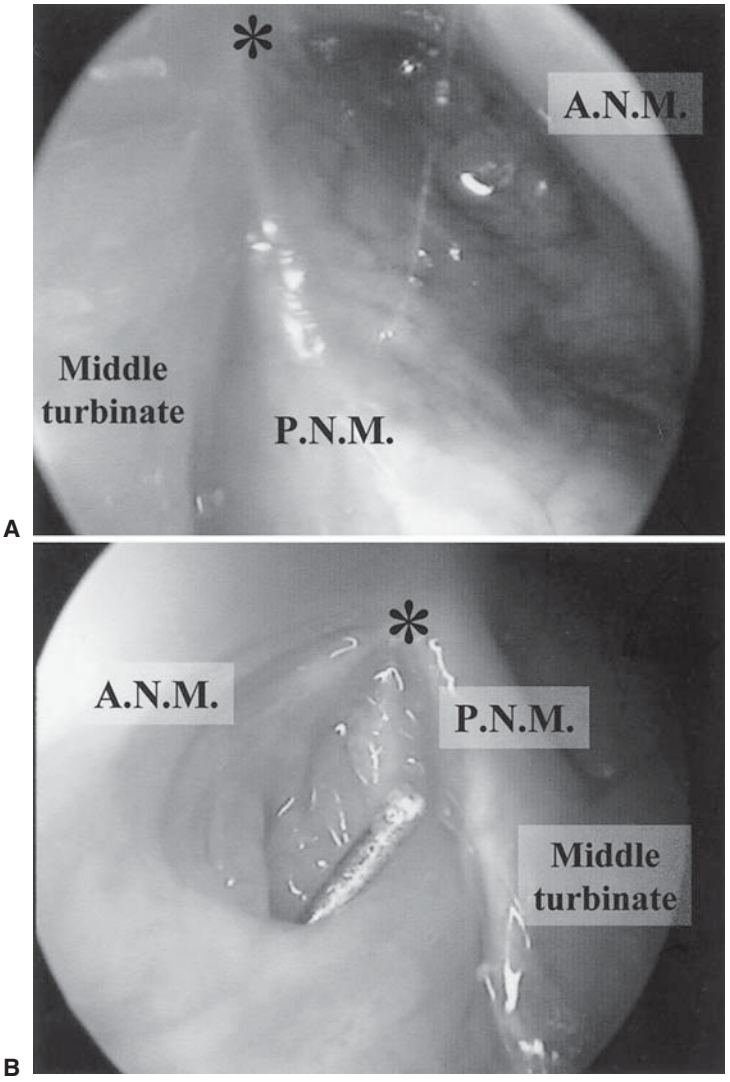

FIGURE 11.8. Healed external DCR, showing **(A)** the left lacrimal sac opened widely to the nasal space and **(B)** a successful right-sided anastomosis, with intracanalicular probe. P.N.M., posterior nasal mucosa; A.N.M., anterior nasal mucosa; asterisk marks the area of secondary intention healing on the skull base.

ii. Small leaks may be sealed by occlusion with a tiny slip of orbicularis muscle fibers
iii. Postoperative antibiotics should be administered and vigilant monitoring maintained for symptoms and signs of meningitis; a neurosurgical opinion might be sought in certain circumstances

(d) Inadvertent orbital entry
   i. Orbital fat prolapse may occur during ethmoidectomy or incision of the sac
   ii. Traction on the orbital fat should be avoided to reduce the risk of motility disturbance or, more rarely, orbital hemorrhage

2. Postoperative
   (a) Hemorrhage
      i. Simple measures, such as a head-up posture and nasal ice packs, may be all that is required
      ii. If hemorrhage continues, pack the nose with 1/2″ (12.5 mm) ribbon gauze moistened in 1 : 1,000 epinephrine and leave the pack undisturbed for 5 days. Oral antibiotics should be given for a week after hemorrhage
   (b) Wound infection
      i. Prophylactic systemic antibiotics reduce the risk of wound infection
      ii. A single intraoperative dose of a broad-spectrum antibiotic is as effective as a postoperative course of oral antibiotics
      iii. Consider using postoperative antibiotics in the setting of preoperative infection, simultaneous bilateral surgery, with placement of a nasal tamponade, or with postoperative epistaxis
   (c) Wound necrosis and fistula formation
      i. May occur in the setting of previous radiotherapy or overwhelming skin infections
   (d) Stent prolapse or canalicular "cheese-wiring"
      i. With tying over the handle of forceps, prolapse is almost never encountered
      ii. If prolapse should occur, the silicone tubes can be retrieved with nasal endoscopy in almost all cases
      iii. Medial migration ("cheese-wiring") of stent arises where it is not passing through the fibrous annulus of a lacrimal punctum – as, for example, after punctoplasty or retrograde canaliculostomy
   (e) Hypertrophic scar or bowing of the incision
      i. Generally caused by a posteriorly placed incision, in the concavity of the inner canthus (Figure 11.9)
      ii. May be exacerbated by excessive diathermy or placement of large numbers of subcutaneous sutures
   (f) Failure of drainage
      i. Most often caused by fibrosis at the site of a too-small soft-tissue anastomosis
      ii. If caused by fibrous obstruction at the internal opening of the common canaliculus, this may be treated by transcanalicular trephination and intubation
      iii. A redo-DCR may be required if there has been inadequate bone removal

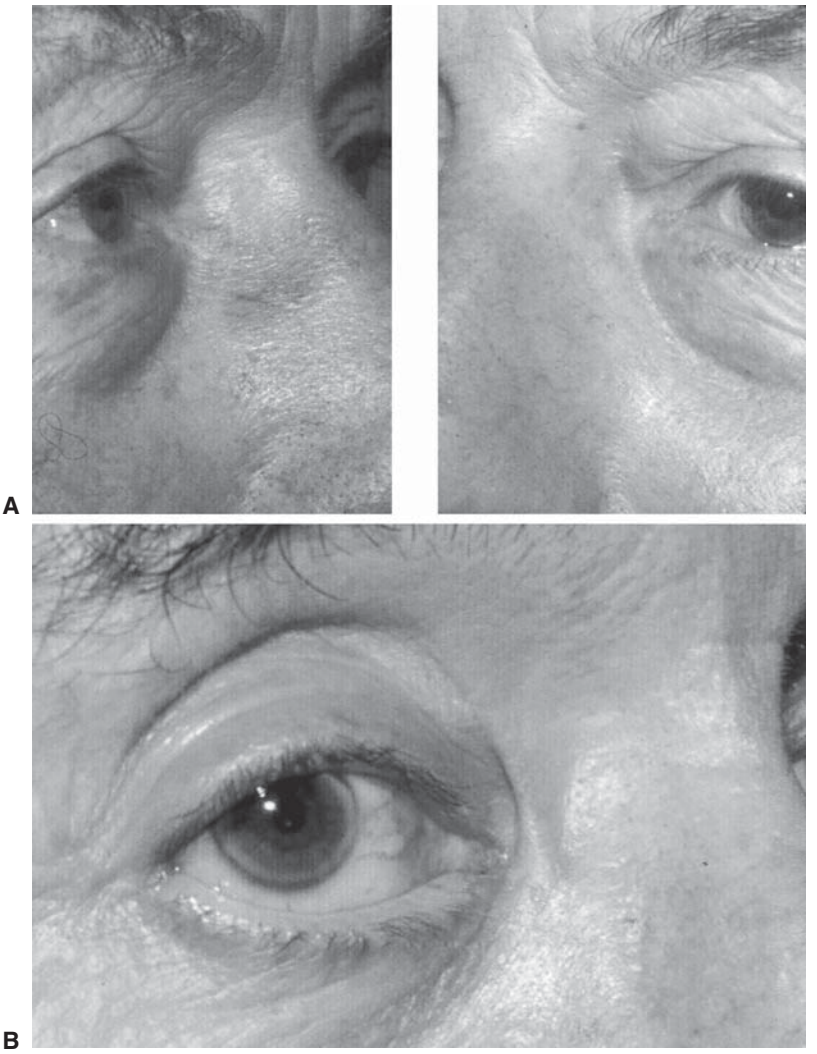

FIGURE 11.9. (A) Well-placed incision for external DCR, with an "invisible" scar at 1 year after right-sided surgery. **(B)** Bowing of a DCR scar in the convexity of the inner canthus; this bowing is common with superior and posterior placement of the incision.

iv. Failure because of canalicular obstruction at a more proximal level usually requires placement of a glass canalicular bypass (Lester Jones) tube.

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