OPEN ACCESS ATLAS OF OTOLARYNGOLOGY, HEAD & NECK OPERATIVE SURGERY

EXTERNAL DACRYOCYSTORHINOSTOMY (DCR) SURGERY TECHNIQUE

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Dacryocystorhinostomy (DCR) is done to bypass obstruction of the nasolacrimal duct *i.e.* distal to the lacrimal sac, to re-establish drainage of tears into the nasal cavity. It involves removing the bone between the lacrimal sac and the nasal cavity and anastomosing the mucosa of the lacrimal sac to the nasal mucosa *(Figure 1)*.

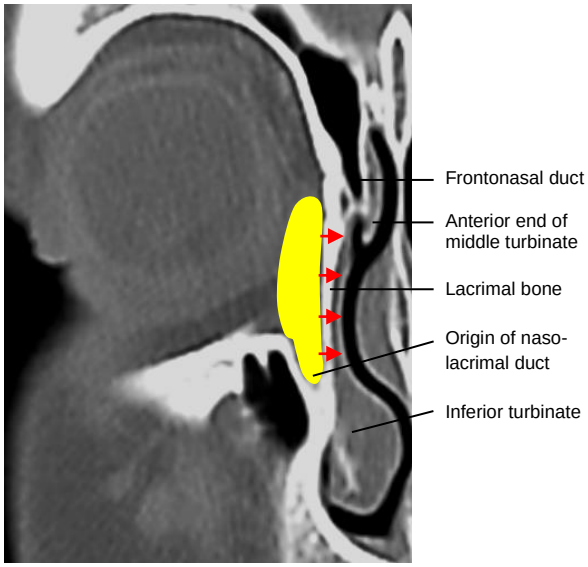

Figure 1: DCR involves removing the bone between the lacrimal sac (yellow) and the nasal cavity

The operation can be done either by external or endoscopic approach with success rates of >90% for both techniques. This chapter describes the external approach.

Aetiology

Nasolacrimal duct obstruction (NLDO) can be categorised as ***either congenital or acquired***. ***Congenital NLDO*** occurs because of an imperforate duct, often with a membrane overlying Hassner's valve. Most cases spontaneously open within the first year. Congenital NLDO requiring intervention responds well to direct probing and perforation of the membranous occlusion.

Acquired NLDO can be further categorised as either primary or secondary.

- ***Primary NLDO*** is a clinical syndrome characterised by chronic inflammation and fibrosis of the nasolacrimal duct. The exact pathogenesis is not known. It occurs most commonly in middle aged females.
- ***Secondary NLDO*** may be caused by trauma, chronic rhinosinusitis, chronic ocular surface inflammation and previous radiotherapy.

Clinical presentation of NLDO

Epiphora is the main presenting complaint. Epiphora is typically consistent and continuous, and worse with conditions that stimulate reflex tear production. Patients frequently report "thickened tears" with a sticky discharge most commonly noted on waking from sleep.

With total or near-total obstruction, a lacrimal sac mucocoele may form. Patients can get recurrent episodes of acute infection of a mucocoele presenting with a tender swelling in the area of the medial canthus (acute dacryocystitis).

Clinical evaluation

Evaluation of epiphora involves careful examination to exclude causes of reflex tear production as well as to determine the location and degree of obstruction within the outflow tract.

Lacrimal sac distension or a mucocoele confirms the presence of NLDO. Patients who present with a mucocoele or acute dacryocystitis therefore do not require probing and syringing as the clinical features are diagnostic of NLDO.

With partial NLDO, the presence of a thickened, increased tear lake and reflux on expression of the lacrimal sac are suggestive signs. Diagnostic probing and syringing are required in such cases to confirm a stricture in the outflow tract.

Diagnostic procedures

Confirmation of NLDO is achieved using both passive and active investigative procedures. Tests common utilised to evaluate the lacrimal drainage system are the dye disappearance test (DDT), and the Jones 1 (JT1) and Jones 2 tests (JT2). The tests are generally performed in the following order: DDT → JT1 → JT2.

Inserting instruments into the canaliculi

Procedures that require inserting instruments into the canaliculi include

- Punctal dilation *(Figure 3)*
- Probing *(Figure 4)*
- Syringing *(Figure 5)*

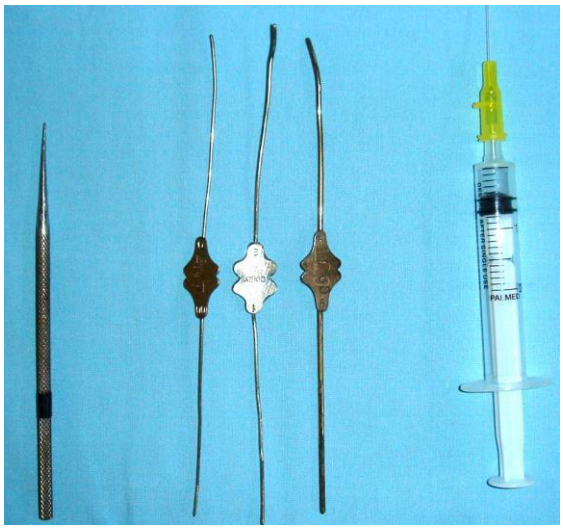

Figure 2: Dilator, Bowman probes and syringing instrumentation

Insert the instrument vertically into punctum for 2mm, then put lateral traction on eyelid while rotating the instrument horizontally and advance the instrument horizontally toward nasolacrimal sac at the level of the medical canthal tendon (MCT).

The total distances of insertion are:

- Punctal dilation: As far as is necessary to dilate punctum
- Probing: ±12mm (or until hard/soft stop)
- Syringing: ±5mm

Figure 3: Punctum dilated with a punctum dilator

Figure 4: Diagnostic probing

Figure 5: Syringing via lower canaliculus

Dye disappearance test (DDT)

Technique

- Apply 1-2 drops of topical anaesthesia *e.g.* Oxybuprocaine or Benoxinate HCl 0.4%, into the conjunctival fornix
- Wait 10 seconds before applying 1 drop of Fluorescein 2% into the conjunctival fornix
- Check the height of the fluorescein meniscus 5 minutes after applying the fluorescein

Findings

- Normal: little or no dye
- Abnormal: residual or excessive dye (also compare to contralateral side)

Interpretation

- Significant residual dye, especially if asymmetrical, could be indicative of physiological or anatomical (partial or total) obstruction

Jones test 1 (JT1)

- Apply topical anaesthesia and fluorescein as described in the DDT (if not already applied)
- Check for fluorescein under inferior turbinate with cotton-tipped bud moistened in local anaesthetic 5 min after applying fluorescein
- Positive JT1: Fluorescein on cotton bud
- Negative JT1: No fluorescein on cotton bud

JT1	***JT 2***	***Probable site of obstruction***
+	+	Normal
-	+	Partial or Functional NLDO
-	- & dye reflux from opposite punctum	Complete lower NLDO
-	- & saline reflux from opposite punctum	Complete common canaliculus
-	- & dye reflux from same punctum	Complete NLDO and opposite canaliculus
-	- & saline reflux from same punctum	Complete same canaliculus

Table 1: Interpretation of JT1 and JT2 tests

Jones test 2 (JT2)

- Apply topical anaesthesia as described in the DDT (if not already applied)
- Any residual fluorescein is washed from conjunctival fornix with saline irrigation
- Dilate punctum with a Punctal Dilator
- Warn patient that they might taste salty fluid in the back of the throat and that they will have to swallow it. It is important that they tell you if they taste it
- Insert a 24G (yellow) intravenous cannula as described above and syringe the lacrimal system with saline while holding a cotton bud under the inferior turbinate *(Figure 5)*
- Positive JT2: Fluorescein on cotton bud
- Negative JT2: No fluorescein on cotton bud

Probing and syringing

Probing can be diagnostic (congenital and acquired causes of epiphora) and therapeutic (only in congenital NLDO)

- Apply 1-2 drops of topical anaesthesia *e.g.* Oxybuprocaine or Benoxinate HCl 0.4%, into the conjunctival fornix
- Dilate the puncta with a punctal dilator as described above *(Figure 3)*
- Probe the upper and lower canaliculi with a Bowman probe size "0" or "1" as described above *(Figure 4)*
- Only in Congenital NLDO
  - After hard stop, rotate the probe back to a vertical orientation while holding the probe flat on face
  - Advance the probe downwards, inferiorly, and laterally until a "pop" is felt as the probe enters the NLD
- Result and Interpretation
  - Soft stop (probe catching on soft tissue): Same canaliculus or common canaliculus obstruction
  - Hard stop (probe stopped by mucosa overlying lacrimal bone: no canalicular obstruction

Syringing

- Apply 1-2 drops of topical anaesthesia (*e.g.* Oxybuprocaine or Benoxinate HCl 0.4%) into the conjunctival fornix
- Dilate puncta with punctal dilator as described above
- Warn patient that they might taste salty fluid in the back of their throat. It is important that they tell you if they taste it and that they will have to swallow it.
- Insert a 24G (yellow) intravenous cannula as described above and syringe the lacrimal system with saline mixed with fluorescein
- Interpretation of results is summarised in *Table 2*

Reflux through puncta	***Taste Fluorescein in throat***	***Probable site of obstruction***
-	+	Normal
+ Both	+	Depending on force of irrigation: • Normal • Physiological • Partial NLDO
+ Opposite	-	Common Canaliculus
+ Same	-	Same canaliculus

Table 2: Interpretation of syringing

Management principles

The objective of external DCR is to re-establish the lacrimal outflow passage into the nasal cavity by creating a fistula between the lacrimal sac and the nasal mucosa. To achieve this, a bony osteotomy involving the lacrimal and maxillary bones is created *(Figures 1, 6)*.

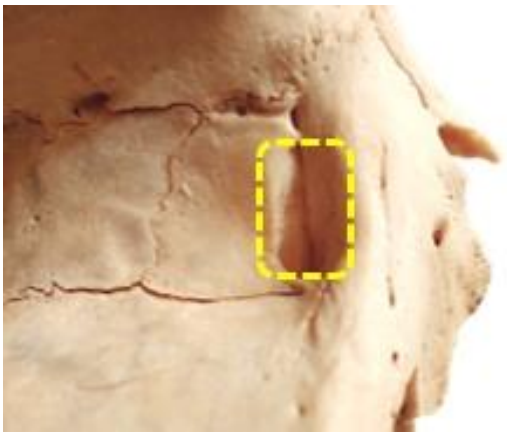

Figure 6: Area of bone removed

Surgical anatomy

The lacrimal sac is located within the lacrimal fossa and drains into the nasolacrimal duct *(Figures 7, 8)*. The lacrimal puncta open at the medial ends of the upper and lower eyelids and drain into the lacrimal sac via the upper and lower canaliculi *(Figure 7)*. The common canaliculus opens high on the lateral wall of the lacrimal sac.

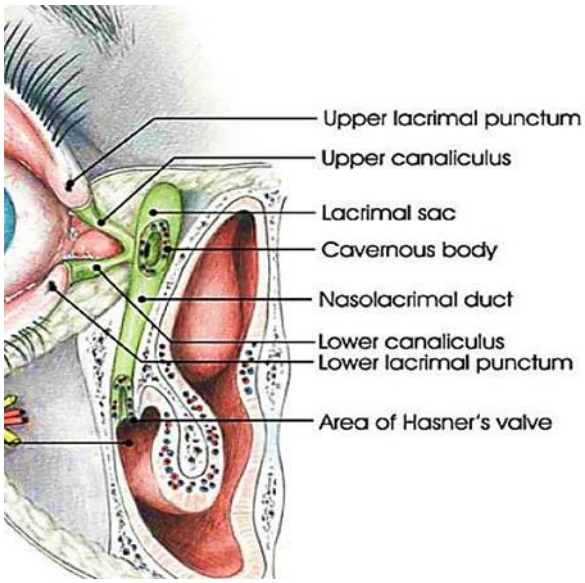

Figure 7: Ocular and nasolacrimal duct anatomy

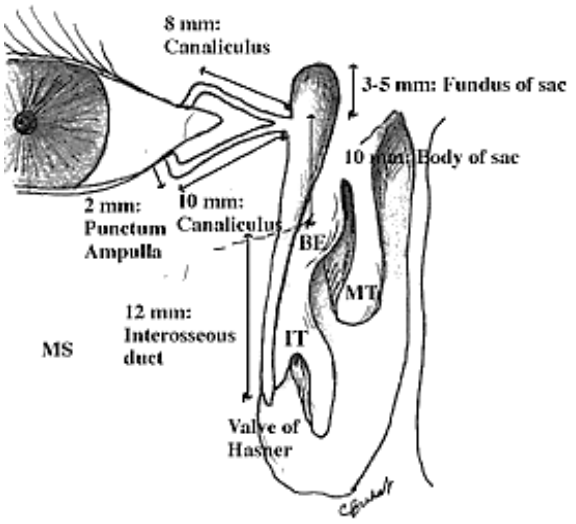

Figure 8: Approximate dimensions of the lacrimal excretory system. BE, bulla ethmoidalis; IT, inferior turbinate; MS, maxillary sinus; MT, middle turbinate
http://www.oculist.net/downaton502/prof/ebook/duanes/pages/v8/v8c002a.html

The lacrimal sac extends approximately 9mm above the axilla of the middle turbinate. The thick anterior limb of the medial canthal tendon wraps along the anterior upper half of the lacrimal sac to insert onto the anterior lacrimal crest, and the thin posterior limb passes behind the sac to insert onto the posterior lacrimal crest *(Figure 9)*.

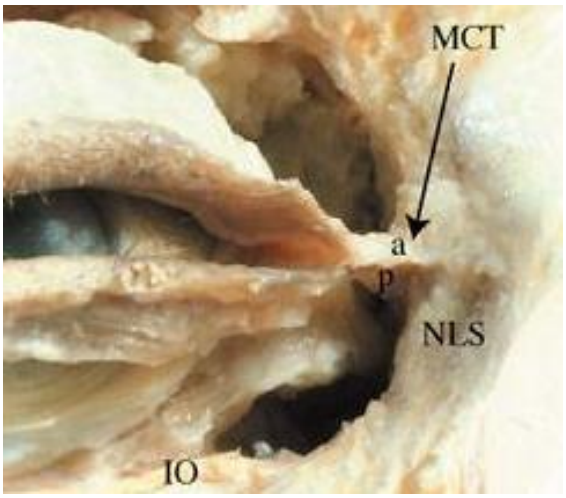

Figure 9: The thick anterior limb of the medial canthal tendon wraps along the anterior upper half of the lacrimal sac to insert onto the anterior lacrimal crest, and the thin posterior limb passes behind the sac to insert onto the posterior lacrimal crest. IO, inferior oblique muscle origin; MCT-a, medial canthal tendon-anterior limb; MCT-p, medial canthal tendon-posterior limb; NLS, nasolacrimal sac
http://www.oculist.net/downaton502/prof/ebook/duanes/pages/v8/v8c002a.html

The lacrimal sac is located within the lacrimal fossa *(Figures 10-12)*. The nasolacrimal duct runs within a bony canal created by the maxillary and lacrimal bones and opens into the inferior meatus of the nose *(Figures 7, 8, 11-13)*.

The lacrimal bone extends between the frontal process of the maxilla anteriorly *(Figure 11)*, to the attachment of the uncinate posteriorly. It is important to note that the lacrimal bone and sac are located just anterior to the orbit. The retrolacrimal region of the lamina papyracea is a thin bone and forms the medial wall of the orbit *(Figure 10)*.

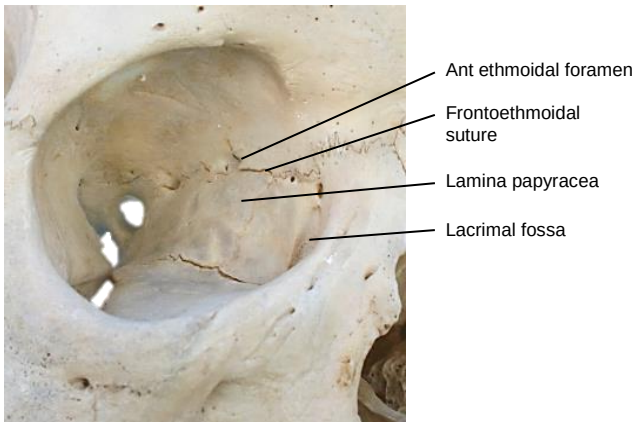

Figure 10: Right medial orbital wall

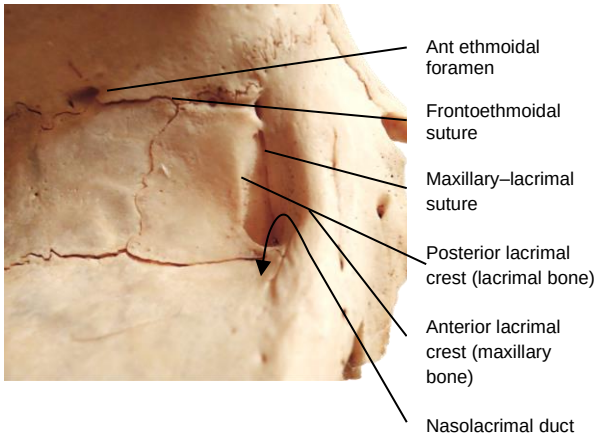

Figure 11: Anterior and posterior lacrimal crests are formed by the maxillary and lacrimal bones

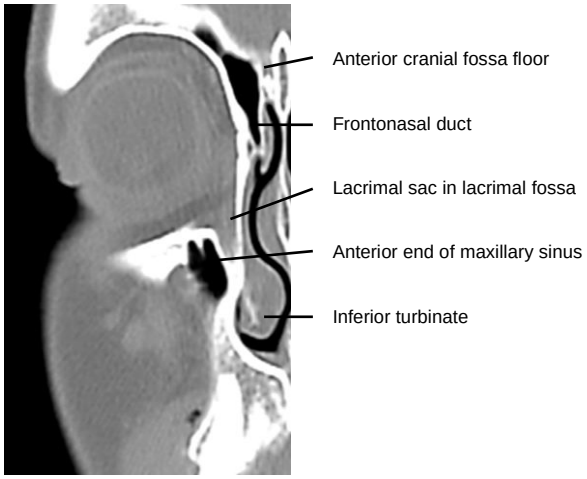

Figure 12: Coronal CT slice through lacrimal fossa

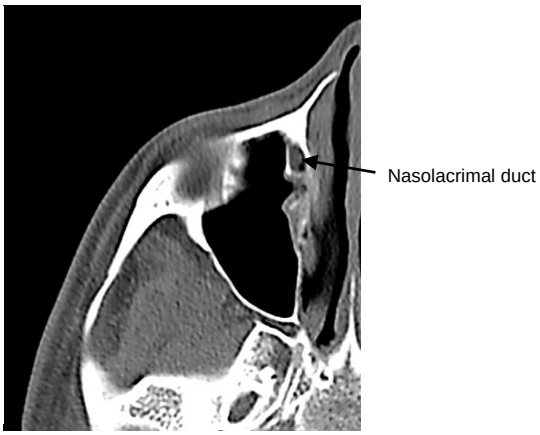

Figure 13: Nasolacrimal duct seen in axial cut at level of infraorbital nerve and orbital floor

Vasculature

The *angular artery* and *angular vein* are located near the medial orbit and are the only significant vessels encountered during external DCR *(Figure 14)*.

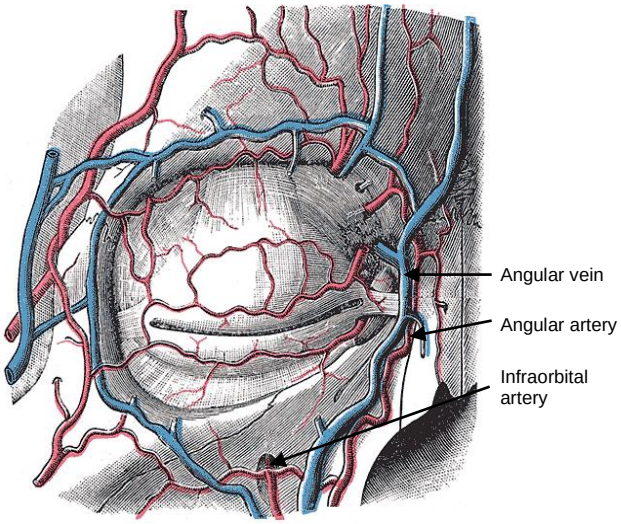

Figure 14: Vasculature around the orbit

The angular artery is generally a branch of the facial artery; however, some studies have shown that it can occasionally originate from the ophthalmic artery. It terminates in an anastomosis with the dorsal nasal branch of the ophthalmic artery.

External DCR steps

Anaesthesia

Preferred routes of anaesthesia

- General anaesthesia with local anaesthesia augmentation
- Local anaesthesia with sedation

Local anaesthesia

- 50:50 mix of 2% lignocaine and 0.5% bupivacaine with 1:00000-1:200000 epinephrine
- The authors use the following regional blocks:
  - Infratrochlear block
  - Infraorbital block
  - Anterior ethmoidal block
- In addition, the following areas are infiltrated with local anaesthetic
  - Skin along intended incision
  - Nasal mucosa overlying the lacrimal fossa
- Topical anaesthetic drops are instilled into the conjunctival fornix

General anaesthesia / sedation

- Total intravenous anaesthesia (TIVA) is considered the best as it avoids vascular dilatation caused by volatile gasses

Optimising haemostasis

Preoperative

- Control blood pressure
- Stop anticoagulants in consultation with treating physician
- Rule out bleeding diathesis

10 min prior to starting surgery

- Insert ribbon gauze soaked in 2ml 1:1000 adrenaline, between the inferior turbinate, nasal septum and into the middle meatus (superior and posterior direction)
- Administer local anaesthesia as described above
- Administer broad spectrum antibiotic

Intraoperative

- Reverse Trendelenburg position (15º head-up)
- General anaesthesia
  - Hypotensive anaesthetic
  - TIVA
- Local anaesthesia with adrenaline as described above
- Judicious use of cautery
- Haemostatic powder or sponges should be available if needed
- Packing wound
  - Adrenaline /saline moistened gauze
  - Nasal packing with absorbable surgical cellulose sponge
- Gentle handling of tissues and avoiding known vessels

Instrumentation

- Toothed forceps
- Needle holder
- Punctal dilator *(Figure 2)*
- Bowman probe 0 or 1 *(Figure 2)*
- Freer's periosteal elevator
- Blades
  - No 15-scalpel blade
  - Crescent knife *(Figure 15)*
- Kerrison Punch *(Figure 16)*
- Stitches
  - 4-0 chromic or 6-0 vicryl
  - 6-0 silk
- Lacrimal (Crawford) stents *(Figure 17)*

Figure 15: Crescent knife

Figure 16: Kerrison Punch

Figure 17: Crawford stents

Surgical Steps

1. Incision

- Make a 10-20mm (depending on age) skin incision with a No 15 scalpel blade *(Figure 18)*
- Start 3-4mm medial to medial canthus and 2-3mm above the MCT, and curve the incision along the apex of the anterior lacrimal crest, extending it inferiorly and laterally
- Avoid injuring the angular artery and vein
    - Make the initial incision only though skin to avoid the angular vessels that run at a deeper plane
    - Dissect bluntly through the subcutaneous tissue
    - Identifying the angular vessels and keep them reflected medially throughout surgery
- Dissect through subcutaneous tissue and orbicularis to the periosteum *(Figure 19)*
    - Blunt dissection with spring scissors
    - Identify, avoid, and reflect the angular vessels medially
    - Expose and identify the MCT as an important anatomical landmark

Figure 18: Skin incision site is marked 3-4 mm anterior to the medial canthus and 10-20mm in length

Figure 19: Blunt dissection through the orbicularis oculi to expose the anterior limb of the MCT. The angular vein is displaced anteriorly

2. Periosteal elevation and reflecting sac out of the lacrimal fossa

- Use a Freer's periosteal elevator to incise the periosteum with a side-to-side cutting motion along the anterior lacrimal crest *(Figure 20)*
- Elevate the periosteum
    - Posterior to the anterior lacrimal crest, lifting the lacrimal sac out of

the lacrimal fossa, until you reach the lamina papyracea
  - Superiorly & inferiorly as much as is reasonably possible
  - MCT: Some authors preserve the MCT while others free up the MCT with the periosteum

Figure 20: Elevating the lacrimal sac from lacrimal fossa

Figure 21: Periosteal elevator is used to strip the anterior limb of the medial canthal tendon to start the subperiosteal dissection

3. Create and enlarge the bony ostium

It is important to avoid inadvertently injuring your nasal mucosa by Initial controlled inward fracture of the lacrimal fossa bone with the Freer's periosteal elevator, and gentle insertion of the Kerrison's bone punch between bone and nasal mucosa during bone removal

- Fracture the thin bone of the lacrimal fossa inward with the Freer's periosteal elevator
- Enlarge the ostium with a Kerrison punch *(Figure 22)*
  - Anteriorly: up-to-and-including the anterior lacrimal crest
  - Posteriorly: up-to-and-including the posterior lacrimal crest (up to lamina papyracea)
  - Superiorly: to just inferior to the MCT
  - Inferiorly: to the beginning of the NLD

Figure 22: A Kerrison's punch is used to create an osteotomy by removing lacrimal bone. Care is taken not to injure the underlying nasal mucosa

- Expose the nasal mucosa via a wide osteotomy *(Figure 23)*

Figure 23: Exposure of nasal mucosa via wide osteotomy

4. Create a lacrimal sac flap

- Dilate the upper and lower puncta with the punctal dilator as previously described
- Probe the lacrimal sac with a Bowman probe 0 or 1. Use the probe to tent the lacrimal sac and to create counter-pressure for to incise the sac *(Figure 24)*
- Tent the lacrimal sac more posteriorly as this will create a longer anterior flap*(Figure 24)*

Figure 24: A Bowman probe is then inserted into the lower canaliculus and advanced into the sac. The sac can then be tented as shown to aid incision of the sac

- Incise the lacrimal sac in an H-configuration, thereby creating both anterior and posterior flaps *(Figures 25, 26)*

Figure 25: A No 10 blade is used to incise the sac over the probe to avoid injuring the common canalicular opening

Figure 26: Incision into the sac reveals the Bowman probe as well as the intact common canalicular opening

- Make the 1st incision in a superior-inferior direction with a crescent knife. One can use Wescott spring scissors to extend the incision superiorly and inferiorly *(Figure 27)*
    - Try to make this incision a little more posteriorly as this will create a longer anterior flap and shorter posterior flap
    - Superiorly, direct the blade away from common canaliculus to avoid injury

- Inferiorly, extend the incision to the NLD opening to avoid *lacrimal sump syndrome*

- The subsequent incisions are horizontal cuts to create an H-configuration. The crescent knife or the Wescott spring scissors can be used for this purpose

Figure 27: Wescott spring scissors

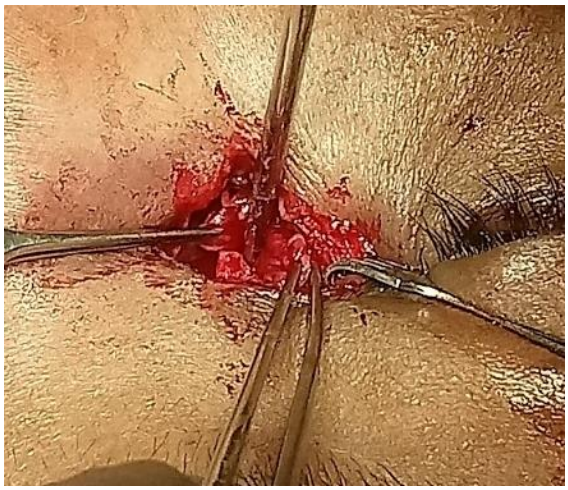

Figure 28: An H shaped flap is created in the lacrimal sac mucosa as well as in the nasal mucosa to create anterior and posterior flaps

5. Create a nasal mucosal flap

- Incise the nasal mucosa in an H-configuration, thereby creating anterior and posterior flaps
- The 1st incision is made in a superior-inferior plane with a crescent knife. One can also use spring scissors to extend the incision superiorly and inferiorly
- Try to make the nasal mucosal incision the same length as the one in the lacrimal sac
- Make this incision a little more posteriorly to create a longer anterior and a shorter posterior flap
- The subsequent incisions are horizontal cuts to create an H-configuration. The crescent knife or the Wescott spring scissors can be used for this purpose

6. Suture the posterior flaps

- Suture the posterior nasal and lacrimal sac flap together with 4-0 chromic or 6-0 vicryl (*Figure 29)*
- 2x interrupted stitches are usually adequate
- A half circle needle is more convenient as this suture is passed deep in the wound

OR

- Amputate the posterior flaps

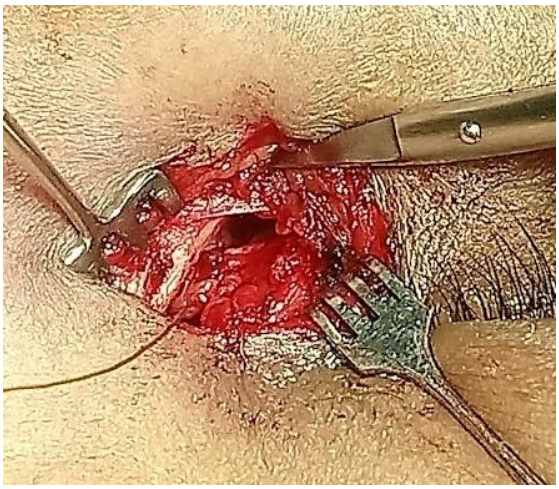

Figure 29: The posterior flaps are sutured together with the inserted lacrimal probes lying between the anterior and posterior flaps

7. Intubate upper and lower canaliculi

- The upper and lower puncta have already been dilated
- Intubate the upper and lower canaliculi with Crawford or other preferred lacrimal stents and pass the tubes out through the nose *(Figures 30, 31)*

Figure 30: Lacrimal stents are intubated into the canaliculi, advanced into the sac, and guided into the nose via the newly created ostium

Figure 30: The tubes are then retrieved from the nose

- Tie the tubes together with 4-0 silk just inside the nasal opening so they do not become displaced
- Put the tubes on a mild stretch and at a length where if the tension on the tubes is released, they retract to just inside the nose where they do not bother the patient
- Check that the tube is not too tight at the medial canthus as it may cause lead to "cheese-wiring" of the medial canthus
- Cut the tubes at nasal opening while applying putting the tubes on a mild stretch

8. Suture the anterior flaps

- Suture anterior flaps together with 4-0 chromic or 6-0 vicryl *(Figure 31)*
- 2x interrupted sutures are usually adequate
- Excessive nasal mucosa can be:
  - Excised in a controlled manner

    OR

  - Sutured to the overlying orbicularis oculi muscle

Figure 31: Anterior flaps sutured over the stent with 4/0 chromic suture

9. Wound closure

- Orbicularis oculi is approximated with interrupted 6-0 Vicryl *(Figure 32)*
- Skin is closed with interrupted 6-0 silk

Figure 32: Orbicularis and skin are closed in layers with absorbable sutures such as 6/0 vicryl or 6/0 chromic suture

Postoperative care

Discharge instructions and medications

- Bedrest with head-up positioning for 24hrs to reduce nasal venous congestion
- Hot drinks and food avoided for 12 hrs to reduce epistaxis due to vasodilation
- Nose blowing avoided for 1 week
- Dressing removed Day 1
- Medication
    - Antibiotic/steroid drop *qid* into conjunctival fornix
    - Saline nasal douche *tds*….continue for 1 month after surgery
    - Paracetamol po
    - Antibiotic ointment to skin wound

At 1-week follow-up visit

- Remove skin sutures
- Medication
    - Saline nasal douche *tds* until 4wk visit
    - Antibiotic/steroid drops *qid* until 4wk visit

At 4-week visit

- Remove stents
- Stop medication

Complications

Intraoperative

- Bleeding
- Canalicular injury
    - Gently pass probes and tubes to avoid forming false tracts
    - Direct scalpel blade away from the common canaliculus when creating the lacrimal sac flaps
- Cerebrospinal fluid leak: Caused by inadvertent fracture of the cribriform plate
- Orbital entry causing prolapse of orbital fat

Postoperative (Early)

- Haemorrhage
    - Mild: Head-up position and nasal icepacks
    - Moderate: Pack the nose with nasal tampon or ribbon gauze moistened in 1:1000 adrenaline
    - If severe or persistent: consult ENT
- Stent prolapse or canalicular "Cheese-wiring"
- Wound infection (Single dose intraoperative systemic antibiotic recommended for prophylaxis)
- Wound breakdown with fistula

Postoperative (Late)

- Keloid
- Nasolacrimal drainage failure, usually due to too small anastomosis window
- *Lacrimal sump syndrome* due to lacrimal sac not incised inferiorly up to opening of NLD

Recommended reading

Surgical Anatomy of the Lacrimal Fossa. A Prospective Computed Tomodensitometry Scan Analysis *Ophthalmology* 2005;112: 1119 - 28 © 2005 http://www.voies-lacrymales.com/uploaded/Lacrimal%20fossa%202005.pdf

Physiology of the Lacrimal System by Burkat CN, Hodges RR, Lucarelli MJ, and Dartt DA
http://www.oculist.net/downaton502/prof/ebook/duanes/pages/v8/v8c002a.html

Video demonstration of external DCR
http://www.oculoplastics.info/video/lacrimal/dcr/

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