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Endoscopic Dacryocystorhinostomy

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Abstract

Epiphora, or abnormal tearing, occurs because of the blockage in the lacrimal drainage system, which impairs normal tearing channeling into the nose. It is essential that with proper history and examination including syringing and probing, a correct diagnosis is made. Syringing and probing are performed only in congenital and acquired nasolacrimal duct obstruction (NLDO). Dacryocystorhinostomy (DCR) is a procedure performed for the treatment of tearing (epiphora) due to blockage of the nasolacrimal drainage system. Endoscopic dacryocystorhinostomy (E-DCR) using telescopes has gained a lot of momentum among otolaryngologists, since the outcomes are comparable to the external approach. Advances in surgical technique and a better understanding of the anatomy have resulted in improvements in outcomes. The anatomy of the lacrimal system will be discussed in detail including the surgical indications and techniques of DCR. The advantages, results, and complications of surgery will be highlighted.

Keywords: epiphora, E-DCR, surgery

1. Introduction

Epiphora or abnormal tearing occurs because of blockage in the lacrimal drainage system. Recurrent infection may also occur as a result of the stagnation. Tears drain into the lacrimal sac located at the upper outer margin of the eye. Between the eye and nose lies the lacrimal sac which funnels tears into the nasal cavity through the nasolacrimal duct (**Figure 1**). Blockage of the nasolacrimal duct is the commonest cause of excessive tearing and be treated by creating a direct opening from the sac into the nasal cavity in a procedure known as endoscopic dacryocystorhinostomy (EDCR). The operative approach to the sac may be external or endoscopic. Toti first described the external approach and West subsequently described the endonasal approach in 1911. The latter approach became unpopular because of difficult visualization

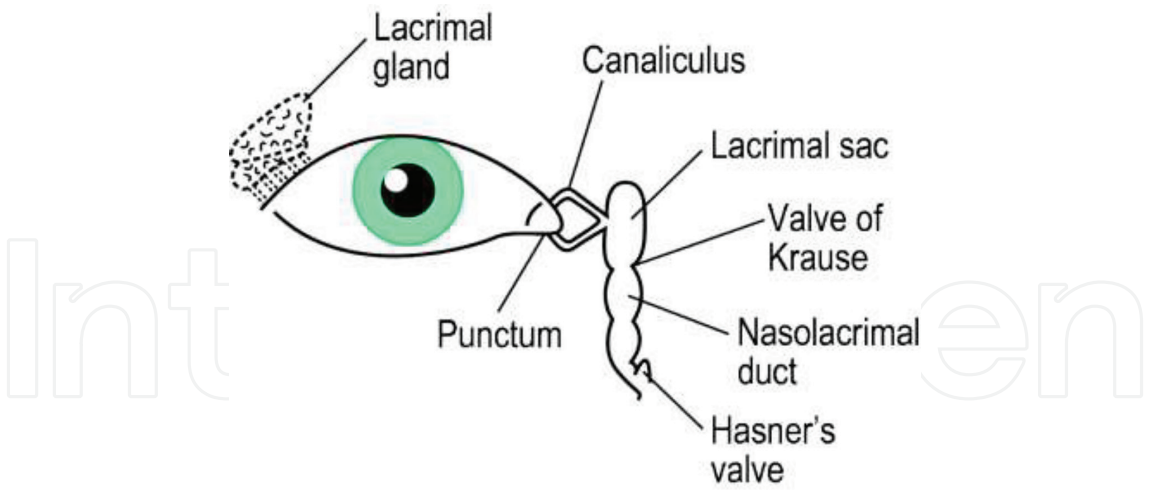


Figure 1. Diagrammatic anatomical picture of the lacrimal gland and nasolacrimal drainage passage way.

Endoscopic DCR	External DCR
No external scar	Cutaneous scar
Less bleeding	More bleeding
Less chances of injury to adjacent structures	More chances of injury to adjacent structures
Less operating time	More operating time
No postoperative morbidity	Significant postoperative morbidity
Better visualization of nose	No visualization of nose
Requires skilled ophthalmologist	Easily performed
Expensive	Less expensive equipment

Table 1. Advantages and disadvantages of endoscopic versus external DCR.

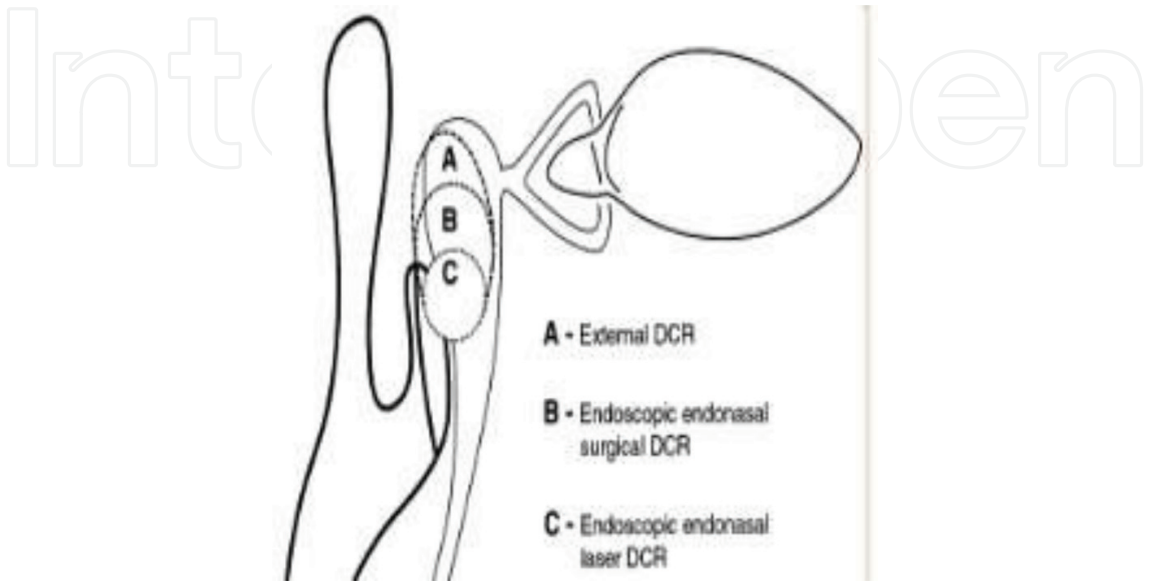


Figure 2. Sites of location of surgical landmarks of external DCR, EDCR, and laser DCR.

and access to lacrimal sac. However, recently with the advent of newer rigid scopes, these difficulties have been overcome, resulting in the resurgence of the endoscopic approach. The advantages and disadvantages of endonasal versus external DCR are listed in **Table 1**. **Figure 2** highlights the sites of location of surgical landmarks of external DCR, EDCR, and Laser DCR, respectively (**Figure 2**). The evaluation and management of excessive tearing may involve both an ophthalmologist and an otolaryngologist. In this text, the endonasal approach will be discussed using the rigid scopes.

2. Anatomy of lacrimal drainage system

The main lacrimal gland is located in a shallow depression along the superior lateral orbit. The lacrimal glands are exocrine glands, and they produce a serous secretion. The lacrimal system constitutes of the upper and lower puncta, lacrimal canaliculi, lacrimal sac, and nasolacrimal duct [9]. The first 2 mm of canaliculi is perpendicular to the lid margin but the distal 8 mm is parallel to the lid (**Figure 3**). The two canaliculi join to constitute a common canaliculus before entering the lacrimal sac, which is engulfed in an oval-shaped fossa measuring 15 mm in height and 10 mm in width. The fossa is bounded by anterior and posterior lacrimal crests (**Figure 4**). The lacrimal sac opens into the nasolacrimal canal, which is formed by the maxillary, lacrimal, and inferior turbinate bones. The nasolacrimal duct traverses through this osseous canal for approximately 12 mm and turns into a membranous duct for 5 mm before entering the inferior meatus (**Figure 3**) [7]. Hasner's valve at the inferior meatus opening covers the duct orifice to prevent reflux of secretions (**Figure 5**). In some neonates, the nasolacrimal duct outlet is obliterated for about 6 months, and occasional probing may be helpful.

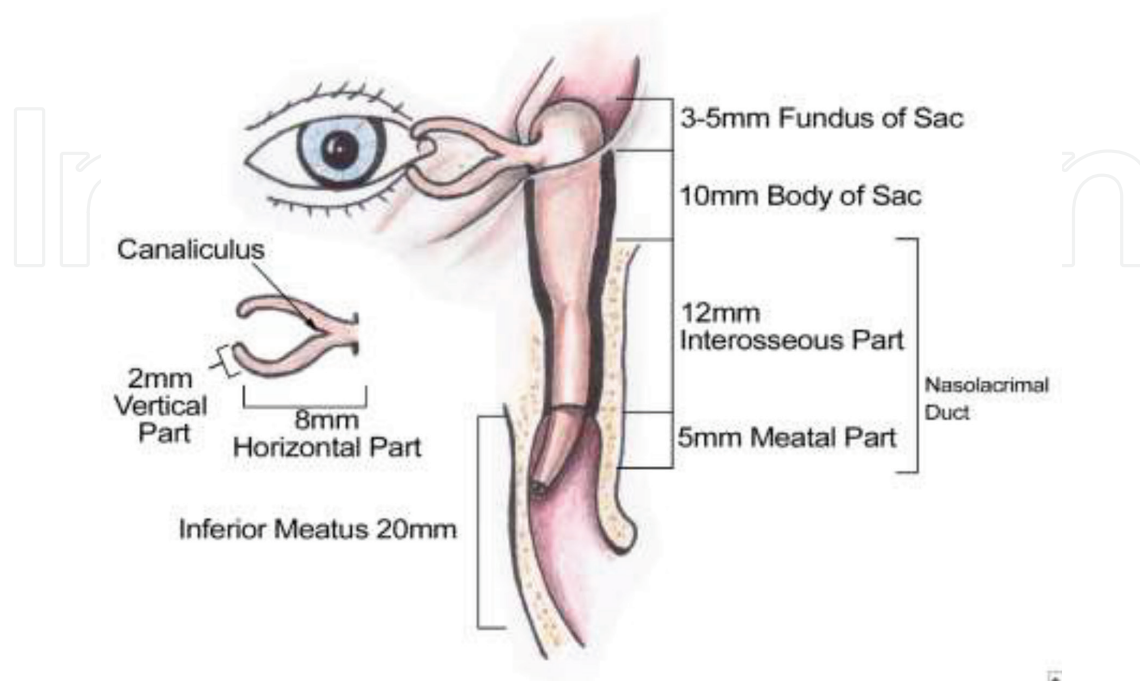


Figure 3. Diagram illustrating the anatomical measurement details of the nasolacrimal drainage pathway.

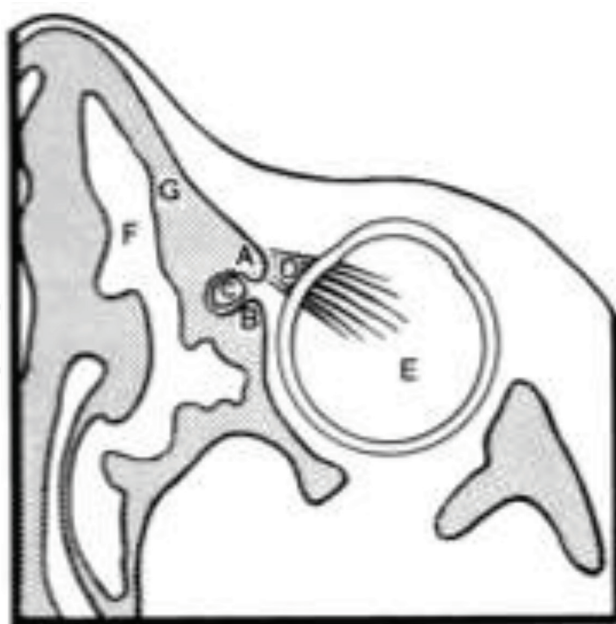


Figure 4. Diagrammatic axial view of lacrimal fossa in relation to anterior and posterior lacrimal crest. (A) Anterior lacrimal crest, (B) Posterior lacrimal crest, (C) Lacrimal sac, (D) Inferior oblique muscle, (E) Orbit, (F) Nasal cavity, (G) Frontal process of maxilla.

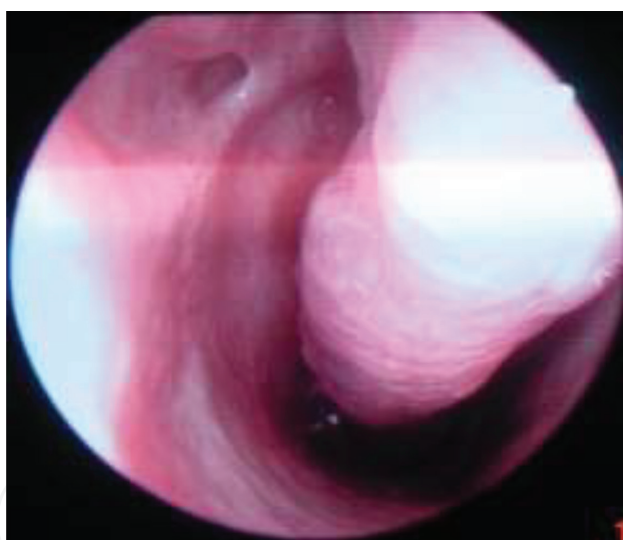


Figure 5. Endoscopic view of the right nasolacrimal duct opening into inferior meatus.

3. Etiology and pathophysiology

The occurrence of symptoms may be related to congenital or acquired causes. Acquired causes include recurrent dacryocystitis, canaliculitis, dacryolithiasis, lacrimal system tumors, nasal pathology obstructing drainage, and iatrogenic trauma. As a result of the obstruction of the nasolacrimal duct, accumulation of tears in the lacrimal sac promotes infection and its accompanying sequelae.

4. Presentation

Excessive unilateral or bilateral tearing interfering with vision and persistent neglect of the symptom may induce chronic dacryocystitis, resulting in purulent discharge. In acute exacerbation, inflammation of the skin in the region of the medial canthus may occur.

5. Assessment of the patient

5.1. Physical examination

An eye examination is essential in the evaluation of every patient with epiphora. A slit lamp examination can reveal the normal or abnormal tear film over the conjunctiva, and if the film thickness is more than usual, it is a sign of lacrimal system obstruction.

Gentle pressure over the sac produces reflux of mucopurulent material suggestive of lower sac obstruction.

An appropriate lacrimal syringe is gently guided through the inferior lacrimal punctum and 2–5 ml distilled water is injected and if it passes easily into the nose, the drainage system is patent. In complete canalicular obstruction, the irrigation fluid refluxes from the same canaliculus (**Figure 6**).

Nasal endoscopy should be obligatory for every lacrimal obstruction patient. Endoscopy provides a clear diagnostic look for nasal polyps, anatomic variations, tumors, and other pathological conditions such as septal deviation.

5.2. Radiologic evaluation

Radiological tests are performed before EDCR, which include dacryocystography (DCG), nuclear lacrimal scintigraphy (dacryoscintillography), computed tomography (CT), and magnetic resonance imaging (MRI) [6].

An anatomical investigation like dacryocystography is indicated if there is a block on syringing in the lacrimal system.

A functional test like scintigraphy is useful in assessing the site of a delayed tear transit and indicated if the lacrimal system is patent on syringing [8].

For patients with preceded trauma, facial surgery, and tumor or in whom sinus diseases are suspected, both CT and/or MRI is indicated.

5.3. Dacryocystography (DCG)

An injection of the radio-opaque water soluble fluid is instilled into either lower or upper canaliculus, taking magnified images utilizing digital subtraction technique. A DCG better evaluates the lacrimal sac and duct anatomy. It shows intrasac pathology namely dacryoliths

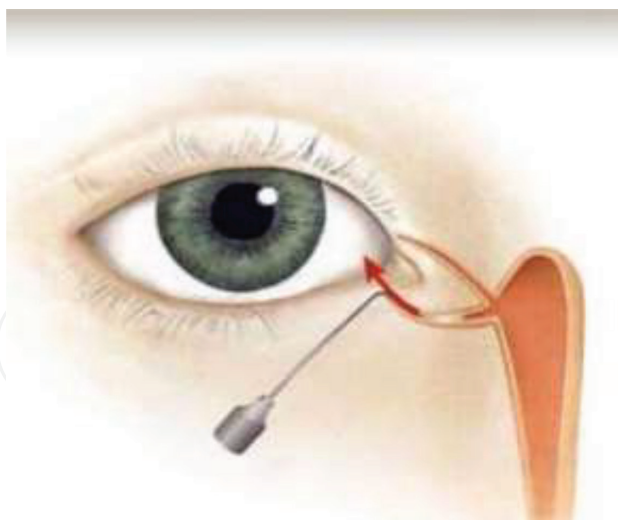


Figure 6. In complete canalicular obstruction, the cannula is advanced with difficulty and irrigation fluid refluxes from the same canaliculus.

or tumor and the sac size (**Figure 7**). It is useful to determine the size of the sac in patients with previous trauma to localize the position of the bone fragments or after previously unsuccessful lacrimal surgery. It helps to determine whether the stenosis is in the common canaliculus or sac and rules out the presence of a lacrimal sac diverticulum. A DCG can often find drainage abnormalities present in patients with “functional obstruction.”

5.4. Nuclear lacrimal scintigraphy

It is a simple, noninvasive physiological test that evaluates patency of the lacrimal system using a radiotracer (technetium-99 m pertechnetate). DCG is indicated in complete obstruction,



Figure 7. A DCG showing evidence of dacryoliths in the left lacrimal drainage pathway.

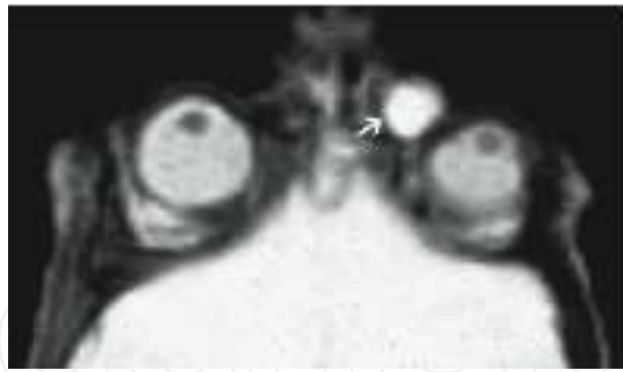


Figure 8. An axial MRI showing a left dacryocystocele.

while scintigraphy for those patients whose lacrimal system is patent to syringing in the presence of constant epiphora. Correlation of anatomical study (DCG) and functional study (scintigraphy) may be necessary in planning surgery. Normal results are considered to be a contraindication to any surgical intervention.

5.5. Computer tomography and MRI

Computed tomography (CT) can be helpful in assessing the structures intimately associated with the nasolacrimal drainage system. The CT scanning is used mainly when an extrinsic disease is suspected and is useful when the lacrimal system is associated with paranasal sinus tumor surgery or facial pathology [2, 9].

MRI is reserved only for cases where differentiation of masses of the lacrimal sac is required (Figure 8).

6. Endoscopic dacryocystorhinostomy (EDCR)

EDCR involves creating a bypass from the lacrimal sac to the nose. With a proper history and examination including syringing and probing, a correct diagnosis is achieved. Probing and syringing are indicated in congenital and acquired nasolacrimal duct obstruction (NLDO) and not in acute and chronic dacryocystitis [1].

6.1. Surgical indications

The procedure is performed for NLDO which can be demonstrated clearly on a dacrocystogram (Figure 9). EDCR is not indicated for obstruction of a punctum or canaliculus. Distal obstruction may be mixed with numerous degrees of proximal obstruction, and this needs to be explained to the patient. For defining the site of obstruction, syringing and probing are helpful (Table 2).

A dacrocystogram is performed if there is evidence of mass within the sac and scintigraphy to define a functional problem. Malignancy of the sac can present with symptoms of bloody discharge from the punctum which will need further investigations. A dacryocystocele can present with epiphora, swelling, or recurrent dacryocystitis (Figure 10A and B) [4]. Wegener



Figure 9. A dacrocystogram showing distal obstruction of right nasolacrimal pathway on failure of penetration of dye into the inferior meatus in a patient with unresolving tearing.

-
- 1. Primary acquired NLDO
 - 2. Secondary acquired NLDO
 - a. Secondary acquired lacrimal duct obstruction due to infection
 - b. Secondary lacrimal obstruction due to inflammation
 - c. Lacrimal obstruction due to neoplastic causes
 - d. Lacrimal obstruction due to traumatic causes
 - e. Lacrimal obstruction due to mechanical causes
-

Table 2. Indications for EDCR.



Figure 10. A preoperative (A) and postoperative picture (B) of a patient with large left dacryocystocele presenting with recurrent dacryocystitis.

-
1. Known or suspected lacrimal system neoplasm
 2. Large lateral lacrimal sac diverticulum
 3. Common canalicular stenosis
 4. Lacrimal system stones
 5. Extensive midfacial trauma
-

Table 3. Contraindications for EDCR.

granulomatosis and sarcoidosis are rare causative factor. Middle-third facial fractures can present with NLDO. Usage of Stammberger Rhinoforce Antrum Punch (Storz, Germany) in endoscopic sinus surgery if placed too far forward to remove uncinate process can result in injury and ultimately NLDO.

6.2. Contraindications

The contraindications for EDCR are listed in the table above (**Table 3**).

7. Highlights of EDCR

- Provides a better esthetic result with no external scar.
- Allows one-stage procedure to also correct associated nasal pathology.
- Avoids injury to medial canthus.
- Preserves the pumping mechanism of orbicularis oculi muscle.
- Is superior to external approach in revision surgery.
- Can be performed during active infection of the lacrimal system.

8. Relevant anatomy

The lacrimal sac which lies in the lacrimal fossa is formed by the thick frontal process of the maxilla anteriorly and the thin uncinate bone posteriorly (**Figure 11**). Inferiorly, the sac forms the nasolacrimal duct, which drains into the inferior meatus about 1 cm posterior to the anterior end of the inferior turbinate (**Figure 4**). The inferior meatal opening is protected by several variable folds of mucous membrane that acts as valves preventing retrograde air aspiration. The anterior lacrimal crest, unlike its anterior margin, is made of very dense bone. In rare instances, an anterior ethmoidal air cell may lie medial to the lacrimal fossa in which instance it needs to be removed before a rhinostomy is created.

The reflex act of blinking is triggered by the contraction of the palpebral fibers of orbicularis oculi muscle. When the muscle relaxes, tears are sucked up through the canaliculi when the

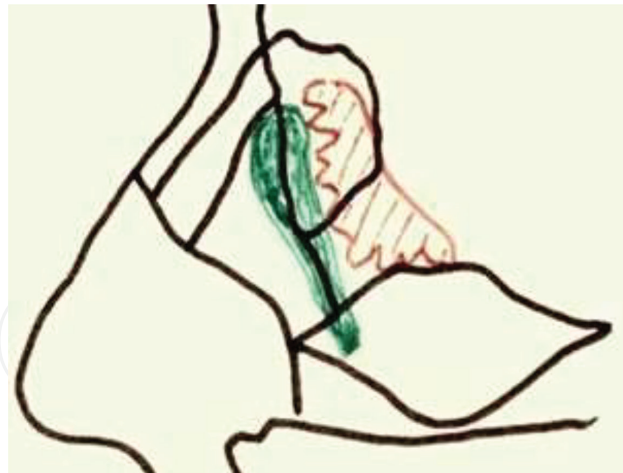


Figure 11. A diagrammatic sagittal section showing the anatomy of the lacrimal sac in relation the frontal process of the maxilla anteriorly and the uncinate process posteriorly.

sac is drawn open. The lacrimal sac then contracts to its original volume, and the tears are pushed down the nasolacrimal duct.

9. Preoperative assessment

Topical local anesthetic drops are placed in the eye followed by dilatation of the upper and lower puncta with punctum dilator followed by passage of Bowman probe through the dilated punctum and angled medially (**Figure 12**). A slight resistance may be felt as a “soft stop” when the probe enters the common canaliculus, and there is a “hard stop” when it touches the medial wall of the sac. Subsequently, the probe is angled vertically down to feel whether there is any sac pathology or distal obstruction. Fine obstructing membranes causing proximal obstruction can be found at the medial aspect of the upper and lower canaliculi when viewed with rigid

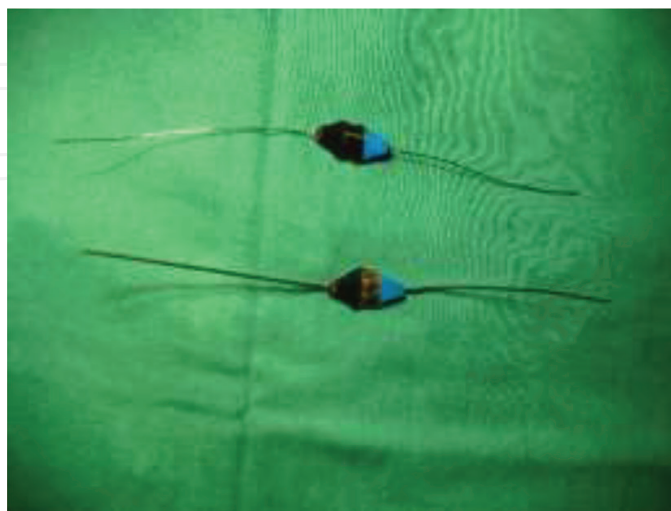


Figure 12. Picture of Bowman probes.

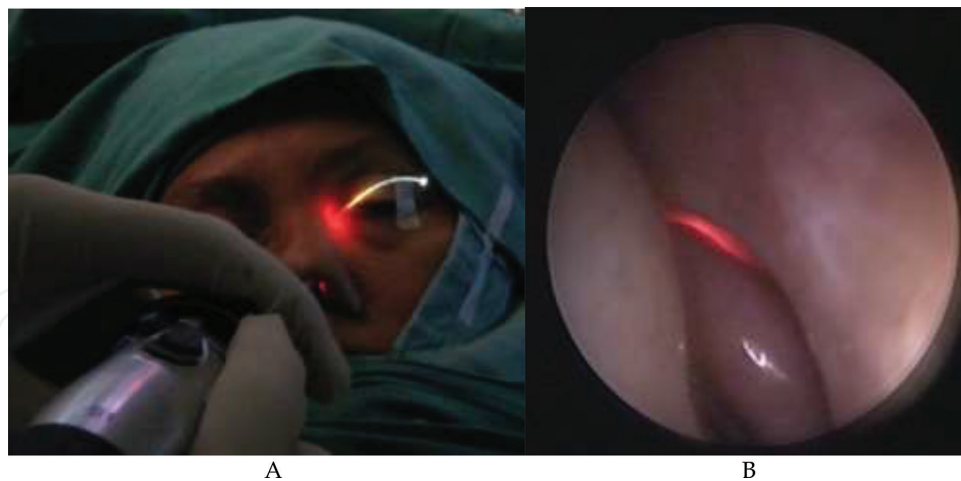


Figure 13. Picture showing a fiber-optic endoilluminator being introduced via the left inferior canaliculus to illuminate the nasolacrimal sac (A) and a zero degree endoscopic view intranasal identifying the location of the illuminated lacrimal sac in the same patient (B).

0.7-mm dacryocystoscopes [15, 16]. EDCR is not indicated if this is the site of the obstruction. For surgeons becoming familiar with intranasal anatomy, it is helpful to introduce a 20-gauge fiber optic endoilluminator (Storz, Germany) through the superior or inferior canaliculus and advanced gently until a hard stop signifying the lacrimal bone is identified [14]. The location of the lacrimal sac may then be visualized endoscopically by transillumination (**Figure 13A and B**).

Distal obstruction is diagnosed by probing and then syringing, and if it refluxes through the other punctum, it indicates that there is distal obstruction. If there is reflux through the same punctum, then there is canalicular or common canalicular stenosis which can be confirmed by gentle probing. Where the sac becomes the duct, is the site most common for distal obstruction. EDCR may be offered to patients with a functional blockage where there is free flow on syringing but a nonfunctioning pump system on scintigraphy. Lester-Jones Pyrex tube is required only in extensive bi-canalicular obstruction on failure of forced probing and silicone intubation.

10. Surgical technique

Nasal decongestion is performed with neuropatties and infiltration with lidocaine and adrenaline, and then, a 15 scalpel blade is used for mucosal incisions horizontally 1 cm superior, commencing 3 mm posterior to axilla of the middle turbinate and moving forward 1 cm onto the frontal process of maxilla. The blade is then turned vertically and incision is made about two thirds of the vertical height of middle turbinate, stopping above the insertion of inferior turbinate into lateral nasal wall. The blade is then turned horizontally, and the inferior insertion commenced at the insertion of the uncinate process and brought anteriorly to meet the vertical incision (**Figure 14**).

The mucosal flap is elevated using a Freer's dissector suction (Storz, Germany) to expose and identify the junction hard frontal process of maxilla and the soft lacrimal bone. The thin

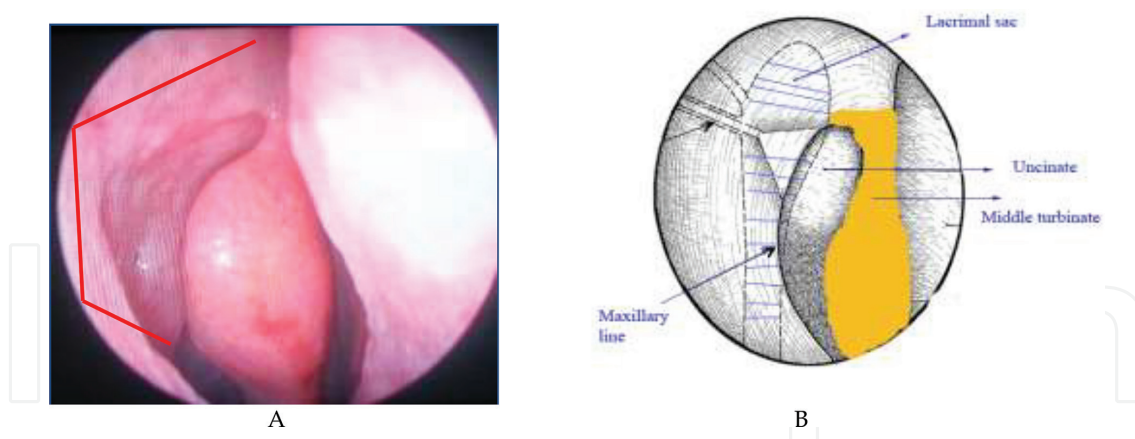


Figure 14. A zero degree endoscopic view of the left lateral nasal wall showing the maxillary line and uncinate process (A) and a diagrammatic illustration (B) showing the anatomical relationship of lacrimal sac to the maxillary line, uncinate process, and middle turbinate.

lacrimal bone is 2 to 5 mm wide anterior to the insertion of the uncinate process where the dissection ends. The soft lacrimal bone is elevated and removed away from the posteroinferior region of the sac using a round knife (Storz, Germany) [11].

The lower portion of the frontal process of the maxilla is removed using a forward-biting Hajek Kofler punch (Storz, Germany; **Figure 15**). During the removal of the hard lacrimal bone, the tip of the punch is used carefully to push the lacrimal sac away from it to expose the anteroinferior portion of the lacrimal sac. Bony removal is performed as far superiorly as possible until it becomes too thick for the punch to engage. The rest of the thick bone up to the superior mucosal incision is removed using a 15-degree curved 2.9 mm rough diamond burr (Medtronic Xomed, Jacksonville, Florida, USA) attached to the micro-debrider (Jones, 1998). Eventually as the sac is followed superiorly above the axilla of the middle turbinate, an agger nasi cell is approached and the frontal recess is exposed on removing it. Damage to the lacrimal sac wall is

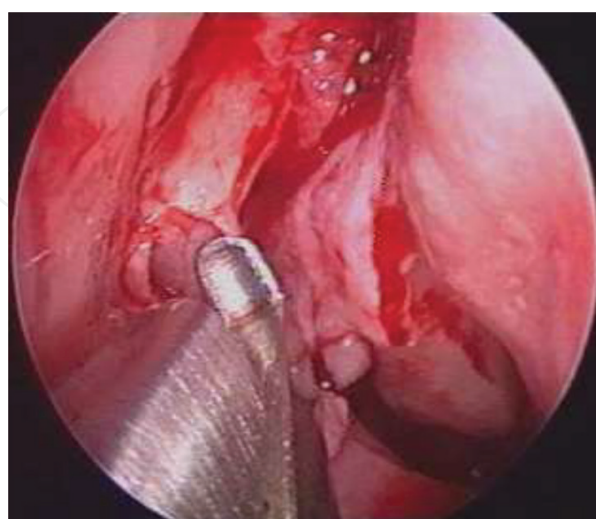


Figure 15. Intraoperative endoscopic view showing right DCR with initial removal of the thin frontal process of maxilla with Hajek Kofler sphenoid punch and subsequently the superior hard bone with a microdrill.

avoided by using a diamond burr that may cause light contact with it as compared to a cutting burr that will remove the bone faster but with significant damage to the wall.

Next, the inferior punctum is dilated with a punctum dilator, and a Bowman's canalicular probe is passed into the sac (**Figure 16**). If the tip of the probe is not seen to move behind the thin sac wall, the probe is not in the lumen. For complete marsupialization of the sac, it is exposed and incised vertically with a DCR mini-sickle knife (Medtronic Xomed, USA) and eventually an upper and lower releasing incisions made with Bellucci scissor (Storz, Germany) on the posterior flap which is rolled out flat on the lateral nasal wall. To avoid secondary intention healing and reduce the formation of granulation tissue and scarring,

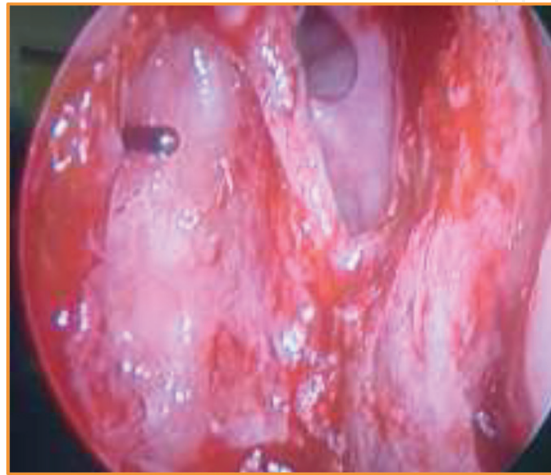


Figure 16. Intraoperative endoscopic view showing a right dacryocystorhinostomy and wide exposure of the nasolacrimal sac with visible end of Bowman's canalicular probe with removal of agger nasi cell exposing the frontal recess.

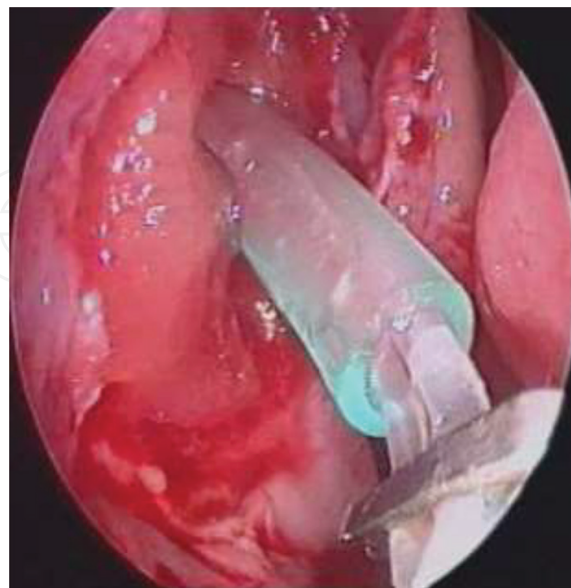


Figure 17. Intraoperative endoscopic view showing right dacryocystorhinostomy with stent and ligar clips in situ in an adult patient presenting with unresolving tearing.

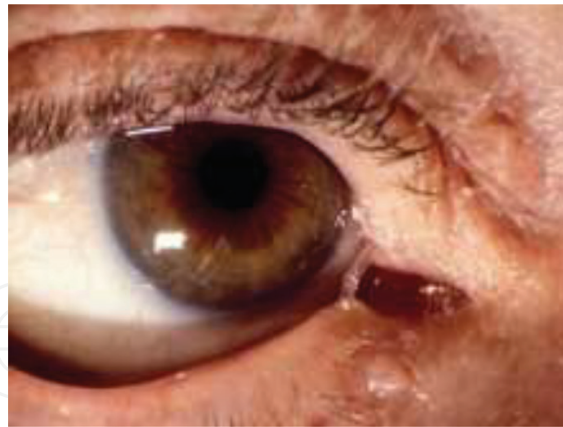


Figure 18. Picture showing looping of the O'Donoghue tubing placed through the upper and lower puncta and retrieved endonasally.

the lacrimal sac lining and nasal mucosa are approximated well. Silastic lacrimal intubation tubes (O'Donoghue tubes) are placed through the upper and lower puncta and retrieved endonasally and secured with ligar clips (**Figure 17**) [3]. A loop of tubing is pulled in the medial canthus of the eye to ensure that the tubes are not tight before placing the ligar clips (**Figure 18**). Tight tubing loops at the medial canthus can cheese-wire through the punctum [5]. To hold the flaps in position intranasally, a square of Gelfoam (Pharmacia NSW, Sydney, Australia) or Merogel (Medtronic Xomed) is slid up the tubing and placed over the flaps [12].

Saline irrigation is commenced within 3 to 4 hours postsurgery, and broad spectrum antibiotics started for 5 days and eye drops for 3 weeks. Removal of the O'Donoghue tubes is performed in clinic at about 4 weeks postsurgery. Stents can be used for small fibrotic lacrimal sacs to make sure that the neo-ostium remains patent. The patient is reviewed for a further 18 months before discharge.

11. Laser-assisted DCR

Laser was used exclusively in the early part of 1990s, and the site for osteotomy was the thinnest bone in the inferoposterior parts of the lacrimal fossa, corresponding to the brightest area in the nasal cavity by the transilluminator. Laser-assisted DCR success rate was around 78%, which was well lower than that of conventional technique. In late 1990s, osteotomy was performed with either a drill or a punch or both, and subsequently with time, the site moved to the level of medial canthus, which was anterior and superior to that of previous surgeries (**Figure 2**). When completed, the common internal punctum was visible on endoscopy, and the success rate improved to 92% [10].

In 65 patients with a mean follow-up of 74 months, it was reported that the success rate of endoscopic laser-assisted DCR has gradually declined over the years to 56%. Umapathy et al., in 2006, did not encourage the use of laser in endonasal DCR with epiphora [13].

12. Revision EDCR

Since the bone along the lateral nasal wall has already been removed in primary DCR, revision EDCR is therefore much easier procedure to perform. The size of the lacrimal duct is of importance in revision EDCR. For a normal sized sac, the success rate is high (89%) compared to low rates in scarred condition where limited amount of lacrimal mucosa can be marsupialized. The agger nasi mucosa can be utilized as free graft functional mucosa to surround the common canaliculus-sac junction in severe lacrimal sac stenosis and scarring.

13. Postoperative care

The nasal spacer is removed the following morning. Patients must irrigate their nose with saline at least twice a day, and clinic visit was scheduled 1 week later and intranasal debris was removed then. The silastic tubing is removed in about 4 weeks postsurgery. Exposed tubing at the medial canthus is cut with scissors and the stent is withdrawn through the nose. In revision cases with scarring, the stent can be left in place even longer.

During surgery, sufficient opening from the lacrimal sac into the nose is made but the final size of the healed surgical ostium is 1 to 2 mm in diameter on average (**Figure 19**).

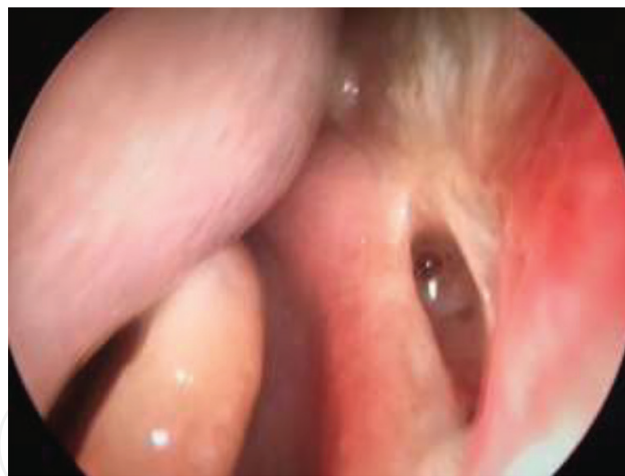


Figure 19. Endoscopic view of a patent left DCR at 6 months postsurgery.

14. Outcome of surgery

14.1. Complications

Complications of EDCR can be divided into intraoperative and early or late postoperative. Early postoperative (up to 1 month) complications include hemorrhage, crusting, perirrhinotomy granuloma, transnasal synechia, and periorbital emphysema (**Figure 20**). Most of the

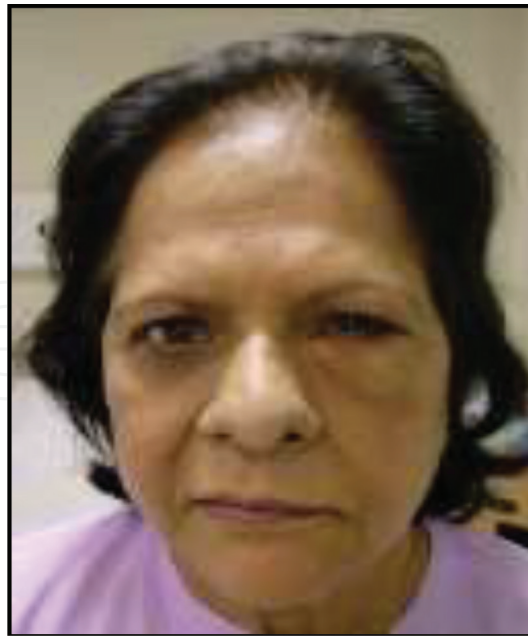


Figure 20. Left periorbital emphysema postpowered endoscopic sinus surgery which resolved spontaneously.

later complications occur between 1 and 3 months of surgery and include surgical failure from impacted tubes, rhinostomy scarring, granuloma, synechia, and cheese wiring.

In inexperienced hands, the rate of complications from EDCR is greater and similar to those of endoscopic sinus surgery (ESS). Poor visualization during surgery due to excessive bleeding can result in major intraoperative complications namely blindness and CSF leak. In such circumstances, it is better to convert to an open technique. A branch of the sphenopalatine artery supplying the remnant of a partially resected middle turbinate can cause bleeding within 1 week of surgery.

Sometimes during bone removal to expose the lacrimal sac, orbital fat may be exposed, and in such situations, the orbital fat should be left alone to avoid injury to orbital contents namely blood vessels, nerves, and medial rectus muscle. Nasal or orbital infection following DCR is rare, and perioperative antibiotics are administered to avoid this complication.

The most common causes of surgical failure for EDCR are postoperative adhesions, which can result in obstruction of new ostium. Surgical insult to the middle turbinate mucosa should be avoided, and the anterior end of the turbinate resected to avoid it from nearing to the ostium. Postoperative adhesions are reduced by prior septal corrections.

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