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The Techniques Used for Flaps Management in External Dacryocystorhinostomy: Review Article

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ABSTRACT

External dacryocystorhinostomy (DCR) is a procedure that is established to treat obstructed tear ducts. There remains some discussion regarding dealing with the posterior flaps in DCR, and varying methods are utilized to enhance the outcome of surgery. This study examines alternative methods of dealing with the back flap in external DCR. The study will compare these methods in terms of success with surgery, healing in patients, as well as long-term outcomes. Clinic studies and research were reviewed to determine each posterior flap procedure's success. Some posterior flap procedures involve cutting out tissue, conserving tissue, and stitching. The studies also examine surgery issues, whether these issues occur again frequently, as well as whether the patients are satisfied. Studies indicate that while suturing posterior flaps may enhance anatomical stability, excision of the posterior flap leads to comparable success rates while simplifying the procedure. The choice of technique often depends on surgeon preference, patient-specific factors, and intraoperative conditions. Cutting and stitching on the back flap are both reliable choices in external DCR. Stamping can create a more ideal shape, though cutting is also a reliable alternative with equal success. There are more studies and random tests suggested that should be conducted to formulate standardized rules on dealing with the back flap in DCR.

1. INTRODUCTION

External dacryocystorhinostomy (DCR) is the gold standard treatment of epiphora caused by acquired nasolacrimal duct obstruction due to patient acceptance, low cost, and high success rate.

The development of the lacrimal excretory system begins around the sixth week of gestation, forming along the cleft between the lateral nasal and maxillary processes. Initially, it appears as a solid cord of epithelial cells, which extends downward into the mesenchyme to create the nasal optic fissure and separate from the surface. This epithelial cord becomes situated between the developing medial canthus and the nose. Between weeks 6 and 12 of gestation, the lacrimal ectodermal bud grows and extends toward the inner

canthus and nasal cavity. As it approaches the medial canthus, the cord splits, aligning with the medial canthal angle, thus establishing the precursors of the canalicular system. By the eighth or ninth week of gestation, the epithelial cord reaches the eyelid margin. During this period, epithelial cells proliferate further, forming the rudimentary lacrimal sac and extending inferiorly toward the nasal cavity [1].

The lacrimal drainage system consists of lacrimal puncta, lacrimal canaliculi, lacrimal sac and nasolacrimal duct (figure 1).

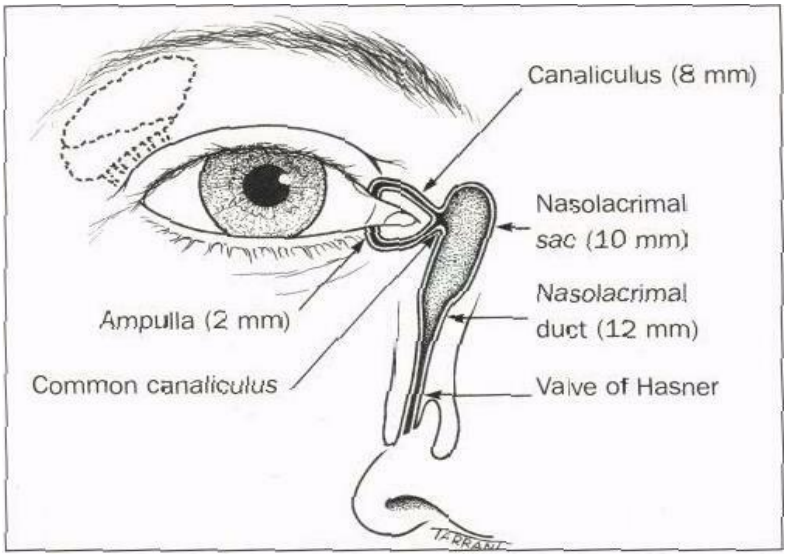

Fig.1 Anatomy of lacrimal drainage system [2].

Physiology of tear drainage:

The lacrimal outflow system operates through an active, dynamic pumping mechanism. Tears spread across the surface of the eye and eyelids, entering the puncta, then the ampulla. From there, they pass through the canaliculi into the lacrimal sac, and finally through the nasolacrimal duct into the nasal cavity. About 25% of the tears evaporate, while the remaining 75% is directed into the nasal cavity via the lacrimal drainage system [3].

Factors helping in tear elimination

Evaporation

When the eyes are open, some evaporation occurs, leading to hypertonic tears compared to the corneal epithelium. This creates an osmotic gradient that moves from the cornea to the tear film. As a result, evaporation contributes to corneal deturgescence, helping maintain optical clarity. The tear film's outer lipid layer serves as a barrier to evaporation, and when tear flow is rapid, the impact of evaporation becomes less significant [3]. Evaporation increases with infrequent blinking, such as when watching television, leading to dry eye.

Gravity

The role of gravity in tear elimination has been the subject of much speculation but limited experimental investigation. In 1978, Murube sought to assess gravity's impact on lacrimal drainage by observing the flow of a radiopaque contrast agent introduced into the lacrimal sac. His findings indicated that normal tear outflow occurs regardless of gravitational influence [4].

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Capillarity

Capillarity refers to the adhesive interaction between a liquid and a solid surface. In narrow tubes, this force drives the movement of a liquid column within the tube. The lacrimal punctum and the vertical portion of the canaliculus provide the ideal conditions for capillarity due to their small, rigid structure. As a result, capillarity facilitates tear drainage by drawing tears from the lacus and the marginal tear strip into the canalicular system [5].

Air movement

Air movement within the nasal cavity has been proposed as a contributing factor in tear excretion. Advocates of this idea suggest that convection currents generated during respiration help draw tears through the nasolacrimal duct. In specific situations, airflow within the nose can influence the tear-outflow pathways, potentially aiding in the process [5].

Blinking

The movement of the eyelids not only distributes tears across the cornea but also directs them toward the puncta (Fig 14.1). Reifler (1996) notes that anatomical evidence supporting a blinking-associated tear drainage mechanism dates back to the 18th century. In 1730, Schobinger described the pars lacrimalis of the orbicularis oculi, attributing its discovery to his mentor, Duverney. Duverney believed that this muscle facilitated tear drainage by contracting the canaliculi and exerting a similar effect on the lacrimal sac [6].

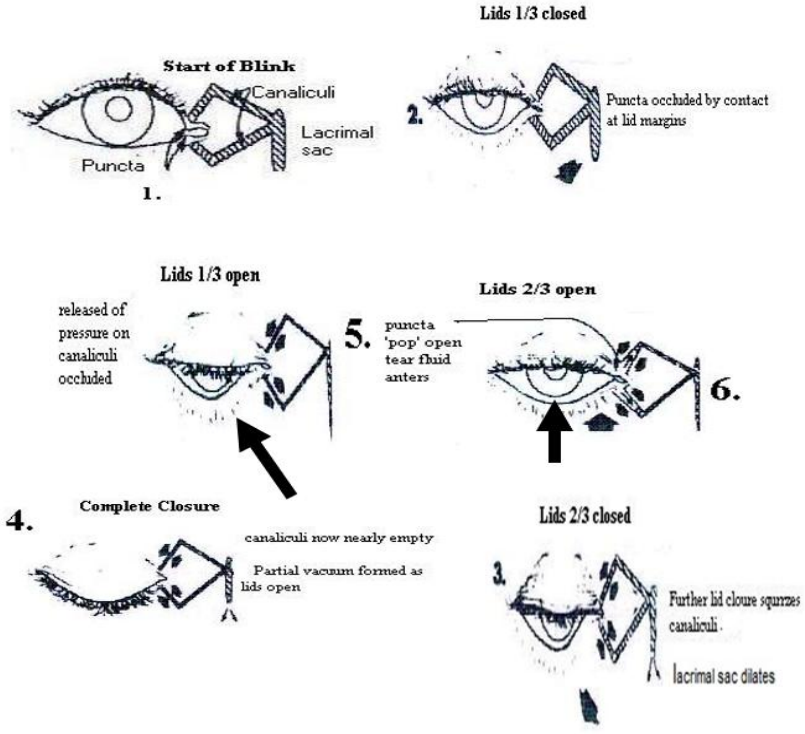

Figure 2: Mechanism of lacrimal drainage [6].

Clinical evaluation of a tearing patient:

A complaint of a wet eye does not always indicate a problem with the lacrimal drainage system. Other potential causes, such as reduced lacrimal secretion, ocular irritation, or allergies, should also be evaluated. In some cases, moderately reduced baseline tear production can trigger intermittent reflex tearing due to the sensation of dryness. These individuals may report a feeling of a foreign body in the eye along with

occasional tearing, even though the underlying issue is dry eye [8].

A. History taking

A comprehensive history is essential for any clinical assessment. Patients might report having a "wet eye," but in reality, there may only be a small amount of mucoid discharge in the conjunctival sac. Reflex hypersecretion can also be triggered by various irritants, such as smoke, smog, wind, dry weather, and pollutants [8].

B. External and slit lamp examination

A thorough patient history combined with a detailed external examination helps guide physicians toward an accurate diagnosis and the selection of appropriate diagnostic tests. Indicators of dry eye syndrome may include irregularities in tear film quality or stability, alterations in the tear meniscus size, and changes to the corneal epithelium. Additional findings might include conjunctival redness, a lack of shine in the conjunctiva, or congestion around the limbus. The corneal reflex may appear diminished, accompanied by superficial punctate erosions, epithelial filaments, or, in severe cases, corneal ulcers. Tear production can range from mildly to severely reduced [9].

C. Tests to demonstrate the functional state of the tear passages

These tests monitor the progress of substances introduced into the conjunctival sac through the tear passages including:

- Jones Dye Test
- Fluorescein Dye Disappearance Test (FDD)

D. Tests to determine the anatomical state of the passages including:

- Lacrimal Irrigation
- Diagnostic probing of canaliculi

E. ENT examination

The examination should be conducted with a nasal speculum to rule out nasal conditions such as a deviated septum, rhinitis, polyps (figure 3), enlarged turbinates, and any other local issues that might obstruct the nasolacrimal duct [10].

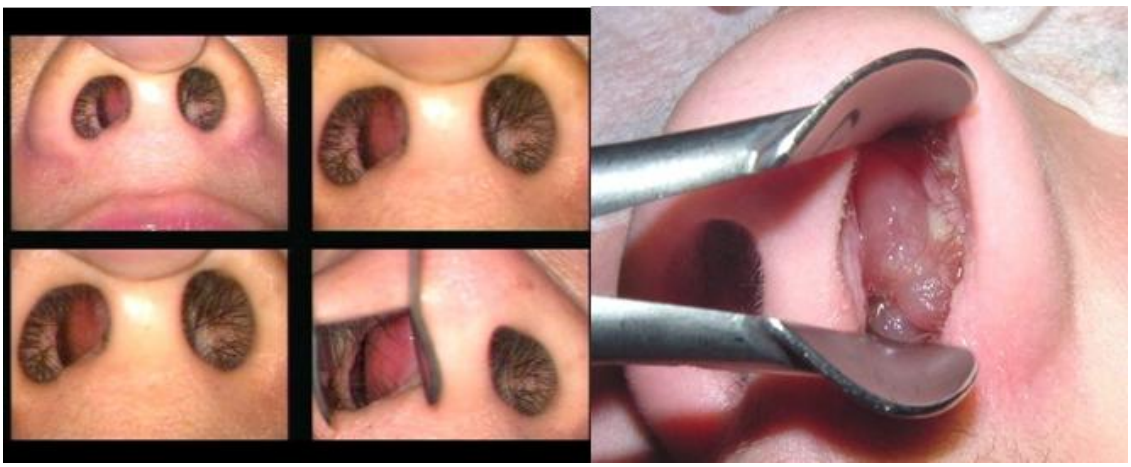

Figure 3: Septum deviations and Nasal polyps [11].

Imaging techniques:

This encompasses dacryocystography, scintigraphy, computed tomography, magnetic resonance imaging, as well as other methods such as ultrasound, percutaneous contrast dacryocystography, and thermography [12].

Lacrimal Dacrocystography:
This imaging method is regarded as the gold standard for assessing the nasolacrimal system; however, it does not capture the soft tissue and bone around the lacrimal sac and duct. To obtain a comprehensive view of the nasolacrimal system and its surrounding structures, it can be combined with CT scans. During the procedure, ultra-fluid Lipiodol is injected into the canaliculus, and films are taken immediately as well as after 10 and 20 minutes. Digital subtraction dacryocystography is preferred as it removes confusing bone shadows, providing clearer images [13].

Nuclear Lacrimal Scintigraphy:
This simple physiological test assesses the openness of the lacrimal drainage system. It is primarily useful for patients with a patent lacrimal system confirmed by syringing but provides limited anatomical information. The test involves administering a drop of radiotracer (technetium-99m pertechnetate), which can be detected by a gamma camera. Images are captured immediately after the drop is instilled and then at 5, 10, 15, and 20 minutes [14].

Computed Tomography and Magnetic Resonance Imaging:
These imaging techniques are employed in specific cases of patients experiencing epiphora. CT dacrocystography is highly useful for evaluating the lacrimal system and the surrounding bone structures. However, a limitation of CT is its inability to assess soft tissue. In contrast, Magnetic Resonance Imaging (MRI) with contrast agents like Gadolinium is ideal for examining the soft tissues around the lacrimal system. MRI is also crucial when lacrimal sac tumors are suspected [13].

Dacryocystorhinostomy:
Acquired nasolacrimal duct obstruction (NLDO) can be categorized into primary and secondary types. Linberg and McCormick describe the primary type as being associated with inflammation and fibrosis, without a clear underlying cause. In contrast, Bartley suggested an etiological classification system specifically for the secondary form of NLDO [14].

Primary NLDO is more frequently observed in middle-aged females, who tend to have smaller lower nasolacrimal fossae and middle nasolacrimal ducts, as seen in CT scans. Additionally, females experience changes in the anteroposterior dimensions of the bony nasolacrimal canal due to osteoporosis. The higher prevalence in middle and older age may be attributed to hormonal fluctuations and immune system abnormalities associated with menopause [14].
Secondary NLDO may be due to [15].

- Infections, including bacterial, viral, or fungal
- Inflammatory conditions such as Wegener's granulomatosis or sarcoidosis
- Neoplasms, whether primary, secondary, or metastatic
- Traumatic causes, potentially iatrogenic due to excessive probing
- Mechanical factors, such as foreign bodies or dacryoliths
- Drug-induced reactions, including those from anti-neoplastic and anti-glaucoma medications

The treatment of lacrimal obstruction is based on the location of the blockage (proximal or distal), the severity (partial or complete), and the underlying cause. Lacrimal surgery is constantly advancing, and all appropriate options should be reviewed with the patient prior to any procedure. Treatment choices for primary acquired nasolacrimal duct obstruction include:

(A) Lacrimal probing, Dilation and intubation

Many lacrimal surgeons argue that probing, dilation, and intubation have no significant role in managing PANDO, with dacryocystorhinostomy (DCR) ultimately being necessary. However, some practitioners

believe that lacrimal intubation can be beneficial for partial or functional nasolacrimal duct obstructions, as it provides a stent to keep the lacrimal system open. Intubation can be done using either a monocanalicular or bicanalicular approach, and it is typically left in place for a specified duration [12].
Balloon catheter dilation, with or without intubation, was effective for treating partial nasolacrimal duct obstruction, with success rates ranging from 53% to 68%. Similarly, monocanalicular or bicanalicular silicone intubation yielded comparable success rates between 53% and 60%. In cases of partial nasolacrimal duct obstruction, double bicanalicular silicone intubation led to symptom resolution in 79% of patients [16].

(B) Dacryocystorhinostomy DCR:
The fundamental concept of this procedure is to establish a connection between the lacrimal sac and the nasal cavity in order to bypass an obstruction in the nasolacrimal duct. Various methods have been outlined for this process.
External DCR
History:
This technique was initially introduced by an Italian rhinologist named Toti in 1904. Later improvements to the external method were made by Dupuy-Dutemps and Mosher, who introduced the use of mucosal flap anastomosis. The primary goals of the surgery are to prevent fluid retention in the lacrimal sac and to bypass the increased resistance in the blocked nasolacrimal duct [12].
Indications:
1. Acute dacryocystitis (following resolution and treatment with systemic antibiotics) or chronic dacryocystitis.
2. Acquired obstruction of the nasolacrimal duct, which can be primary or secondary to causes such as dacryolithiasis, tumors, nasal or sinus inflammation, endonasal surgery, or midfacial trauma.
3. Persistent congenital nasolacrimal duct obstruction, especially after failed probing or intubation of the duct [17].

Anesthesia:
External DCR can be performed under either local or general anesthesia, depending on factors such as the patient's overall health, preferences, and the surgeon's expertise.

For local anesthesia, the anterior nasal area is first sprayed with 4% lignocaine, followed by the insertion of ribbon gauze soaked in 2 ml of 4% or 10% cocaine solution. This packing helps provide both effective anesthesia and vasoconstriction. The gauze should be positioned just above and in front of the anterior end of the middle turbinate.

Additionally, local infiltration using 0.5% bupivacaine with or without 1:100,000 to 1:200,000 epinephrine is applied to block the supratrochlear nerve, infraorbital nerve, and the anterior ethmoidal branch of the nasociliary nerve. To block the anterior ethmoidal nerve, the anesthetic is injected about 5mm above the medial canthal tendon and just below the trochlea, aiming caudally at a 20-degree angle to reduce the risk of damaging the anterior ethmoidal vessels. Additional hemostasis can be achieved by injecting epinephrine into the mucosa during surgery [18].

General anaesthesia provides better control over blood pressure during surgery and is preferred by many patients who do not want to be awake during the procedure. It also offers convenience for doctors who are learning the technique. Haemostasis can be achieved through methods such as injecting local anaesthesia at the incision site, packing the nasal mucosa with diluted epinephrine, positioning the patient with their head elevated 10 to 15 degrees in reverse Trendelenburg to reduce venous congestion, using a continuous suction device, handling tissues carefully, applying gentle diathermy when necessary, and employing hypotensive

anaesthesia when appropriate [18].

Surgical Technique:

The skin incision is typically placed 10-12 mm medial to the medial canthus, starting just above the insertion of the medial canthal tendon and extending laterally for about 10 mm. Various skin incision techniques have been outlined in the literature, such as a vertical incision on the nasal skin, medial to the angular vein, or a curvilinear incision along the anterior lacrimal crest. Another method involves a skin incision along the lower eyelid crease, which has the advantage of concealing the scar within the crease, though it may limit exposure to the lacrimal sac and bony surgical areas (see figure 4).

Figure 4: DCR skin incision along the inferior lower lid crease [19].

The bony ostium is formed by separating the suture line between the thick maxillary bone and the thinner lacrimal bone. This opening is then widened using punch instruments and rongeurs to establish a rhinostomy (see figure 5). A bone burr can also be utilized to create and expand the ostium.

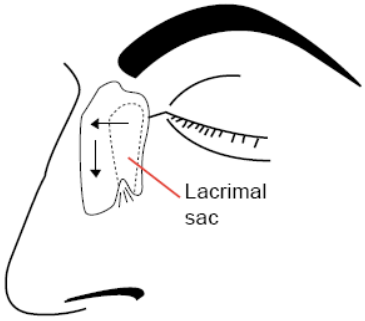

Figure 5: The easiest way to remove bone (arrows) in relation to the lacrimal sac (dotted line) [20].

The typical size of the osteotomy should be between 15 and 18 mm both vertically and horizontally. As a general guideline, it is important to maintain a bony margin that is at least 5 mm away from the common canaliculus (figure 6). [18].

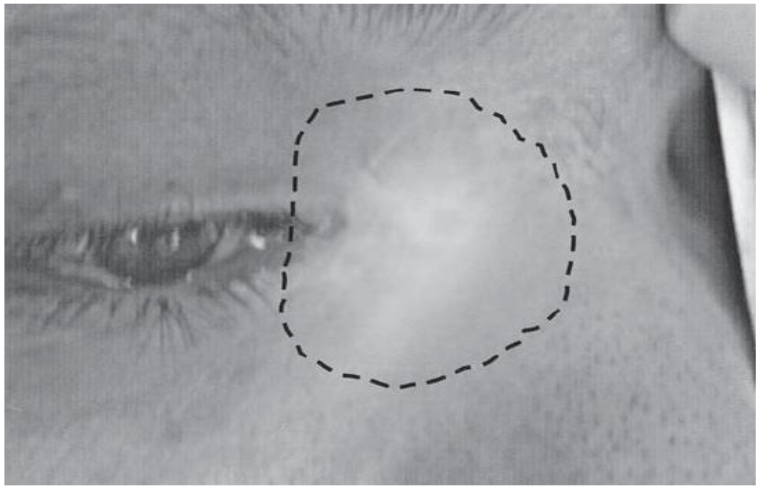

Figure 6: Size of typical osteotomy outlined by nasal transillumination [21].

Creating flaps between the nasal mucosa and lacrimal sac is crucial for the success of external DCR. The incision should be positioned as far posterior as possible to form a large anterior flap (figure 7).

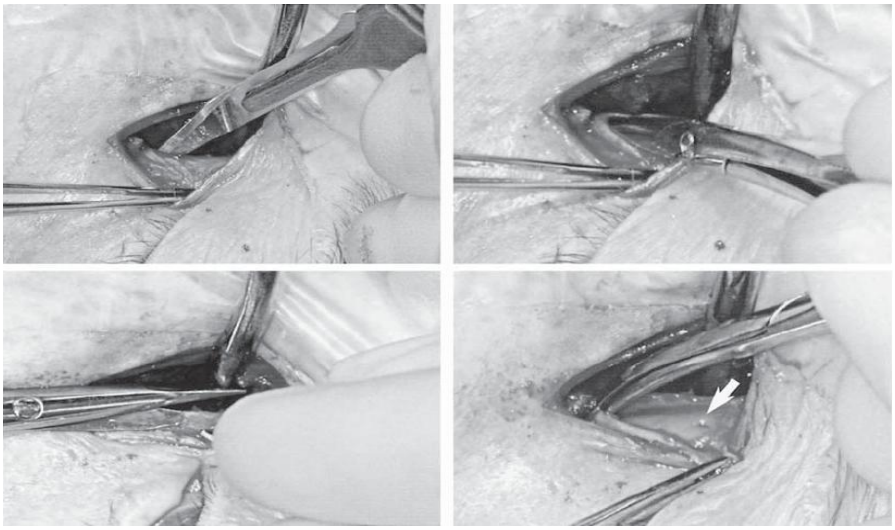

Figure 7: Creation of lacrimal sac flaps. H shaped incision of the lacrimal sac. Arrow indicates the internal opening of the common canaliculus [21].

The nasal mucosa is cut with the blade in a top-to-bottom direction, creating both posterior and anterior flaps (figure 8) [18].

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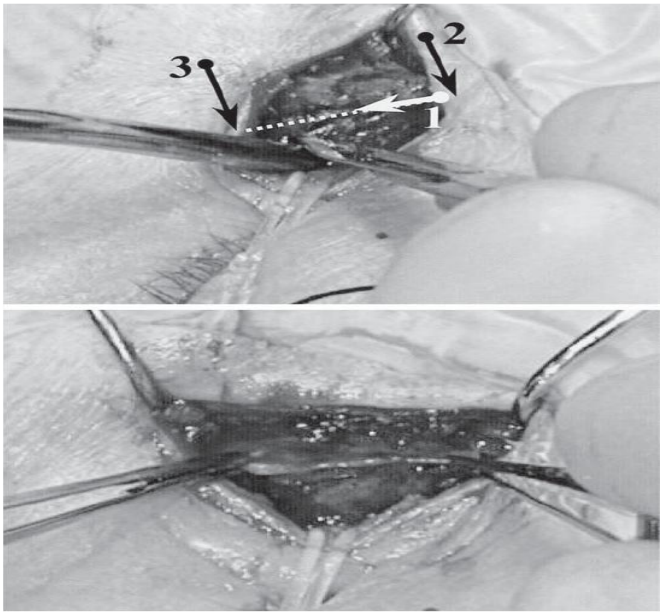

Figure 8: Fashioning of the nasal mucosal flaps with an anatomically vertical incision (1), and other two incisions (2) (3) [18].

The posterior flaps, including the nasal mucosa and lacrimal sac, are stitched together using a 6-0 Vicryl suture (see figures 9). In current practice, excising the posterior lacrimal sac and nasal mucosa flaps is common. Various studies have demonstrated that both suturing and excising the posterior flaps yield nearly identical success rates [22].

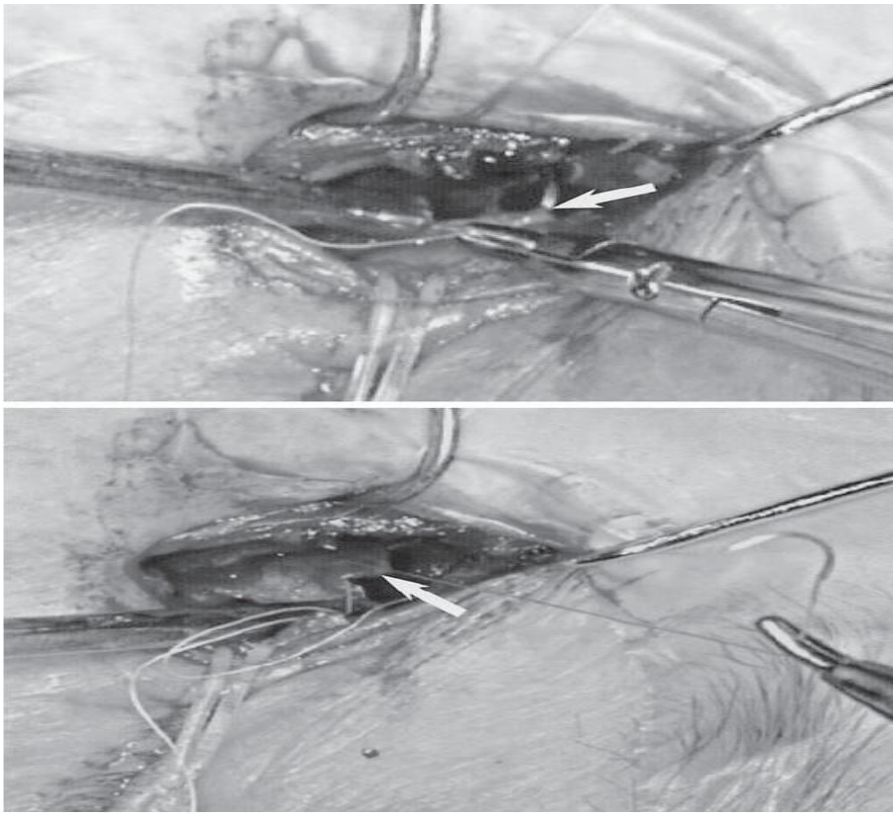

Figure 9: Anastomosis between the posterior flaps (arrows) [18].

Silicone tubes are inserted through the upper and lower canaliculi and retrieved from the nose. The tubes are then tied over a haemostat without putting excessive tension on the puncta. Some surgeons argue against routinely using tubes in Dacryocystorhinostomy (DCR), as there is no significant difference in success rates. They reserve tube insertion for specific situations such as extensive adhesions, canalicular stenosis, recurrent cases, or tuberculous dacryocystitis. Various types of lacrimal tubes, including monocanalicular and bicanalicular, can be used [18].

The traction sutures can now be removed. The anterior flaps, including the nasal mucosa and lacrimal sac, are closed with two 6-0 Vicryl sutures. These sutures are securely attached to the orbicularis fibers (as shown in figures 10). The anterior limb of the medial canthal tendon may either be sutured or left in place, and it can also be included in the upper suture of the anterior flap [18].

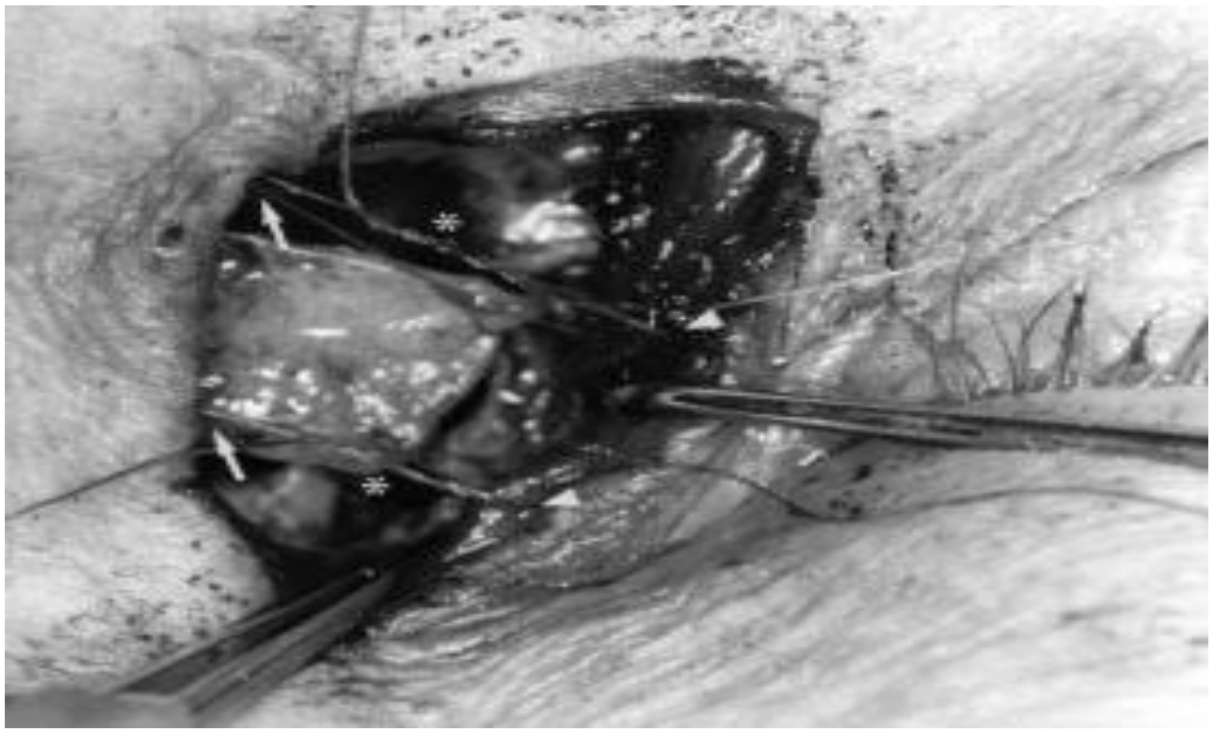

Fig 10 Suspended suturing of the anterior flaps(arrow heads)to the orbicularis(arrows) [18].

The skin incision is closed with either interrupted or continuous sutures using 6-0 Vicryl or silk, following the suturing of the muscle fibers with two 6-0 Vicryl stitches.

Post-operative care

Postoperative care for the patient involves the use of local antibiotic ointment, nasal decongestants, and systemic antibiotics. The patient is instructed not to blow their nose to prevent bleeding or dislodging the tube. Sutures are typically removed after 7-10 days, while the silicone tube remains in place for approximately 6 months. However, the tube can be removed as early as three months without affecting the success of the surgery [23].

Complications of external DCR:

External DCR is considered safe surgery; however, complications might also occur during or after the surgery.

1. **Intra-operative complications:**
   (a) Hemorrhage

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(b) Canalicular injury
(c) Inadvertent orbital entry
(d) Cerebrospinal Fluid Leakage

2. **Postoperative Complications:**
   (a) Hemorrhage
   (b) Wound-related complications
   (c) Stent extrusion and canalicular cheese-wiring
   (d) Failure

While Dacryocystorhinostomy (DCR) is generally considered a highly effective surgical procedure, with success rates reaching up to 95% in skilled hands, there are instances where patients continue to experience postoperative tearing. Common reasons for surgical failure include:

- Insufficient bone removal leading to an inadequately sized bony ostium.
- Fibrosis resulting from a soft tissue anastomosis that is too small.
- Development of a membrane or closure over the osteotomy site.
- Formation of adhesions (synechiae) between the ostium and structures like the middle turbinate or nasal septum.
- Obstruction or narrowing at the internal opening of the common canaliculus.
- The "sump syndrome," caused by a small and high-positioned rhinostomy, leaving residual lacrimal sac tissue [24].

Endonasal dacryocystorhinostomy:

The endonasal approach to the lacrimal system was first introduced by Caldwell in 1893. The technique has since developed, with the first modern endonasal DCR procedure utilizing endoscopes being described later (see figure 11) (McDonogh and Meiring 1989).

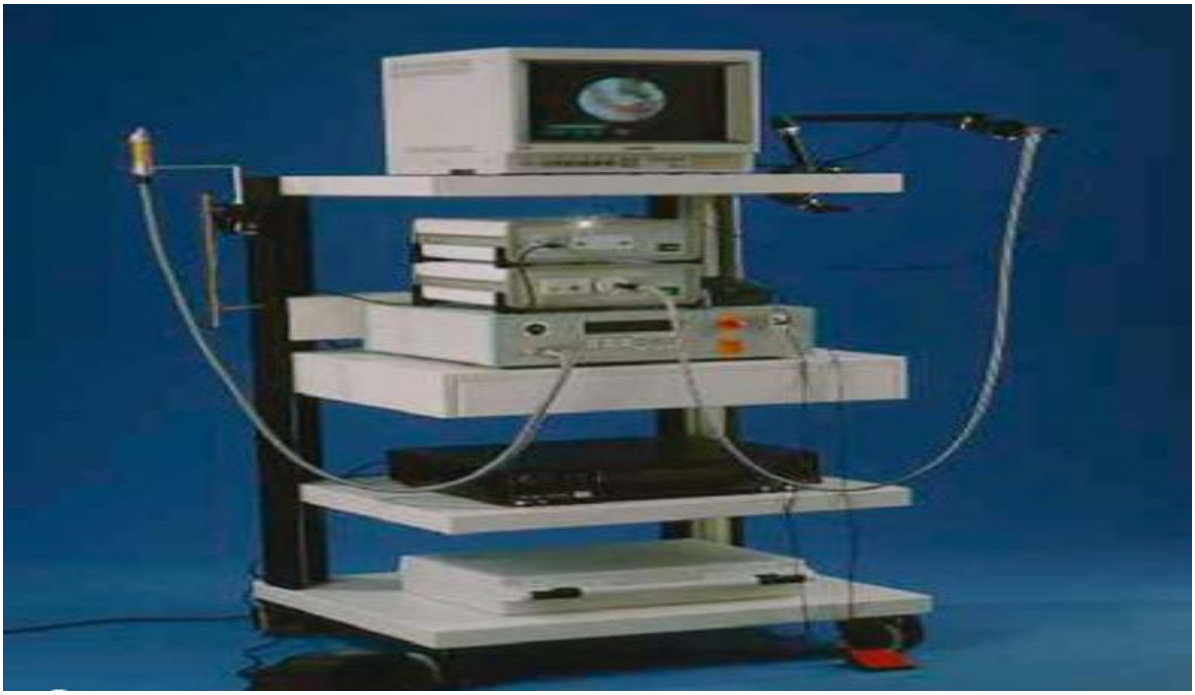

Figure 11: Endoscopic system [18].

The puncta are dilated, and a fiberoptic probe is carefully inserted into the canaliculi to illuminate the lacrimal sac. A small incision is made in the nasal mucosa just in front of the ridge created by the frontal

process of the maxilla and extended downward for approximately 10 mm. The mucosal flaps are created and raised medially toward the middle turbinate to reveal the thin lacrimal bone and the area illuminated by the fiberoptic probe. The osteotomy begins with the removal of the frontal process of the maxilla using a 2-mm Kerisson rongeur, exposing the posterior part of the sac and duct by removing the lacrimal bone. The lacrimal sac is filled with a viscoelastic solution. The fiberoptic probe is used to gently pull the sac medially, allowing for a vertical incision to be made. The nasal mucosal flap is then moved laterally, so it can contact the posterior part of the lacrimal sac flap. This contact on the lateral nasal wall facilitates the fusion of the mucosal flaps, forming a fistula between the sac and the nose once healed. Lastly, a bi-canalicular silicone intubation is performed. Postoperative care includes advising the patient to refrain from blowing their nose for about 10 days [25].

The drawbacks of this technique include the requirement for general anesthesia, the high cost of instruments and equipment, a steep learning curve, and the potential need for additional procedures such as septoplasty. There is also a risk of accidental injury to the orbit, which could lead to hemorrhage or damage to the medial rectus or inferior oblique muscles. Additionally, there is a possibility of cerebrospinal fluid leakage due to injury to the skull base, postoperative synechia between the middle turbinate and the lateral nasal wall, granulation tissue formation at the inner ostium of the DCR site, and a relatively lower success rate compared to external DCR [25].

Laser-assisted endoscopic dacryocystorhinostomy:

Laser-assisted endoscopic dacryocystorhinostomy (DCR) was first documented in 1990 by Massaro and his team. They reported a successful procedure using an argon laser. Since then, various types of lasers have been utilized in the procedure, and numerous studies have evaluated the effectiveness of laser-assisted DCR [26]. It is a fast and secure procedure that can be performed under local anesthesia, yielding excellent cosmetic outcomes. The use of a diode laser for trans-canalicular laser-assisted DCR has been recommended, with a success rate of 83.3% [26].

A fiberoptic light source is inserted into the lower canaliculus after punctal dilation and advanced into the lacrimal sac. The light is then tilted inferonasally to locate the most inferior part of the sac and is secured in place with a small artery clip over the drape. Different types of lasers, such as holmium: YAG (through a handheld fiberoptic wire) or KTP (through a laser probe), are used to ablate the nasal mucosa, bone, and lacrimal sac. Combining cold steel techniques with laser may be more effective for removing thick bone and cause less pain for the patient. After the connection is made, silicone intubation is performed [26].

The drawbacks of this technique include the high cost of the necessary instruments and equipment, the small size of the osteotomy, the risk of unwanted collateral heating from the probe, and potential residual thermal damage to surrounding tissues. Other complications may include epistaxis, conjunctivitis, surgical emphysema, improper localization of the illuminated area, and failure, which is typically caused by the complete healing of the nasal mucosa or adhesion between the nasal mucosal opening and the middle turbinate. Additionally, the success rate tends to be lower than that of external DCR [27].

Trans-conjunctival approach:

In 2003, Adenis and Robert conducted dacryocystorhinostomy using a retro-canalicular incision to prevent facial scarring. Their study involved eleven cases, with a success rate of 82% [28]. A new technique for scarless dacryocystorhinostomy was presented in 2011 by Kaynak, utilizing an inferomedial conjunctival incision [29].

Conclusion:

External dacryocystorhinostomy is the ideal surgery for correcting blocked tear ducts. The surgery is effective and gives relief from symptoms in the short as well as in the long run. Proper care of the flaps at the back is crucial and impacts the success rate of surgery. Closing flaps at the back will stabilize the area as well as allow it to heal more. Removing flaps at the back simplifies surgery but does not impact its success rate much.

Many studies have demonstrated that both methods produce similar outcomes in terms of how effective they are, whether patients are satisfied, and whether the problems return. The procedure chosen will be varied according to patient variables, such as severity of obstruction, tissue type, and skill level of surgeon. Conditions that occur at surgery, such as hemorrhage and visibility in the surgical field, can also impact on whether to treat the back flap.

Both methods are effective, though more studies are necessary in order to determine the ideal approach in dealing with the back flap in external DCR. Upcoming studies, particularly randomized studies, will examine outcomes concerning long-term success, patient satisfaction, and surgical complications each procedure can lead to. Improving surgical methods and advancements will allow external DCR to keep on giving wonderful outcomes in blocked tear duct patients.

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