CT Dacryocystography: Technique and results

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Authors: I. Melki, A. BEN SALAH, M. Elloumi, O. Nassej, K. Bouzaidi; Department of radiology MTM hospital Nabeul/TN
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Learning objectives

1. To learn about CT-Dacryocystography technique.

2. To review most common causes of NLD obstruction.

3. To outline anatomic elements that may influence the choice of treatment of NLD obstruction.
Background

Anatomy: (fig 1) the lacrimal excretory pathway begins at a 0.3-mm opening on the medial portion of each eyelid termed the punctum. In more than 90% of individuals, the superior and inferior canaliculi merge to form a common canaliculus before entry into the nasolacrimal sac. The functional valve between the common canaliculus and the lacrimal sac has traditionally been attributed to the valve of Rosenmüller. The nasolacrimal sac and duct are portions of the same continuous structure, the nasolacrimal duct then travels inferolaterally and slightly posteriorly in its bony course to the inferior turbinate. Hasner’s valve (or plica lacrimalis), may be present at the opening of the duct into the inferior meatus of the nose [1].

Fig. 1: Anatomy of the lacrimal excretory pathway. BE, bulla ethmoidalis; IT, inferior turbinate; MS, maxillary sinus; MT, middle turbinate.

Nasolacrimal duct obstruction is a common disorder which presentation can range from a patient having no symptoms to one with a life-threatening infection. Its management generally consists of a surgical procedure in which patency of the lacrimal outflow system is restored. Lacrimal bypass surgery was performed more commonly via external routes through most of the twentieth century. In this external approach, imaging of the lacrimal pathways was not necessarily performed, for the safety or the success of the procedure. Therefore there were few studies in the literature on lacrimal surger.

However, over the last decade, the advent of endoscopy has raised the interest of endonasal procedures. This approach is generally considered to be contraindicated if a neoplasm is suspected. Imaging may be helpful in this regard to delineate a mass within the lacrimal outflow, and give anatomic information regarding not only the lacrimal outflow system but also surrounding soft tissues and bony structures, including the sinuses.
Findings and procedure details

High-resolution contrast-enhanced CT scan of the lacrimal sac was performed in 10 patients affected by primary nasolacrimal outflow obstruction (8 patients) or postsurgical recurrent epiphora (2 patients). The opacification of NLD were performed by cannulation in all patients. The results are summarized in table 1.

**Technique**

With the patient in supine position, 3-mm thick plain axial helical CT scan (at a slice thickness of 1.25 mm, reconstructed in 0.60-mm slices with 80 mAs, 120 kV, 512 x 512 matrix, and a pitch of 1) of the paranasal sinus and orbit is taken from the hard palate to the roof of the orbit. The acquisition should include nasal cavity and paranasal sinuses.

Lacrimal system opacification can be performed by administration of contrast by cannulation or instillation in the conjunctival cul de sac:

- Procedure by instillation is a well-tolerated non-invasive method that consists of bilateral and symmetric instillation of contrast in the conjunctival sac. Instillation details varies between authors: Contrast can be non diluated instilled in a seating position before CDCG then in a supine position just prior to the acquisition (2 drops per eye) [2], or can be diluated with distilled sterile water, instilled in two drops per minute during 6 minutes before the acquisition [3].

- Cannulation is often performed by an ophthalmologist, Pre-DCG irrigation and expression of the lacrimal sac was done to flush out accumulated secretions within the duct system, which may lead to interpretive difficulties, including improper estimation of the size of the lacrimal sac or misdiagnosis of obstruction proximal to a stenosing lesion due to the retained secretions. Topical anesthetics should be applied first. The contrast material is put into a syringe connected to a 26 gauge lacrimal cannula with a plastic hub and tubing. The inferior punctum was dilated with a lacrimal dilator. Then the lacrimal cannula is placed into the inferior canaliculus. After assuring that the cannulation system is cleared of any air bubbles and avoiding any placement of the cannula wich may create artefacts, injection of 1 to 2 ml of contrast material is performed softly. In bilateral imaging, two cannulae and tubing with a #Y# connector can be used.

Injection should be stopped:

- If small amount of contrast agent (often 2 ml are sufficient) is needed to reach the nasal fossa or the nasopharynx which indicates the permeability of nasolacrimal system.

- If there is a resistance felt by the operator.
**Associated risks:** Although this technique is relatively safe and has been well tolerated by patients, Cannulation of the lacrimal system can rarely result in iatrogenic trauma to the punctum or canaliculus. Ocular surface irritation may result from abrasion of the cornea from tubing or chemical irritation from contrast material.

**Contraindications:**

Pregnant women and in patients with a known allergy to iodine.

It is not recommend in the setting of acute dacryocystitis.

Also, children or uncooperative adults may not be good candidates for the study unless sedation is used.

**Findings**

**Normal findings: (fig 2 and 3)**

The two nasolacrimal ducts have symmetrical caliber. The bony nasolacrimal canal is regular and intact. The mean minimum diameter—generally found halfway through the canal—measures 3.5 mm (1.5-6.3 mm) [4].

Without opacification, the content can be aeric or tissular (Fig. 2)

There is no resistance during the injection and the patient rapidly feels that contrast agent has reached the nasal fossa. After injection, the content can be heterogeneous (not fully filled). There is no visible obstacle though.

![Fig. 2](image)

**Fig. 2:** Axial (A), sagittal (B) and Coronal (C) oblique MPR reconstruction CT scan without opacification of nasolacrimal duct. Normal nasolacrimal duct. The content can be aeric or tissular

**References:** Department of radiology MTM hospital Nabeul/TN
Fig. 3: Normal nasolacrimal duct in CT dacryocystography performed by unilateral cannulation. (A) Axial image showed the contrast medium reaching the nasopharynx (blue arrow). (B) Axial image passing through the middle third of the nasolacrimal duct. The lumen is homogeneous without lacuna. Coronal (C) and sagittal (D) oblique MPR reconstruction. 1. Lacrimal sac 2. Nasolacrimal duct 3. Valve of Hasner.

References: - Department of radiology MTM hospital Nabeul/TN

**Imaging objectives:**

Ø Describe the level of the obstruction;

Ø Evaluate whether the obstruction is complete or incomplete, intrinsic or extrinsic to the duct (Fig. 5-9)

Ø Determine the cause of the obstruction;

Ø Assess the anatomic variations in the nasal cavity, turbinates or nasal septum and the possibility of encountering ethmoidal air cells.
**Etiologies:**

**A. Congenital NLD obstruction:**

It occurs in approximately 5% of normal newborn infants, congenital nasolacrimal duct obstruction is the major cause of nasolacrimal duct obstruction in children. It can be unilateral or bilateral. Most commonly it is caused by a membranous obstruction at the valve of Hasner at the distal end of the NLD. Congenital lacrimal sac mucocele or dacryocystocele is frequently associated. CDCG is rarely indicated.

**B. Primary acquired nasolacrimal duct obstruction (PANDO): (Fig. 4)**

PANDO represents the most common cause of NLD obstruction in adults. Although the etiology is unknown, the role of the osseous nasolacrimal canal has frequently been discussed usually with the suggestion that a narrow canal predisposes one to the development of lacrimal obstruction. The canal is longer and narrower in women than in men, and in whites as compared to other races, explaining the increase prevalence in women and whites.

Sinus and nasal disease have also been implicated as a causative factor [5].

**C. Specific acquired obstruction of the NLD:**

1. **Trauma:**

The obstruction can be caused by fracture (Fig. 10 D), displaced bone and/or edema and inflammation. Imaging offers additional benefits of more exact localization of the lacrimal drainage system fractures, bone displacements, location of previously placed miniplates, wire or silastic sheets.

2. **Foreign bodies and dacryolithiasis:**

The most common foreign bodies are iatrogenic. Eyelashes and epinephrine crystals which may occur many years after collyre instillation are classic. Foreign bodies can cause dacryolithiasis.

The etiopathogenesis of dacryolithiasis is not well known. It is often related to narrow NLD and tears stagnation. Thus, it can be either a cause or a consequence of NLD obstruction. Size varies from 3mm to a maximum length of 2.9cm and a maximal width of 9mm in some case series. They commonly take the shape of the lacrimal sac or the nasolacrimal duct in which they arise. Its composition is various. The majority of dacryoliths have been found to be primarily composed of organic substances. They can also be composed largely of inorganic material. Thus they can be hyperdense or isodense [6]. Realising a CT scan acquisition prior to opacification may be useful but it is not necessary [7].
In CDCG, foreign bodies and dacryolithiasis typically appear as an intraluminal lacuna surrounded by contrast medium. The diagnosis is difficult when the calculus is small and unique. Differentiating foreign bodies and calculus may be difficult by imaging.

Diverticula and fistulae can be associated.

3. Infectious:

Dacryocystitis can be caused by bacterial, fungal, parasitic or viral agent. Obstruction occurs often in the proximal part of NLD. The diagnosis is clinical and acute dacyocystitis contraindicates CDCG.

4. Neoplasms:

Primary neoplasms of lacrymal system are very rare. Metastases are extremely rare (the most common are lung and breast metastases).

5. Inflammation:

Particularly sarcoidosis (which commonly cause a distal NLD obstruction), Wegner's disease and after local radiotherapy.

D. Nasal cavity and paranasal sinuses conditions:

Many conditions of the nasal cavity and paranasal sinuses can be the cause of NLD obstruction:

- Anatomic conditions: hypertrophic inferior turbinates (Fig. 5).
- Chronic rhinosinusitis, atrophic rhinitis, exudative rhinitis.
- Osteoma.
- Neoplasms.

*Endoscopic management of NLD obstruction (EDCR):*

1. Advantages over external DCR (EDCR): Absence of facial incision. Preservation of integrity of orbicularis oculi muscle and medial palpebral ligament which form the functional lacrimal pump mechanism. Simultaneous correction of any intranasal pathologic conditions which may contribute to EDCR failure.

2. Indications for primary EDCR: PANDO, posttraumatic lacrymal duct injuries, Inflammatory and infiltrative disorders.
3. Pre-therapeutic CDCG:

**Detect contraindication to EDCR:** Suspicion of neoplasm involving lacrimal outflow system. Relative contraindications include large diverticulum lateral to lacrimal sac, common canalicular stenosis and large lacrimal system stones.

**Assess anatomic variants** that should be noted prior to endoscopic procedure:

- Nasal septum variants: Nasal septal deflections and spurs (Fig. 6 B).
- Ostialmeatal complex variants:
  - Concha bullosa (Fig. 6 and 7).
  - Lateral deviation of the uncinate process, which can increase the risk of medial orbital wall injury during uncinectomy.
- Congenital or posttraumatic dehiscence of the lamina papyracea which can provide a direct route for sinus surgery instruments to cause orbital injury.
- The depth of the olfactory fossa can be graded with the Keros classification. Risk of fracture during endoscopy, especially when the olfactory fossae are deep or asymmetric.

4. **Predicaments of success:** Achieving an adequate osteotomy (3- to 5-mm radius around the common canaliculus) by either external or endonasal DCR must take into account the overlapping of the lacrymal fossa by both the uncinate process and the opercule of the middle turbinate. Although these structures are often resected during the osteotomy from an external approach, they should be specifically addressed by the endonasal technique. To meet the safety and efficacy criteria defined by external DCR, the same osteotomy performed from an endonasal approach must integrate the specificity and variability of the medial anatomy of the lachrymal fossa [8].

5. **Post-therapeutic CDCG:**

Succes rate of dacryocystorhinostomy for both techniques varies from 85% to 97%. In patients with failed DCR, CDCG shows the location of the bony opening, soft tissue scarring, bony regrowth, secondary stenosis of the canaliculi, synchecia between the ostium and nasal septum. CTDCG best shows the relationship of surgical clips, sutures and fixation plates to the nasolacrimal sac or the osteotomy site. The "sump syndrome" occurs when a residual nasolacrimal sac forms, collects fluids, and leads to a dacryocystocele most commonly due to small osteotomy.

**Table1. Details of patients who underwent CT Dacryocystography in our study.**
<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age</th>
<th>History of trauma or previous surgery</th>
<th>Symptom</th>
<th>Side</th>
<th>Method of CTDCG</th>
<th>Level of obstruction</th>
<th>Complete/incomplete Sinus abnormalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Male</td>
<td>9</td>
<td>-</td>
<td>recurrent dacryocystitis</td>
<td>Right</td>
<td>Unilateral cannulation method</td>
<td>None</td>
<td>Inferior turbinate osteoma</td>
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<tr>
<td>2</td>
<td>Male</td>
<td>47</td>
<td>-</td>
<td>recurrent dacryocystitis</td>
<td>Right</td>
<td>Unilateral cannulation method</td>
<td>Partial</td>
<td>Bilateral Concha bullosa</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Diameters= 1.1 mm</td>
<td>Surface= 0.7 mm²</td>
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<tr>
<td>3</td>
<td>Female</td>
<td>66</td>
<td>-</td>
<td>Epiphora</td>
<td>Right</td>
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<td>Proximal</td>
<td>Bilateral Concha bullosa</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Complete</td>
<td></td>
</tr>
<tr>
<td>4</td>
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<td>65</td>
<td>-</td>
<td>recurrent dacryocystitis</td>
<td>Right</td>
<td>Unilateral cannulation method</td>
<td>Proximal</td>
<td>Left Concha bullosa</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Complete</td>
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</tr>
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<td>Complete</td>
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<td>Hypertrophic inferior turbinate</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>- Left Concha bullosa</td>
<td></td>
</tr>
<tr>
<td>6</td>
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<td>+</td>
<td>Epiphora</td>
<td>Right</td>
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<td>Distal</td>
<td>Complete</td>
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<td></td>
<td></td>
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<tr>
<td>#</td>
<td>Gender</td>
<td>Age</td>
<td>Side</td>
<td>Epiphora</td>
<td>Cannulation Method</td>
<td>Proximal Complete</td>
<td>Dacryocystocele</td>
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<tr>
<td>7</td>
<td>Female</td>
<td>47</td>
<td>+</td>
<td>Right</td>
<td>Unilateral cannulation method</td>
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<tr>
<td>8</td>
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<td>-</td>
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<td>Bilateral cannulation method</td>
<td>Partial with diameter=1mm</td>
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<tr>
<td>9</td>
<td>Female</td>
<td>48</td>
<td>-</td>
<td>Right</td>
<td>Bilateral cannulation method</td>
<td>Complete with surface=0.5mm²</td>
<td>None</td>
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</tr>
</tbody>
</table>
**Fig. 4:** 65-year-old woman with a history of right recurrent daryocystitis. Sagittal CT dacryocystography showing a complete proximal obstruction of the nasolacrimal duct (red arrow) caused by Primary acquired nasolacrimal duct obstruction (PANDO).

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Fig. 5: 35-years-old woman presenting with left epiphora. CT dacryocystography in coronal (A) and sagittal (B) oblique plane showing a complete distal obstruction of the nasolacrimal duct by mucosal hypertrophy of the left inferior turbinate (blue arrow).

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Fig. 6: 66-year-old woman with right epiphora. CT dacryocystography performed by right cannulation. (A) Sagittal MPR reconstruction showing complete proximal obstruction of the right NLD. (B) Coronal MPR reconstruction. Note the bilateral concha bullusa (blue arrows) and the nasal septum deviation.

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Fig. 7: 47-years-old man with recurrent right dacryocystitis. CT DCG performed by right cannulation showing partial proximal obstruction of the right NLD (red arrow). Axial (A and B), sagittal (C) and Coronal (D) MPR reconstruction. (B) showing the contrast medium reaching the nasopharynx. Note the bilateral Concha bullosa (blue arrows).

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**Fig. 8:** 50-years-old woman presenting with left medial canthal swelling and epiphora. Axial (A) and frontal (B) oblique CT DCG performed by left cannulation showing partial proximal obstruction of the left nasolacrimal duct (red arrow) with dacryocystocele (blue arrow).

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**Fig. 3:** Normal nasolacrimal duct in CT dacryocystography performed by unilateral cannulation. (A) Axial image showed the contrast medium reaching the nasopharynx (blue arrow). (B) Axial image passing through the middle third of the nasolacrimal duct. The lumen is homogeneous without lacuna. Coronal (C) and sagittal (D) oblique MPR reconstruction. 1. Lacrimal sac 2. Nasolacrimal duct 3. Valve of Hasner.

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Conclusion

Helical CT dacryocystography is a relatively safe and well-tolerated radiologic technique that provides detailed imaging of the lacrimal outflow system and surrounding structures. These informations are needful to understand and improve endonasal DCR and may help the oculoplastic surgeon experience a smoother transition when moving from the external to the endonasal DCR approach.
References


