REVIEW

The role of multi-detector CT dacryocystography in the assessment of naso-lacrimal duct obstruction

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Abstract  Epiphora is related to functional or anatomic obstruction of the nasolacrimal system. 
Aim: Evaluate the role of multi-detector CT dacryocystography “CT-DCG” in naso-lacrimal duct obstruction “NLDO”.

Patients and methods: Twenty patients with NLDO assessed by CT-DCG.

Results: In nine infective lesions, CT-DCG revealed lacrimal sac distension, dacryoceles and dacryolith. Five patients had neoplastic NLDO; two primary adenocarcinomas, one neuroblastoma, one lymphoma and one fibrous dysplasia. Of four patients with idiopathic NLDO; three had mucous plugs and stenotic canals. The fourth proved as sarcoidosis. CT-DCG characterized NLDO in two post traumatic patients.

Conclusion: CT-DCG is indispensable in the assessment of NLDO.
1. Introduction

Epiphora, the imperfect drainage of tears through the lacrimal passages, is a common ophthalmic problem that can degrade visual acuity. An understanding of the anatomy of the lacrimal drainage system, including the bony conduit, the membranous conduit and the surrounding soft tissues is necessary to appreciate how different diseases can affect the function of the system. Epiphora may be caused by functional or anatomic obstruction of the nasolacrimal system. Nasolacrimal drainage obstruction (NLDO) is classified as congenital obstruction or acquired obstruction which is either primary or secondary. Primary acquired nasolacrimal duct obstruction (PANDO) describes obstruction caused by inflammation or fibrosis without precipitating cause (1). An etiologic classification was proposed for secondary acquired lacrimal drainage obstruction (SALDO) as infectious, inflammatory, neoplastic, traumatic and mechanical (2–4).

Epiphora can often be managed by adequate clinical assessment and syringing the lacrimal drainage apparatus; however, this will not always determine the site and nature of the obstruction (5–8). Because of the surgical biopsy associated morbidity, non-invasive imaging, including conventional dacryocystography (DCG), computed tomography (CT), magnetic resonance imaging (MRI) and nuclear scintigraphy, is often required to assess complex lacrimal conditions such as medial canthal tumors, mid-face trauma or following sinus or lacrimal surgery. MDCT – Dacryocystography “CT-DCG” of the nasolacrimal system frequently defines morphologic features that may serve as clues regarding the nature and level of obstruction (9). The aim of this study was to evaluate the role of CT-DCG in the assessment of NLDO.

2. Material and methods

Twenty patients, including eight males and twelve females ranging between 16 and 52 years with a mean age of 34 years, were included. Epiphora and inner canthus swelling were the presenting complaints in 14 patients (70%); of whom 10 patients (50%) had painful swelling, while four patients (20%) had painless swelling. Six patients (70%) presented with epiphora with no inner canthal swelling. (Table 1). The patients were recommended for CT-DCG after a risk–benefit analysis to ensure that the amount of benefit outweighs the amount of risk.

No exclusion criteria were specified apart from that of exclusion criteria for CT examination; only when intravenous contrast media was to be further administered. Cases with severe conjunctival allergic reactions were excluded by the attending ophthalmologist; however mild conjunctival reaction was accepted and managed by corticosteroid eye drops.

The CT-DCG examinations were performed on GE Lightspeed4 scanner and Siemens Emotion6 MDCT. Scanning parameters included volumetric high-spatial-frequency kernel algorithm. Slice thickness: 1.25 mm. Table speed for volumetric CT to enable the least cycles of breath-holds as possible. Tube rotation: 0.6–0.9 s (0.75 s). Detector Collimation 1 mm. Helical mode (volumetric CT). Matrix: 512 × 512, FOV: 150–180. kVp and mAs per slice: 120 kVp and approximately 150 mAs. The thin slices were sent to the workstation, where they were available for viewing in axial, sagittal and coronal planes. Coronal oblique views were valuable in viewing the contrast column in the nasolacrimal duct.

The patients were clinically examined by the ophthalmologist and CT-DCG was performed following topical instillation of CT contrast medium in the conjunctival cul de sac used in 1:1 volume dilution with distilled water or saline. Two drops per minute, per eye were instilled. In three patients, where the topical instillation failed to adequately demonstrate the lacrimal drainage system, cannulation of the lacrimal canaliculi was performed by the ophthalmologist where irrigation and expression of the lacrimal sac was done to flush out accumulated secretions within the duct system. The inferior punctum was dilated with a lacrimal dilator, the lacrimal cannula was placed into the inferior canaliculus just as far enough to remain stable, and the tubing was taped to the patient’s face. One to two milliliters of contrast medium was injected on each side. The nasolacrimal systems of the 20 patients were scanned in the prone position for direct coronal imaging and to allow for retention and gravitational flow of the instilled contrast media through the nasolacrimal ducts.

3. Results

The non-obstructed bony nasal canal was relatively tighter in female patients compared to the male patients. In the female patients, the transverse diameter of the non-obstructed bony nasolacrimal canal ranged from 2.2 to 6 mm while that of the male patients ranged from 3.8 to 8.7 mm.

NLDOs were encountered at different levels from as high as the punctum; to as low as the inferior nasolacrimal meatus at the inferior nasal turbinate. From a clinical point of view; a broader classification was proposed in this study classifying...
high obstruction as those in the common canaliculus, mid-level obstructions as those in the region from the lacrimal sac neck to the lower third of the bony canal; which was encountered in 18 patients and low-level obstructions as those at the lower end of the nasolacrimal duct; which was encountered in two patients, one with a neoplastic lesion involving the distal third of the bony nasal canal, and another with a post-traumatic distal bony nasal canal obstruction.

There was nine patients (45%) with infective aetiology, four (20%) with idiopathic lesions, five (25%) with neoplastic lesions and two (10%) with posttraumatic obstruction. Of the five (25%) neoplastic lesions; two lesions (10%) proved to be adenocarcinomas, one olfactory neuroblastoma (5%), one lymphomatous infiltration (5%) and one fibrous dysplasia (5%).

The two patients with adenocarcinoma presented by different degrees of obstruction on CT-DCG; the first had partial unilateral obstruction secondary to a low level polyp at the distal bony nasolacrimal canal with a dilated bony canal related to long standing pressure effect (Fig. 1) and the second had total unilateral NLDO at the mid-level (sac-duct junction) with a dilated lacrimal sac and thickened perilacrimal duct fat planes but no definite masses. The third patient with a neoplastic etiology was previously managed surgically for ipsilateral nasal wall neuroblastoma and currently presented with unilateral epiphora; on CT-DCG, the sac-duct

Fig. 1 Adenocarcinoma of the right nasolacrimal duct. A 45 year old female with right-sided epiphora. (A) Coronal oblique CT-DCG of the right nasolacrimal duct showing right low level partial NLDO by a polypoidal lesion with contrast delineating its medial contour. (B) Axial CT-DCG showing the polypoidal lesion at the right lower right nasolacrimal duct.

Fig. 2 Recurrent neuroblastoma involving the mid and distal parts of the nasolacrimal duct. A 16 year old male surgically managed for left-sided nasal neuroblastoma and currently presenting with left sided epiphora. Axial CT-DCG images in high resolution windows (A and B) at the mid-lacrimal sac level and sac-duct junction levels showing dilated lacrimal sac surrounded by thickened disorganized soft tissue at the sac-duct junction level confirmed as recurrent neuroblastoma. Coronal oblique (C) CT-DCG image showing left mid-level total obstruction at the sac-duct junction; with contrast distending the lacrimal sac.

Fig. 3 Fibrous dysplasia involving the nasolacrimal bony canal. A 35 year old male with right-sided epiphora. Axial (A), coronal oblique (C and D) CT-DCG images of the nasolacrimal ducts demonstrating mid-level obstruction at the sac-duct junction secondary to nasolacrimal bony canal involvement. The left nasolacrimal duct was patent.
junction was surrounded by disorganized soft tissue; which proved to be recurrent/residual neuroblastoma. In the fourth patient with non-Hodgkin lymphoma and presenting with unilateral epiphora, CT-DCG revealed near total mid-level NLDO with distended thick wall lacrimal sac and histopathology revealed lymphoproliferative infiltration of the lacrimal duct wall. In the fifth patient with fibrous dysplasia and skull base affection, CT-DCG revealed mid-level NLDO in addition to right nasal bone and lacrimal duct involvement with ground glass appearance also seen at the clivus and sphenoid bone (Fig. 3).

Infective lesions occupied the bulk of this study; with nine patients (45%) having lacrimal sac distension and dacryocystitis formation. Streptococci and staphylococci were the causative agents in eight out of nine infective NLDO lesions (40%). The infective nasolacrimal obstructive lesions were consistently associated with dacryocystitis presenting with cystic dilatation of the lacrimal sac along with perilacrimal fat stranding (Fig. 4). Fungal infection was responsible for one NLDO lesion (5%) complicated by a dacryolith within the lacrimal sac sequel to obstruction at the sac-duct junction. CT-DCG delineated peripherally calcified swollen lacrimal sac with the contrast fading within the dilated sac harboring a dacryolith which was seen as a high attenuation oval shaped structure with an inner hypodense core and an outer laminated calcific shell. (Fig. 5) Thickening of the lacrimal duct was also seen

Fig. 4  A 52 year old female with right-sided epiphora. Coronal (A and B) and axial (C) CT-DCG of the nasolacrimal ducts showing a right mid-level totally obstructed nasolacrimal duct at the sac-duct junction with consequent mucocele formation of the distended lacrimal sac revealing air focus reflecting abscess formation. The chronically obstructed and widened nasolacrimal duct is thickened with increased CT-density.

Fig. 5  Dacryolithiasis complicated by dacryocystitis. A 34 year old male with right-sided epiphora. Axial (A and B), coronal oblique (C) CT-DCG images of the nasolacrimal ducts demonstrating a dense structure within the swollen right lacrimal sac with peripheral calcification; proved to be dacryolithiasis complicated by dacryocystitis. No aggressive bony destruction. The ethmoid and sphenoid sinuses are clear. There is no intraocular involvement.

Fig. 6  Idiopathic NLDO. A 37 year old female with bilateral epiphora. Axial (A) and coronal (B) CT-DCG of the nasolacrimal ducts showing bilateral mid-level totally obstructed nasolacrimal ducts at the sac-duct junction with consequent mildly distended lacrimal sacs; A preliminary diagnosis of idiopathic NLDO was proposed. Balloon-dilatation performed prior to DCR relieved the NLDOs; no etiology elicited apart from bilateral mild strictures at the lacrimal ducts with impacted mucus plugs.
in two patients, likely secondary to the infiltrative inflammatory process. Previous DCG and probing failed to reveal the underlying dacryolith however fungal growth was cultured.

Four patients (20%) with idiopathic obstructive lesions were encountered and categorized as three patients (15%) with idiopathic PANDO related to canalicular mucus plugs and one patient (5%) with sarcoidosis. The patients with mucous plugs had anatomically tight bony canals and a small proximal mucocele detected on CT-DCG. These patients were confirmed to have idiopathic PANDO on DCR and histologic assessment with no definite underlying cause (Fig. 6). The patient with sarcoidosis; was referred for CT-DCG; with no definite causative factor where CT-DCG revealed mid-level obstruction at the lacrimal sac-duct junction and distended lacrimal sac with retained contrast medium, which failed to pass beyond the sac duct junction (Fig. 7). The bony lacrimal sac diameter was normal and no ductal masses, along the proximal lacrimal drainage system, or extra-ductal masses were identified. Preliminary idiopathic PANDO was suggested as no signs of inflammation or an occlusive lesion were seen on CT-DCG; however, histology of the lacrimal sac confirmed sarcoidosis. The patient was further subjected to laboratory investigations and chest X-ray that confirmed the diagnosis.

Two patients had epiphora following facial trauma. A patient with unilateral epiphora was recommended for CT-DCG after an inconclusive conventional DCG showing obstruction at the lacrimal sac-duct junction and distended lacrimal sac with retained contrast medium, which failed to pass beyond the sac duct junction (Fig. 7). The bony lacrimal sac diameter was normal and no ductal masses, along the proximal lacrimal drainage system, or extra-ductal masses were identified. Preliminary idiopathic PANDO was suggested as no signs of inflammation or an occlusive lesion were seen on CT-DCG; however, histology of the lacrimal sac confirmed sarcoidosis. The patient was further subjected to laboratory investigations and chest X-ray that confirmed the diagnosis.

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unexplained distal obstruction of the left nasolacrimal duct. CT-DCG revealed multiple partially healed fractures and callus formation at the base of the left inferior nasal turbinate compromising contrast flow proximal to the distal bony nasal canal. The second patient was a victim of a facial assault and had facial bone plate and screw reconstructive surgery along the right nasal bone, the right orbital floor and maxilla. Epiphora continued to progress, despite the regression of both post-traumatic and post-operative edema that were initially incriminated to cause mal-alignment of the inferior punctum and hence epiphora. CT-DCG following cannulation of the inferior canaliculus revealed blocked contrast flow by a fixation screw traversing the nasal bony canal and consequently violating the lacrimal duct (Fig. 8).

The bony canal was assessed for irregularities, expansion, invasion, stenosis or fracture. In a case with adenocarcinoma poly, bony expansion of the canal was noted, while in the cases with callus formation and fibrous dysplasia, the bony canal was encroached upon and hence compromising the nasolacrimal duct by external compression. Violation of the bony nasal canal and the nasolacrimal duct was appreciated in the post-reconstructive trauma case. In the three cases with PANDO, the canal was fairly smooth however relatively tighter. The canal was normal in size in the rest of the cases (Table 2).

The final diagnosis was confirmed following surgical intervention by dacryocystorhinostomy (DCR) in patients with sarcoidosis, lymphoma, mucocoeles formations and dacryolith. The two patients with adenocarcinoma underwent surgical excision with wide margins. One patient with traumatic NLDO did not attend for follow-up. Fourteen patients underwent DCR for diagnosis confirmation and treatment; of which nine had infective NLDO with mucocoeles that were excised and three with mucous plugs. A dacryolith was recovered in one patient with underlying fungal growth. Histological evaluation of the lacrimal sac in the patient with sarcoidosis revealed non-caseating granuloma; while in the patient with non-Hodgkin lymphoma revealed lymphoidyte proliferations. Wide surgical excision biopsy was performed in two patients with NLDO secondary to adenocarcinoma of the lacrimal sac. In the patient with neuroblastoma, CT-DCG revealed abrupt termination of the contrast flow at the sac-junction level with neoplastic infiltration of the lacrimal duct confirmed at surgery. The patient with fibrous dysplasia underwent wide excision and lacrimal drainage reconstructive surgery.

### Table 2 Distribution of patients according to bony nasal canal changes.

<table>
<thead>
<tr>
<th>Status of bony canal</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expansion</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Tight bony nasal canal</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>External compression on the NLD</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Violated</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Normal appearance</td>
<td>13</td>
<td>65</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>100</td>
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4. Discussion

Epiphora constitutes an important portion of the practice of the lacrimal ophthalmologist (10–13). MDCT with post-processing techniques have allowed CT to assume a pivotal role in the non-invasive evaluation of nasolacrimal obstructions (13,14). CT-DCG is a useful tool in challenging cases as it defines the lacrimal system anatomy, facilitates preoperative planning and intraoperative decision-making. Few studies of CT-DCG used dye instillation technique instead of the cannulation technique (15). Instillation of non-ionic, water-soluble contrast material in the conjunctival cul de sac is a physiologic method to evaluate lacrimal obstruction, with catheterization being used only in the absence of opacification after instillation. Plain or intravenous enhanced CT does not image the superior, inferior and the common canaliculi; however, they can be identified by CT–DCG (16,17).

CT-DCG with topical contrast material can identify nasolacrimal system obstructions as well as the adjacent soft tissue and osseous abnormalities seen with pathologic conditions like sinusitis, mucoceles, nasal polyposis, and dacryoliths (18). In the current study, this was especially useful in patients with facial trauma or nasolacrimal duct tumors utilizing multiplanar reconstruction of the thin sliced axial images, facilitating not only coronal and sagittal viewing but also 360° oblique views to trace the non-opacified parts of the obstructed NLD. CT-DCG is of choice for evaluating the patency of the ostomy after a dacryocystorhinostomy (19). In this study, under normal conditions, the injection through cannulation was stopped when the patient signals the passage of contrast into the nasal cavity or nasopharynx. In suspected pathology, the injection was stopped when there is resistance and the patient does not usually indicate passage in the nasopharynx.

Females are more prone to NLDO than males which may be attributed to the relatively smaller size of the nasolacrimal canal in females. The greater prevalence of PANDO in females is possibly related to the smaller diameter of the bony nasolacrimal canal and the fluctuating hormone levels affecting mucous membranes in females (20–22).

Despite that the bony nasal canal tended to be narrower in the older age group, no linear relation could be concluded between the age and the diameter of the nasolacrimal bony canal as a predisposing factor in this age group. A small diameter of the bony canal is not the only etiologic factor in obstruction of the lacrimal drainage system (22).

The lacrimal passage obstruction level classification was implemented (23), where the commonest was mid-level obstruction at the lacrimal sac-duct junction, while two patients suffered low level obstruction. The location of obstruction is classified into three categories; high, middle and low. High level obstructions are located in the canaliculi or sinus of Maier. Mid-level obstructions are located in the region from the neck of the sac to the lower third of the bony canal and are the most common in adults. Low-level obstructions are located at the lower end of the nasolacrimal duct (23).

Different neoplastic lesions were identified and the impression of being a benign rather than malignant NLDO was based on the smooth surface of the obstructing soft tissue and the incomplete obstruction of the NLD manifesting as contrast distal to the obstructing lesion with lacrimal sac dilatation. The lack of adjacent structure invasion along with the widening of the bony nasolacrimal duct was more in favor of benign nature. Tumors derived from the lacrimal drainage system include lymphoma, Kaposi’s sarcoma, adenocarcinoma, angiofibroma, and squamous cell carcinoma (24). Papilloma and other benign lesions, such as oncocytoma and benign mixed tumors appear as filling defects within the lacrimal sac (25).
The most common neoplasms of the lacrimal sac are epithelial tumors and the most common benign epithelial tumor is papilloma (26).

NLDO secondary to olfactory neuroblastoma recurrence invading the nasolacrimal duct presented as thickened disorganized soft tissue at the sac-duct junction level. The most frequent recurrence of ONB is local, with rates from 20% to 40% (26). In the patient suffering NLDO secondary to non-Hodgkin lymphoma, CT-DCG revealed obstruction of the duct-sac junction with a mildly dilated lacrimal sac and relatively thickened wall. Lymphoproliferative diseases are the second most common type of tumor causing nasolacrimal obstruction leading to epiphora and acute or chronic dacryocystitis. Lymphomas are more frequent than benign lymphoproliferative lesions. Lymphosarcomas, reticulum cell carcinomas, and Hodgkin’s disease have been reported in the lacrimal sac (24,26).

In the patient with fibrous dysplasia, CT-DCG was superior to conventional DCG and revealed right nasal bone and bony lacrimal duct involvement. The added value of CT-DCG over CT was confirming the patency of the lacrimal duct system proximal to the obliterated level namely the canaliculi and the dilated lacrimal sac. Fibrous dysplasia involving the maxilla can result in nasal obstruction and orbital symptoms (27–30).

NLDO secondary to an infective process presented on CT-DCG as dilated lacrimal sac with retained secretions and stranded surrounding fat planes. In this study, the commonest level of obstruction in infectious NLDO was at the sac duct junction level. CT-DCG was superior to conventional DCG in demonstrating the size and content of the inflamed dacroceles. Despite that in three patients the contrast opacified segment was abruptly terminated at the common canaliculus on conventional DCG and a trial of canalicular probing was performed however not relieving the lacrimal duct obstruction; CT-DCG revealed the assumed common canalicular impedance due to dacrocystitis. The most common infectious agents responsible for dacrocystitis are streptococcus pneumoniae, staphylococcus, and pseudomonas. In acute and chronic dacryocystitis, the lacrimal sac demonstrates distension which can extend into the canaliculi, and filling defects may be noted secondary to pus or dacryoliths. On CT, chronic dacryocystitis appears as an inferior medial orbital mass with cystic dilation of the lacrimal sac (25). With acute dacryocystitis, postseptal inflammation may be present; that can cause orbital cellulitis with abscess formations. Although the diagnosis of dacryocystitis is based on clinical manifestations, imaging is valuable to exclude orbital cellulitis (31,32).

Manipulation of the lacrimal drainage system in patients with acute dacryocystitis carries the risk of spreading inflammation which can be reduced by using a flexible, hydrophilic, coated atraumatic guide wire. Potential complications when the inflammation spreads include pericystitis or extension around the lacrimal sac, orbital cellulitis and orbital abscess. Failure of antibiotic treatment of a chronic lacrimal abscess is not attributable to the choice of antibiotic agent but rather to obstruction of the lacrimal duct system distal to the lacrimal sac (33). In the higher potential risk of complications, visualization of the level of obstruction and identifying the cause of obstruction is crucial in the management plan. In the current study, dacryolithiasis was encountered in one patient with chronic dacryocystitis; who underwent dacryocystorhinostomy, and the dacryolith harboring fungal infection was retrieved from the lacrimal sac. Dacryoliths are typically found in the setting of chronic infections with superimposed fungal colonization and are most common in the lacrimal sac, but may occur in any part of the nasolacrimal system. Denuded epithelial cells clump with exudated proteins and debris to form a cast in the lacrimal sac and with time, the material eventually mineralizes, most typically with calcium to form dacryoliths. High calcium and phosphate levels within an obstructed lacrimal system may contribute to the formation of dacryoliths. Scanning electron microscopy showed dacryoliths as lobes and lobules built on an amorphous core material (34–36). On dacryocystography, dacryoliths appear as round or oval filling defects and on CT are characterized by focal high attenuation within soft-tissue attenuation mass with or without peripheral calcification.

Three of the four patients with idiopathic NLDO had only relatively tighter nasolacrimal bony canal. In the three patients with PANDO, the aspirated dacryocyst fluid was sterile and only mucous plugs were retrieved from the lacrimal drainage system. PANDO may be secondary to unrecognized low-grade dacryocystitis (26). The organisms in the lacrimal sac may contribute to inflammation and scarring and therefore to obstruction and dacryocystitis. A small minimum diameter of the bony canal is not the sole etiologic factor in PANDO (22).

PANDO is caused by fibrous obstruction secondary to chronic inflammation with hyperaemia and swelling of the mucous membrane of the nasolacrimal outflow system causing obstruction of the lacrimal passage (37). The most common site of obstruction is at the proximal lacrimal duct (38).

In a study to unveil the predisposing factors to PANDO, the reduced levels of mucin mRNA in a non-functioning though patent segment of the lacrimal passage, which is associated with epiphora, suggests that mucins ease tear flow through the efferent tear ducts (34).

In the majority of patients, NLDO is related to idiopathic inflammation with hyperaemia and swelling of the mucous membrane of the nasolacrimal outflow system where dacryocystography shows stenotic nasolacrimal duct with prestenotic enlargement. CT-DCG offer overview of the lacrimal system and neighboring structures while lacrimal endoscopy allows direct viewing of the causes of stenosis. Additionally, CT-DCG following topical application of a contrast medium shows the function of the nasolacrimal apparatus (37,39,40).

In the fourth patient of the idiopathic group proved to have sarcoidosis; CT-DCG revealed distended lacrimal sac with retained contrast, which failed to pass beyond the sac duct junction. We reviewed the CT-DCG data of the two patients with lymphoma and sarcoidosis of the NLD and concluded that histopathological analysis is indispensable for diagnosis; as CT-DCG and DCR revealed nonspecific findings. Due to the wide causes of diseases predisposing to PANDO; pursuing further measures to reach the underlying cause is essential if specific causes are not to be overlooked. The lacrimal sac can be involved by inflammation, the most common being granulomatous non-granulomatous inflammation, granulation tissue, lymphocytic infiltrate and sarcoidosis (26). Lymphoma is the second most common type of tumors (35). Lymphomas involving the lacrimal sac are usually secondary to systemic lymphoid involvement, but can be seen as a primary lymphoid tumor (41). The CT findings of an aggressive form
of lymphomatous infiltration involving the nasolacrimal duct area and the adjacent paranasal sinuses were reported (42). Although most patients with sarcoidosis of the lacrimal sac have a history of sarcoidosis or an abnormal appearance of the nasal mucosa or lacrimal sac, some cases do not and chronic dacryocystitis may be the initial presentation, with the diagnosis of sarcoidosis ultimately resulting from a biopsy at the time of DCR (43). Recognizing non-caseating granulomas on DCR specimen may be the instigating factor to search for other evidence of sarcoidosis. DCG findings are nonspecific and may show partial or complete obstruction of the lacrimal drainage system. Biopsy of the lacrimal sac wall at DCR is indicated if specific pathology is suspected. To minimise the risk of overlooking specific pathology, it is important to assess for systemic diseases, to inspect the lacrimal sac intraoperatively, and to biopsy the lacrimal sac when specific pathology is suspected. Specific pathology that might be overlooked with such approach includes sarcoidosis, lymphoma and papilloma. Overlooking specific pathologies can occur if biopsy is not performed in cases of PANDO. Chronic inflammation and fibrosis are the most common histopathologic findings in lacrimal sac specimens obtained during DCR and the rate of malignant NLDO is low enough to justify lacrimal sac biopsy only in suspicious cases (44–46).

In post traumatic lacrimal obstruction, CT-DCG can identify the site and cause of obstruction. Mid-facial fractures frequently involve the bones about the lacrimal sac fossa, and/or nasolacrimal ducts, leading to nasolacrimal obstruction. Fractures involving the distal portions of the nasolacrimal duct include the midface naso-orbital fractures, LeFort II, and LeFort III fractures. Bony fractures may also initiate a cicatrising reaction that may result in nasolacrimal duct obstructions (47).

CT-DCG is better in displaying the smaller components of the lacrimal system; the superior, inferior and common canaliculi. Spiral CT techniques with topical contrast material are especially useful in nasolacrimal obstructions related to facial trauma, prior sinus or lacrimal surgery and medial canthal tumors. Spiral CT reconstruction technology has improved the diagnostic accuracy in partial nasolacrimal obstructions by viewing the entire system from multiple projections (14).

The superficial location of the nasolacrimal system facilitates MRI with small surface coils which can give a high spatial resolution. MRI has limitations including low sensitivity in differentiating lacrimal sac diverticulum and local neoplasm. In contrast to CT-DCG, MR-DCG is not adequate to assess small drainage pathways (48).

The current study was performed simultaneously with a nasal sinus CT to provide anatomical background data for the nasolacrimal system before an endonasal procedure. Topical contrast instillation in the conjunctival sac, posing an added advantage of physiological drainage, or punctum cannulation was the ophthalmologist’s decision.

Nasolacrimal duct probing is a successful treatment of congenital nasolacrimal duct obstruction, nevertheless in about 20% of cases; there are persistent symptoms of NLDO. Surgeons may choose between repeat probing, nasolacrimal intubation, balloon catheter dilation, and dacryocystorhinostomy. CT-DCG is a valuable to evaluate probing and DCR failures where small size and inappropriate position of osteotomy are frequent causes of DCR failure (49).

Although nasolacrimal pathway obstruction is clearly demonstrated by CT-DCG; considerable overlap of imaging features may be encountered in cases of lymphoma, sarcoidosis and early idiopathic inflammatory cases, which may be addressed by tissue characterization. During this study, assessing the role of CT-DCG may have been limited by the non-availability of several nasolacrimal pathologies and different patterns of the encountered diseases; still we believe that CT-DCG is indispensable in the management of NLDO to assess the nasolacrimal drainage system and the adjacent facial skeleton, thus improving therapeutic planning.

References

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