Clinical & Refractive Optometry is pleased to present this continuing education (CE) article by Dr. Jennifer Murray and Dr. Leonid Skorin entitled **Dacryocystofluoroscopy: Dynamic Observation of Lacrimal Outflow.** In order to obtain a 1-hour Council of Optometric Practitioner Education (COPE) approved CE credit, please refer to page 237 for complete instructions.

Dacryocystofluoroscopy: Dynamic Observation of Lacrimal Outflow

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Abstract

Dacryocystofluoroscopy (DCGF) is a dynamic study of the lacrimal drainage system by means of x-ray which involves injection of a radiographic contrast dye into the canaliculus. This is a relatively simple way to diagnose, localize, and manage patients presenting with epiphora. This article will review the anatomy of the nasolacrimal system, followed by a description of how to confirm an obstruction clinically, and then how to perform DCGF. Clinical cases are presented showing how DCGF was used as a guide in making the final management decision.

Introduction

Imaging of the lacrimal drainage system is indicated for a variety of problems. Epiphora is the most common reason one might consider imaging, however, it can also be useful to visualize masses in or around the lacrimal sac, hemorrhagic tears, or trauma.[1] Current imaging techniques include dacryocystography (DCG), nuclear dacryoscintigraphy, computed tomography (CT), and magnetic resonance imaging (MRI). The relatively simple and affordable modality of DCG under fluoroscopy (DCGF) allows the examiner to visualize the movement of tears out of the lacrimal drainage system from start to finish. Because epiphora is a common clinical complaint, once it is determined that there is an obstruction in the lacrimal system, it is important to consider DCGF as a method of determining the location and type of obstruction at hand so that appropriate management decisions can be made.

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Anatomy of Lacrimal Drainage System

In order to better evaluate the results of dacryocystofluoroscopy, one must be familiar with the anatomy of the lacrimal drainage system. Tears travel from the lacrimal lake, an area in the medial canthus of the eye, through the puncta into the canaliculi, lacrimal sac, and nasolacrimal duct to drain through an opening in the nasal cavity just beneath the inferior turbinate.[2,3] There are two lacrimal puncta, located on a small elevation called the papilla, on the upper and lower lid margins. The opening of each punctum is approximately 0.3 mm and lead into a superior and inferior canaliculus.[2-4]

Each canaliculus proceeds 2 mm vertically from the puncta and turns nasally, continuing for about 8 mm. At the point where the canaliculi turn, the passage widens to approximately 2 mm to form the ampulla. The horizontal tubes narrow again to about 0.5 mm. They join at the common canaliculus, also called the sinus of Maier, in 90% of people.[2] The remainder of cases have two separate entries to the lacrimal sac from each canaliculus. The common canaliculus then enters the lateral aspect of the sac at an angle which produces the valve of Rosenmüller to prevent reflux of tears.[3-5]

The lacrimal sac is the widest portion of the lacrimal drainage system and averages 10 to 12 mm in length. Its width varies depending on how dilated it is, often with the more dilated state indicating an inferior obstruction. It usually lies flat in the lacrimal fossa and tends to be larger anteroposteriorly (4 to 8 mm) than laterally (1 to 2 mm).[1,2,4] Connecting the lacrimal sac to its continuation into the nasolacrimal duct is a narrowing and mucosal fold known as the valve of Krause. The duct then continues 12 to 18 mm, with approximately 10 mm passing through the nasolacrimal canal in the maxillary bone, ending at the inferior meatus of the nose just lateral to the inferior turbinate.[2,3] At the end of the nasolacrimal duct there is a fold of mucosal tissue called the valve of Hasner that prevents retrograde movement of fluid up the duct from the nasal cavity. The valve is closed in approximately 6% of neonates, often causing epiphora in these infants.[4,5]

Evaluating the Lacrimal System

Before performing DCGF, it is important to determine whether the cause of the epiphora is due to oversecretion,

misalignment of the puncta, or obstruction within the lacrimal drainage system. The nasolacrimal evaluation should begin by examining the eyelids and puncta for entropion or ectropion. The puncta should appear patent and symmetrically aligned with the globe. Next, the medial canthus should be palpated over the lacrimal sac to check for mucopurulent discharge to rule out dacryocystitis.[6] Once it is determined that the puncta are aligned and there is no infection, there are a variety of clinical tests one can perform to differentiate between oversecretion of tears or an obstruction in the nasolacrimal system.

A relatively quick and straightforward clinical method to diagnose nasolacrimal obstruction is lacrimal dilation and irrigation. This diagnostic procedure may even release a simple blockage. First, instill a drop of topical anesthetic into the inferior conjunctival cul-de-sac and perform punctal dilation. Next, use a 3-mL syringe filled with clear irrigating solution with a lacrimal cannula attached. Insert the cannula, making sure to follow the anatomy of the canaliculus 2 mm down and 8 mm nasally until you reach a hard stop at the nasal bone. Retract the lacrimal cannula slightly and inject the irrigating solution. Ask the patient if they taste the solution at the back of their throat. If so, this is a negative result which means the lacrimal drainage system is patent. This, however, does not indicate the system is fully functioning and should be considered when evaluating patients with ongoing complaints of epiphora. If the solution did not make it through to the throat, you can roughly localize the obstruction by monitoring in what fashion the fluid egresses the system.[4]

If the solution regurgitates back through the lower canaliculus only, this is a high-level obstruction located in the lower canaliculus. If it flows back out of the upper and lower canaliculi, this is considered a high- or mid-level obstruction that is either in the sinus of Maier or the lacrimal sac. If there is a delay in reflux or the solution is contaminated by mucopurulent discharge, consider this a mid- or low-level obstruction, usually in the nasolacrimal duct.[2,4]

After performing this test, if the location of the obstruction is not clear, or when the system appears to be patent with repeated complaints of epiphora, dacryocystography under fluoroscopy is indicated. This will show a dynamic radiographic image of the nasolacrimal system as contrast dye travels through, revealing the exact location and extent of obstructions or abnormalities.

Dacyrocystofluoroscopy Procedure

DCGF is a relatively simple and inexpensive procedure performed by injecting a radiographic contrast dye into the lacrimal drainage system with a cannula, providing constant view and remarkable anatomical detail of the nasolacrimal system with only a minimal increase in radiation compared to static films (maximum exposure is less than 5 roentgens).[7]

There are two main types of contrast material used for DCGF, oil-based and water-based. The oil-based formulations are more popular, readily available, and result in higher quality images.[4,8] The most common oil-based contrast medium used in the United States and Canada is Ethiodol® (Savage Laboratories). It has a normal clearing time of 15 minutes, with longer times indicating significant obstruction. Due to its low viscosity, this amber-colored oily fluid flows steadily through the lacrimal passageway.[4] In patients with iodine sensitivity, an alternative such as Gadobutrol® (Schering), should be used.[9] Care should be taken to avoid extravasation because this material can remain in the soft tissue for years, which can lead to an inflammatory granulomatous lesion.[10]

After the patient has signed a written consent form for the DCGF, have him or her lie in a supine position on the x-ray table. Trial x-rays may be taken to view any bony abnormalities, sinus air-fluid levels or to verify positioning. Several drops of topical anesthetic should then be instilled in the patient's lower conjunctival cul-de-sac before using a blunt punctal dilator to dilate the lower lacrimal punctum. Care should be taken to follow the anatomy of the canaliculus. Before inserting the cannula, any debris that may be present from the lacrimal sac can be rinsed with a syringe filled with saline.

The lacrimal cannula is connected to a small-diameter, 30-cm long Teflon catheter, which has been filled with contrast material that has been cleared of air bubbles. The lacrimal cannula is carefully inserted about 5 to 7 mm into the patient's lower canaliculus. The cannula and catheter are then taped into place so that the examiner's hands are not exposed to the central beam of the x-ray. Then, 0.5 to 1.0 mL of contrast medium is slowly and steadily injected through the catheter. Excess dye should be wiped immediately from the patient's eyelids in order to prevent obscuring details. The practitioner can easily analyze the fluoroscopy image as the dye traverses the lacrimal system. As the dye progresses, the clinician can instruct the radiology technician when to take the x-ray images. For the still x-rays, the Caldwell (posteroanterior) basic radiologic view shows the image optimally and magnification can help improve anatomic detail.[2,4]

Case Reports

Case 1

An 81-year-old Hispanic man was referred to us for ongoing symptoms of epiphora in both eyes. To evaluate his lacrimal system, we first observed that his lids and puncta were in normal apposition to the globe. The patient

Fig. 1 DCGF x-ray for the patient's right side. No obstructions or abnormalities noted.

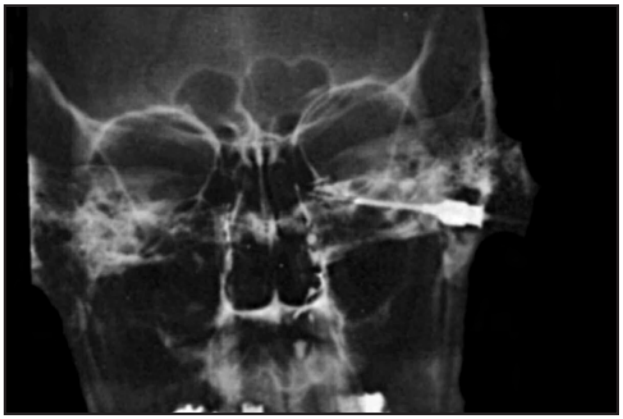

Fig. 2 DCGF x-ray for the patient's left side. No complete obstruction, however, multiple filling defects can be seen throughout the lacrimal drainage system.

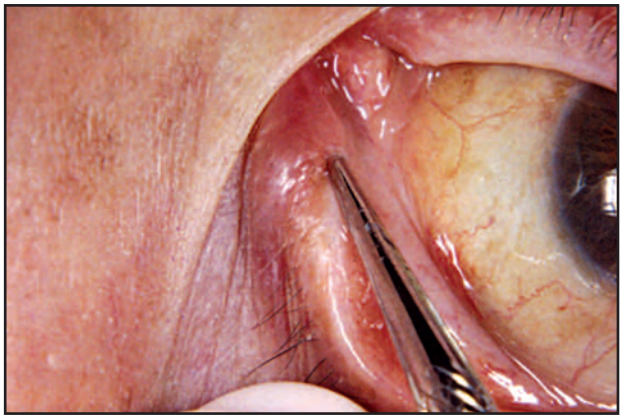

Fig. 3 Dilation of the punctum before performing 3-snip punctoplasty.

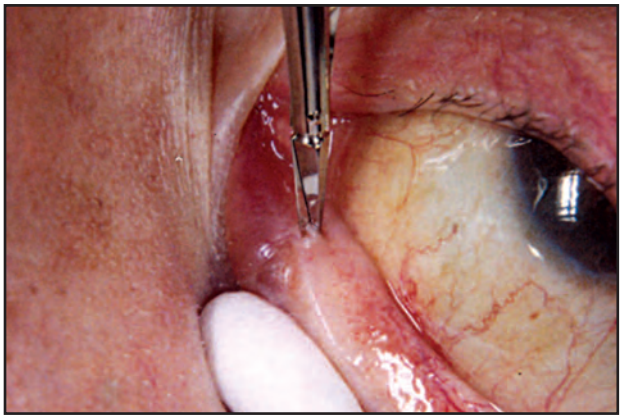

Fig. 4 Scissors oriented to perform the first snip.

was noted to have mild punctal stenosis of his left lower eyelid punctum. When performing lacrimal dilation and irrigation, he had a negative result (tasted saline at the back of his throat) for the right eye, and a positive result with pain when irrigation was attempted on the left eye. We were unable to localize the obstruction on the left side using irrigation, so we offered to perform a DCGF on the patient.

The patient was seen again at the radiology department of the local hospital. The trial x-rays before contrast dye injection appeared normal. We then performed DCGF starting with the right side, which we suspected to be patent so that comparison between the two could be made. The dye traveled through the system in the usual fashion (Fig. 1). We then proceeded to inject the left side with the suspected clinical obstruction, while observing the fluoroscopic image. These images showed that the dye was able to travel completely through the nasolacrimal system, however, the path was not smooth, having multiple filling defects (Fig. 2). These are suspected to be areas of stenosis. No diverticuli, dacryoliths, or fistulae were seen. Because the patient's left nasolacrimal system was not completely obstructed, we felt that the initial therapeutic intervention should address this patient's punctal stenosis. Therefore, the first surgical procedure performed was a 3-snip punctoplasty.

To perform the 3-snip punctoplasty, we started by injecting 2% lidocaine with epinephrine subcutaneously inferior to the lower punctum. The punctum was then dilated using a punctal dilator (Fig. 3). It was stretched and stabilized with a Bowman probe. The first snip was made on the posterior-medial edge of the punctum with the vannas scissors oriented vertically, extending approximately 1 to 2 mm on the conjunctival surface (Fig. 4). The next snip was performed with the scissors positioned laterally within the punctum with a slight lateral angle. The third snip was made to connect the ends of the first two incisions, resulting in excision of a small tissue section. It is optional to apply cautery to the incision edges to help maintain the opening. Immediately

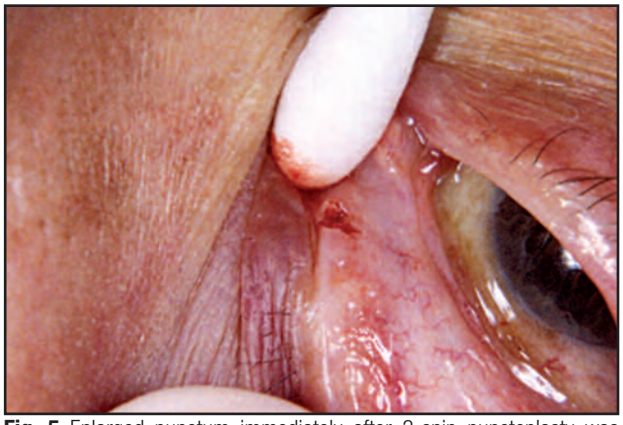

Fig. 5 Enlarged punctum immediately after 3-snip punctoplasty was complete.

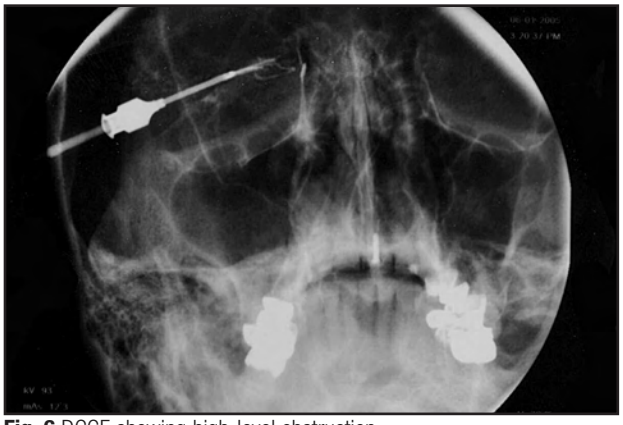

Fig. 6 DCGF showing high-level obstruction.

Fig. 7 DCGF showing no obstruction.

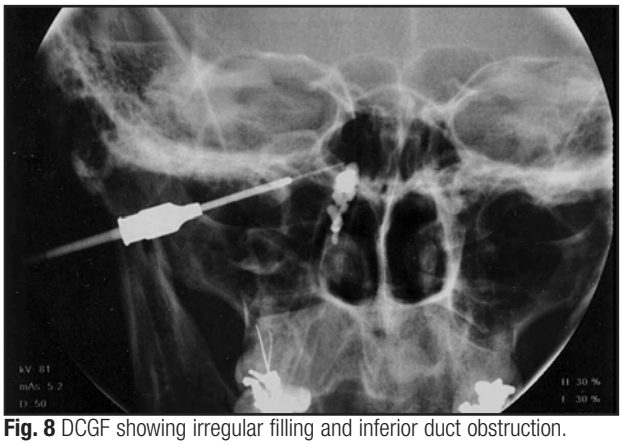

Fig. 8 DCGF showing irregular filling and inferior duct obstruction.

after the procedure, it is clear that the punctum has been enlarged (Fig. 5).[11,12]

If the punctoplasty does not relieve the patient's epiphora sufficiently, then an endoscopic dacryocystorhinostomy with silicone tube intubation or balloon catheter dacryoplasty may be considered.

Case 2

A 58-year-old man complained of watering of his right eye and having to constantly wipe his tears away. He denied any trauma.

A DCGF was performed and identified a high-level obstruction at the junction of the common canaliculus and the lacrimal sac. Prompt reflux into the superior canaliculus was seen following inferior punctal-canaliculus injection, without passage of dye into the sac (Fig. 6).

Common canaliculus stenosis should be suspected if any of these DCGF findings are seen: canalicular caliber is less than 1 mm, diameter is less than ipsilateral canaliculus, or canalicular dilatation occurs with increased injection pressure.[13] Canalicular obstruction or stenosis may occur following canalicular laceration, punctal plug placement, infection, chronic use of topical medication or papilloma formation.[14] The location of the obstruction is best defined by DCGF since the contrast dye flow is visualized as it encounters the obstruction. At this point still x-ray images may be taken. This direct visualization is not possible with simple office irrigation. Routine DCG does not show the dynamic aspect of the dye's encounter with an obstruction.

The patient underwent probing and irrigation in the office and was treated with tobramycin/dexamethasone eye drops for one week. One month after the probing procedure he did not have any recurrence of his epiphora.

Case 3

A 57-year-old woman presented with a 16-month history of recurrent episodes of left-sided epiphora and dacryocystitis.

A DCGF identified a normal transit of contrast dye through the left nasolacrimal system. There was no obstruction noted in the canaliculi and the lacrimal sac

and duct appeared smooth and of normal caliber. No filling defects were noted (Fig. 7).

Although it is true that partial obstruction may present clinically without a definitive level of blockage, in this case it was felt that the patient had not been adequately treated previously for the dacryocystitis. Therefore, she was started on a 10-day course of topical tobramycin/dexamethasone and oral amoxicillin/clavulanate 500/125 mg. There was no recurrence of this patient's epiphora or dacryocystitis after six months of follow-up.

Case 4

A 50-year-old woman complained of a two-week episode of constant right-sided epiphora. She denied any trauma.

A DCGF identified an abnormally dilated lacrimal sac with loss of its smooth wall appearance. The transit time of the contrast dye was found to be prolonged. There appeared to be an obstruction in the inferior aspect of the duct. The final dye distribution showed a mottling and clumping at the sac and duct walls (Fig. 8).

Thick secretions or other debris may cause this type of appearance. Dacryoliths or neoplasms usually form filling defects that would appear as dark objects within bright contrast.[14]

This patient was started on topical tobramycin/dexamethasone and scheduled for an otorhinolaryngology consultation. Before being able to see the otorhinolaryngologist and one week after the DCGF, the patient called to inform us that her epiphora had resolved. The patient was asked to discontinue her eye drops. She has had no recurrence of epiphora over the last three years.

We have had several similar cases where the epiphora has resolved after a DCGF procedure even when office probing and irrigation have been unsuccessful. This appears to occur only in cases with partial obstruction that has existed for less than one or two months.

Conclusion

DCG was the first radiologic method used to evaluate the lacrimal system by Dr. A.E. Ewing in 1909.[15] The fluoroscopy technique was invented a year after the advent of x-rays, but was not used until many years later with DCG.[16] For the purpose of defining areas of stenosis, dilation, or masses within the lacrimal system, DCG and DCGF are still very useful. However, in DCG without fluoroscopy, the lacrimal drainage system might be incompletely examined with static films alone. The advantages of using DCGF include its relative simplicity and low cost to the patient; the ability of the ophthalmologist to interpret the results independently without needing the presence of a radiologist; and the constant visualization of the dynamic movement of the tears through the drainage system under fluoroscopy. Video fluoroscopy is used commonly to analyze other areas of the body, such as swallowing, but has not been documented to evaluate the lacrimal system.[17] This technique should be attempted in the future, as it would have the advantage of allowing the practitioner to replay the video multiple times and to stop it at any point to look at a static picture of a specific point in time. The use of DCGF to localize and classify obstructions in the lacrimal drainage pathway facilitates diagnosis and aids in the selection of the most appropriate treatment in patients presenting with epiphora. ❑

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