Lacrimal Scintigraphy v2

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This guideline must be read in conjunction with the BNMS Generic Guidelines

Purpose

The purpose of this guideline is to assist specialists in Nuclear Medicine and Radionuclide Radiology in recommending, performing, interpreting and reporting the results of Lacrimal Scintigraphy. This guideline is intended to assist individual departments to formulate local protocols.

Background Information

Lacrimal Scintigraphy was first described in 1972 and is an established method for assessing patency of the lacrimal drainage system. Although fine anatomic detail cannot be defined the method allows safe, non-invasive, physiological and, if desired quantitative, assessment of the lacrimal system.

In the normal system, with no laxity of the eyelids and a normal rate of blinking, tears, produced by the lacrimal gland situated on the superolateral aspect of the orbit, rapidly traverse the corneal surface of the eye over which they maintain a thin protective cover through blinking. In the medial canthus of each eye the tears flow through puncta into upper and lower canaliculi, then into a common canaliculus and subsequently through the valve of Rosenmuller into the 10mm long lacrimal sac. The sac empties into the nasolacrimal duct with the valve of Krause situated at the junction of the two. The nasolacrimal duct has a 12mm intraosseous portion and a 5mm membranous portion and terminates at the valve of Hasner in the nasal cavity.

Abnormalities of lacrimal drainage commonly present with epiphora or overflow of tears from the conjunctival surface of the eye onto the facial skin. Unilateral or bilateral epiphora may result from malfunction at any level within the lacrimal pathway whether this be a problem with tear production, tear flow or tear drainage. Increased tear production may result from ocular surface irritation due to local infection and/or inflammation, eyelid trauma or occupational hazards. Abnormalities of tear flow may be a consequence of eyelid malposition (in-turning/entropion or eversion/ectropion) or may have a neurogenic aetiology such as in facial nerve palsy or myasthenia gravis. Impairment of drainage can be seen with canalicular obstruction following infective or inflammatory canaliculitis, punctal stenosis, dacrocystitis, lacrimal sac malfunction and nasolacrimal duct obstruction.

Even when there is no mechanical or physical obstruction evident on syringing of the nasolacrimal duct, scintigraphy may demonstrate impaired flow through one or both ducts. This impairment may be termed ‘functional impedance to flow’ a phrase used to describe epiphora without tear overproduction but with easy passage on syringing and with delayed or absent excretion of tracer through the nasolacrimal system without anatomical obstruction of the system. Use of the term implies exclusion of the causes of tear hypersecretion as well as problems with the lacrimal system proximal to the nasolacrimal duct including punctual stenosis and cannalicular blockage.

The overall aim of lacrimal scintigraphy is to demonstrate the level of impaired drainage.

Clinical applications

1. Indications

Investigation of epiphora.
To demonstrate functional patency of the nasolacrimal duct in symptomatic patients.
To demonstrate the level of impaired drainage within the nasolacrimal system.
To quantify tear flow in dry eye syndromes.
Follow up/assessment of response to therapy eg post eyelid surgery.

2. Contraindications

Absolute: Acute Conjunctivitis requiring treatment.
Relative : Irritable/Itchy eyes on the day of the test.
Inability to tolerate the imaging procedure.
Pregnancy/Breast feeding: The effective dose from lacrimal scintigraphy is 0.04mSv and therefore no interruption to breast feeding is required however, as epiphora is a non-life threatening condition, consideration should be given to delaying investigation until after breast feeding has ceased. The same principle applies in pregnant patients.

Procedure

1. Patient Preparation

1.1. Explanation of the procedure and the time course of imaging and the relevant history taken and symptoms recorded e.g. pain or scratchiness in eyes; if one or both eyes affected, previous surgeries or deviated septum.

1.1 Remove contact lenses if worn. Eye makeup should be avoided for the procedure.

1.2 Patients generally imaged sitting using a head support and chin rest (similar to a slit lamp head rest). The patient should be positioned and comfortable as possible before the administration to avoid movement during the scan.

1.3 Use of waterproof coverings to protect patient clothing in case of drips or excess epiphora.

1.4 History taken prior proc (pain or scratchiness in eyes; both eyes affected?) and clinical history, such as surgeries or deviated septum.

1.5

2. Radiopharmaceutical

2.1 Technetium-99m colloid 20MBq in 1ml is dispensed into a sterile tube with screw lid. A small amount of solution is drawn into each of two micropipettes. A single drop (10ul) of solution is delivered to each eye. If quantification is envisaged then a graduated micropipette is required for administration.

A possibility of an alternative use of 1mL syringe with a red cap, with 99mTcO-4 diluted between 0.1 and 0.2 mL and a bubble of air may need to be considered if the micropipette is not available. For quantification purposes, the residual in the syringe is measured.

NB: Some publications refer to use of Tc-99m-Pertechnetate drops. Current ARSAC guidelines refer to use of 99mTc-colloid.

2.2 ARSAC diagnostic reference level is 4MBq per eye. The dose to the lens of the eye is estimated to be 0.02 – 4 mGy and will be dependent upon the degree of functional impairment to drainage and whether a post administration saline wash is used.

2.3 Paediatric doses should be calculated as per ARSAC guidelines.

3. Protocols

Technique of Administration

3.1 The patient's head is tilted backwards slightly. At this point, the camera should be already set and ready to start the dynamic sequence.

3.2 A single drop of radiolabelled solution is placed into the lateral canthus of each eye using a micropipette and ensuring that the pipette does not touch or make contact with the corneal surface or the eyelashes. A separate pipette is used for each eye and if sufficient personnel are available a drop should be instilled into each eye simultaneously. The drops should be, as far as is possible, equal in size. The patient should not blink during drop administration. Any inadvertent spillage or immediate epiphora is wiped.

3.3 The patient's chin is positioned in the chin rest of the head support and a head strap is fastened to minimise movement. Alternatively, the patient should be asked to either place their forehead or nose against the detector or the chin against the detector trying to reach a stable position.

3.4 The patient is encouraged to blink normally after instillation.

3.5 Imaging commences as soon as possible following drop administration.

4. Image Acquisition

4.1 Single detector gamma camera with head positioned vertically or dual detector system where one head can be rotated to face outwards.

4.2 Pinhole Collimator with 6mm insert (3mm insert can be used if only one eye is imaged). A pinhole collimator is considered optimal but some centres report successful use of a LEHR collimator.

4.3 Patient positioned in head support and chin rest with patient to collimator distance optimised to allow visualisation of both eyes and maintained constant throughout the procedure. Patient positioning relative to the pinhole collimator is checked prior to radiopharmaceutical administration and adjusted with the use of cobalt markers, placed on the lateral borders of the eyes, to ensure both eyes are within the field of view. Ideally the bridge of the nose should be about 5cm from the collimator but the patient position should be adjusted until the image is as large as possible bearing in mind that magnification falls with increasing distance. The sensitivity of the pinhole collimator drops significantly with distance and at 5cm is over six times more sensitive than the same collimator at 15cm.

4.4 Image acquisition commences immediately after drop instillation with minimal delay.

4.5 Any epiphora evident during acquisition should be gently wiped using absorbent swabs taking care not to cause smearing of activity onto the face.

4.6 Image acquisition protocol:
20% window centred on the 140keV photopeak of Tc-99m.
Dynamic images: 128 matrix, zoom 1.0.
Static images: 256 matrix, zoom 1.0.

60 x 15 second frames (15 minute initial dynamic sequence).
60 second static image with cobalt markers (eg left side, nasal bridge, tip of nose +/- chin). Late imaging may be acquired to 30-60 minutes post administration.

4.7 Up to 3 drops of 0.9% saline solution instilled into the lateral canthus of each eye preferably simultaneously.

60 x 15 second or 15 x 1 minute frames (15 minute post saline wash dynamic sequence).
60 second static image with cobalt markers.
Patient asked to blow his/her nose: 60 second static image immediately post blow.

4.8 If both eyes have completely drained at the end of the initial 15 minute dynamic sequence and marker static image, the post wash sequence may be omitted however saline drops should be administered to wash out any remaining residual activity.

NB: The purpose of the ‘saline wash’ is to reduce the absorbed radiation dose in the eye.

5. Data Analysis

5.1 Images are reviewed as a cine display and may be summed to display 15 x 1 minute images however the 15 second frames are useful for determining the time sequence of passage of activity from the lateral canthus of the eye to the medial canthus and through the nasolacrimal ducts in the early stages of the study. Motion correction may be applied if required.

5.2 With respect to the initial image sequence note is made of the timing of appearance of activity in the medial canthus, in the upper part of the nasolacrimal ducts and in the lower ducts bilaterally.

5.3 Any pooling of tracer within the eye/eyes, any apparent pooling in the ducts and the presence of epiphora is noted. With the resolution of the procedure it is not possible to visualise the upper and lower cannaliculi as discrete structures and it is difficult to separate the lacrimal sac from the upper part of the nasolacrimal duct.

5.4 The post wash sequence is best viewed as 1 minute frames. Depending on the findings of the initial sequence note is made of the appearance of activity within the ducts, epiphora and pooling as above.

5.5 The static images are displayed with markers labelled. Right and left markers are placed on the post blow image.

5.6 If desired regions of interest may be drawn around the palpebral apetures, the lacrimal sacs and nasolacrimal ducts. From these regions time activity curves can be derived. These curves may aid interpretation by giving some indication of the timing and pattern of passage of tracer through the nasolacrimal systems. Accuracy is, however, severely affected by patient movement and heavily dependent on the relative position and overlap between regions of interest. It is difficult to accurately define the cannaliculi and lacrimal sac distinct from the upper part of the nasolacrimal duct.

6. Interpretation Criteria

6.1 In the normal eye, as demonstrated by fluorescein dye studies, activity placed within the lateral canthus should be rapidly cleared by blinking and appear in the medial canthus. When the nasolacrimal drainage system is patent activity should subsequently appear in the nasal cavity without undue delay. Any deviation represents an abnormality of drainage however there is wide variation in the ‘normal’ transit time from lateral canthus to lacrimal sac, from sac to nasolacrimal duct and from duct into the nose presumably due to variation in the frequency and intensity of blinking, changes in the volume of tears produced, variations in tear flow, resistance offered by valves in the lacrimal system and other factors such as emotion and conjunctival irritation. Various publications have quoted a wide range of transit times and clearance values however the value of quantification over qualitative and careful review of the dynamic

images is open to question given that variable tear flow is a normal feature of lacrimal drainage.

Gencoglu et al (2005) describe a half time of tear clearance of 3 – 6 minutes in normal subjects (mean 4.16 +/- 1.22 minutes). This is calculated by defining a region of interest over the medial canthus, correcting for decay and deriving a time activity curve. Wearne et al defines impaired drainage as follows: 'Presac delay' when there is hold up at the inner canthus and failure to reach the lacrimal sac by 3 minutes post drop instillation, 'Preductal delay' when there is early filing of the lacrimal sac but no sign of emptying by 5 minutes post drop instillation and 'Intraduct delay' when tracer is seen in the upper duct by 5 minutes post instillation but there is no further drainage over the next 15 minutes.

In the authors experience; after instillation of a single drop of tracer into the lateral canthus of the eye, activity is usually apparent in the medial canthus within the first 15 seconds post administration. The upper parts of the nasolacrimal ducts are visualised shortly thereafter and the lower ducts by the mid to end of the initial 15 minute image sequence.

6.2 In the symptomatic eye when tracer appears as expected in the medial canthus but fails to drain via the nasolacrimal duct into the nasal cavity and, as in the majority of cases, where patency of the nasolacrimal duct has been demonstrated by syringing this is best referred to as 'functional impedance to flow' rather than 'obstruction'. **NB:** The use of the term impedance rather than obstruction is at the request of ophthalmology colleagues who find the term 'obstruction' confusing when anatomical patency has been demonstrated.

6.3 Instillation of saline drops after the initial image sequence and static image leads to overloading of the tear film. When tracer fails to drain via the nasolacrimal duct until after saline drop instillation this may represent partial functional impedance to flow.

6.4 In some cases there appears to be temporary impairment to passage of activity into the nasal cavity ie in the distal nasolacrimal duct which may clear following blowing of the nose. Whilst this may imply local inflammation it has also been described in normal asymptomatic individuals therefore may merely represent resistance offered by the valve of Hasner.

6.5 The presence of pooling of tracer within the orbit suggests either eyelid laxity or impairment of the tear flow mechanism.

7. Sources of Error

7.1 Delay in commencing imaging after drop insertion may prohibit comment on the clearance of tracer across the eye(s) thus preventing assessment of the adequacy of the blinking

mechanism which transfers tears from the lateral to the medial canthus.

7.2 Significant asymmetry between the two eyes with respect to the size of the drop of fluid and thus the administered activity may hinder interpretation. In such cases, and also when there is significant epiphora leading to loss of administered activity and images of suboptimal diagnostic quality, consideration should be given to repeating the study.

7.3 The normal precorneal tear film has a volume of approximately 7ul thus a 10ul volume of administered activity is greater than the volume of tears present over the normal conjunctiva. Care should be taken to ensure that the administered volume is not in excess of this amount so as not to overload the tear film.

7.4 Although motion correction can be applied to the data a significant degree of patient movement will degrade image quality. Patient comfort prior to acquisition should therefore be maximised.

7.5 Spillage of activity from the pipette onto the face should be avoided as this will significantly impair image quality.

7.6 If the patient is not positioned as close as possible to the collimator insufficient counts will be collected and suboptimal images acquired.

7.7 Too small a pinhole insert will decrease sensitivity hence the recommendation for a 6mm insert for imaging of both eyes at the usual distance. For imaging of a single eye the smaller 3mm insert can be used at shorter distance to achieve greater magnification and better resolution. In such circumstances it may be possible to resolve the upper and lower cannulici.

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Approval

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Review

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