

Evaluation of lacrimal apparatus



Balasubramanian Thiagarajan

Drtbalu's otolaryngology online

Introduction:

Dacryocystorhinostomy as a treatment modality for epiphora is commonly being performed endonasally using a nasal endoscope by otolaryngologists. It is hence imperative that they diligently examine the entire lacrimal system before proceeding with the procedure. Despite the commonality of this surgical procedure, standard otolaryngology text books contain fewer literature on this subject. History of surgery for nasolacrimal pathway obstruction dates back to Hamurabi 2200 B.C¹. Dacryocystorhinostomy is the undisputed treatment of choice for lacrimal system drainage obstruction below the level of common canaliculi. Endonasal approach of dacryocystorhinostomy was first described by Caldwell in 1893².

Epiphora can be caused by blockage of lacrimal drainage system / excess lacrimation / loss of lacrimal pump mechanism. Lacrimal pump mechanism could be disrupted due to lower lid laxity or weakness of orbicularis oculi muscle. Normal lacrimation / or excess of it can be caused by irritation to cornea / conjunctiva³. This reflex is initiated by stimulation of trigeminal nerve. Trigeminal stimulation can be caused by:

1. Corneal foreign body
2. Keratitis
3. Conjunctivitis
4. Ocular surface disorders (dry eye)

Epiphora:

Greek terminology meaning "Downpour".

This is defined as excessive watering of eye. This is invariably caused by obstruction to tear drainage. Causes of epiphora include:

Congenital: Congenital nasolacrimal duct obstruction. Incidence varies between 1-6%⁴. It is believed that massage of entire naso lacrimal system relieves obstruction in more than 90%⁵ of cases. Majority of these obstruction resolve during the first year of life hence urgent surgical management is not necessary⁶. Probing is also known to be beneficial in these patients. The time of probing is controversial. Probing is advised up to the age of 5 in these patients⁷.

Acquired:

1. Primary acquired nasolacrimal duct obstructions
2. Dacryocystolithiasis
3. Orbital / lacrimal trauma
4. Canalicular lacerations
5. Actinomyces within the canaliculi – Actinomyces are anaerobic gram positive bacilli resembling fungi. These organism are normal commensal of oropharynx. These organism are capable of causing cast – forming canaliculitis⁹ leading onto lacrimal tract obstruction.
6. Canalicular infections following herpes infections / ectropion – Viral infections constitute a well recognised common cause of acquired canalicular obstruction⁸. These patients give history of an episode of blepharokeratoconjunctivitis before epiphora. Antivirals (idoxuridine) which are prescribed for this condition too add to the woes by causing more lacrimal obstruction. Naso

lacrimal obstruction caused by antivirals are transient and disappear after the drug is discontinued. Herpes simplex viral infections are known to cause punctal changes.

Clinical examination goal in these patients is to distinguish between epiphora and lacrimation. While epiphora needs to be surgically managed medically. The focus should be in differentiating anatomical obstruction from functional disorders.

Anatomical obstruction:

Obstruction to the lacrimal drainage system is the feature to look for in this condition. Pathological changes could be seen involving the lacrimal sac, irregularities in lacrimal drainage system (canalicular stenosis, canalicular blockage, obstruction to nasolacrimal duct, diverticulosis formation etc.) Lacrimal pathways can be obstructed due to internal derangements like inflammation of the epithelial lining. This is known as intrinsic obstruction. If lacrimal pathways are affected by deforming lesions from outside like tumors causing compression to it has been termed as extrinsic obstruction.

Physiologic dysfunction causing epiphora:

This is also known as functional epiphora. Here there are no anatomical changes to the lacrimal pathway. The functioning lacrimal pump mechanism is at fault. Pump mechanism can be affected in conditions like eyelid malpositions, eversion of lacrimal punctum, poor orbicularis oculi muscle tone as seen in patients with Bell's palsy.

Grading of epiphora:

The commonly used grading system was devised by Sahlin ¹⁰.

Grade	Degree of Epiphora
0	No epiphora
1	Epiphora only outdoors and during windy times
2	Outdoor epiphora No indoor epiphora
3	Outdoor and indoor epiphora

Anatomy of lacrimal system an overview ¹¹:

The lacrimal system consists of a superior and inferior puncta at the medial ends of upper and lower eyelids. These two drain into upper and lower canaliculi. These two canaliculi join to form the common canaliculus. This zone is known as the upper lacrimal system. The common canaliculus inturn leads into the lacrimal sac. The sac is about 12 - 15 mm long. It eventually narrows and

leads into the nasolacrimal duct which drains into the inferior meatus of the nose. The nasolacrimal duct is about 18 mm long. The sac and the duct comprise the lower lacrimal system. The junction between the common canaliculus and the lacrimal sac is guarded by the Rosenmuller valve. This valve prevents tear reflux. The nasal end of the nasolacrimal duct at the level of inferior meatus is guarded by Hasner's valve.

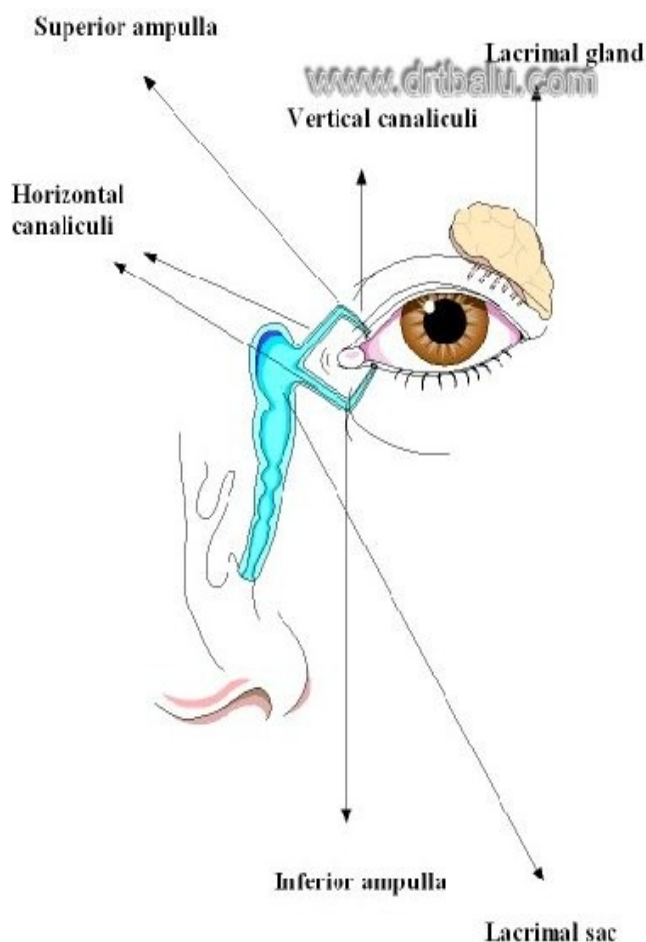


Figure showing the entire lacrimal system

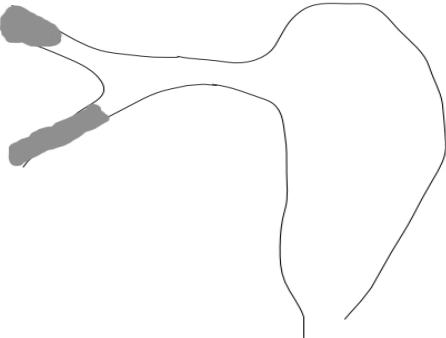
Sites in the lacrimal system prone for obstruction:

Suprasaccal obstruction:

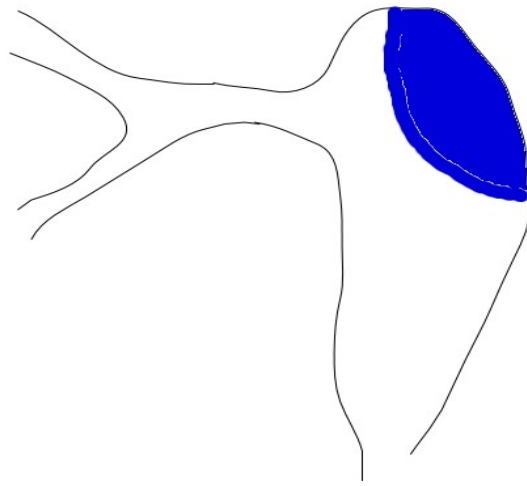
In this type obstruction lies proximal to the lacrimal sac. Obstruction can occur at the level of upper canaliculus, lower canaliculus and common canaliculus. Obstruction in these areas can occur following herpetic infections, trauma, irradiation.

Saccal obstruction:

Here obstruction occurs at the level of lacrimal sac. This could be caused by tumors, diverticula, trauma etc.



Diagrammatic illustration of suprasaccal obstruction



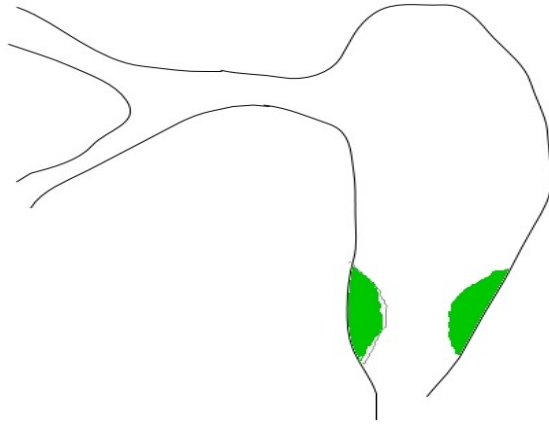
Diagrammatic illustration of saccal obstruction

Subsaccal obstruction:

In this category the obstruction lies below the level of lacrimal sac. This condition commonly requires endoscopic dacryocystorhinostomy. This obstruction is more common than the rest.

Causes include:

1. Congenital nasolacrimal duct obstruction
2. Primary acquired nasolacrimal duct obstruction
3. Nasolacrimal duct obstruction following FESS



Diagrammatic representation of incomplete subsaccular obstruction

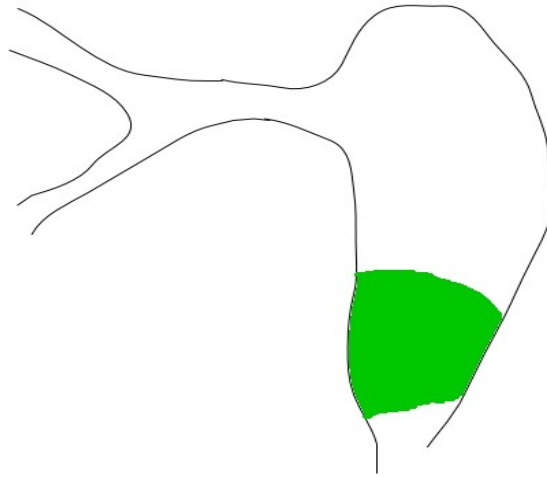


Illustration showing total subsaccular obstruction

Functional obstruction:

This controversial term is used to explain those patients whose lacrimal system is patent to syringing but they still complain of epiphora. It should be borne in mind that the term obstruction should be used only to indicate anatomical obstruction only.

Diagnosis of epiphora the Philosophy behind it:

Theoretically speaking excessive tearing may be caused by -

Hypersecretion
Epiphora
Combination of both

Diagnostic evaluation should include:

1. Quantification of tear production
2. Assessment of nasolacrimal system patency
3. Differentiating epiphora from lacrimation
4. Defining the pathological process of epiphora
5. Differentiating anatomical from functional obstruction
6. Attempting to locate the obstruction in order to define the optimal surgical approach

Classification of Tests for lacrimal drainage pathway:

Anatomical tests
Functional tests
Secretory tests

Anatomical tests:

These tests are performed to locate the probable area of lacrimal tract obstruction. These tests include:

Palpation of lacrimal sac
Syringing / irrigation
Diagnostic probing
Dacryocystography
Nasal examination
CT / MRI

Functional tests:

These are performed to assess the function of lacrimal apparatus under physiologic conditions. This test is performed if there is no obstruction as evidenced by negative anatomical tests. These tests include:

Flourescein dye disappearance test
Scintigraphy
Jones dye test I
Sacharin test

Tests of secretion:

These tests are performed to assess secretory function of the lacrimal apparatus. These tests are performed in examining dry eyes. These tests include:

Schrimers test
Bengal Rose test
Tear-film break up
Tear lysozyme

Knowledge of various causes of lacrimation and epiphora really helps in clinical examination of these patients.

Excess lacrimation:

Supranuclear causes – Psychogenic / emotions
Stimulation of V cranial nerve – (Reflex tearing)
 Lid causes (Blepharitis / Trichiasis)
 Conjunctival diseases
 Corneal diseases
 Neuralgia
 Ocular inflammation
Infranuclear causes – facial palsy, aberrant innervation, crocodile tears
Lacrimal gland stimulation
Others – Bright lights, sneezing

Epiphora:

Functional insufficiency
 Incorrect lid closure
 Lid malposition
 Punctal eversion
 Punctal medialization
Anatomical obstruction

Combined lacrimation / epiphora – A combination of the above two categories

 Facial nerve palsy – Corneal irritation and pump defects

 Lower lid ectropion – Conjunctival irritation , ineffective pump mechanism

 Thyroid diseases – Corneal irritation, defective canalicular function

Clinical history:

This is a very important aspect of lacrimal apparatus examination. This will provide vital clues to the presence of canalicular disorders¹². History should include patient's present and past ophthalmological problems, nasal symptoms, medical and interventional relevant procedures also. Unilateral tearing usually indicate obstructive pathology whereas bilateral tearing could be physiological. A child with a history of tearing since birth should arouse suspicion of membranous obstruction to nasolacrimal duct. Nasal disorders like nasal polyposis / sinusitis can also cause unilateral epiphora.

Inspection and palpation should involve the following areas:

1. Eyelids
2. Medial canthus
3. Palpation of lacrimal sac

Eye lid examination:

Look out for lower eyelid laxity

Ectropion

Punctal eversion

Trichiasis

Blepharitis

Snap-back test – This test is performed by pulling the lower eye lid down and away from the globe and held for several seconds. On release the lower lid resumes its normal position. The time taken for resumption of normal position is noted. The patient should not blink during the test. This test provides an assessment of laxity of lower lid. The longer it takes for the lower lid to spring back to position the more lax it is. This test is graded on a scale of 4 starting from 0. 0= normal and 4= lax lower lid.

Medial canthal laxity

Lateral canthal laxity

Orbicularis oculi muscle tone check

Pinch test – This test helps to assess orbicularis oculi muscle tension.

Examination of medial canthus:

Lacrimal sac enlargement will be seen as mass below medial canthal tendon.

Enlargement above medial canthal tendon indicates neoplasm.



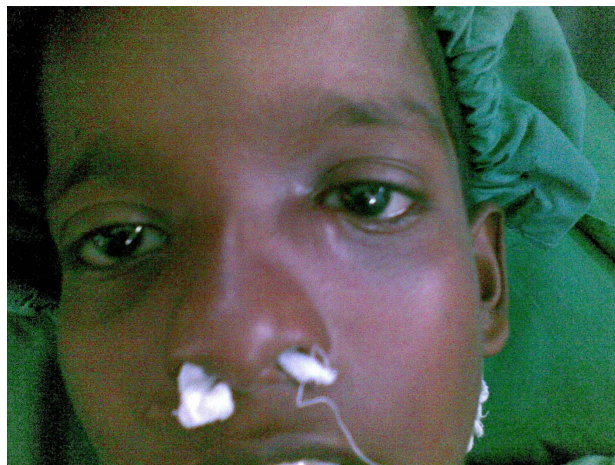
Swelling above medial canthus



Lacrimal sac being emptied



Swelling over medial canthus



Swelling below medial canthus

Palpation of lacrimal sac:

Normal sac is not palpable. Sac swelling is usually confined to below the medial canthal tendon. If there is neoplasm then it is likely to extend above the medial canthus.

Reflux of tears / pent up mucopurulent secretions can be seen on palpating the lacrimal sac area.

Pain and tenderness over this area indicates acute dacryocystitis.

Dye excretion tests:

These tests help in ascertaining drainage functions and patency of the entire nasolacrimal system. Fluorescein dye is used for this purpose. This test is considered to be more physiological¹³ since

the lacrimal system is not instrumented and the dye flows along with tears through the normal passages. The principle of this test is evaluation of residual fluorescein dye in the eye following instillation of one drop of it into the unanaesthetized conjunctiva.

Caution: This test doesnot distinguish anatomical from functioning defects ¹⁴.

In performing this test one drop of 1% fluorescein is instilled into the lower fornix of each conjunctival sac. After 5 mins, the thickness of fluorescein of the tear meniscus is measured using cobalt blue filter. Studies reveal that it takes 5 mins for tears to normally drain through the system. This test can safely be performed in infants and children ¹⁵.

Presence of fluorescein gives no information on the localisation of obstruction. Presence of residual fluorescein is an indication for probing and syringing. When performing this test in infants the child should be held in a vertical position.

Dye test grading:

0=No fluorescein in the conjunctival sac

1=Thin fluorescing marginal tear drop persists

2=More fluorescein persists somewhere between 1 and 3 grades

3=Wide brightly fluorescein tear strip

Among these grades 0 and 1 are considered normal

False negatives can occur in:

1. Large lacrimal sac
2. Mucocele
3. Distal nasolacrimal duct block

Break up time test:

This test is performed by placing a drop of fluorescein in the external canthus in the lower eyelid. Its transport can be observed from lateral to medial across the eyelid and into each punctum. Holes in the tear film can be observed. This is break up time test.

Jones dye tests: This group of tests are used to distinguish between functional and anatomic outflow problems. The primary test is performed by placing topical anesthetic and fluorescein dye into the conjunctival sac. Topical 4% xylocaine and oxymetazoline nasal sprays may be used to anesthetize and vasoconstrict the inferior meatus of the nose. A cotton tipped applicator is placed beneath the inferior turbinate near the opening of the nasolacrimal duct. Recovery of fluorescein dye in the nose indicates a functionally and anatomically patent system. Non recovery of the dye (negative result) suggests a functional or anatomic blockage.

In the event of negative dye test, secondary dye test should be performed. This test is performed after removal of residual fluorescein from the conjunctival sac. Clear saline solution is placed into the inferior canaliculus using a syringe / cannula. The irrigant is retrieved from the nasal cavity by tilting the patient's head forward over a basin. If fluorescein dye is present in the irrigant (positive

result) then it is assumed that the upper lacrimal system is functional while the lower system is partially open and is not functional. Recovery of a clear irrigant (negative result) indicates a functional problem with the upper system.

Caution: This test is useless in patients with total lacrimal tract obstruction. This test should be performed only if the lacrimal system is patent for syringing.

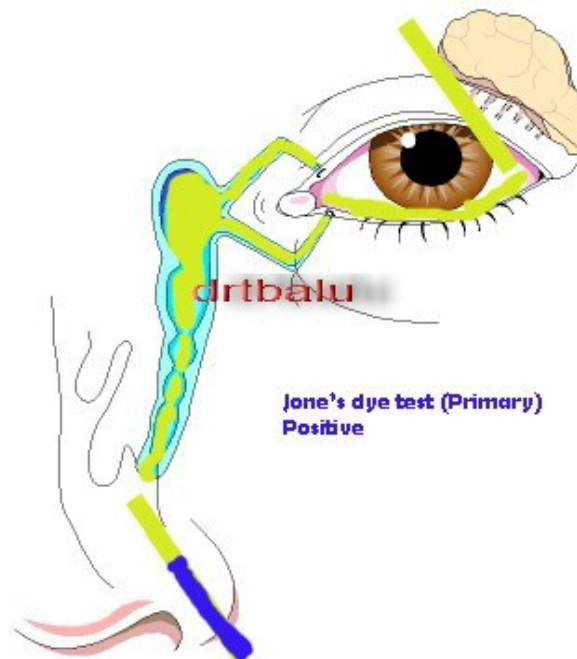


Diagram showing primary Jones test

Saccharin test:

This test is more or less similar to fluorescein dye test. This test is also hence physiological. A drop of saccharin is placed into anesthetized and the time taken for the patient to taste saccharin is measured. Approximate time is about 3.5 mins. The flip side in this test is that the patient should have normal taste sensation.

Diagnostic probing and lacrimal syringing:

These are invasive tests. They provide valuable information on location of obstruction. They establish diagnosis of anatomical obstruction in the lacrimal system. This test is virtually useless in functional obstruction¹⁶. Syringing / irrigation of lacrimal system is not a physiological test since the pressures used is more than the normal pressure of lacrimal system. Hence this test should be interpreted with fluorescein dye test and clinical examination.

Procedure:

1. Topical 4% xylocaine drops applied to the conjunctiva
 2. Punctum dilator is used to dilate the punctum and ampulla
 3. A blunt cannula is placed in the inferior canaliculus. The lower eyelid is pulled down to straighten the inferior canaliculus. Superior canaliculus is gently stretched laterally prior to irrigation
 4. Tip of the irrigator is placed in the inferior canaliculus, first vertically and then horizontally with the eyelid on stretch. The tip is advanced 3-7 mm into the canaliculus and sterile saline is injected.
 5. It is important to avoid forced irrigation to avoid damage to the canaliculi
- Interpretation: Regurgitation of irrigated saline through the opposite punctum indicates an obstruction in the common canaliculus or more distal structures. Regurgitation of fluid via the same canaliculus indicates punctal obstruction and syringing should be repeated via the opposite canaliculus. Irrigation into the nose indicates normal drainage function. It does not rule out functional obstruction.

Probing (Diagnostic):

This test should be performed if syringing test indicate obstruction and the location of the obstruction is to be ascertained. Obstruction can be located in the canaliculi and their assessment is vital in deciding the management modality in these patients. If irrigated fluid regurgitates through opposite punctum obstruction of common canaliculus or more distally is possible. The exact site in this scenario could be ascertained by careful probing of the entire system. Probing can be performed using blunt Bowman's probe which come in various sizes.

Procedure:

After instilling topical anesthetic drops into the conjunctiva the punctum is dilated using lacrimal probe. The probe is then passed vertically and then horizontally with the eyelid in stretch till the

lacrimal bone is encountered or soft obstruction is reached. If the probe encounters lacrimal bone then it is known as hard stop. This is actually normal. If the probe encounters obstruction then it is known as soft stop. If irrigation showed reflux through the opposite punctum and the probe encounters hard stop then obstruction could be at the level of lacrimal sac or nasolacrimal duct.

Interpretation of irrigation and probing results

	Liquid in nose/pharynx	Reflux into lower canaliculus	Reflux into upper canaliculus	Result
Hard stop	yes	No	No	Normal
	No	No	Yes	Nasolacrimal duct stenosis
	No	No	No	Subsaccal obstruction
Soft stop	No	Yes	No	Medial canicular/common canicular block
	No	No	Yes	Distal common canicular block

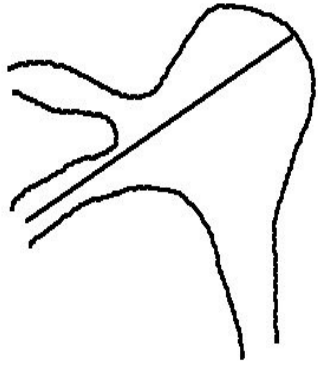


Figure showing hard stop

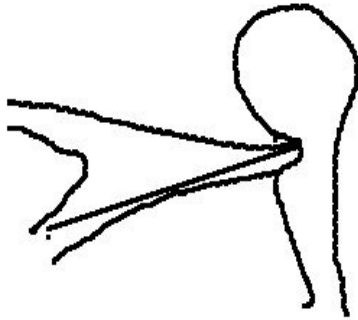


Figure showing soft stop

Radiological evaluation:

Include:

Dacryocystography
Nuclear lacrimal scintigraphy
CT
MRI

Dacryocystography:

This is an anatomical investigation. This is indicated when there is block in the lacrimal system as indicated by syringing test. It helps in creating an internal image of the entire lacrimal system. In this test radio opaque water soluble dye is injected either into upper / lower canaliculus and magnified images are taken. Using digital subtraction techniques excellent images of the entire lacrimal system can be ensured.

Radiologic criteria of lacrimal pathology ¹⁷:

1. Regurgitation of radio-opaque fluid into the conjunctival sac
2. Absence of fluid in the nose
3. Fluctuation of lumen of lacrimal system
4. Irregularity in contrast
5. Deformation involving lacrimal sac

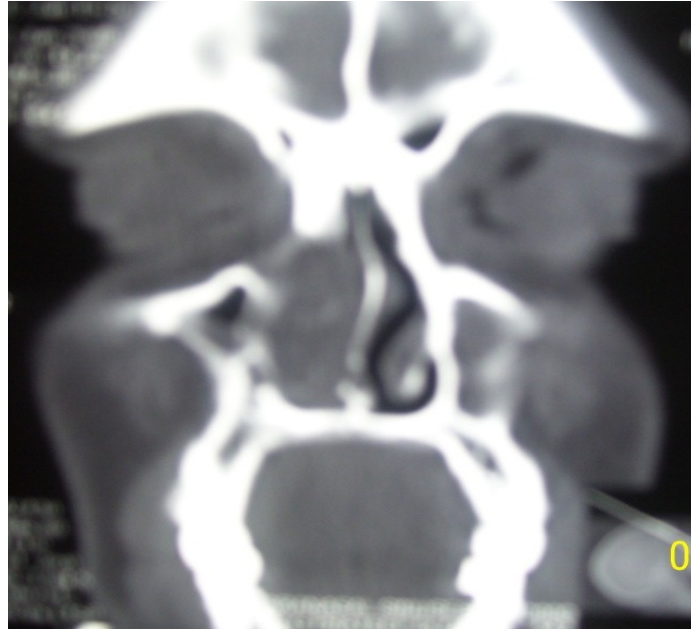
Nuclear lacrimal scintigraphy:

This is a non invasive physiological test. This test utilizes radiotracer technetium-99M pertechnitate. This can be analysed using a gama camera. This is useful only in patients whose lacrimal system is patent on syringing despite epiphora. This is found to be useful in difficult cases and incomplete obstruction.

This test is performed without instilling topical anesthesia. A drop of technetium-99m is instilled into each conjunctival sac of a patient sitting in front of a gamma camera. Normal blinking of eyes are allowed. Patient stares at a distant target during a 20 mins test period while images are being recorded with a gamma camera.

CT scan/ MRI scan:

Helpful in identifying tumors involving sac, or adjacent areas.



CT scan of a patient with rhinosporidiosis involving the lacrimal sac

Secretory tests:

These patients are useful in evaluating those with complaints of dry eye.

Schirmer's test: This test is basically prepared to quantitate tear production. This test is performed by placing strips of white filter paper 35x5 mm at the junction of the middle and lateral thirds of the lower eyelids after administration of a topical anesthetic agent. The tear production is measured with the eyes closed. Produced tears will wet the filter paper. The length of the filter paper which becomes wet is assessed at the end of 5 minutes. Normal test result is between 10mm and 30 mm of wet filter paper. Normally it should not exceed 30 mm. A value of more than 30 mm is considered to be epiphora. A value of less than 10 mm is considered to be dry eye (hyposecretion).



Figure showing schirmer's test

Breakup time test:

This test indicates function of mucin layer / reflex hypersecretion of aqueous component of the tears. One drop of fluorescein is instilled into the external canthus of a lower lid and the patient is instructed to blink once and then to keep his eyes open. The holes developed in the tear film are observed at the cornea through a slit-lamp with illumination through the cobalt filter. The normal breakup time should be approximately 15–30 s. A break-up time of less than 10 s indicates a deficiency and the epiphora should be treated with lubricating eye drops .

Bengal Rose test:

This test is also similar to that of Break up time test. One drop of Bengal Rose dye is placed in the conjunctiva and the patient is instructed to blink several times within a minute. Interpalpebral staining is seen in patients with dry eye.

Lysozyme lysis test:

The amount of a lysozyme activity and concentration is decreased in hypersecretion and in hyposecretion, and it usually precedes clinical symptoms. A lysozyme activity (and concentration)

is estimated on the basis of the inhibition of the growth of the bacterium *Micrococcus lysodicticus*.

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