EDITOR'S PAGE

At the outset, I wish to thank the KSOS for giving me the responsibility to edit this CME series on **COMMON OPHTHALMIC PROCEDURES**. Having said that, I must admit that this book is the brainchild of our Secretary Dr Sasikumar. Our President Dr. R.R. Varma has also been a constant source of inspiration. Initially we were planning to release this book during August-September 2009. But later, we decided to release it during DRISHTI 2009.

The book contains some of the common procedures performed in our day-to-day practice. Also included are certain procedures like B-Scan Ultrasonography and corneal topography, knowledge of which is very essential in the practice of modern day Ophthalmology. I wish to thank all the contributors for sparing their time for this book. PowerPoint / Video footage is available for most of the articles. I am sure this book will be useful for all Ophthalmologists in Kerala.

As the name "CME SERIES" implies, this will be the first in a series of books to come. I am sure that our Society will be able to release more such books in future.

Dr. S.J. Saikumar
Chairman, Scientific Committee, KSOS

12 / 11 / 2009

Contents

IN-OFFICE DIAGNOSTIC TESTS FOR DRY EYE DISEASE

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Dry eye can be clinically evaluated by a number of fairly simple tests which can be performed in the out patient clinic.

Clinical tests for lacrimal gland function

Shirmer's 1 and 2 tests

These tests measure the reflex tear secretion. They are performed with out anaesthesia. The Shirmer 1 and 2 tests measure the minimal amount of lacrimal secretion. A sterile commercially available 35 x 5mm paper test strip (What man 41) is placed at the junction of the middle and lateral one third of the inferior eye lid margin. Patient is asked to look forward and blink normally during the test. After 5 minutes the strips are removed and the distance of wetting in millimeters is measured. Shirmer's 2 is performed in a similar manner. The nasal mucosa is stimulated by a cotton tipped applicator placed in the nose. For either tests, a value of 5mm or less in 5 minutes is abnormal.

Schirmer 1 Test

Schirmer 2 Test	Normal (>5mm/5")	Abnormal (≤5mm/5")
Normal (>5mm/5")	Normal Lacrimal Gland Normal Ocular Surface	Ocular Surface Disease
Abnormal (≤5mm/5")		Lacrimal Gland Disease

Interpretation of Schirmer's 1 and 2 tests

Shirmer's 1 test measure the response of the lacrimal gland to irritation of ocular surface. A decrease in lacrimal secretion may be due to a lacrimal gland disease or absent ocular surface sensitivity, or disruption of the afferent nerves from the ocular surface to midbrain. When Shirmer 2 result is greater than Shirmer 1 result, the problem is at the ocular surface. If both Shirmer's 1 and 2 results are abnormal, the problem lies at the lacrimal gland level.

Cotton thread test

The crimped end of a piece of phenol red – impregnated fine cotton thread in placed between the eyelid and the globe. The amount of wetting is measured after 15 seconds. Normal values are 9-18mm of wetting. The test measures the volume of tear lake.

Basal Tear Secretion Test

The third test (Schirmer's 3) is performed similarly to the Schirmer's 1 test but with retinal stimulation (looking at the sun). None of the three tests are performed using topical anaesthesia. The basal tear secretion test or Jones test is performed similarly to the Schirmer's 1 test but with the addition of topical anesthesia prior to placement of the paper strips. Even with anaesthesia, reflex tearing cannot be totally eliminated. The Jones test gives a measure of the minimal amount of lacrimal secretion. This test is more useful to

screen subjects prior to contact lens fitting or laser in situ keratomileusis to determine what effect a relative decrease in corneal sensation has on residual lacrimal secretion.

Fluorescein Staining

Although 1 to 2 uL of a 1 or 2% solution of fluorescein sodium can be used, fluorescein impregnated strips are preferred because of their availability and simplicity of use. The technical aim of fluorescein instillation is to achieve delivery of a sufficient concentration of dye to obtain highly fluorescent staining of areas of the conjunctiva and cornea where the epithelia lack cellular and junctional integrity. Because fluorescein diffuses rapidly into the corneal stroma when there is loss of epithelial integrity, the ability to see punctate staining is lost after a short period of time (1 to 3 minutes). It is essential to assess staining as soon possible after fluorescein instillation. A single drop of sterile, nonpreserved saline is applied onto the fluorescein-impregnated strip. The drop is allowed to just saturate the tip of the paper strip, and the excess is shaken off. The lower eyelid is pulled down and the tip of the strip touched gently on the inferior palpebral conjunctiva. The patient is asked to gently close and roll the eyes around to adequately distribute the dye across the ocular surface. The right eye is done first, followed immediately by the left eye. Using a blue exciter filter over a white light source, each eye is then examined in turn, observing the staining pattern and density of staining of the conjunctiva and cornea. It is important to remember that conjunctival staining also occurs with fluorescein.

Rose Bengal and Lissamine Green Staining

Both dyes are commercially available in dye –impregnated strips. Either dye can be used and they seem to yield similar results, but the lissamine green impregnated strips are preferable because the dye stings less on instillation and the impregnated strips release more dye with less wetting than the rose Bengal impregnated strips.

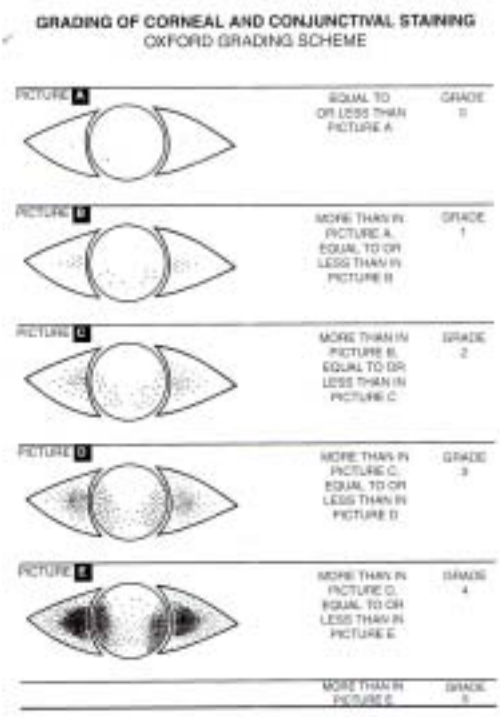
With dye impregnated strips, a single drop of sterile non preserved saline is applied to the strip. As dye staining is concentration dependent, an attempt should be made to use a standardized application technique. The drop is allowed to just saturate the tip of the paper strip, and the excess is shaken off. The lower eyelid is pulled down, and the tip of the strip is touched gently on the inferior palpebral conjunctiva. The subject is asked to gently close and roll the eyes around to adequately distribute the dye across the ocular surface. The right eye is done first, followed immediately by the left eye. Staining with rose Bengal and lissamine green is both time and concentration dependent, so examination should be done at a standard time interval after dye placement (1 minute).Using a white light source, each eye is then examined in turn observing the staining pattern and density of staining of the conjunctiva and cornea. A green barrier filter placed over the slit lamp objective improves viewing of rose Bengal staining. A red barrier filter improves visualization of lissamine green staining.

Staining Grading Systems

The three most common grading systems are the Van Bijsterveld grading system, the Oxford grading scheme and that recommended by the National Eye Institute (NEI)/Industry Workshop on Clinical Trials in Dry Eyes. The major differences among the systems are that the van Bijsterveld system uses rose Bengal staining of the conjunctiva and cornea; the Oxford Scheme grades the conjunctiva and cornea together using fluorescein, rose bengal or lissamine green staining and the NEI workshop system uses fluorescein staining to grade the cornea and rose bengal to grade the

conjunctiva. The grading system first proposed by van Bijsterveld grades three areas in each eye-the nasal and temporal bulbar conjunctiva and the cornea. The intensity of rose Bengal staining is graded on a scale from 0 to 3 for each area. The maximum value of staining for each eye is 9. Staining values of 3 or higher are considered abnormal.

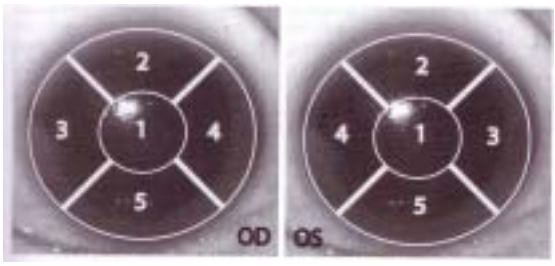
The van Bijsterveld grading system. The exposed interpalpebral portions of the nasal and temporal conjunctiva and cornea are graded on a scale from 0 (no staining) to 3 (confluent staining). The maximum possible total score for each eye is 9. A score above 3 is considered abnormal.



The Oxford Grading Scheme. Staining is represented by punctuate dots that increase by 1 log unit between panel A and B and by ½ log unit between subsequent panels. The scheme relies on gestalt comparisons of the amount of ocular surface staining and the panels.

The Oxford grading scheme uses a chart consisting of a series of panels labeled A to E in order of increasing severity of staining. Staining is represented by punctuate dots and increases by 1 log unit between panel A and B and by ½ log unit between each subsequent panel (b to E). Comparisons are made between the staining on the exposed interpalpebral conjunctiva and cornea and panels.

In the NEI Workshop grading system, the cornea is divided into five areas for each eye. The amount of staining in each area is graded on a scale of 0-3 according to the intensity of fluorescein staining. The conjunctiva is graded similarly on a scale from 0 to 3 according to the intensity of rose Bengal or lissamine green staining in three areas each of the nasal and temporal bulbar conjunctiva. This grading system takes into account the intensity and the area of staining. The maximum score is 18 for each eye with values above 3 being abnormal.



The National Eye Institute corneal grading system. The cornea is divided into five areas, each graded on a scale of 0 to 3. The maximum possible staining score is 15. A score higher than 3 is considered abnormal.

The National Eye Institute conjunctival grading system. The nasal and temporal interpalpebral conjunctiva is divided into three areas for each eye. Each area is graded on a scale of 0 to 3. The maximum possible staining score is 18 for each eye. A score above 3 is considered abnormal.

Impression Cytology

By pressing cellulose acetate or cellulose nitrate filter paper on to the conjunctiva and then gently removing it, one to three layers of conjunctival epithellum and goblet cells can be obtained which remain adhered to the paper. After staining, the specimens can be evaluated and graded by the size and shape of the epithelial cells and by the density of goblet cells. It allows characterization of the conjunctiva surface as to the degree of squamous metaplasia that occurs in KCS. In addition, it is useful in situations where one needs to determine whether there is damage to the corneal epithelial stem cells. Goblet cells on the cornea imply the presence of conjunctival epithelium and the loss of corneal epithelium.

Clinical Tests of Tear Film Stability

Tear Breakup Time

The classic test of tear film stability is the fluorescein BUT(FBUT). This is an invasive test, as it requires the instillation of fluorescein sodium. Tear film stability can also be assessed by noninvasive methods (non invasive BUT;NIBUT). In these methods, a grid or other pattern is projected onto the cornea and the amount of time for distortion of the image is measured.

FBUT is performed by either wetting commercially available fluorescein impregnated strips with a drop of sterile, non preserved saline or by instilling 1 to 2 ul of a 5% sodium fluorescein into the tear film. The patient is asked to close the eyes then open and keep them open as long as possible. The time from eyelid opening to the appearance of the first dry spot formation is measured. The mean of three trials is recorded. Normal FBUT is 10 seconds or more. Values less than 5 seconds are indicative of significant dry eye disease. The normal range for NIBUT is 40 to 60 seconds.

Reference:

J. Daniel Nelson, Penny A Asbell, Michael A Lemp. Dry Eye Disease – The Clinician's Guide to Diagnosis and Treatment.

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TESTING PATENCY OF THE LACRIMAL DRAINAGE SYSTEM

■ **Dr. B. Jayaprasad** ■
Amardeep Eye Hospital, Trivandrum

A complete evaluation of the lacrimal excretory system can be made with syringing.

Once the presence of an abnormal tear outflow is established by a Flourescein dye disappearance test, we proceed to syringing to establish the location and severity of obstruction.

Instruments . punctum dialator ,lacrimal canula , 2 cc syringe, normal saline (avoid using 26 G needle).

Step I

Local anaesthesia drops instilled. Punctum is dialated.The canula is inserted in to the lower canaliculus and see if it can pass in to the sac.If the canula hits soft tissue (soft stop), then an obstruction is present proximal to the sac.If it hits bone (hard stop), then it has passed in to the sac.

Step II

Irrigation of saline with moderate pressure on the plunger.

Four things can happen.

a. 100% fluid comes in to the nose-indicates patent system
b. 80% fluid comes in to the nose,20% through the other punctum-indicates a NLD stenosis.
c. 100% regurgitation through the other punctum-complete obstruction at the NLD(hard stop) or or common canalicular block(soft stop)
d. 100% regurgitation through the same punctum indicates canalicular obstruction

In a patient with epiphora with situation a or b ,how will you distinguish between pump failure and NLD stenosis?

Instill fluorescein in to the eye and wash out after 3 mts.use a cotton swab in the nose or a n endoscope to observe the dye in the nose.This indicates that it is an NLD stenosis and a DCR WILL WORK.

REFERENCE:

Prabakaran.V.C.PRACTICAL APPROACH TO ADULT NLD OBSTRUCTION J OF Tamil Nadu Ophthalmic Association volume:45 issue:3 september 2007.

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CORNEAL SCRAPING

■ Dr. Abraham Kurian ■
Chaithanya Eye Hospital, Trivandrum

Indications

[1] Diagnostic- to know the etiological agent causing infection

[2] Therapeutic – for necrotic debridement to aid penetration of antimicrobial agents, especially in fungal keratitis.

Instruments

Any of the following three instruments can be used for corneal scraping

[a] Kimura Spatula

[b] No.15 Bard Parker knife

[c] Calcium Alginate Swab

Procedure

It can be done in the out patient clinic under slit lamp or in the minor operation theatre under surgical microscope. Topical anaesthesia is employed preferably using 4% proparacaine [Paracain]. Removal of loose debris from surface of ulcer needs to be done before scraping. It is better not to use this material as it may not be representative of causative organism. Scraping is done with one edge of the instrument in short firm unidirectional strokes. It is taken from the edges as well as base of the ulcer. Most organisms are found at the edges of ulcer, one exception being Moraxella which is found more at the base of the ulcer. The material is plated on slides and culture plates for microbiological study. In the culture plates, the material is plated in the shape of a 'C' to differentiate the organisms from contaminants. The penetration of agar surface is to be avoided.

Routinely, two slides – one for Gram's stain, one for KOH preparation, and 3 culture plates - 1 blood agar, 1 chocolate agar and 1 Sabaroud's dextrose agar are used. Addition of calcoflour white can highlight fungal filaments during microscopy but requires a fluorescent microscope. If there is clinical suspicion of Nocardia / Mycobacteria one slide can be sent for AFB [Acid Fast Bacillus] also. If Acanthameba is suspected, Non nutrient agar enriched with E.coli is used. If HSV keratitis is suspected, scraping can be sent for polymerase chain reaction [PCR] for HSV DNA.

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Anterior chamber wash with intracameral injection

■ Dr. Anil Radhakrishnan ■
Chaithanya Eye Hospital, Trivandrum

Indication

Fungal keratitis involving deeper layers of cornea with endothelial exudate seen as projection into anterior chamber. It is preferably done in selected cases of fungal keratitis in which the corneal infiltrate is not progressing after intensive topical anti-fungal treatment, but endothelial exudate is progressing. If successful it can obviate the need for therapeutic keratoplasty

Procedure

The surgical procedure can be done under topical or peribulbar anaesthesia. Eye is cleaned and draped as in any intraocular surgery. A limbal incision is made with Bard Parker No:11 blade at the clear corneal side. The incision size is just large enough to accommodate a Simcoe cannula. The endothelial exudate is removed with Simcoe cannula or McPherson's forceps and sent for microbiological study. The anterior chamber is washed with Simcoe to remove hypopyon and exudates. 0.1 ml containing 10 micrograms of Amphotericin–B is injected into the anterior chamber. 1% voriconazole can also be used. 1 corneal suture [10.0 nylon] is put.

Postoperative care

[1] Can resume topical antifungal treatment as early as 2 hours after the procedure.

[2] Systemic acetazolamide can be given to counter post operative IOP elevation.

Complications

[1] Corneal oedema due to endothelial damage which is usually transient

[2] Anterior uveitis and secondary glaucoma

[3] Progression of cataract

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Theory & practice of Tonometry

■ Dr. Meenakshi Dhar, Dr. Jisha Vimoj ■
Amrita Institute of Medical Sciences, Cochin

Measuring the intraocular pressure[IOP] is tonometry. It is done for glaucoma screening, diagnosis and followup. IOP is the only modifiable risk factor in glaucoma. It is the most commonly assessed parameter in the followup of this disease.

There are various ways of doing tonometry. The Applanation Tonometry introduced by Hans Goldmann is the most accurate, and is taken as the gold standard for decades. Practice of applanation tonometry is important for every general ophthalmologist. All it requires is a slit lamp with the applanation attachment, few seconds of your clinic time, little practice of the procedure.

IOP is measured by correlating deformation of globe when force is applied to deform it i.e. indent the cornea

Depending on type of deformation its categorized into 2 types

1.Indentation tonometry where shape of deformation is a truncated cone Shiotz being its prototype.

2.Applanation tonometry where simple flattening is the shape of deformation. It is based on Imbert Fick's Law which states that the amount of force required to flatten a perfectly round, dry, thin sphere is proportional to the product of area deformed, and pressure inside the sphere.

Schiotz tonometry[Fig.1] displaces a large volume of fluid, hence scleral rigidity plays an important role. Thus readings are modified by

scleral rigidity which is variable & inpredictable giving inconsistent results & hence requires conversion tables based on emperical data.

Correct Illumination Source Placement. Temporal to the Tonometry Probe for patient's right eye.

In **applanation tonometry[Fig2.]** simple flattening occurs & IOP can be calculated from simple mathematical formula. It is the prototype of variable force tonometer.

It measures the force required to applanate an area of 3.06 mm diameter.

Non contact tonometer [NCT]/Air puff tonometer [fig.3] is a non invasive tonometer used for screening. It measures the time required to deform cornea in response to standard force & then calculates the IOP. Here light is reflected from cornea which is aligned by the optical system. Time from internal reference to peak reflection is converted to IOP. It is very useful in measuring IOP where cornea can not be touched as in the post operative period after cataract surgery / Trabeculectomy. It has no need for disinfection as it is a no touch technique. Studies have shown good correlation between NCT & Applanation.

Perkin's Tonometer is a hand held & portable tonometer that can be used in sitting / supine position and has the same biprisms as applanation

In scarred / edematous corneas McKay Marg & Pneumatic Tonometer can be used.

Tonopen [Fig.4]can be used in scarred corneas, it is portable based on principle of applanation & thus handy for children, & bedridden patients.

Procedure of applanation

Applanation is contrainduicated in infected & in eyes with penetrating trauma

1. When doing applanation first explain to the patient that you'ld be measuring the eye pressure which tells us if an eye is suffering from glaucoma - the irreversible silent killer of vision. The eye is anaesthetised, and thus it doesn't pain. All the patient has to do is to look straight with both eyes wide open. In fact I tell them to look as if they are angry or staring at something. Attempt to close the other eye causes this eye ball to move up.
2. After anaesthetising the eye with 0.5% Proparacaine with one drop, patient is ready. The usual precaustions while viewing through the slitlamp are kept in mind ie. the lateral canthus is aligned to the marking on the outerframe of slitlamp.
3. The sterile fluorescein strip, moistened with antibiotic / mild lubricant is used to stain the tear film while the patient looks up, by touching on the lower bulbar conjunctiva.

   After a single blink to spread the stain in tear film, patient places the chin on the chinrest with forehead touching the top bar.
4. Slit lamp illumination is kept at an angle of 60^0 with illumination open fully. The applanation attachment of the slit lamp may be base mounted as in Zeiss or top mounted as in Haag strait. It is clicked into position. The tonometry attachment should not be loose. The observation is done at max illumination using the cobalt blue at a magnification of 10-16. A 5^0 inclination of the illuminating & observing beam allows better viewing.

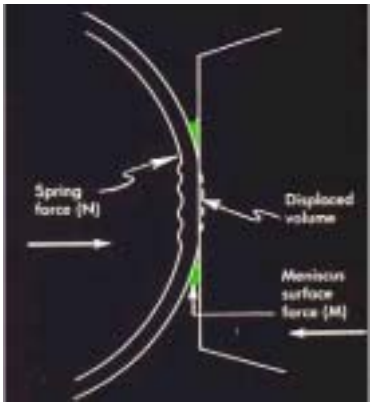
The measuring durm has marking from

Proper beginning setting for the Tonometer Micrometer

1-8[1 implies = 10mmHg], 0-80mmHg of IOP can be measured. It is kept at bar reading 1 ie 10mm**[fig.6]** and slowly increased to adjust the mires The **byprism[fig.5,8]** splits the image into

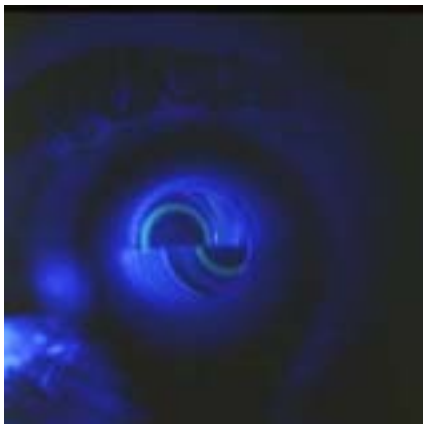
Side view of Tonometry Probe

Bi-Prism of the Tonometry Probe as seen through the Biomicroscope



Applanation graphic of the Cornea and Tear Wedge of Fluorescein

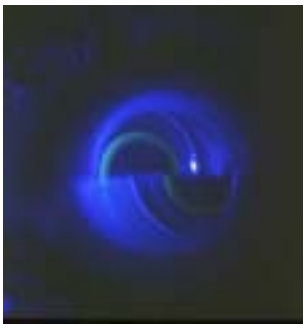
2 semicircles which are formed by the tear film pool just outside the knob**[fig.7].** On rotating the drum, the reading is achieved when the inner



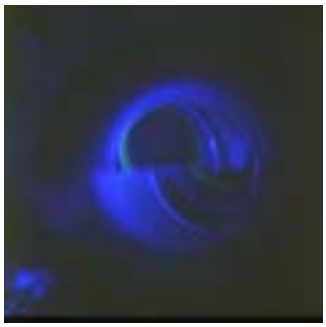
Doctor's view of the Tonometer's Fluorescein Semicircles as seen through the slit lamp. Slit lamp needs to be moved slightly up and to the doctor's right.

rim of each semicircle is just touching the other**[fig.9]**. The tear film width should be $1/10^{th}$ of that of the area applanated.

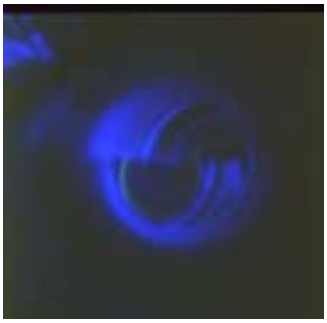
If the 2 halves are not equal it requires vertical adjustment & if the circle is small, we need to go closer & if too large, we need to move away a bit **[fig.10,11,12,13,14,15]**. We must change the tip yearly. The horizontal alignment is inadequate if tip is either too close or too far away from the cornea.



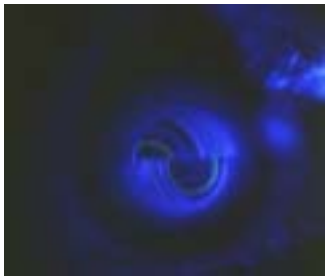
Almost correct alignment. Slit lamp needs to be moved slightly to the doctor's right.



Probe too low on the patient's Cornea and needs to be moved up and slightly to the doctor's right.



Probe too high on patient's Cornea snd needs to be moved down to even semicircles.



Magnification only 10x. Probe too high and needs to be lowered and moved to the doctor's left.

Only 10x magnification and there is not enough fluorescein. Need to pull the slit lamp back dry Off the probe and instill more fluress.

If you see this pattern when you look Through the slit lamp, stop, you have advanced the whole slit lamp and probe too far forward. You must pull the slit lamp back to get the correct semicircles.

Patient should not move the eye when the prism is touching it otherwise an abrasion can occur. In case of such an abrasion simple lubrication & patching heals it. **[fig.16 &17].**

If the tear film is excessive the semicircle will have a very wide rim & give erroneous readings

After the procedure ant biotic is again instilled.

The **calibration check** should be done monthly

Take it off the mount use the calibration bar at 0, 2 & 6. The calibration bar has markings at its midpoint and at marking signifying 20 & 60mmHg on either side. . If it moves forward then its calibrated (as in video)

Steeper cornea overestimates and flatter cornea underestimates IOP

Daily cleaning We need to clean & dry the tip both in between successive patient & at the end of the day. This can be done with mild soap & water

Other suggested measures are cleaning with Sodium hypochlorite, dilute bleaching powder, H_2O_2 - but these have to be thoroughly dried away lest they may harm the corneal epithelium. These can be kept at hand and used at least after using applanation tip in HBSAg+ve / HIV +ve cases.

Tonometry & Pachymetry

The last decade has brought about innumerable studies that have conclusively proven that corneal thickness alters IOP measurement.

Thin corneas have falsely low readings as in patients after radial keratotomy or LASIK.

Also thick corneas have falsely high IOP readings.

In corneal edema a falsely low reading is measured. Thin & thick cornea can give erroneous readings of IOP. Thickness of cornea as measured by Pachymetry should be done and correlated with IOP.

Method of using Shiotz & Tonopen are demonstrated in the video.

The last decade has seen the development of newer methods of IOP measurement that hope to overcome the corneal factors, or easier more frequent / home IOP measurement.None have come into wide clinical usage These include

1. **Ocular Response Analyser** measures clinical properties of cornea that most clinicians were previously unaware of.
2. **Dynamic Contour Tonometry**

   Records IOP dynamically possibly independent of corneal properties. It is based on Pascal's law & gives the average diastolic IOP & the ocular pulse amplitude which is the difference between average systotic & diastolic IOP. It reflects filling of ocular blood vessels counterbalance by the ocular rigidity (resistance of the eye to distension). The choroidal vessels filling can be correlated with Optic Nerve Head perfusion both being supplied by short posterior ciliary arteries

   A low ocular pulse amplitude and worse glaucoma show good correlation.
3. **Rebound Tonometer** is a portable hand held tonometer not requiring anaesthesia
4. **Proview Phosphene Tonometer** is designed for self tonometry

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Slit Lamp examination of the anterior segment

■ Dr Deepa Paulose *DO, DNB (Ophth)* ■
Dr Tony's Superspeciality eye institute, Aluva.

Introduction

The slit lamp is a compound microscope with an objective lens and an eyepiece. Its wide magnification range, variable illumination systems and unlimited angles of view make it an indispensable tool for viewing ocular tissues and performing diagnostic and treatment procedures.

The two basic parts of the slit lamp biomicroscope are

1. The slit lamp / illumination system
2. The biomicroscope

Modern slit lamps are of two basic designs.

1. Haag streit type, with a vertical illumination source
2. Zeiss type with a horizontal prism reflected light source.

The main difference between the two is that the Haag streit type can be decoupled in the vertical meridian. This can avoid reflections in gonioscopy and peripheral fundus examination .The advantage of the Zeiss type is that it is more compact.

The biomicroscope is based on the optics of a compound microscope.

Techniques of Illumination

By changing the position of the light source in relation to the microscope, various illumination techniques are produced.

There are two basic techniques of illumination:

1. Direct focal
2. Indirect (Retro)

With direct illumination techniques, the light is shone directly onto the area of interest. With indirect illumination methods, the object of interest is illuminated by light that is reflected off from another surface.

Direct focal illumination include

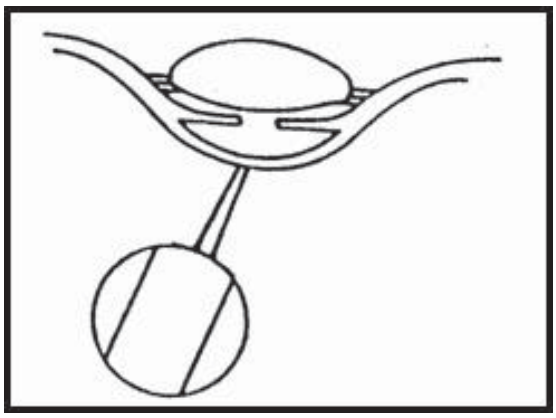
1. Diffuse
2. Parallelepiped
3. Optic section
4. Conical beam
5. Specular reflection

Diffuse illumination

The diffuse illumination is performed using a wide slit beam. The light source and the microscope form an angle of about 45 degrees. Magnification is set on low. Diffuse illumination provides an overall view of the anterior segment. The advantage of this type of illumination is that the entire surface of the cornea, iris or lens may be viewed.

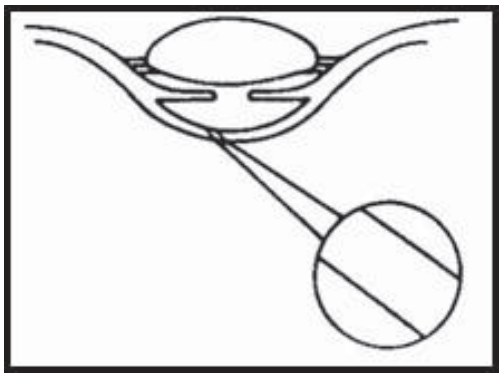
Parallelepiped

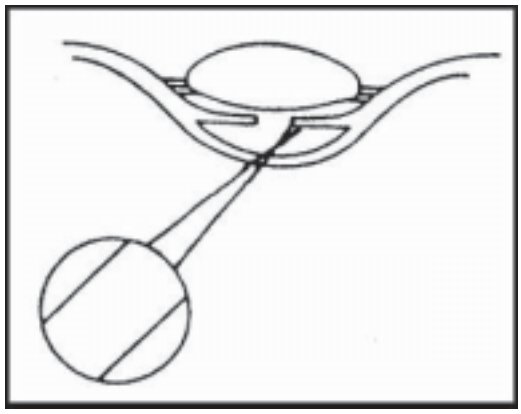
A diffuse illumination changes to a parallelepiped by narrowing the slit beam to 1 to 2 mm. The light source and the microscope remain about 45 degrees apart. Magnification is set on low to medium. This illumination is useful for the general survey of the corneal layers as well as viewing scars, abrasions and corneal nerves.



Optic section

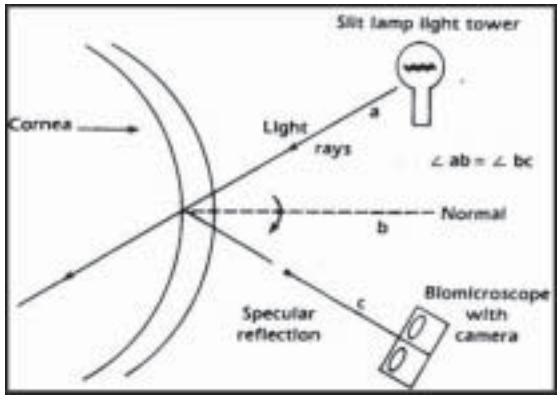
A parallelepiped changes to an optic section by narrowing the slit width to a thin slice. The angle between the light source and the microscope is about 60 degrees. Magnification is set on medium to high. This illumination is used to view a cross section of the cornea. It helps to differentiate the various layers of the cornea including the epithelium, the stroma and the endothelium.





Conical beam

A parallelepiped transforms into a conical beam by decreasing the slit height to a small spot. The angle between the light source and the microscope is about 45 degrees. The rheostat intensity and the magnification are set high. Decrease the slit height to fit within the pupil. Begin by focusing the beam on the cornea. Now focus the beam in the anterior chamber between the lens and the corneal endothelium. If the eye is inflammed, cells and flare may be present in the aqueous. This type of illumination is easier if the pupil is not dilated.



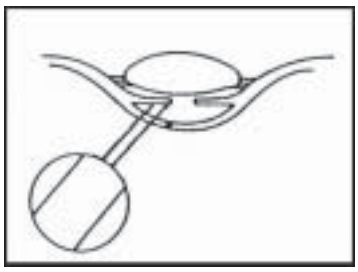
Specular reflection

This type of illumination is formed by positioning a parallelepiped to reflect off the corneal surface. The rheostat intensity is at

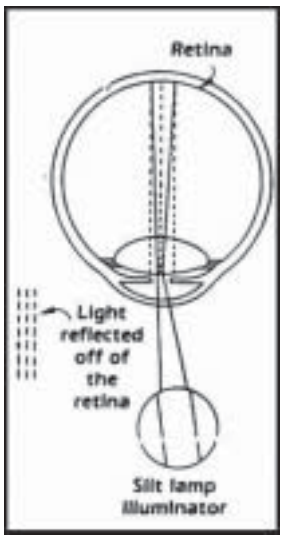
maximum and the magnification is set initially at low. The light source and the microscope are separated to about 60 degrees, until a bright, specular reflex appears in one ocular. This is the point where the angle of incidence equals the angle of reflection. Zoomed to the highest magnification, the bright image is seen with the duller image adjacent to it. Adjust the joystick slightly to bring the endothelial mosaic into view. Any irregularity in the endothelial mosaic like guttata will be enhanced by this illumination.

Indirect or retro illumination

The second category of illumination is the indirect or retro illumination. The light is reflected off the deeper structures such as the iris or retina, while the microscope is focused on the more anterior structures.



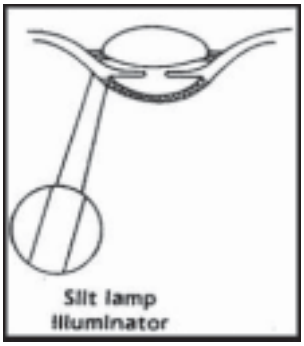
In direct retro illumination, the lesion is viewed in the direct pathway of the reflected light.



In indirect retro illumination, the light path is positioned adjacent to the lesion, diffusely illuminated from behind and the lesion is viewed against a dark background. This technique of illumination is used for viewing corneal scars, pigment deposits and crystalline lens opacities.

Retro illumination from the fundus

In this technique, the light is directed so that it strikes the fundus and creates a glow behind the abnormality. The slit beam and the microscope must be nearly coaxial. Shorten the beam to the height of the pupil to avoid reflecting the bright light off the iris. This type of illumination is best seen if the pupil is dilated and is used for viewing posterior sub capsular cataracts, after cataract and transillumination defects of the iris.



Sclerotic scatter

Another indirect method of illumination is sclerotic scatter.

This technique is based on the principle of total internal reflection. With the microscope focused on the cornea and the magnification set on low, position the illumination at about 45 – 60 degrees. The light source is taken out of click stop position and rotated to a focus of broad beam at the limbus. A halo of light is observed around the entire limbus as the light is transmitted throughout the cornea. The normal cornea appears dark since the light is being internally reflected. Any corneal opacities, microcystic oedema or foreign bodies will be highlighted by this method.

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Gonioscopy

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The angle of the anterior chamber needs to be assessed in all glaucomas. It usually holds the secrets to pathogenesis in that particular case. It may also reveal pathology in other cases in the form of a retained intraocular foreign body, small hyphemas, small hypopyon, etc. The object of this write up is to be a guide to the accompanying PowerPoint presentation.

Due to total internal reflection we are unable to see the angle of the anterior chamber without compensating for the air cornea interphase. This can be achieved by direct gonioprisms used in surgeries (not dealt in detail in this treatise) and by indirect goniolenses that use a mirror to see the angle.

In general we use Goldman two or single mirror lenses as well as Sussman or Zeiss 4 mirror lenses in diagnostic gonioscopy with slit lamp examination.

The Procedure

First we need to explain the procedure to the patient. Under topical anaesthetic (Proparacain) the patient is to be seated comfortably at the slit lamp. For the surgeon's comfort one has to place the elbow rest in a convenient position prior to inserting the goniolens.

Placing the contact lens

The Ziess or Sussman lens requires no coupling fluid. These lenses are placed onto the patient's eye with the patient looking straight ahead (fig 1). (Great care is taken so as not to put undue pressure on the eye which can cause the angle to open up with indentation, cause corneal folds that obscure visualization of the angle and make the patient uncomfortable due to vagal stimulation.

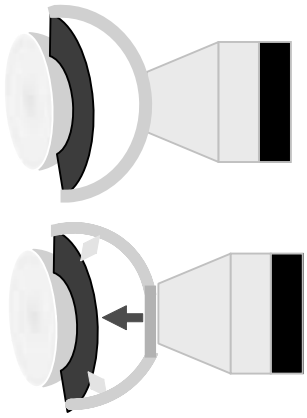

Fig 1 Inadvertant indentation. These lenses are placed onto the patient's eye with the patient looking straight ahead . (Great care is taken so as not to put undue pressure on the eye which can cause the angle to open up with indentation, cause corneal folds that obscure visualization of the angle)

When using a Goldmann lens we need to fill the contact lens partly with a coupling fluid (one drop of our surgical viscoelastic / surgical methyl cellulose or even a couple of drops of artificial tears will do). I say partly fill because once on the eye there is need of only about 1 - 2 drops. The excess always flows down the patient's cheek during the procedure making it uncomfortable for the patient. It would also mess up your slit lamp. After instilling the coupling fluid we can ask the patient to look down, retract the upper lid with your nondominant hand and place the goniolens onto the eye using the edge of the goniolens to retract the lower lid. Now one can ask the patient to look forward and move the goniolens with the eye (fig 2).

Fig 2

Placing the Goldmann lens with the eye looking down. After instilling the coupling fluid we can ask the patient to look down, retract the upper lid with your nondominant hand and place the goniolens onto the eye using the edge of the goniolens to retract the lower lid. Now one can ask the patient to look forward and move the goniolens with the eye

Alternatively we can ask the patient to look up and place the goniolens over the inferior sclera. Now when the patient looks straight we rotate and place the lens onto the eye (fig 3).

Fig 3

Placing the Goldmann lens with the eye looking up. After instilling the coupling fluid we can ask the patient to look up and place the goniolens over the inferior sclera. Now when the patient looks straight we rotate and place the lens onto the eye.

Slit lamp adjustments

Now we need to adjust the slit lamp. The beam is kept vertical and the illumination housing slant at about 30 degrees. To assess occludability the slit beam is made as thin and short as possible to view structures in the angle (this will avoid light from going into the pupil and constricting it). This position will allow for good visualization of the upper and lower angles.

To visualize the nasal and temporal angles one needs to make a few other adjustments. The illumination and microscope housings are aligned to be coaxial (0-2 deg). The housing is now tilted so that the beam is directed at about 15 degrees from below. The slit beam is made horizontal by rotating the lamp housing. This will allow for enough parallax to assess the angle structures without glare. (Fig 4)

Magnification. Use **just enough** magnification to visualize the angle. Higher magnification makes one lose depth of focus and can be confusing. If a specific feature like

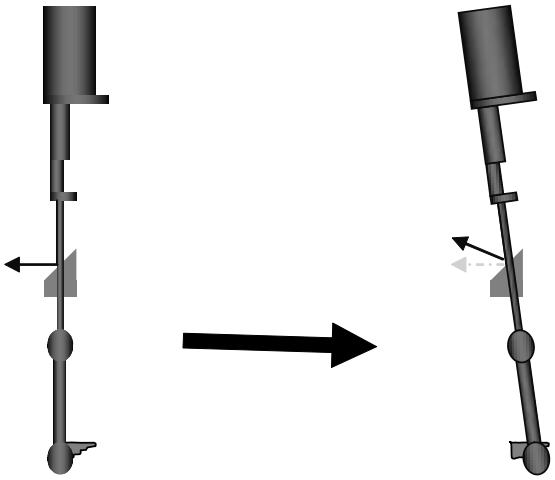

Fig 4.
Tilting the Illumination housing to visualize nasal and temporal angles. The illumination and microscope housings are aligned to be coaxial (0-2 deg). The housing is now tilted so that the beam is directed at about 15 degrees from below. The slit beam is made horizontal by rotating the lamp housing. This will allow for enough parallax to assess the angle structures without glare.

new vessels in the angle is to be looked at closely, the change magnification for that instant alone.

Gonioscopy

The questions to be asked in gonioscopy are:

1. Grading
2. Is the angle occludable?
3. How much can it potentially open up to?
4. Is there any other features? (e.g. Secondary glaucoma features)

Anatomical landmarks

For grading we need to be clear about landmarks in the angle. The anteriormost landmark is the Schwalbe's line. This is the edge of the Descemet's membrane and can be identified by following the corneal parallelepiped to its end where all lines coincide (the epithelial, endothelial and iris lines of illumination) (Fig 5)

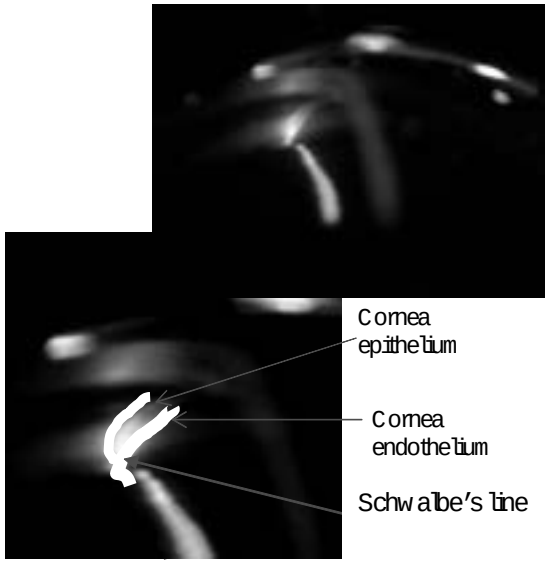

Fig 5 Identifying the Schwalbe's line using the corneal wedge or parallelepiped. This is the edge of the Descemet's membrane and can be identified by following the corneal parallelepiped to its end where all lines coincide (the epithelial, endothelial and iris lines of illumination).

Schlemm's canal is sometimes seen if blood has refluxed into it as a pinkish line in the middle third of the trab meshwork. This would be the middle third of the trab meshwork or the anteriormost part of the filtering part of trab meshwork. The trabecular meshwork itself has a granular appearance. Pigmentation can vary a lot in normal patients.

Posterior to this one may see a glistening white line – the scleral spur. This is often a broken line than a continuous one. Behind this would be the grayish ciliary body band. The width of this is very variable and needs to be compared to the contra lateral eye in suspected angle recession. Beyond this would be the root of the iris.

Grading

For grading I prefer an anatomical system of grading as developed at RP center by Dr Madanmohan. (Fig 6). This eliminates

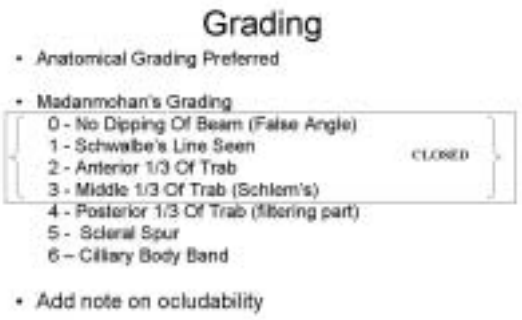

Fig 6 Madanmohan's grading system

subjective assessment of the angle entry from interfering with the grading system. This note however about the angle recess should be mentioned as one's judgment of "whether this patient has an occludable angle or not?" (i.e. is this patient prone for primary angle closure?)

Peeping into the angle recess

To see into the angle recess one can peep over the hill. This is done when the lens is

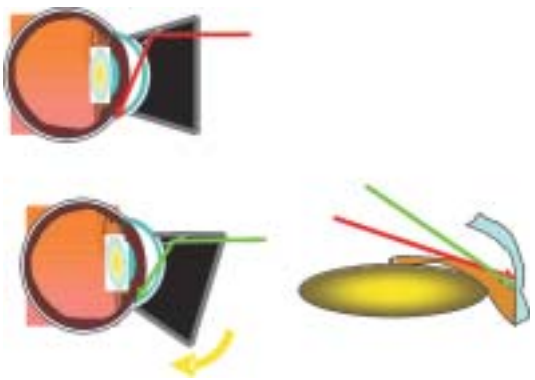

Fig 7 . Peeping over the hill to view the angle recess when the lens is anteriorly placed. To see into the angle recess one can peep over the hill. This is done when the lens is jutting into the ac obscuring the angle recess. The goniolens is tilted towards the angle in question taking great care not to indent the angle open.

jutting into the AC obscuring the angle recess. The goniolens is tilted towards the angle in question taking great care not to indent the angle open. (Fig 7).

A case

Now let me take you through gnioscopy of a particular patient (Fig 8). Top left picture is

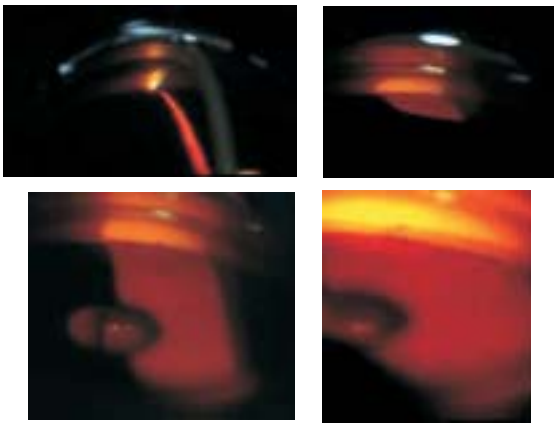

Fig 8. Top left grade 0, top right with more illumination grade 2, Bottom left grade 3 with pupil constriction by light and bottom right grade 6 with indentation.

with the slit beam not hitting the pupil and the angle appears totally closed. The corneal parallelepiped has not joined up at schwalbe's line - grade 0. The beam is now widened and the pupil starts to constrict causing the angle to open up. Top right picture of the same angle shows up the schwalbe's line and with the beam length also increased the anterior trab meshwork is seen in the bottom left picture. The bottom right picture shows the angle to be fully open on indentation- Grade 6.

Thus if we had not gone step by step we could go wrong here. If we had full illumination and a little pressure on the eye, then the angle would have been fully open and the patient labeled as POAG / NTG requiring life long therapy. When we go step by step it turns out to be an appositional PACG requiring a one time peripheral iridotomy.

Indentation (How much can this angle potentially open up?)

Indentation with a Sussman lens or Zeiss lens is straight forward pressure on the corneal apex (Fig 9). When the corneal apex is indented, the limbal ring gets stretched. The peripheral cornea is pushed outward and the iris root rotates backwards. The zonules are stretched pushing the lens (lens iris diaphragm) backwards. All these contribute to the angle opening up fully.

Fig 9 Indentation with Sussman lens. Corneal apex is indented. Limbal ring gets stretched. The peripheral cornea is pushed out and the iris root rotates back. The zonules are stretched pushing lens iris diaphragm back. The angle recess opens up fully.

The same can be achieved with a Goldman lens. We need to ask the patient to look towards the mirror we are looking at. At the same time we resist this movement with the goniolens and thus use the edge of the lens to indent the angle open. (Fig 10).

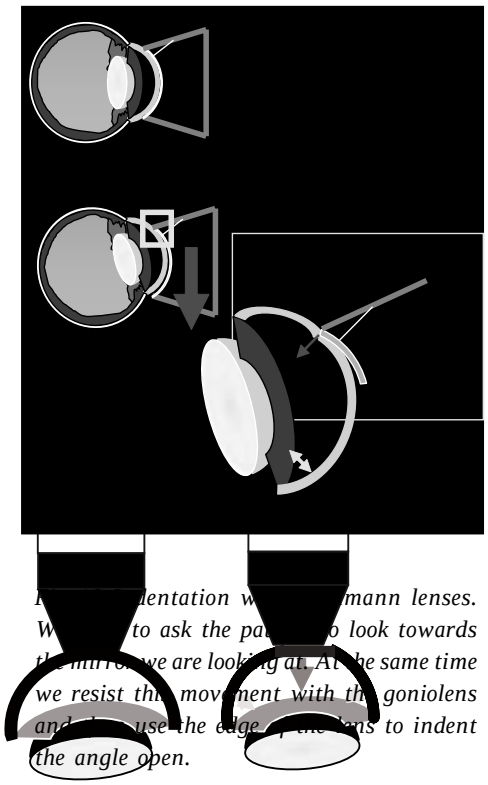

Fig 10 Indentation with Goldmann lenses. We need to ask the patient to look towards the mirror we are looking at. At the same time we resist this movement with the goniolens and thus use the edge of the lens to indent the angle open.

This is less efficient when one uses a Goldmann lens than when one uses a Sussman or Zeiss lens. Therefore if there is a doubt confirm with one of these lenses.

The Goldmann 3 mirror lens is too big to do indentation gonioscopy. The lens does not allow one to tilt at all and even peeping into the recess is impossible. Furthermore the mirror angulation is different and hence one would call an angle more closed than it really is when using a three mirror lens. I would strongly advise all to maintain the three mirror lens as a retinal contact lens and invest in a dedicated goniolens for gonioscopy.

Once we have got grading out of the way we look for telltale signs of angle closure – peripheral synechia, coarse pigment deposits etc. Any features of secondary glaucomas, developmental glaucomas are also noted. This entire information is put down in the case record for each quadrant. (Minimum grade and maximum grade of the angle opening, ocludability, secondary features)

I will detail a few of the specific features in the accompanying PowerPoint slide show. Most of these are self explanatory.

Synechiae:

Peripheral anterior synechiae are adhesions between the iris and angle structures or peripheral cornea.

Synechia of an appositional closure tend to be a smooth anterior edged bump with some areas more open on indentation than others. i.e. synechiae have varying height.

Where as for creeping angle closure the synechia seems to have a uniform height and again has a regular anterior edge.

Inflammation leads to patchy synechia. These have an irregular anterior edge.

Often they are point synechiae that look triangular (teepees – as they are called in comparison to the red Indian tents). Inflammatory synechiae are more often in the inferior angle whereas angle closure synechiae are more often in the superior angle.

These need to be differentiated from iris processes that are strands of iris and not full thickness areas of iris plastered on to the angle.

Plateau Iris

The peripheral iris seems to drop off as in a plateau. The central parts of AC are deeper than one expects from the look of the angle. On indentation one can see the sine wave sign. The iris goes back the up over the ciliary processes and back again before coming up along the convexity of the lens. (Fig 11)

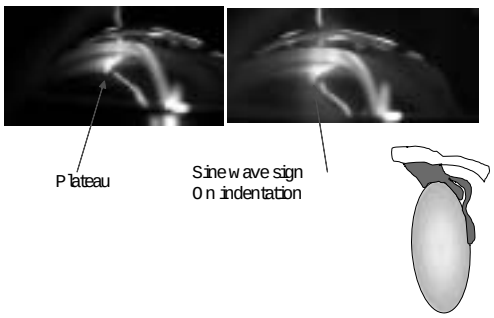

Fig 11 Plateau iris with sine wave sign. The iris drapes over the ciliary process and the comes up again on the lens convexity on indentation.

Pigmentation

Pigmentation of the trabecular meshwork varies a lot in normals. But it assumes significance in the presence of pseudoexfoliation on the lens surface and features of pigment dispersion syndrome such as Kruckenberg spindle. Dense pigmentation of the posterior trabeculum tends to be significant compared to uniform pigmentation of trabeculum. Coarse clumps of pigment in an ocludable angle may suggest previous apposition even in the absence of synechiae.

Angle recession

Always compare width of ciliary body band between the 2 eyes. Look for additional features of trauma. Here the ciliary body band is widened. The width often varies a lot in different parts of the same eye in recession. One may note torn iris processes when present. (one half on iris and the other on trab). There may be old blood in form of hemosiderin balls (black in Colour not brown – that would be iris pigment).

Cyclodialysis

Invariably here there is recession in the

angle. One sees sclera through a cleft like opening. This opening widens and narrows when one presses with goniolens slightly (on indentation). An associated feature would be low IOP.

Neovascularisation

New vessels in the angle may precede new vessels on the iris in neovascular glaucoma. These vessels arise from the iris root and branch in an arborising pattern onto the trabecular meshwork surface. These later contract and cause pulled up synechiae with vascular anterior edges.

Axenfeld anomaly

There is ridge like posterior embryotoxon. Iris strands attach to this as bridging synechia (with a gap behind).

Iridocorneal Endothelial syndromes

There is some corneal edema in all 3 forms of ICE. The synechiae are broad and have a pulled up appearance due to the contracting membrane.

Blocked Trabeculectomy osteum

In failed trabeculectomies one of the causes could be some stray tissue in the excised trab block area. This could be iris, vitreous, lens capsule, etc.

Post Trauma progressive inferior corneal edema

This is often due to a retained foreign body in the anterior chamber angle.

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2. Thomas R, George T, Braganza A, Muliyil J The flashlight test and Van Herick's test are poor predictors for occludable angles. *Aust NZ J Ophthalmol* 1996;24:251-56.

3. Personal communication with my Professor – Ravi Thomas. MD.

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CORNEAL TOPOGRAPHY

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Corneal topography, also known as Photokeratoscopy or Videokeratography is a non invasive medical imaging technique for mapping the surface curvature of the cornea.

Development

The corneal topography owes its heritage to 1880, when the Portugese Ophthalmologist Antonio Placido viewed a painted disk [Placido disk] of alternating black &white rings reflected in the cornea .The rings showed as contour lines projected on the corneal epithelium. In 1896, Allvar Gullstrand incorporated the disk in his ophthalmoscope, examining photographs of the cornea via a microscope &was able to manually calculate the curvature by means of a numerical algorithm. The flat field of the Placido's disk reduced the accuracy close to the corneal periphery &in 1950's the Wesly- Jessen company made use of a curved bowl to reduce the field defects. In 1980s, photographs of the projected images became hand digitilized &then analysed by computer. Automation of the process soon followed with the image captured by a digital camera and passed directly to a computer. In 1990s this system became commercially available from a number of suppliers.

Principles of corneal topography

New technologies have met the demand for increased precision in evaluation of complex corneal shapes. These include Placido disk imaging, Three dimensional topography, PAR, Slit scanning topography, Scheimpflug imaging, Ultrasound &interferometric system.

Placido Disk Imaging:-

Placido disk imaging is based on the overlay of concentric mires on the cornea. The closer the mires the steeper the axis. The wider the rings , the flatter the axis.It was the first technology to be used to evaluate the shape of the cornea in conjuction with computer analysis. While systems may differ somewhat, all contain a transilluminated Placido target in the shape of a cone or disc. The number, position, color &thickness of the rings varies between systems.

Most systems projects images onto the corneal surface to produce a virtual image of the Placido disk about 4mm behind the corneal vertex. They directly measure the curvature of the cornea & calculate the elevation map using a coordinate system from the curvature data. Elevation is generated by fitting slope data to a predefined mathematical model that may be spheric, aspheric or a conical section. While this practice is reasonable in normal corneas, it may result in serious error in diseased eyes or eyes having undergone keratorefractive surgery.

Studies regarding the accuracy of Placido disk systems found acceptable levels of

accuracy& reproducibility. System tends to be more accurate centrally than peripherally &defocus increases errors. Clear surfaces are required for clear mires.

Placido disk imaging system

Astramax Three Dimensional Topography

This method utilises a three dimensional grid system which provides both radial and concentric data points, enabling measurement of radial distance and rotational concentric changes in the cornea. The Astramax uses three cameras to obtain multi angled shots, generating 35,000 data points in 0.2 seconds.Unfortunately ,no literature reports of the system's reliability or validity exit.

Astramax three dimensional topography

The PAR Corneal Topography & Rasterstereo Photogrammetry

The PAR CTS was the first topography system to produce an elevation map of the corneal surface using Raster stereography. It projects a grid onto the corneal surface &computes elevation data based on the distortion of the grid. In PAR CTS a small amount of flourescein is placed in the tear film &the images are collected using standard flourescein based photography.

PAR CTS can provide elevation, curvature and keratometry maps. Unlike Placido disk based videokeratoscopes, which require a smooth reflective surface, this system demonstrates the ability to image irregular, deepithelialized and keratinized corneas. PAR CTS can be installed on slit lamp microscopes, or automatic optometry instruments etc.

Slit Scanning Topography

Slit scanning technology is currently utilized by a single system, the Orbscan. During the 1.5 – second examinations two slit scanning lamps projects a series of 40 slit beams angled at 45 degrees to the right and left of the video axis. Twenty slits are projected from the left and 20 from the right. Proprietary software image registration attempts to minimize the influence of involuntary eye movements during data acquisition.

The typical display used for the Orbscan incorporates four images: the anterior &posterior elevation maps, the curvature (axial) map, the pachymetry map.

Slit scanning topography seems to be a reliable technique for evaluating normal corneas not only for anterior shape and curvature, but also for a real pachymetry gradient recording. However the accuracy of pachymetry measurements remain controversial. It is generally accepted that Orbscan measurements of central corneal thickness were greater than ultrasonic pachymeter measurements in virgin eyes. The

accuracy & repeatability of the instrument is reported to be below 10 microns. In clinical practice, it is even more dependent on many factors, such as the limited movement of the patients eye, ability of patients to keep the eye wide open, optically clear cornea and the presence of corneal abnormalities. The other limitations of current slit technology are the inability to detect interfaces (example : after Lasik flap) and the longer time of image acquisition and processing compared to standard Placido based topography.

ORBSCAN

ORBSCAN: Slit scanning technology combined with an advanced Placido disc system.

Scheimpflug Imaging System

The Pentacam utilizes Scheimpflug imaging. It is a rotating Scheimpflug camera that provides 50 Scheimpflug images during one scan in less than 2 seconds with 500 true elevation points per image.

The pentacam has two intergrated cameras. One is located in the center for the purpose of detection of the size &orientation of the pupil , & to control fixation. The second is mounted on the rotating wheel to capture images of the anterior segment. The Scheimpflug is a complete picture from the anterior surface of the cornea to the posterior surface of the lens. It generates 25,000 true elevation points for each surface, including the center of the cornea. Possible eye movements are captured &corrected internally. The Pentacam provides a complete analysis of the anterior & posterior surface topography of the cornea, including curvature , tangential & sagittal maps. The Scheimpflug principle allows data capture in patients with significant keratoconus &other severe irregularities which may prevent successful Placido imaging.

The Pentacam calculates the pachymetry of the cornea from limbus to limbus &displays corneal thickness in a coloured map. The pentacam offers the correction of intraocular pressure (IOP) which is affected by corneal thickness. This is useful for glaucoma screening &management. The TRUE Net Power map reflects the true power of the cornea in its entirety & facilitates improved IOL calculations for post keratorefractive patients. The Pentacam also provides a corneal wavefront analysis for both surfaces using Zernike indices to detect high order aberrations attributable to the corneal surfaces.

PENTACAM

PENTACAM PACHYMETRY DATA

Artemis Ultrasound Digital Topography

This system uses high – frequency ultrasound scanning enhanced by digital signal processing. Ultrasonic echo data from consecutive parallel B-scans of the cornea spaced at 250 microns intervals are digitalized and stored. Layer thickness measurements are made with a precision of two microns standard deviation at 120 micron intervals along each scan plane. This technique provide the corneal surgeon with a new tool for the topographic evaluation of anterior corneal layers in normal &pathological corneas with high precision.

Interferometric system

This technique utilizes laser holographic interferometry fringe patterns to depict deviations of the corneal surface. Interferrometry is based on the principles of light wave interference. High accuracy is theorically possible. Unfortunately interferometric methods are sensitive to eye movements, & a system is required to maintain head position. The system is too complicated to gain a foothold in the field.

General Characteristics

Corneal topography provide both quantitative &qualitative evaluation of corneal curvature. Most corneal topographers evaluate 8,000 to 10,000 specific points across the entire corneal surface.By contrast , keratometers measure only four data with in the cornea's central 3-4 mm.The small size of this area can lead to errors in determining precise toricity.

The most common maps ,the practioners use are

1) **Axial map**: Also called power or sagittal map. It shows variation in corneal curvature as projections &uses colors to represent dioptric values. Warm colors such as red &orange show steeper areas; cool colors such as blue &green denote the flatter areas.

   The axial map gives a global view of the corneal curvature as a whole; its downside is its tendency to ignore minor variations in curvature.

2) **Tangential map**: It is the map that more closely represents the actual curvature of the cornea over the axial map. The tangential map recognizes sharp power transactions more easily than the axial map & eliminates the smoothing appearance that appears on the axial map. This is not universally true for all topographers. It also uses colors to represent changes in diopteric values.

   Compared to axial maps, tangential maps yield patterns with details that are more centrally located. It also offers a better visualisation of the precise location of corneal defects.

3) **Elevation map**: This utilises yet another algorithm to give additional information about the cornea. An elevation map shows the measured height from which the corneal curvature varies from a computer generated reference surface. Warm colors depict points that are higher than the reference surface, cool colors designate lower points.

4) **Refractive map**: This utilizes the measured dioptric power & applies Snellen's law to describe the cornea's actual refractive power. Clinician use refractive maps to evaluate visual performance in post - refractive surgery patients.

Corneal topography in normal cornea

The normal cornea flattens progressively from the center to the periphery by 2-4D , with the nasal area flattening more than the temporal area. The approximate distribution of keratographic patterns described in normal eyes includes the following : round (23%), oval(21%) ,symmetric bow tie typical for regular astigmatism (18%) , asymmetric bow tie (32 %) & irregular (7 %) .

Every map has a color scale that assigns a particular color to a certain keratometric dioptric range.Never base an interpretation on color alone. The value in keratometric diopter is crucial in the clinical interpretation of the map & has to be looked at with the interpretation of every map. Normalized maps have different color scales assigned to each map based on the instrument software that identifies the actual

minimal & maximal dioptric value of a particular cornea.

Clinical indications

* Topography is indicated in many clinical conditions such as Keratoconus & Pellucid marginal degeneration which may exhibit corneal steepening before any biomicroscopic signs are evident. In Keratoconus, the color maps provide information of the location, size & curvature of the cone's apex, & can help to follow the progression of the disease,in contact lens fitting , & in planning surgery.
* Screening before refractive surgery.
* Evaluation of the effects & stability of corneal refractive surgeries.
* Evaluation of irregular astigmatism especially after Penetrating Keratoplasty.

  Corneal topography is valuable for detection of post operative astigmatism, planning of removal of sutures, & post operative fitting of contact lenses.
* Topography also is invaluable when evaluating pre & post surgical patients, particularly those who have had Penetrating Keratoplasty, Radial keratotomy or Lasik.
* Topography may lend insight into those unusual or difficult refractive cases.
* Contact lens fitting: Corneal topography is especially valuable in fitting complex corneal surfaces (eg: advanced keratoconus)

Conclusion

Understanding of the type of topographic technology & how each system derives the maps, is important for clinical interpretation. Placido disk & slit -scanning systems are the most widely used & understood by clinicians. The use of Scheimpflug images to create corneal topographic maps is the most recent addition to the field. It's evaluation of the structures posterior to the anterior surface may enable us to verify the slit scanning technology's information & continue to help us to increase our understanding of pachymetry & the posterior surface changes that occur in some patients.

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TIPS AND TRICKS FOR GOOD A SCAN BIOMETRY

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INTRODUCTION:

The refractive power of the human eye depends on three factors:

- the power of the cornea
- the power of the lens and
- the length of the eye.

Following cataract surgery, only the power of the cornea and the length of the eye are relevant. If both of these variables are known, it is possible to calculate what lens power will give the best refraction.

Biometry is the process of measuring the power of the cornea (keratometry) and the length of the eye, and using this data to determine the ideal intraocular lens power. If this calculation is not performed, or if it is inaccurate, then patients may be left with a significant refractive error

Despite sophisticated technology and intelligent software, one frequently encounters biometry mistakes or 'surprises'. Most are avoidable and most are due to human error. This article will examine the steps involved in biometry and the ways in which mistakes can be minimized.

MEASUREMENT OF ACCURATE AXIAL LENGTH:

The measurement of axial length measurement has the greatest potential for error in calculating IOL power. Traditionally, contact A-scan ultrasonography is used.

Principle: This measures the time taken for sound to traverse the eye and converts it to a linear value using a velocity formula. Part of the ultrasound beam reflects back from each surface in the eye – cornea, anterior lens, posterior lens, and retina. The reflected beam is translated into an image showing lines (spikes) for each surface. The distance between the corneal and retinal spikes gives the axial length of the eye.

Biometry:

1) Applanation method: most commonly done
2) Immersion method:

APPLANATION METHODS:

Advantages:

1) no additional set up is required
2) good control over patient positioning
3) less dependency on patient steady fixation
4) patient doesnot have to maintain positioning in headrest, and examiner can easily hold the eyelids open.

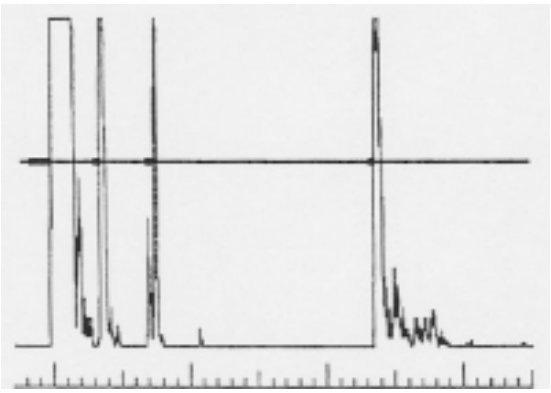
Disadvantages:

1) the examiner has less precise control over

the positioning of the probe relative to the eye

2) corneal compression and falsely short axial length, an compression of 0.4mm can cause 1 D error of calculated IOL power.

Fig 1 - Note the high quality A scan spikes



with good resolution of scleral and retinal spikes

IMMERSION METHOD:

In the immersion method, a scleral (Prager) shell is placed between the eyelids and centered on the cornea of the supine patient. This method avoids any corneal compression (and thus a falsely short axial length) and gives high quality, consistent spikes.

Fig 2 - PRAGER SHELL

Fig 3 – Showing immersion method

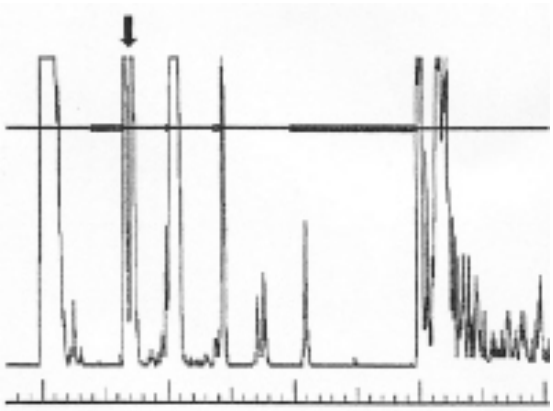


Fig 4 - Note separate spike for probe and cornea (arrow) in immersion

Tips for accurate measurement of axial length (using applanation):

- ensure the machine is **calibrated** regularly.
- set for the **correct velocity settings**, **this ensures the instrument is using a correct velocity of sound for the particular eye which you are measuring:**

  cataract mode

  pseudophakic mode

  aphakic mode

- good patient instruction for better cooperation
- **spike height** from cornea, anterior lens, posterior lens, and retina should be present and good amplitude.

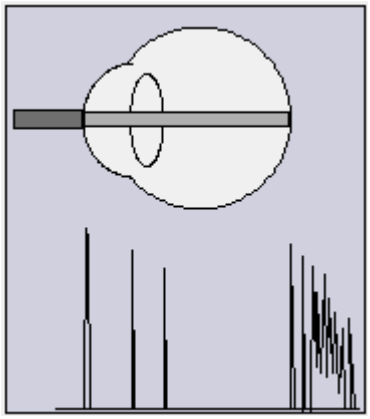


Fig 5: high quality spikes

- **Alignment of the probe**: ensure good fixation of eye, better to fixate a target usually a light in the probe. Patient with dense cataract or any visual problem use fellow eye to fixate the distant target.

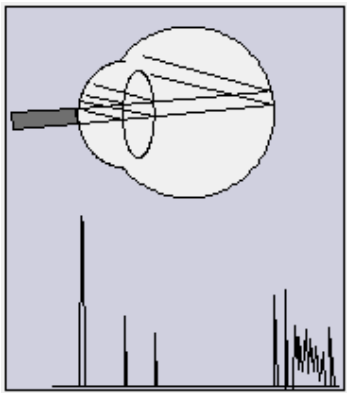


Fig 6: Poor alignment with short spike

- False reading with misalignment:
  1) Short lens spike: if the probe (e.g., sound beam) is not perpendicular to the lens

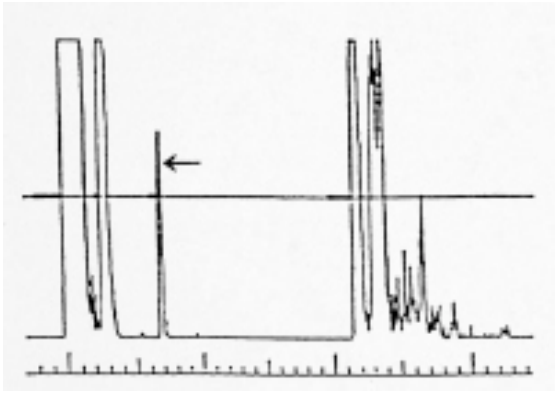


Fig 7: Note the short lens spike

  2) Poor retinal spike: if probe is not perpendicular to macula.
  3) No scleral spike: if the probe is aligned along the optic nerve.

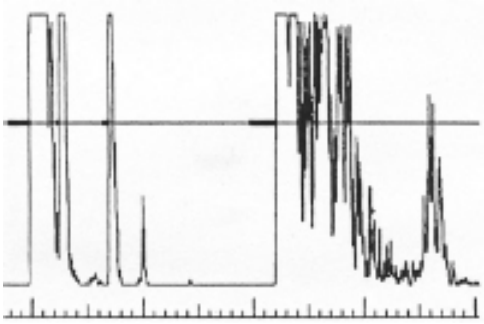


Fig 8: Note the missing scleral spikes.

- **The gain** should be set at the lowest level at which a good reading is obtained

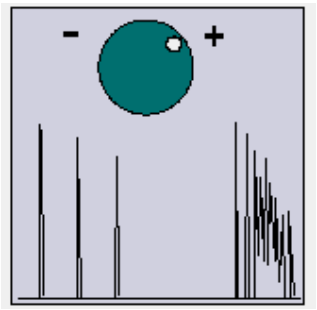


Fig 9: Shows effect of gain on spike height

- **Gain too high** — although this increases the sensitivity, it also produces poor resolution of spikes, causes the retina and sclera spikes to merge, combines the anterior and posterior corneal peaks, and cuts off the tops of all spikes (flat-topped rather than pointed spikes).

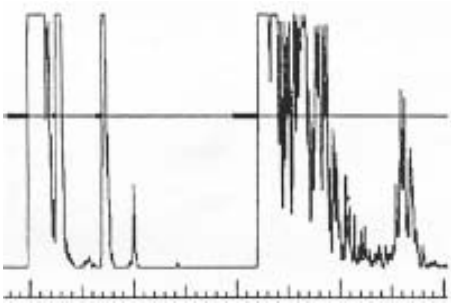


Fig 10:Increased gain cause loss of resolution with flat topped spikes take care with axial alignment, especially with a hand-held probe and a moving patient (as described above)

- **don't push too hard** – corneal compression commonly causes errors commonly noticed with applanation method. A 0.4 mm corneal compression can produce a error of 1D error of calculated IOL power

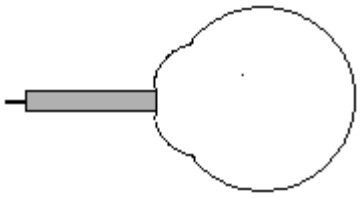


Fig 11: Shows corneal compression

- average the 5–10 most consistent results giving the lowest standard deviation (ideally < 0.06 mm)
- errors may arise from an insufficient or greasy corneal meniscus due to ointment or methylcellulose used previously
- always avoid using any contact maneuver before A scan biometry
- **Falsely short reading error**— this type of error may be caused by
  - Ø corneal compression (AL & ACD will both be 0.14-0.36 mm shorter than their true values),
  - Ø the beam not being perpendicular,
  - Ø presence of vitreous opacity or membrane, choroidal thickening / effusion,
  - Ø wrong gate position,
  - Ø incorrect velocity
- **Falsely long reading** — such an error occurs from
  - Ø a fluid meniscus (between the probe and cornea),
  - Ø posterior staphyloma, measuring to the sclera instead of the retina spike,
  - Ø wrong gate position,
  - Ø incorrect velocity (too fast).
- **Incorrect velocity** — if the eye is not phakic, it is important to change the setting so the machine uses the correct velocity for either an aphakic or a pseudophakic eye with the specified IOL material (alternatively for pseudophakes, the aphakic setting can be used with a correction factor). The aphakic scan has 1 less spike (lens spikes absent but spike from capsule or hyaloid face is present), whereas the pseudophakic eye shows multiple spikes in the vitreous due to reverberation artifact from the IOL. Phakic eyes filled with silicone oil also pose a potential for incorrect velocity errors. In this situation, accurate biometry requires using a silicone oil setting (980 or 1040 m / s depending on the type of silicone oil).

- Size: Axial length errors are more significant in short eyes (<22mm) and a posterior staphyloma may be present in a long eye (>25 mm).
- Look out for the unexpected result, for example an axial length of 27 mm in a patient with a +4.00 D refractive error.
- Measure both eyes and repeat if the difference between eyes is greater than 0.3 mm, or if consecutive measurements differ by more than 0.2 mm

MEASUREMENT OF ACCURATE CORNEAL POWER:

Again, accuracy is essential, as an error of 0.75 D in the keratometry will result in a similar post-operative refractive error. Keratometry may be carried out manually or using an automated or hand-held device

Tips for accurate keratometry readings:

- calibrate and check the accuracy of the keratometer
- use a dedicated single instrument that is known to be accurate
- don't touch the cornea beforehand and ensure a good tear film
- perform keratometry before A scan biometry.
- adjust the eyepiece to bring the central cross-hairs into focus
- make sure that the patient's other eye is occluded and that the cornea is centred
- take an average of three readings, including the axes
- if high or low results are encountered (< 40.00 D or > 48.00 D), it is advisable to have a second person check the measurements
- repeat if the difference in total keratometric power between the eyes exceeds 1.50 D
- in a scarred cornea, use the fellow eye or average the results

Fig 12: baush and lomb keratometer

TIPS FOR AN ACCURATE FORMULA IN DIFFERENT SITUATIONS:

The Hoffer Q, Holladay I, and SRK/T & SRK II formulae are all commonly used, but the SRK I regression formulae are now regarded as obsolete

Range of axial length and preferred formula

Axial length (mm)	Formula
<20 mm	Holladay II
20–22 mm	Hoffer Q
22–24.5 mm	SRK/T/ SRK II / Hoffer Q/Holladay (average)
>24.5–26 mm	Holladay I
>26 mm	SRK/T

IN DIFFICULT SITUATIONS:

- Extremely dense cataracts create difficulties, as they absorb sound as it passes through the lens.
  - ✓ SOLUTIONS: A higher gain setting may be necessary to achieve adequate spikes.
- Posterior staphylomata in myopic eyes not only cause an elongated globe, but often tilt the macula as well so that the ultrasound beam is deflected.

- ✓ SOLUTIONS: add the A-scan anterior chamber depth measurement to vitreous depth taken from a B-scan

WHY THINGS GO WRONG?

No matter how good the system, people will still make mistakes. Some reasons include:

- people in a hurry
- lack of training or accessible guidelines
- reliance on others
- technical failure (rarely)
- human error (often).

Some common mistakes :

- wrong A-constant selected
- wrong formula used
- wrong K-readings entered by hand (90 degrees out)
- biometry print-out stuck in wrong patient's notes
- incorrectly labelled IOL
- wrong patient in theatre
- reversed IOL optic
- wrong IOL implanted (25.5 D implanted instead of 22.5 D or +30 D instead of +3.0 D).

CONCLUSIONS:

Departments should aim for consistency in their biometry and audit their results. Mistakes are easy to make, but difficult (and sometimes expensive) to rectify. The following list sums up some lessons that can be learnt from others' mistakes:

- slow down
- train and certify your biometry staff
- follow guidelines
- don't rely on others
- watch out for the unexpected
- learn from mistakes, particularly any eyes with error greater than 2 dioptre
- audit your outcomes.

If you are using biometry, 80 per cent of eyes should be within 1 dioptre of their intended refraction. Try to identify any issues that are leading to consistent errors.

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ULTRASOUND EVALUATION OF THE POSTERIOR SEGMENT OF THE EYE - A READY RECKONER

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Ultrasound Principles

Ultrasound is an acoustic wave that consists of an oscillation of particles in a medium. Ophthalmic ultrasound uses 8-10 MHz probes (1 MHz is 1000000 cycles per second). Ultrasound used in other medical specialties uses 1-5 MHz. When the frequency decreases the wave length increases and penetration increases. Longer wavelength also reduces the resolution.

UBM uses higher frequencies like 50-100MHz resulting in less penetration and better resolution. Ultrasound wave is propagated as a longitudinal wave of alternating compressions and rarefactions of molecules. This wave can be refracted and reflected as light. It is the reflected wave or echo that is utilized in ultrasound evaluation. It depends on the acoustic impedance of the media and the difference in acoustic impedance at an interface called acoustic interface. Also the angle of incidence determines the amount of echo returning. Perpendicular incident waves produce maximum echoes.

Ophthalmic ultrasound uses a pulse echo system which is a piezo electric element which undergoes mechanical vibration when stimulated by electrical energy producing a longitudinal ultrasound wave. The parts of ultrasound system include a pulser, transducer, receiver and a display screen. Amplification plays an important role in ophthalmic ultrasound. It determines the ability of the system to display range of echo intensities. This dynamic range is displayed in units of decibels.

Terminologies

Linear amplification- is on a small range and can display minor differences in echo strength between two echo sources but the range of intensities that can be displayed is limited.

Logarithmic amplification- Large dynamic range can be displayed but the small differences between two echo signals cannot be displayed.

S amplification – developed by Ossoinig – Combines the wide range of logarithmic amplifiers and great sensitivity of linear amplifiers

Gain measured in decibels represents relative units of ultrasound intensity. By adjusting the gain, amplification of echo signals displayed in the screen can be changed. It is just like adjusting the volume of radio where we can control the signals received by the radio. The higher the gain the greater the

ability of the machine to detect weaker signals. When gain is reduced only stronger echoes will be displayed.

Time gain compensation (TGC): To enhance weaker signals from deeper tissues. Allows selective amplification of weaker distant echoes compared to stronger nearer echoes.

Standardized echography: Combined use of standardized A scan and contact B scan developed by Ossoinig.

Indications for Ultrasound Examination

1. Posterior segment evaluation in the presence of opaque ocular media like corneal opacity, hyphema, cataract or vitreous haemorrhage
2. In clear ocular media – Tumors, choroidal detachment, optic disc anomalies like drusen
3. Intra ocular foreign body
4. Anterior segment evaluation using immersion techniques with scleral shells is mostly replaced by ultrasound biomicroscopy

Examination Techniques

It is usually done with the eye lid closed and other eye kept open fixing at a target. Coupling medium like methylcellulose is applied on the B-scan probe. In case of trauma or recent ocular surgery, probe has to be cleaned before use.

B-scan Probe Orientation:

1. *Transverse scan* – The Probe is kept at the limbus with the axis of marker circumferential at limbus. The area of the marker is displayed in the upper part of screen. This can be horizontal, vertical and or oblique transverse scans.
2. *Longitudinal scan* – The marker is perpendicular to the limbus.
3. *Axial Scan* - Is done with the patient fixing in primary gaze and probe centered in the cornea. It displays lens and optic nerve in the center of the echogram. This is useful for evaluation of macula.

Basic B-scan screening protocol

1. Transverse scan of 4 major quadrants at high gain.
2. Longitudinal scan in 4 major meridians
3. Axial scan.

After using high gain to detect vitreous opacities and gross fundus lesions low gain with improved resolution is used to detect flatter fundus elevations and to detect the topography of large lesions.

Reporting of B Scan Findings:

1. *Topography* - Location, extension and shape. Lesion types can be point like, membrane like, band like and mass like.
2. *Quantitative* – Reflectivity, internal structure and sound attenuation.

[Quantitative Echography type-I]

Reflectivity – Spike height in A-scan (0-100%) or signal brightness in B-scan.

Internal structure – Architecture inside a mass like lesion– regular and irregular.

Sound attenuation - When sound energy is scattered, reflected or absorbed. On A-scan decrease in the spike height is called angle Kappa which is determined by drawing a line through peaks or lesion spikes. The steeper the angle, the greater the sound attenuation.

Quantitative Echography type II - To differentiate retinal detachment from vitreous membrane.

3. Kinetic – After movements and vascularity. Kinetic Echography is used to dynamically assess the motion of or within the lesion. This includes 1.After movement on stopping the eye

movement suddenly 2. Vascularity which is fast spontaneous motion best seen in standardized A-scan with eye steady 3. Convection movements are slow, spontaneous movements seen in longstanding intraocular haemorrhage or cholesterol debri.

Ultrasound Evaluation of Posterior Segment

Few classic ultrasound findings

Fig. 1. 10 MHz ophthalmic ultrasound B/A scan machine with probes and display units

Fig. 2. Point like echoes in vitreous haemorrhage, membrane like lesion in retinal detachment and mass like lesion

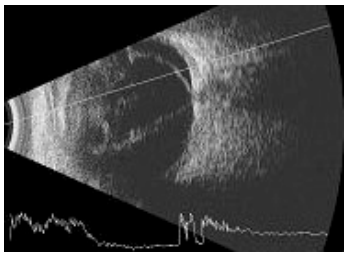

Fig. 3. To differentiate RD and PVD. RD has 100% reflective membranous echo with attachment to optic disc and reduced after movement. PVD has variable spike height with good after movements and if complete no attachment at the disc.

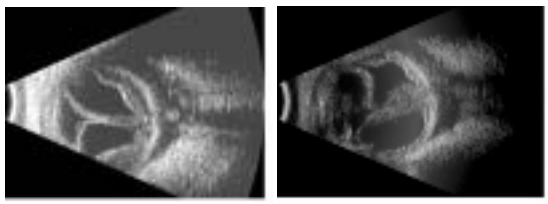

Fig. 4(a& b) Shifting fluid in exudative retinal detachment. The figure on the left shows membranous echo inserting at the disc with high reflectivity and good after movements. To the left is the same retinal detachment in sitting position showing shifting fluid.

There is significant choroidal thickening and T sign.

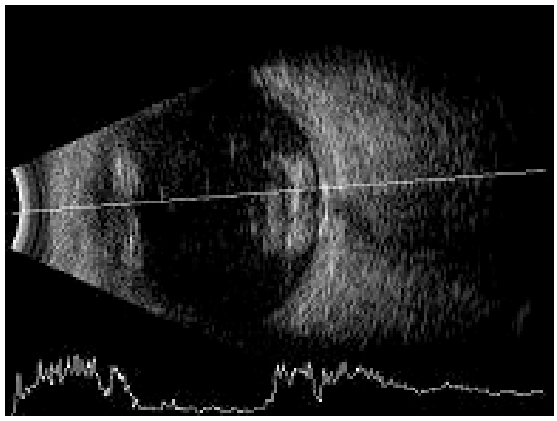

Fig. 5. Dislocated cataractous crystalline lens. Lens capsule is not intact. Point like and membrane like echoes are present in the vitreous cavity. There will be mobility of the lesion on eye movements.

Ultrasound findings in Diabetic retinopathy

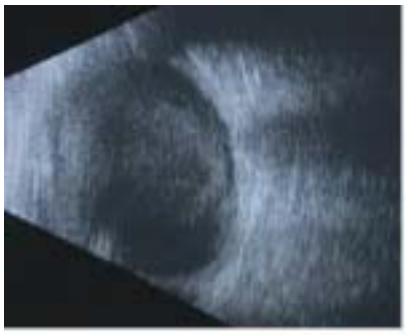

Fig. 6. Plenty of point like echoes in the vitreous cavity suggestive of vitreous haemorrhage

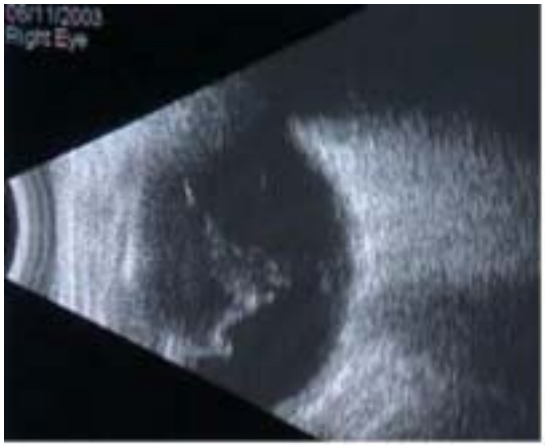

Fig. 7. Vitreous haemorrhage with incomplete posterior vitreous detachment. There are multiple point like echoes in the gel.

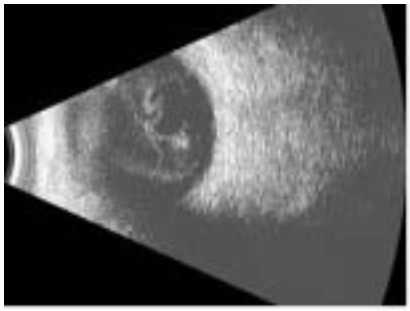

Fig. 8. Vitreous haemorrhage with schisis cavity inside and complete PVD. The after movements will be very good in presence of complete PVD.

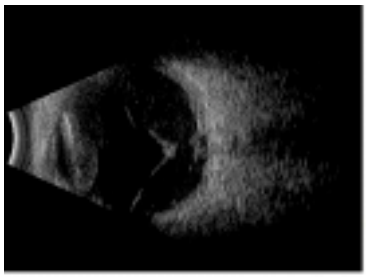

Fig. 9. Membranous echo attached to the disc which is incomplete PVD. There are point like echoes beneath the membrane suggestive of subhyaloid haemorrhage. Also there are multiple echoes in the pre-papillary area due to adherent fibrous proliferation and peripapillary tractional retinal detachment.

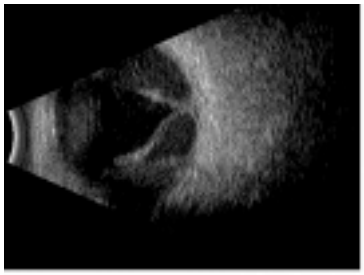

Fig. 10. Membranous echo inserting at the disc with moderate after movements. This is PVD. There is point like echoes beneath this layer suggestive of sub vitreal or subhyaloid haemorrhage.

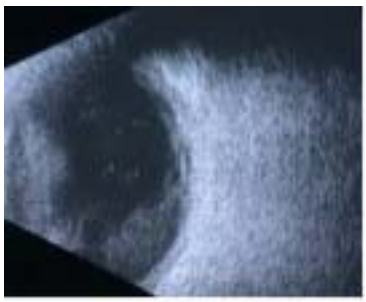

Fig. 11. Membranous echo in the lower part with plenty of point echoes beneath suggestive of Incomplete PVD of lower part with sub vitreal haemorrhage. There is intragel haemorrhage also.

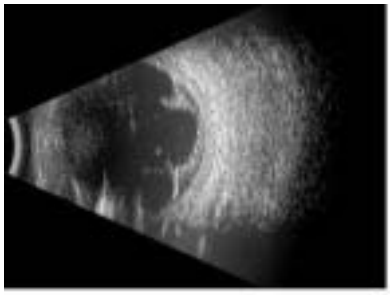

Fig. 12.Two membranous attachment pulling the retina in a tent like fashion. This is tractional retinal detachment. There is no PVD between the TRD along the arcades. This is called table top TRD.

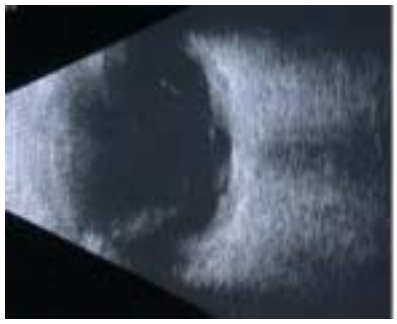

Fig. 13.Two membranous attachment pulling the retina in a tent like fashion. There is PVD between the TRD.

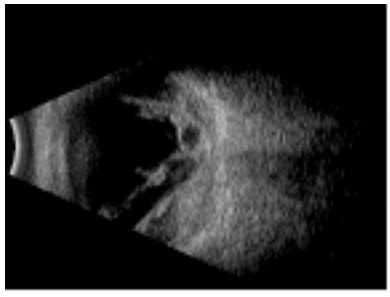

Fig. 14. Multiple membranous lesions attaching to the disc area with vitreoschisis. There is subvitreal haemorrhage as well as subretinal haemorrhage. In the lower part there is retinal detachment.

Ultrasound findings in Trauma

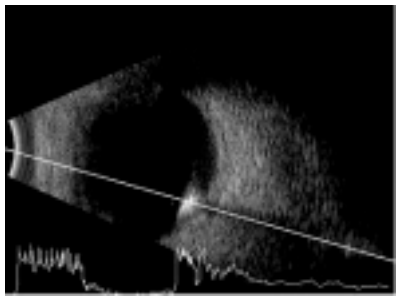

Fig. 15. High reflective (100% spike height) intraocular foreign body with shadowing behind. Low gain examination will help in the better delineation.

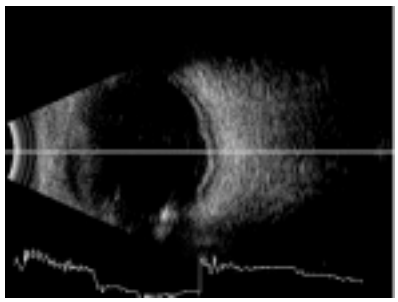

Fig. 16. High reflective point like echo with shadowing suggestive of radio opaque retained intraocular foreign body. Also there is a shallow retinal detachment seen as membranous high reflective echo with not much after movements.

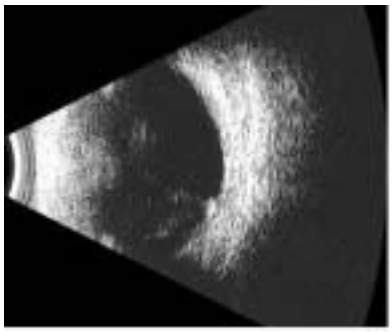

Fig. 17. High reflective intraocular foreign body with membranous echoes attached to it which is a typical vitreous track.

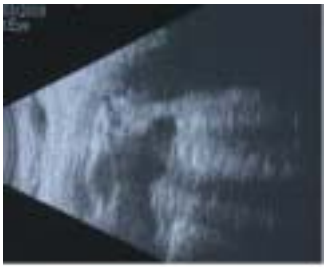

Fig. 18. Occult scleral perforation. There is distorted eye walls and hypo echoic area behind the sclera which is haemorrhage. Also choroidal thickening and intragel haemorrhage can be seen.

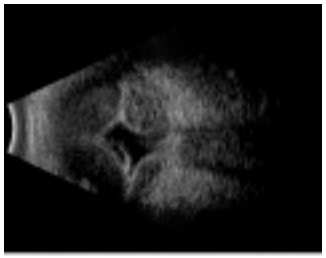

Fig. 19.Classical kissing choroidal detachment with scalloped appearance. Pin point echoes inside the dome shaped choroidal detachment is suggestive of haemorrhagic type. A Scan will show double peak due to retina and choroid.

Fig. 20. Phthisical eye with reduced axial length, retinal detachment with intraretinal cysts and choroidal thickening. Some cases may show calcification

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(Ultrasound pictures from Giridhar eye Institute Archives. Authors have no financial interest in any product or machine shown)

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INTRAVITREAL ANTIBIOTICS: CHOICE, DOSAGE, PREPARATION

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(i) **Choice of antibiotics:**

The choice of antibiotic in the treatment of infective endophthalmitis depends on the infective micro organism. Post cataract surgery Coagulase negative staphylococcus (33-77%) Staphylococcus aureus (10-21%) and Beta hemolytic streptococcus (9-19%) are the most common organisms causing acute endophthalmitis. Usually a combination which covers both the gram positive and gram negative group is preferred as the initial choice of intravitreal injection. The choice of antibiotics should be reviewed following the culture and sensitivity results. In general use

- Vancomycin in a Dose of 1mg has good Gram +ive coverage and also Bacillus and P acnes species. Its therapeutic effect lasts up to 3-4 days after intravitreal injection
- Ceftazidime in a Dose of 2.5mg has good gram negative coverage including Pseudomonas
- Amikacin in Dose of 0.125 mg has good gram negative coverage but possibility of retinal toxicity has to be kept in mind

The ideal combination with least intravitreal toxicity recommended by EVS is a combination of Vancomycin with Ceftazidine. Intravitreal Amikacin is considered for cases with fulminant gram negative infection. The EVS did not address the specific question of intravitreal steroids and to date their use remains unsubstantiated. For suspected fungal endophthalmitis, intravitreal Amphotericin B (5ug in 0.1ml) has been proven to be effective. Intravitreal Miconazole (0.01mg in 0.1ml) should be considered for fungi resistant to Amphotericin B

(ii) **Recommended doses of antibiotics**

Route of admin.	Drug	Dose
Intravitreal	Vancomycin	1 mg in 0.1 ml
	Ceftazidine	2.25 mg in 0.1 ml
	Amikacin	0.4 mg in 0.1 ml
	Dexamethasone	0.4 mg in 0.1 ml
	Amphotericin	5µg in 0.1ml
Topical	Vancomycin	50mg/ml drops hourly
	Amikacin	20mg/ml drops hourly
	Prednisolone acetate	1% drops hourly
Sub Conjunctival	Vancomycin	25mg in 0.5 ml.
	Ceftazidine	100mg in 0.5 ml
	Dexamethasone	4 to 8 mg

(iii) **Preparation Of Intravitreal Drugs**

All intravitreal drug preparations should be freshly diluted. The drug preparation guide is given below:

Drug (Recommended dosage)	*Preparation*
ANTIBIOTICS	
Vancomycin 1 mg/0.1 ml	1. Available as 500 mg 2. Dissolve in 10 ml distilled water 3. Take 0.2 ml of the above 4. Add 0.8 ml distilled water 5. Take 0.1 ml of the above.
Ceftazidine 2.25mg/0.1ml.	1. Available in 500 mg vial 2. Dissolve in 2 ml distilled water 3. Take 0.1 ml from the above 4. Add 0.9 ml distilled water 5. Take 0.1 ml of above.
Ceftazidine 2.25mg + Dexa .4mg	1. Ceftazidine available in 500mg vial 2. Dissolve in 2 ml distilled water 3. Dexa available in 4mg/ml 4. take 0.1ml of inj Cefta 5. add 0.9 ml of Dexa6. take 0.1 ml from above 7. this is Cefta 2.5ml and 0.4 mg Dexa
Cefuroxime (1mg in 0.1ml)	1. The vial contain 1500mg of Cefuroxime powder 2. Reconstitute the vial with 15 ml of 0.9% NS 3. Withdraw 1ml (100mg) of this solution and add 9ml of 0.9% NS 4. Take 0.1 ml (= 1mg)
Amikacin (0.4mg in 0.1ml)	1.The vial contains a solution of sulfate 500mg of amikacin sulfate in 2 ml (250mg/ml) 2. Withdraw 0.8 ml (200 mg) and add 9.2ml of 0.9% NS 3. Withdraw 0.2 ml (4 mg) and add 0.8 ml of 0.9% NS 4. Take 0.1 ml (= 0.4 mg)
STEROID	
Dexamethasone (0.4 mg in 0.1 ml)	1. The vial contains a solution of 4 mg of Dexamethasone in 1 ml 2. Take 0.1 ml (= 0.4 mg)
ANTIFUNGAL	
Amphotericin B (0.005mg in 0.1ml)	1. The vial contains 50-mg of Amphotericin B powder 2. Reconstitute the vial with 10ml sterile water for injection 3. Withdraw 1ml (5mg) and add 9ml of sterile water for injection. Mix well 4. Withdraw 1ml (0.5mg) and add 9ml of sterile water for injection. Mix well 5. Take 0.1 ml (= 0.005mg
Miconazole (0.01mg in 0.1ml)	1. The ampoule contains 10mg/ml of Miconazole 2. Withdraw 1ml (10mg) and add 9ml of 0.9% normal saline. Mix well 3. Withdraw 1ml (1mg) and add 9ml of 0.9% normal saline 4. Take 0.1ml (=0.01mg)

(iv) **Complications of intravitreal antibiotic injection**

The most fearsome toxicity of intravitreal antibiotic is the toxicity of aminoglycosides (Gentamicin and amikacin) which can cause macular infarction. In general therefore one should try and avoid use of aminoglycosides.

Tips :

- The intravitreal dose is given in 0.1ml except when combination therapy is used and 0.2ml is given.
- Avoid solutions or preparations containing preservatives.
- Prepare fresh dilutions before every repeat injection.
- Prepare and dilute intravitreal antibiotics using an aseptic technique.
- Prepare different antibiotics in separate syringes
- The quantities for intravitreal injection may be drawn up in 1ml syringes, and injected with a 27 or 30 gauge needle.
- Make sure to fill the dead space of the needle with antibiotic solution.
- Make sure that intraocular pressure in normal at the end of procedure.
- Intravitreal drugs are toxic to the retina, therefore it is advisable to strictly limit the dosage as recommended. ●

INTRAVITREAL INJECTIONS- CLINICAL PRACTICE GUIDELINES

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I Guidelines for Care and Prophylaxis Before Injection

A. Disorders with the potential to increase risk from IVT injection should be managed before treatment

1. Preexisting glaucoma

- Patients with glaucoma should receive appropriate treatment before IVT injection.
- IVT injection should not be denied or withheld from patients with a history of glaucoma if such therapy is deemed important to preservation of central vision.
- Before performing IVT injection, physicians should conduct a thorough risk assessment based on standard medical practice. This should include the monitoring of intraocular pressure before and after injection.
- Anterior chamber paracentesis is not the treatment of choice for the management of transient injection - related rises in intraocular pressure.

2. Allergies to povidone iodine

- Since true contact allergy to povidone iodine is quite rare, a reported history of povidone iodine allergy should be verified by applying a skin patch test before use of topical povidone iodine.

3. Active external infection, including marked blepharitis

- Postpone injection until after active infection is effectively treated.

4. Eyelid abnormalities

- Consider eyelid abnormalities as a risk factor for endophthalmitis

B. Gloves and draping

5. As part of universal precautions and for the safety of physicians who may be exposed to blood, gloves are appropriate.

6. Draping of the periorbital region and eyelashes may be employed but is not essential.

C. Prophylactic antibiotics

1. Physicians may consider using preinjection topical antibiotics.

Caveat: Limited data support preinjection use of antibiotics

Caveat: Data also indicate that antimicrobial resistance may be more likely to occur with antibiotics treatment.

2. Lid scrubs

- Excessive lid manipulation is to be avoided

3. Preinjection globe softening

- While not believed to be necessary in most instances, if globe softening is desired, pressure should be applied directly to the globe so as to avoid eyelid manipulation.

4. Pressure should not be applied to the eyelids, eyelid margins, or the adnexa

II. Guidelines for Peri-Injection Management

A. Pupillary dilation

Dilation is preferred for adequate visualization after the injection is given, unless otherwise contraindicated.

B. Topical anesthetic

Topical anesthetic should be applied as indicated by standard medical practice.

C. Supplemental subconjunctival anesthetic in addition to topical anesthetic may be considered.

D. Povidone iodine

Povidone iodine should be applied directly to the eyelid margins, eyelashes, and conjunctival ocular surface before the injection via a sterile applicator, drops, or a flush. Lid scrubs are not to be performed.

E. Speculum

A speculum is generally recommended to avoid needle contact with lids and lashes. Once the speculum is in place, additional drops of povidone iodine should be applied to the ocular surface at the intended site of injection.

F. Site of injection

The injection is place through the pars plana in the inferotemporal quadrant 3.5 to 4mm posterior to the limbus for a pseudophakic and phakic eye, respectively.

G. Needle size

Use a needle of 27 gauge or smaller with a length of 0.5 to 0.62 inches

Insert the needle at least 6mm toward the center of the eye.

H. Injection

A moderately slow injection should be used to place the drug gently into the vitreous cavity. Rapid injection causes excessive dispersion of the drug into the vitreous cavity and can cause the needle to come off the syringe.

After injection, the needle should be carefully removed from the eye, and consideration should be given to using a sterile cotton-tip applicator to prevent reflux of both the therapeutic agent and vitreous.

I. Protocol: Sequence of events

An appropriate sequence of steps for IVT injection is to:

1. apply topical anesthetic;

2. apply povidone iodine to eyelid margins, eyelashes, and conjunctival surface;
3. Insert speculum;
4. apply additional drop of povidone iodine to site of injection;
5. gently inject therapeutic agent;
6. remove needle

III. Guidelines for Postinjection Management

A. Postinjection antibiotics

Physician may consider use of postinjection topical antibiotics.

Risks of promoting antimicrobial resistance should guide drug selection and dosage.

B. Intraocular pressure

Monitor intraocular pressure after injection. Provide therapy when elevated intraocular pressure warrants treatment. This usually occurs in the context of increased intraocular pressure to the extent that the central retinal artery remains closed and the patient has no light perception for more than 1 to 2 minutes. Transient graying or obscuration of vision following injection, however, is expected and should not be treated.

C. Postinjection reperfusion of the optic nerve Visualize the optic nerve to verify reperfusion of the central retinal artery in the immediate postinjection period.

Verify intravitreous location of therapeutic agent when possible.

Verify that the retina is attached and that there is no new intraocular hemorrhage.

D. Discharge

No special precautions are required before discharge of a patient who has had an uneventful recovery from IVT injection, but patients and/or caregivers should be educated to avoid rubbing the eye and to recognize the signs and symptoms of endophthalmitis, retinal detachment, or intraocular hemorrhage, these are eye pain or increased discomfort, increased redness of the eye (compared to immediately after injection), blurred or decreased vision, and increased ocular sensitivity to light.

Patients should be informed that some blurring of vision is common post-injection, which is often described as seeing spots floating in the eye. The floaters usually resolve after a few days or weeks.

IV. Guidelines for Follow-Up

The patient should be contacted by the physician's office within one week of the procedure. Further follow-up should be dictated by the specific needs of the patient.

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POSTERIOR SUBTENONS INJECTION

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Posterior Subtenons is one of the periocular routes of drug delivery.

This allows administration of a large bolus of drug, minimizing the systemic side effects of the drug and also allows a more sustained release of the drug. (long-lasting response at the site of injection).

Posterior Subtenon Injection

The mechanism of penetration of corticosteroids into the eye is most likely to be trans-scleral. Disadvantage is the multiple barriers between the subtenon space and the retina. Corticosteroid injected in the subtenon space must cross the sclera, the extremely vascular choroid, and the retinal pigment epithelium.

Subtenon injection allows the use of significantly higher drug concentrations, allows frequent repeat injections as needed and they deliver the steroids closer to the macula.

The most popular drug used for subtenon injection is depot steroids – eg,triamcinolone acetonide or methyl prednisolone .

Subtenon injection of triamcinolone acetonide achieves measurable amounts of drug in the vitreous (some levels are comparable to those achieved with intravitreal injection[1]). Treatment effect is usually apparent within 2-3 days. Injections may be repeated every 2-4 weeks, as dictated by the clinical response. [2].

DRUG	FORMULATION	ROUTE, DOSE
Hydrocortisone	100-1000mg powder	Subconjunctival/Tenon 50-125mg
Methylprednisolone		
Sodium succinate	40mg/ml,125mg/ml,2g/30ml	Subconjunctival/Tenon 40-125mg
Acetate	20-80mg/ml suspension	Transseptal/retrobulbar 40-80mg
Triamcinolone		
Diacetate	25-40mg/5ml suspension	Subconjuncival/Tenon 40mg
Acetonide	10-40mg/ml	Transseptal 40mg
Dexamathasone		
Acetate	8-16mg/ml suspension	Subconjunctival/Tenon 4-8mg
Sodium phosphate	4,10,24mg/ml solution	Transseptal 4-8mg Retrobulbar/Intravitreal 0.4mg
Betamethasone acetate and sodium phosphate	3mg/ml suspension	Subconjunctival/Tenon Transseptal-1mg

Regional Corticosteroid Preparations

Indications of posterior subtenons injection

- Intermediate uveitis
- CME in uveitis
- Adjunct to topical or systemic therapy in resistant chronic anterior uveitis
- Severe acute anterior uveitis ,especially in patients with ankylosing spondylitis with a marked fibrinous exudates in the anterior chamber or hypopyon
- Poor patient compliance with topical or systemic medications
- Refractory Pseudophakic CME
- Diabetic macular edema
- CME in retinal vein occlusions

Technique

Topical anaesthesia is applied to the eye prior to injection

The usual site of injection is the inferotemporal quadrant. The superotemporal quadrant can also be used. For an inferotemporal injection the patient is asked to look up and medially. A cotton tipped applicator soaked in paracaine is held on the area for 1-2 minutes. The drug is drawn into a 2cc syringe and a 26G needle is fixed. With the bevel towards the globe the needle is introduced into the bulbar conjunctiva 2-3mm from the fornix avoiding the conjunctival blood vessels, in the inferotemporal quadrant. As the needle is inserted ,lateral motions of the needle are made to ensure that the needle has not penetrated the sclera [at which point the lateral motion would be inhibited]. The curvature of the eyeball is followed attempting to place the aperture of the needle near the posterior sclera .When the needle has been pushed into the hilt , the stopper of the syringe is pulled back to ensure against intravascular penetration. The contents of the syringe are injected and the needle is removed.

Advantages over topical administration[3]

Therapeutic concentrations behind the lens achieved

Water soluble drugs incapable of penetrating the cornea when given topically can enter the eye trans-sclerally,when given by periocular injection

A long lasting effect can be obtained with depot preparations such as triamcinolone acetonide or methyl prednisolone acetate.

Ocular Complications of Periocular Injections [4]

Inadvertent globe penetration

Elevation of intraocular pressure

Cataract formation

Aponeurotic ptosis

Enophthalmos

Tendency for scar formation

Subdermal fat atrophy and Extraocular muscle fibrosis

Atrophy and fibrosis of the periorbita

Central retinal artery occlusion from drug embolisation

Retrobulbar Haemorrhage

Optic nerve injury from retrobulbar injection

Limbal dellen usually after anterior injections

Hypersensitivity to the vehicle

Systemic complications of corticosteroids

Cushingoid features

Peptic ulceration

Aseptic necrosis of head of femur

Osteoporosis

Steroid-induced diabetes

Mental changes

Electrolyte imbalance

Reactivation of infections

Cataract

Increase in the severity of pre-existing disease such as diabetes, hypertension.

Limitation of growth in children

Myopathy

Contraindications of posterior subtenons injection of steroid

Uveitis associated with toxoplasmosis

Necrotising scleritis

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STERILISATION OF OUTPATIENT OPHTHALMIC EQUIPMENTS

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Spread of infections, bacterial and viral is known through the use of diagnostic ophthalmic equipments especially tonometers and gonioscopes.

Adenovirus type 8 that spreads epidemic keratoconjunctivitis, Herpes simplex virus (HSV) type 1,Hepatitis B virus both surface antigen and DNA polymerase , HCV RNA in carriers and Human Immunodeficiency virus transmission risk through tears has focussed interest in sterilisation of tonometers ,diagnostic and therapeautic ophthalmic lenses.

Various methods in vogue and practical tips for outpatient ophthalmic equipment cleaning and maintenance post exposure to ocular infectious disease is discussed in this article.

SCHIOTZ TONOMETER RECOMMENDATIONS FOR STERILISATION

IDEAL METHOD

Disassemble tonometer between each use.Clean the barrel by inserting a white pipe cleaner saturated with alcohol pulling back and forth and then inserting a second dry pipe cleaner.The footplate and plunger is cleaned next followed by the test cornea.Reassemble instrument and wait for at least 60 seconds after cleaning with alcohol before placing the instrument on the cornea.

PRACTICAL METHOD

Keep the base of the tonmeter continuously dipped in a solution of 1:1000 merthiolate solution.Prior to use footplate can be rinsed in saline or distilled water. After use replace in merthiolate solution.

CONTACT TYPE APPLANATION TONOMETERS

Prisms used in Golmann, Perkins, Draegers and Pneumotonometers need to be appropriately sterilised.Mackay Marg tonometers and tonopens have sterile tonofilm cover.

METHODS TO STERILISE

- Mechanical wipe with disposable kim wipe and sterile gauze (inadequate safety against LV type 1 or HSV type 1 or 2.[1]
- Wipe with sterile gauze soaked in 70% isopropyl alcohol or 3% H_2O_2 or 1:10 dilution bleach for 10 seconds and allowed to dry before use. (disinfects adenovirus, HSV, HIV).[2]

  - isopropyl alcohol applied to prism sides may erode etchings on prism

- ❖ UV rays – tend to damage plastic
- ❖ Gas sterilisation

FIGURE - 3

SOAK TECHNIQUE

According to CDC & prevention (Atlanta,USA) & AAO-

Soak tonometer head in 3% H2O2 or dilute household bleach (1:10 dilution sodium hypochlorite) for 5 – 10 minutes between use.Air dry for 70% isopropyl alcohol or irrigate tip with saline and dry in case of H2O2 or sodium hypochlorite.[3]

PROBLEMS ENCOUNTERED

- ❖ Minor burns on fingers with H2O2 or minor burns on cornea
- ❖ Increasing concentration of solution due to evaporation especially in summer in tropics
- ❖ Soaking the entire prism in the solution may remove the colouring of etched calibration marks

Hepatitis B surface antigen is eliminated by 10 minutes of continuous rinsing in running tap water.[4]Soap and water wash reported as the only disinfection method to remove HBV DNA.[5]

Wiping with 3% H2O2 or 70% isopropyl alcohol swabs completely disinfected tonometer tips infected with HIV.

Goldmann tonometer tips inoculated with HCV best sterilised by a 5 minute soak in 3%H2O2 or 70% isopropyl alcohol and then wash n cold water.A 5 second wipe with povidone iodine more effective than 5 second alcohol wipe.

NON CONTACT TONOMETERS

Though they have no contact with cornea or tears the front surface may be wiped with an alcohol soaked sponge due to microaerosol contamination and chances of occasionally touching lashes.

TONOMETRY TO BE DEFERRED IN :

- ❖ Herpetic involvement of face and eyes
- ❖ Lid infection
- ❖ Dacryocystitis
- ❖ Matting of cilia
- ❖ Epidemics of conjunctivitis
- ❖ Tearing red eyes

ARGON/DIODE,YAG AND DIAGNOSTIC LENSES

CLEANING METHOD 1

Rinse : immediately upon removal from patient's eye;thoroughly rinse in cool or tepid water

Wash : Place a few drops of mild soap on a moistend cotton ball.Gently clean with a circular motion.

Rinse : Thoroughly rinse in cool or tepid water,then dry carefully with a non linting tissue.

Then : proceed with disinfection or sterilisation

DISINFECTION

For disinfection of the lenses,it should be soaked in Glutaraldehyde 2% or 3.4% aqueous solution with minimum exposure time of 20 minutes.

CLEANING METHOD 2

The lenses should be wiped with alcohol wipe and then either disinfection or sterilisation needs to be done.

DISINFECTION

a. Glutaraldehyde 2% or 3.4% for disinfection of the lenses,it should be soaked in aqueous solution with minimum exposure time of 10 minutes.

b. Bleach 10% solution mixed with 1 part of bleach to 9 parts water with exposure time of 10 minutes.

Then the lens should be rinsed thoroughly to remove the disinfection solution , 3 cycles of 1 minute with cool or tepid water and dried carefully and placed in a dry storage case.

STERILISATION - EO

Minimum time : 1 hour

Temperature : 130°F(54°C)

Aeration time : 12 hours

WARNING

The lenses should never be steam autoclaved or boiled and never should be soaked in alcohol, actone or other solvents

FIGURE – 1 & 2

SLIT LAMP BIOMICROSCOPE

HIV is a fragile virus and there is no evidence of casual spread from surfaces of ophthalmic instruments.However other viruses such as adenovirus may persist for many hours on a dry surface and thus could be transmitted to other patients.So if a slit lamp biomicroscope has been used for a patient who is suspected of having an ocular infectious disease,it is strongly recommended that the surfaces on the instrument be cleaned with alcohol or bleach.

PRECAUTIONS

- Handwashing for atleast 10 seconds, vigorous rubbing together of lathered hands followed by thorough rinsing under a stream of water
- Mechanical wipe with alcohol swab of – joy stick lever, lever for changing objectives, interchangeable eyepieces, lever for filters, lever for diaphragms, ball handle for turning slit image, centring screw, level adjustment control for chin support, forehead bar and transformer with switch after exposure to each infectious case.

2%Bacillocid – a surface and environmental disinfectant concentrate has a wide range of germicidal action.It can be electively used to disinfect Goldmann applanation prism tips as well as for disnfection of goniolenses and parts of slitlamp biomicroscope.

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Care of Equipments in the Operation Theater

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Operating Microscopes

Microscopes have become an integral part of Ophthalmic surgical procedures. Being a long time investment, proper care and maintenance of the operating microscope is essential for its continued smooth functioning.

- Need a UPS while in use.
- Take care to protect the foot pedal from getting wet by irrigating fluids
- Cover the microscope at least upto the part where the bulbs are located, with plastic while the OT is being cleaned / fumigated. This is to prevent moisture getting into the bulb holders and optics.
- Microscopes should not be moved while the bulb is on or still hot. A hot filament is more likely to break off than a cold filament.
- The bulb should not be touched with bare hand as grease from fingers may cause it to explode. If touched accidentally it may be cleaned with alcohol.
- Always keep sufficient stock of spare bulbs
- Cleaning the optics needs utmost care. Never wipe the lens with gauze or other abrasive materials. Use the cleaning cloth supplied by the manufacturer or soft tissue paper.
- Never spray disinfectants on to the microscope optics. The surfaces around the lenses can be wiped with a cloth soaked in alcohol
- The lens should be cleaned in a circular motion from the center outwards after blowing away the dust with a blower. Cleaning solution recommended by the manufacturer or 30% ether may be used to clean the lens. Never use alcohol or soap to clean the lens as it may damage the antireflective coating.
- The body of the microscope can be cleaned with a wet cloth soaked in soapy water after disconnecting the power supply.
- See that the fiber optic cables are not bent sharply or coiled too tightly. If the fibres crack, the illumination will reduce considerably
- The castor wheels should be kept in the locked position while in use and should be released while the microscopes are moved. Fibre, sutures and lint can get trapped in the wheel joints thereby hampering its function. Periodic oiling should be done to ensure its smooth movement.
- Fungus growth in the optics can be prevented by keeping desiccating agents like silica gel packets or a lighted “zero

watt" bulb in the microscope cover. The bulb should remain suspended without touching any of the microscope parts. If the bulb touches anywhere that area can get damaged due to heat.

Phaco machines

- The phaco accessories should be cleaned after use and autoclaved.
- The tubings have to be flushed with distilled water and made dry after use
- The piezo electric crystal is located inside the phaco handpiece. Rough handling will damage the crystals.
- The phaco tip should be cleaned with distilled water and flushed with air after every case and then autoclaved.
- Special care should be taken if the machine has internal tubings.
- The electric cable of the handpiece should not be coiled too tightly or bent sharply.
- Wipe the machine with a wet cloth after use and keep it covered while not in use

Vitrectomy machines

- The vitrectomy probes should be thoroughly cleaned with distilled water and flushed with air after use
- Always keep the tip immersed in a bowl of irrigating fluid while checking the cutter
- Some cutters are autoclavable. But ETO sterilization will retain its sharpness more.
- Never send the cutter and tubings for ETO unless they are absolutely dry.

Lenses

- Dust accumulating on the 20 D, 90 D, and 78 D lenses can be cleaned with an air blower. The lenses are wiped from inside outwards in a circular manner with a soft cloth or tissue paper and sterilized using ETO. Never use alcohol to clean the lens surface.
- If soiled, they can be cleaned using a soft painting brush and mild neutral soap solution. After washing shake the lenses dry or use a tissue paper or sponge to blot the water droplets from the surface.
- Do not touch the surfaces with bare hands. Always hold them by their edges.
- Gonioscopes and other fundus contact lenses should be cleaned with water after every use. Take care not to touch the observer side of the fundus contact lens. The lenses are disinfected by keeping the contact lens part immersed in 1% hypochlorite solution for 20 minutes.

Slit lamp microscopes

- Clean the optics with the lens cleaning solution using soft tissue paper
- The reflecting mirror can be wiped with a wet cloth
- Never hold the bulb with bare hands while changing it.
- Verify the alignment of the microscope with the calibration rod supplied with the equipment.
- In a busy OPD it is better to dim the illumination after every case rather than switching it every time.
- At the end of the day silica gel sachets and lighted "zero watt" bulb may be kept inside the microscope cover to reduce the humidity.

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NOTES