Case History

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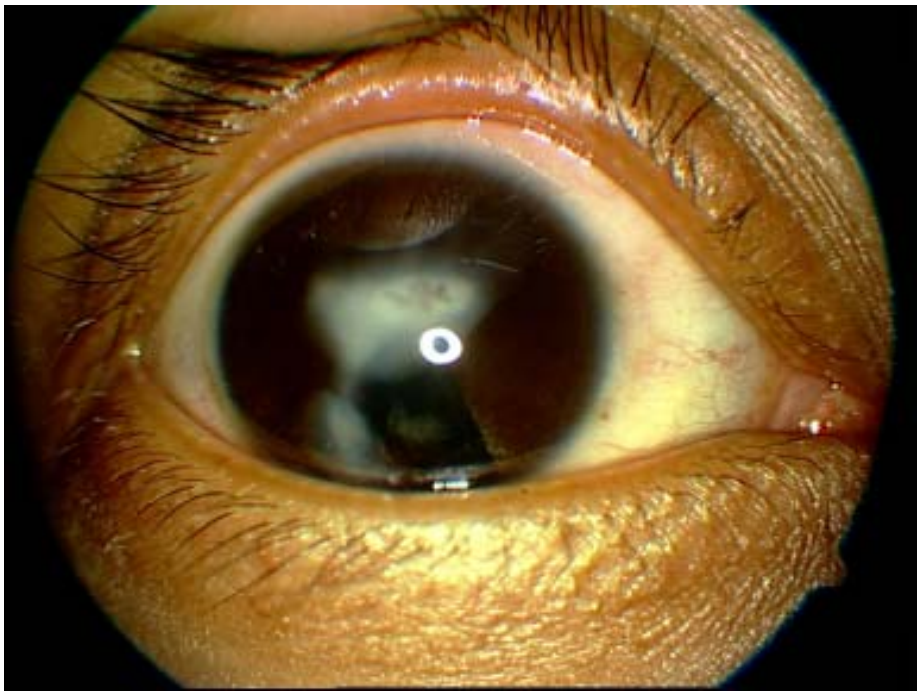
An 18 year old male presented with diminution of vision in right eye since childhood. He had a history of redness and pain in both eyes about 10 years back. Following which he suffered from total vision loss in the left eye and decrease in vision in the right eye.

He was operated in the right eye 7 years back (an optical iridectomy was done), following which his vision improved to some extent.

On examination the BCVA in the right eye is 5/60 and in the left eye PL was absent. The right eye showed a non-vascularised central adherent leucoma as shown in the figure. Inferonasal optical iridectomy is present. The lens is clear and the fundus is apparently normal. Extreme periphery could not be visualised.

What would be the appropriate management in this case - conservative or surgical?

- Is there a role of contact lens?
- If surgical - which procedure?
  (a) PK
  (b) Rotational Auto Graft
- If surgery, then when should it be done?
- What size of graft for PK and Rotational auto-graft should be used?



Editor's Note:

DOS members are requested to come foward with their solutions to this dilemma, the best of which will be published in the forthcoming issue.

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Solution to Clinical Dilemma

Jaswant Arneja, Alka Pandey

The clinical history of a young male with diminishing vision and the impression of the fundus picture shown in the September issue of the DOS magazine, resembles the picture of HIV associated retinopathy.

The features observed in the fundus picture are:

(i) Multiple cotton wool spots

(ii) Intra – retinal haemorrhages

(iii) Disc appears a little hyperemic,

FFA shows focal discrete areas of capillary non-perfusion (CNP) and focal leaks.

All the above features are commonly seen in noninfectious micro angiopathy associated with HIV/AIDS.

Differential diagnosis

Differential diagnosis to be kept in mind will be

a. HIV/AIDS
b. IDDM
c. Renal hypertension
d. Radiation retinopathy

HIV /AIDS

Ophthalmic manifestations are seen in up to 70% of patients infected with HIV. These can be classified into four groups:

1. A non infectious micro angiopathy – referred to as AIDS retinopathy.
2. Opportunistic ocular infections caused by pathogens like:
   - Cyto megalo virus
   - Herpes zoster virus
   - Toxoplasma gondi.
   - Mycobacterium avium-intracellular
   - Pneumocystis carinii
   - Histoplasma capsulatum
   - Candida
3. Ocular neoplasms which includes Kaposi sarcoma and lymphoma.
4. Neuro-ophthalmic lesions secondary to cryptococcal meningitis, zoster ophthalmicus, viral encephalitis and central nervous system lymphoma.

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Investigations :

1. Hb, TLC, DLC, ESR and Blood sugar.
2. HIV antibody testing and viral culture is advised.
   - Serocard, Tridot and immunocomb tests are advised for detection of HIV antibody. These are rapid HIV antibody assays. They generally require 30-90 minutes.
   - More rapid tests are variations of enzyme immunoassays (EIA) with various combinations of HIV 1 & HIV 2 antigen.
   - Western blot or indirect immunofluorescent tests on reactive serum are further confirmatory tests.
   - Viral cultures are expensive and time consuming
3. Measurement of T Lymphocyte sub types especially CD 4 Lymphocyte count. It shows the degree of immunosuppression. CD4+T cell count is also recommended.
4. For Cytomegalo virus (CMV) retinitis ELISA to detect antibodies to CMV. Ig M – raised titer will show recent infection. Ig G - raised titer will show past exposure to virus.

Management :

Risk of HIV transmission must be kept in mind by the examining doctor. Use a face mask, gloves and be careful in needle pricks. A thorough medical examination should be done by a specialist to rule out any underlying systemic disease. Since most of the patients have an underlying systemic disease related to HIV/ AIDS, patient should be referred to an AIDS referral centre for further management. Oral acyclovir for Herpes, Co-trimoxazole for P. carinii, Ganciclovir for CMV may be needed. Focal laser photocoagulation can be tried to prevent further damage.

Editor's Note:

The patient in question had malignant hypertension with hypertensive retinopathy due to a renal pathology. However, HIV retinopathy does form an important differential diagnosis of the picture described and should be ruled out especially in a young patient.

Argon Laser Trabeculoplasty (ALT): Role in Modern Glaucoma Management

Harsh Kumar, MD

Zveng and Flocks were the first to conceive the role of laser photocoagulation of anterior chamber angle to control glaucoma. This procedure has been variably called as Laseropuncture, goniopuncture, laser trabeculoplasty etc. The term "Argon laser trabeculoplasty" was coined initially by Wise & Witter. It was based on the concept of applying low energy burns by Argon laser to anterior trabecular meshwork resulting in lowered IOP's.

At the onset I would like to clarify that the role of ALT in Indian eyes is limited. Its mainly the eyes in west which show remarkable and sustained IOP lowering due to ALT. However we are giving the details since one should have an idea of where it might be useful in general glaucoma practice as some eyes may respond favourably for a long term lowering of IOP.

Mechanism of Action

The mechanism action of ALT is not definitely known but appears to involve a complex interaction of mechanical, cellular & biochemical events. Wise & Witter proposed that thermal energy produced by absorption of laser by pigmented trabecular meshwork caused shrinkage of collagen of trabecular lamellae. This probably opened up intertrabecular spaces in untreated region and expanded Schlemn's canal by pulling the meshwork centrally. Microscopic studies demonstrated increased phagocytic & migratory activity of surviving endothelial cells near the laser lesions increasing the transcellular flow of aqueous into Schlemm's canal.

Another mechanism postulated involves elimination of some trabecular cells post trabeculoplasty. This stimulates the remaining cells to produce a different composition of extracellular matrix with lesser outflow – obstructing properties.

Procedure of ALT

Argon laser is used for ALT in routine practice. A blue-green laser or a monochromatic laser light can be used. Alternatively, a Pea Green laser frequency doubled Nd: YAG laser & Diode laser can also be used Diode lasers have the advantage of portability & lesser maintenance requirements and possible attachment with standard slit lamps. Besides, it causes less disruption of blood aqueous barrier, lesser perioperative pain & peripheral anterior synechiae.

Knowledge of gonioscopy to visualise the angle details and its variation is imperative for a successful ALT procedure. The different gonio prisms used for visualization of anterior chamber angle are Goldman single or three mirror, Thorpe 4-mirror gonioscopy lens or Ritch trabeculoplasty laser lens. All lenses used for laser application should have an antireflective coating on the front surface.

Ritch trabecloplasty goniolens is usually preferred. It has two mirrors inclined at 59^{o} for better view of inferior quadrant & 2 at 64^{o} for superior angle. It has a 17D planoconex button over two mirrors which provide 1.4^{X} magnification reducing a 50 µm laser spot to 35 µm.

Steps in ALT

- The patients are explained the procedure and made to understand the purpose of ALT as an adjunct to medical Rx. A treatment Written consent is taken.
- A drop of topical proparacaine 0.5% or Xylocaine 4% (2 drops separated by 2 minutes) produces satisfactory anaesthesia for the whole procedure. Gonioprism is helpful in fixing the globe. Peribulbar anaesthesia may however be required in very uncooperative pts. or those with nystagmus.
- In our experience a drop Brimonidine 0.5% 1 hour before and immediately after trabeculoplasty minimizes the post operative pressure rise.
- In cases of advanced glaucomatous cupping, preoperative Acetazolamide (Diamox) one tablet one hour before procedure or in high risk, one eyed patients with previously very high IOP records intravenous manitol may be helpful in reducing the magnitude of potential post operative pressure spike.
- A gonioprism is inserted & entire angle exmained carefully. All angle structures should be identified before start of Rx so as to avoid accidental treatment of cornea or ciliary body band with resultant downward migration of corneal endothelial cells and formation of PAS. In case of difficulty in lightly pigmented trabecular meshwork, Schwalbe's line

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should first be identified by locating the apex of corneal wedge.

- The commonly available three mirror Goldman lens may not be appropriate as the mirror is shorter in height and further away from the center of the cornea vis a vis the single mirror and hence visualization of angle may be difficult in narrow entry cases. Ritch trabeculoplasty lens is usuallly preferred as it provides 1.4^X magnification reducing effective spot size from 50 to 35 mm and laser energy by a factor of 2. However one can get used to any of the available lenses.
- Setting for ALT is 50u spot size, 0.1- 0.2 second duration and 750 – 1200 MW of power (average of 1000 mw). The power should be adjusted to produce a depigmentation spot or a small bubble at the treatment site. Power settings may be reduced in highly pigmented angles and *vice versa* for lightly pigmented trabecular meshwork (TM). The power cold vary depending the clarity of your optical delivery system and the life span of laser tube.
- Focus the beam at the junction of pigmented and non-pigmented trabeculum remaining a little anterior rather than posterior. The spot must be round and have clear outline. This may take a lot of time but keep thinking of the dictum that 90% of laser time is spent on focusing & 10% on delivery. This placement minimizes early post-laser pressure rise & (PAS) formation.
- Transient blanching of TM or appearance of minute gas bubble at the point of impact is considered as the reaction. The amount of power necessary for this reaction is inversely proportional to the degree of TM pigmentation as described previously. The variability of Tm pigmentation in different quadrants require a change in power setting. Continuous refocussing of the aiming bean is essential to induce a circular burn.
- Forty to fifty laser spots are applied in 180 degrees or 80 to 100 spots in 360° of the circumference. The burns are regularly spaced from one end of the mirror to the other. The goniolens is rotated clockwise for a 90° and a further 25 burns applied making a total of 50 burns extending for 180° of the angle. As an initial trial one could laser only 180 ° of the angle and do the rest in later sitting if required.

Post-operative Care

- One drop of antibiotic steroid combination instilled immediately after the procedure or 1 tablet of 250mg acetazolamide is given in high risk cases..
- IOP must be done hourly for 1 to 4 hours and the next day.
- If there is no pressure rise after 4 hours, the patient is sent home for 1 week. Meanwhile, all antiglaucoma medication is continued.
- Intra ocular pressure is reassessed after 4-10 weeks. In case IOP reduction is satisfactory a gradual reduction of medication is tried. If the pressure is still high, the remaining 180° of the circumference is treated.

ALT: Indication

Argon laser trabeculoplasty is most effective in those forms of open angle glaucoma in which a favourable response is expected e.g. in chronic open angle, exfoliation syndrome, pigmentary glaucoma and glaucome in aphakia or pseudophakia. This can be done in the following situations:-

- As a primary treatment of OAG (not in Indian Eyes where response is poor).
- To supplement maximal medical therapy. It helps to postpone the need for filtration surgery, this remains the commonest indication for ALT for us today.
- As a primary treatment in patients with poor drug compliance.

Avoid trial of ALT in the following conditions Angle Closure Glaucoma/ Narrow angles media haze due to Corneal cloudiness ordiminished aqueous clarity vitreous in anterior chamber in aphakia or pseudophakia.

- AC IOL
- Neovascular glaucoma
- Active inflammation (Uveitis)
- Primary Congenital glaucoma and angle recession glaucoma etc.

Complications of ALT

Post laser IOP spike

Elevation of IOP less than 10 mm of Hg is seen in as many as 50% of patients transiently. In a small percentage of eyes the increase can be marked (>20 mm Hg) and may be associated with loss of visual field. However the IOP tends to return within a few hours. Problems can be avoided by pre empting this problem in cases with shallow A/C, those who have record of previously very high tensions and giving them extra antiglaucoma medications pre laser and keeping a close watch on IOP post laser. Transient or persistent elevation of IOP soon after ALT can cause progression of visual field loss.

Inflammation

Mild iritis is present in many eyes after ALT which clears rapidly but occasionally may persist for months.

Peripheral Anterior Synechiae (PAS)

After ALT, PAS can occur in a large percentage of eyes (30-45%). Brown irides have greater than two fold PAS formation rate than other irides ater ALT. Posterior placement of burns can result in more PAS formation.

Hemorrhage

Hemorrhage may result from inadvertent photocoagulation of blood vessels in the iris root or from accidently photocaagulating a circumferential ciliary vessel. It is an uncommon problem. Pressure by the goinioscope will usually stop this haemmorhage which any way is a very unusual phenomenon with Argon laser.

Corneal complications

Corneal edema has been reported in a small number of eyes with an underlying corneal disorder such as Fuch's endothelial dystrophy or Chandlers' syndrome. Corneal abrasions and burns are probably of little significance and usually are transient.

Waning of Response

In most Indian eyes the effect of ALT tends to decrease over a period of 6 months to one year despite an initial good control. One therefore can not depend too much on this procedure for a long term control in our set up and at best, use as a stop-gap arrangement.

Pseudotumor Cerebri (Benign Intracranial Hypertension)

J.L. Goyal, Pankaj Vats, Sushil Kumar

Benign intracranial hypertension and pseudotumor cerebri (PTC) are the terms used for a syndrome that is defined by four criteria (1) Increased Intracranial Pressure, (2) normal or small sized ventricles by neuroimaging, (3) no evidence of any intracranial mass, and (4) normal CSF composition. The syndrome was first described by Quincke (1897). Warrington (1914) was the first to use the term "pseudotumor cerebri" for this condition and Foley introduced the term 'benign intra cranial hypertension' in 1955.

Epidemiology

The incidence varies throughout the world. It is almost unknown in countries in which the incidence of obesity, a significant factor in idiopathic form of this condition, is low, and it is common in countries with an increased incidence of obesity. The age range in patients with PTC is broad. The peak incidence of the disease, however seems to occur in the 3rd decade, with a female preponderance that ranges from 2 to 1 in some studies to 8 to 1 in others.

Clinical Manifestations

The most common presenting symptom in patients with PTC is headache, occurring in more than 90% of cases. The headache is usually generalized, worse in the morning, and aggravated when some valsalva maneuver increases cerebral venous pressure. Other common non-visual manifestations of PTC include nausea, vomiting, dizziness, and pulsatile tinnitus. Focal neurologic deficits in patients with PTC are extremely uncommon, and their occurrence should make one consider alternative diagnosis. Visual manifestations are usually preceded by headache and occur in 35- 70% of patients. These symptoms are identical with those described by patients with increased ICP from other causes and include-

(a) Transient visual obscurations;

(b) Loss of vision from macular hemorrhages, exudates, pigment epithelial changes;

(c) Horizontal diplopia from unilateral or bilateral abducens nerve paresis and rarely;

(d) Vertical or oblique diplopia.

The papilledema that occurs in over 90% of patients with PTC is identical with that which occurs in patients with other causes of increased Intra Cranial Pressure (ICP). Post papilledema optic atrophy occurs in untreated or inadequately treated patients after a variable period of time, usually over several months, but occasionally within weeks of the onset of symptoms.

Etiology

PTC occurs primarily in young obese women, and occasionally men, with no evidence of any underlying disease. In such cases, the condition is often called "idiopathic pseudotumor cerebri". In about 10% of patients, however, particularly men and nonobese women, the condition occurs in association with a number of different settings, including -

(a) Obstruction or impairment of cerebral venous drainage;

(b) Endocrine and metabolic dysfunction;

(c) Exposure to exogenous drugs and other substances;

(d) Withdrawal of certain drugs; and

(e) Systemic illnesses.

Diagnosis of Pseudotumor Cerebri

The diagnosis of PTC is based on three crucial findings**. First**- the patient must have normal or small ventricles and no intracranial mass lesion. **Second**- the ICP must be increased. **Third-** the CSF must have no cells and a normal protein and glucose concentration. In order to satisfy the criteria required to diagnose PTC a patient must undergo some type of neuroimagiang study followed by a lumbar puncture. Most patients wth PTC have ICPs greater than 250mm Hg . It is inappropriate and dangerous to make a diagnosis of PTC without both neuroimaging studies and lumbar puncture, even if the clinical setting appears straightforward.Once the diagnosis of PTC is made by CT scanning or MR imaging followed by lumbar puncture, the physician should attempt to determine if an etiology can be found. This is particularly important in nonobese women and in men, regardless of age or body habitus, because such patients are much less likely to develop the idiopathic form of PTC.

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Monitoring

Patients with papilledema most often develop progressive loss of visual function in a manner similar to that which occurs in chronic open angle glaucoma. Loss of central vision is usually a late phenomenon, whereas visual field defects, usually arcuate scotomas and nasal steps, are an early finding, and defects in color vision can occur at any stage.

Treatment

The treatment of PTC depends on whether or not an underlying etiology can be identified and treated. If increased ICP is directly related to a mass lesion, or , if a lesion is blocking either the ventricular system or venous outflow, removal of the lesion is the obvious treatment of choice. If the lesion cannot be removed, or if the CSF absorption is reduced at the level of the arachnoid villi, then treatment is directed towards shunting of CSF into the a trial or peritoneal cavities. I f there is cerebral edema, osmotic agents, diuretics, or corticosteroids may reduce swelling, particularly in the acute period.

There are generally only two reasons to treat patients with idiopathic PTC; severe intractable headache and evidence of optic neuropathy. Methods of treatment include weight loss, medical therapy, serial lumbar punctures, and surgery. No single procedure is completely effective in this regard.

The optimum treatment for obese patients is **weight loss**. Patient with PTC in the setting of morbid obesity who has sleep apnea may respond not only to weight loss but also to low flow oxygen and positive airway ventilation.

A number of **medical substances** can be used to lower ICP. The most effective is acetazolamide. This drug decreases production of CSF by inhibition of carbonic anhydrase, resulting in decreased sodium transport across the choroidal epithelium.

Although systemic corticosteroids are clearly beneficial in the treatment of PTC associated with various systemic inflammatory disorders, such as sarcoidosis and systemic lupus erythematosus, they are generally not recommended for use in idiopathic PTC.

Multiple **lumbar punctures** are advocated as a non-medical, non-surgical method of relieving the increased ICP of idiopathic PTC. The theory behind this treatment is that the needle used for the lumbar puncture creates an opening in the dura through which CSF leaks. With several lumbar punctures, one creates a sieve that allows sufficient egress of CSF that ICP is normalized.

Surgical decompression procedures are generally used only when patients initially present with optic neuropathy or when other forms of treatment have failed, and the patients are incapacitated by headache or have begun to develop evidence of progressive optic neuropathy. Subtemporal decompression was advocated in the past, but most neurosurgeons favor some form of shunting procedure. Venticuloperitoneal **shunting** is quite effective in lowering intracranial pressure in patients with PTC, but this procedure can be difficult unless some type of stereo tactic method is used, because the ventricles in patients with PTC are normal in size rather than being enlarged. Thus, the preferred technique is the lumbo-peritoneal shunt, in which a silicone tube is placed percutaneously between the lumbar subarachnoid space and the peritoneal cavity.

Complications of the shunt procedure are minimal and usually benign but include spontaneous obstruction of the shunt, usually at the peritoneal end, excessive low pressure, infection, radiculopathy, and migration of the tube, resulting in abdominal pain. Nevertheless, most patients treated with a lumboperitonal shunt experience rapid return of ICP to normal and resolution of papilledema, often with improvement in visual function.

De WECKER (1872) first described a surgical procedure on the optic nerve for the treatment of papilledema. A successful **optic nerve sheath fenestration** results in resolution of papilledema on that side and, occasionally, on the other, with improvement in visual function in many cases. Most surgeons prefer a medial approach, but some advocate a lateral approach. The risks of optic nerve sheath fenestration, although low, are nevertheless significant. They include loss of vision from vascular occlusion, diplopia and infection.

In most patients with PTC lumbo-peritoneal shunt is used as the surgical treatment of choice. The major difficiulty in assessing surgical results in patients with PTC is that generally these procedures are not used until evidence of optic neuropathy is already present. In such patients, it is impossible to know at what stage irreversible visual acuity or field loss has occurred.

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Soft Contact Lenses Fitting

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In early 1500s Leonardo da Vinci came up with the concept of placing an optical device directly over the eye. Afterwards Scleral, Hard and Semi soft (RGP) contact lenses were manufactured. In a quest for better comfort and sensitivity, Professor Otto Wichterle and Garshoslav Lim invented the Soft lens in the late 1950s. The lens soon became popular because of better comfort and ease of fitting. The advantages and disadvantages of soft contact lenses are discussed in Table 1.

Patient selection is the most important step for soft contact lens fitting. Apart from the routine history about general and ocular health, patient's occupation, hobbies and hygiene are the main criteria by which one should select a type of contact lens for a particular patient.

Soft contact lenses can be classified in various categories depending upon Wearing schedule, Replacement schedule, Lens design and material:

Table 1

Advantages	*Disadvantages*
Easy adaptability - soft lenses are immediately comfortable and adaptation time is short due to minimal movement and less tearing compared to RGP lenses	More prone to deposits. Spoilage rate is high
Can be used as occasional as well as long and short duration (variable wearing schedule is possible)	In-house verification is not possible. Modification is impossible
Inventory is possible	No visual improvement in irregular corneas.
Apparent eye colour can be changed	
Soft lenses cause minimal corneal distortions so spectacle blur is rare	
Large optic zone makes for minimal glare Better stability	
There is less foreign body trapping than RGPCL	

Classification on the basis of replacement schedule

All lenses are usually used on daily wear basis, that is, during waking hours. But this classification is based upon when the lens should be replaced or discarded. These are classified into 4 types:

A) *Conventional*- replacement interval more than 6 months. All soft lenses should be replaced annually or earlier due to detiorating lens performance, lens loss or lens damage. (e.g. Optima® and Series lenses® of B & L).

B) *Frequent or planned replacement*- monthly disposables (e.g. SL comfort® (B & L), Aqua GM® from Complete, Acuvue® clear from J&J) and three monthly disposables (e.g. SL 38®).

C) Disposable lenses were first considered in 1980.

- Biweekly disposables- the lenses that are disposed every fortnight. (e.g. Acuvue® 2, J & J).
- Daily disposables- no care maintenance required as the lens is discarded after one wear (e.g. Acuvue® 1-Day, J & J).

D) Silicone hydrogel extended wear disposable lenses first introduced in 1999 and were intended primarily for extended wear. This is a hybrid silicone containing hydrogel material. Water content of 20 to 40% gives sufficient oxygen transmissibility to ensure rapid recovery from any lens adherence after overnight wear. The aqueous phase of the tear film is able to penetrate the lens, replenish the post lens tear film and thereby restore lens movement with blinks (e.g. B & L Purevision® and CIBA Vision®, Night and Day®).

In general, conventional lenses can be prescribed to a person who is compliant and following the care regimen as per the instructions provided by the practitioner. Where as disposables or frequent replacement lenses will be a better option for a person whose spectacle power is not stable, an occasional contact lens wearer and who are not following the care regimen.

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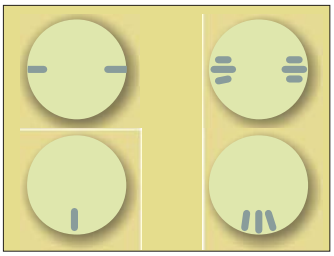

Fig.1: Axis rotation marks on soft toric lenses

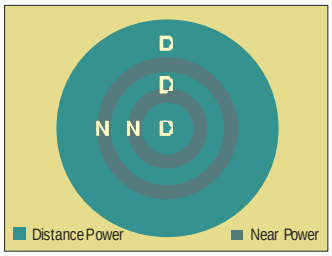

Fig.2: Multi-zone concentric centre - distance design

Fig.3: Cosmetic contact lenses

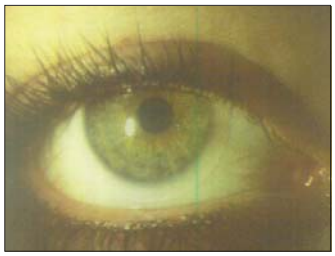

Fig.4: Fit in primary position

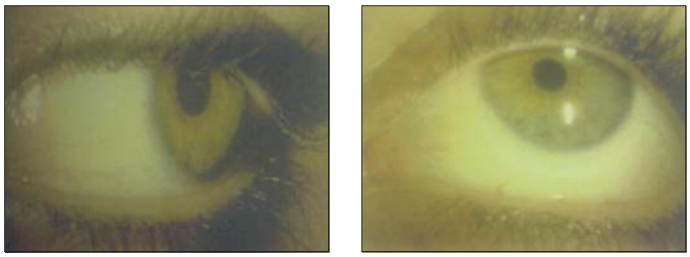

Fig.5: Lens lag in temporal & up gaze

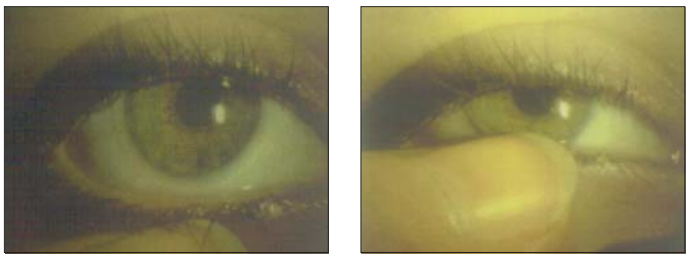

Fig.6: Push up

Classification on the basis of lens materials

FDA classification - in 1986 the FDA and hydogel contact lens manufacturers in US classified hydrogel contact lenses into four groups. Refer to Table 2

There are various types of Soft contact lenses, which correct all types of refractive errors.

Spherical: Corrects Hyperopic and Myopic refractive error. They have a single refracting power, that is, the same power in every meridian. Small amount of astigmatism that is equal to or less than 0.5D can be corrected through spherical lenses.

Toric: correct astigmatism at a particular axis and so require different refracting powers in two main meridians of the eye. Special features are incorporated to minimize rotation with blinking. For a significant amount of astigmatism of 0.75 D or more toric lenses should be used to provide optimal vision.

Multifocals: corrects presbyopia and so incorporates addition power in different portions of the lens for viewing different distances. A bifocal has only distance and near focus while a multifocal incorporates gradual increase in power to allow a focus at different foci. (e.g. Acuvue® multifocals, J & J)

Table 2

GPI	Nonionic with Low Water Content (e.g. Polymacon - B&L Optima & Series and fluoro silicone hydrogel - Ciba vision Night and Day)
GP II	Nonionic with High Water Content
GP III	Ionic with Low Water Content (e.g. silicone hydrogel - B&L Purevision)
GP IV	Ionic with High Water Content (e.g. Hilafilcon B- B&L SL comfort, Etafilcon A - J&J Acuvue, GM Aqua - complete)

Tints:

- Handling tints- a transparent tint, which does not alter eye colour but makes the lens more visible for handling is especially useful for presbyopes and hyperopes.
- Cosmetic tints- enhance or completely change eye colour. There are two types of cosmetic tints
  - Transparent
  - Opaque

Trial lens selection

Soft lenses are quite flexible and exhibit a draping effect, conforming to the shape of the underlying ocular structures. Because of this feature, a single base curve may fit a much wider range of corneal curvatures. Generally fixed base curve and diameter for each particular brand makes soft contact lenses fitting easy.

Lens diameter: A soft lens should provide complete corneal coverage, extending over the limbus by 0.5 to 2 mm larger than the cornea. Usually soft lenses diameter ranges from 12-14.5 mm.

Base curve: The lens should be fitted 0.3 to 0.8 mm flatter than the flatter K reading.

Select a lens whose base curve is 0.3 to 0.5mm D flatter than the flattest K reading for a 12-13 mm diameter contact lens or 0.5 to 0.8mm flatter than the flattest K reading for a 14-15 mm diameter lens. Base curve in soft lenses varies from 8.4mm to 9.1mm.

Lens thickness: In addition to water content, soft lenses may be classified into standard, thin and ultra-thin. The thinner the lens, the greater the amount of oxygen reaching the cornea. Thus thin and ultra-thin lenses may fit tighter as compared to standard lenses. Standard thickness lenses should fit as flat as feasible.

Lens weight: The weight of contact lens is a function of its water content and thickness. Since the polymers of high water content lenses tend to be structurally weaker, high water content lenses must be thicker than low water content lenses. This makes high water content lenses heavier. In terms of fitting, heavier lenses may acquire slightly larger diameter to overcome the increased gravitational pull.

Lens power: The power of trial lens should be with in +/- 3 D of the refractive error of the patient and always be of same sign (i.e. plus or minus). Accurate over acceptance is must for the comfortable lens wear.

Vertex distance calculation: if the spectacle prescription (or spherical equivalent) is greater than +/- 4D, the power must be adjusted for vertex distance. Vertex distance is the distance from the correcting lens to the cornea. For a contact lens, the vertex distance is virtually zero. Spectacle vertex distance is usually assumed to be 13.75 mm.

Evaluation of fit

Corneal coverage: The lens should cover the cornea completely, ideally expanding beyond the limbus and under the eyelids. Incomplete corneal coverage can cause corneal drying and subsequent staining and irritation; also decreases lens comfort.

Lens centration: The lens should be reasonably centered, extending an equal distance beyond the limbus in all directions. Decentration can cause blurred vision if the optic zone is not centered in front of the pupil and may also cause decrease lens comfort.

Table 3

Procedure	*Ideal results*	*Variations from norms*	*Possible cause*	*Remedy*
Comfort	Comfortable lens	Continual discomfort	Foreign body Thick lens Poor centration	Remove and replace lens Refit with thinner lens
		Discomfort worse on blinking	Loose lens Edge stand off	Tighten lens or change design
Vision	Crisp, clear stable vision	Blurred vision	Incorrect Power	Over refract
		Variable vision after blinking	Loose lens	Tighten lens
		Variable over-refraction	Loose lens	Tighten lens
Centration	Full corneal coverage (1-2 mm)	Greater than 2 mm conjunctival overlap	Lens too large	Reduce total diameter
		Corneal exposure	Too small lens Poor centration	Increase total diameterTighten lens
	Centered in all positions of gaze	Corneal exposure at extremities of gaze	Loose lens Tight lids	Tighten lens Increase total diameter Try thinner lens
Edge alignment	Regular alignment to conjunctiva	Edge stand off or fluting	Loose lens peripheral lens design	Tighten lens Try different design
		Conjunctival indentation	Tight lens Peripheral lens design	Loosen lens Try different design
Primary gaze movement	0.2 mm to 0.5 mm	Less than 0.2 mm	Tight lens Hypotonic tears	Loosen lens Try different design / material
		More than 0.5 mm	Loose lens	Tighten lens Try different design
			Excessive lacrimation	Check for FB Allow longer settling
Push-up test	Smooth recovery from push-up	Resistance to movement	Tight lens Hypotonic tears	Loosen lens Try different material
		Excessive movement and erratic recovery	Loose lens Excessive lacrimation	Tighten lens Check for FB

Lens movement with the blink: The patient is asked to blink normally. The lens should move at least 0.2 to 0.5 mm; the movement will depend upon the type of lens, material and manufacturing method. Immobile lenses do not allow adequate tear exchange, causing build up of debris and metabolic wastes behind the lens.

Lens lag: Should be assessed in up gaze and lateral versions. Patient is asked to look up and side gazes and the lens should move or lag in opposite direction. Amount of lens lag is dependent upon the lens type.

Push up: Sometimes small but adequate lens movement is difficult to observe. Then the push up test is a valuable aid in determining the lens fitting relationship. In this test the patient should look in the primary gaze then slide the lens upward by gently pushing it upward with the patient's lower eyelid. The lens should move easily and return to its original place quickly. A tightly fitting lens will be difficult to displace from the cornea. A loose lens will displace readily and may move excessively.

Lens comfort: A well-fitted soft lens should be comfortable with in 10 minutes of contact lens wear.

Quality of vision: Vision should be stable and the lens movement should not affect the vision.

Summary

While dispensing the lens, the fit and vision should always be checked and care regimen should be taught thoroughly. The process of soft contact lens fitting does not caese after the initial assessment. The efforts of factors such as wearing time, environmental conditions and ocular physiology needs to be monitored constantly ongoing aftercare is the key to continued contact lens wear success. The ocular complications of contact lenses wear observed at follow up visits can be viewed as an indication for changing lens design for a given mode of wear.

Ahmed Glaucoma Valve Implant: Surgical Technique

J.C. Das, MD*, **Zia Chaudhuri,** MS, MNAMS, FRCS (Glasg)**

Aqueous drainage devices (ADD) occupy an important place in the surgical armamentarium for the treatment of complicated and refractory glaucomas both as a primary surgical modality and as a secondary procedure where trabeculectomy with or without adjunctive anti-metabolite therapy has either failed or is reported to have a very low chance of success.[1-7] The latter group consists of pediatric glaucomas[8,9,] neovascular glaucomas[10] and a variety of glaucomas associated with low success after filtration surgery in conditions such as uveitis[11], aphakia[12], pseudophakia[12], post-vitreoretinal surgery[13] and post-penetrating keratoplasty[14] surgery.

Glaucoma drainage implants that have been used extensively include the non-restrictive glaucoma drainage devices like Molteno implant, the Baerveldt implant and the Schocket tube shunt, and the valved, restrictive drainage devices like the Krupin Denver Valve and the Ahmed Glaucoma Valve implants (Figure 1). The authors have reported a large series of Indian patients with refractory glaucoma operated with the Ahmed Glaucoma Valve Implant, both in isolation and combined with cataract surgery. [15-18] The surgical technique of the procedure is elucidated below.

Surgical Method

The Ahmed Glaucoma Valve implantation procedure is performed under peribulbar anesthesia in adults and under general anesthesia in pediatric patients.

Steps of the Procedure

Step 1: The conjunctiva is undermined posteriorly by blunt dissection in the superotemporal quadrant. A winged fornix based conjunctival flap is dissected out and traction sutures are passed under the belly of superior rectus and lateral rectus so that the globe can be rotated as convenient to the surgeon (Figure 2)

Step 2: A 6x 8 mm rectangular partial thickness, limbus-based scleral flap is dissected (similar to the trabeculectomy flap). (Figure 3)

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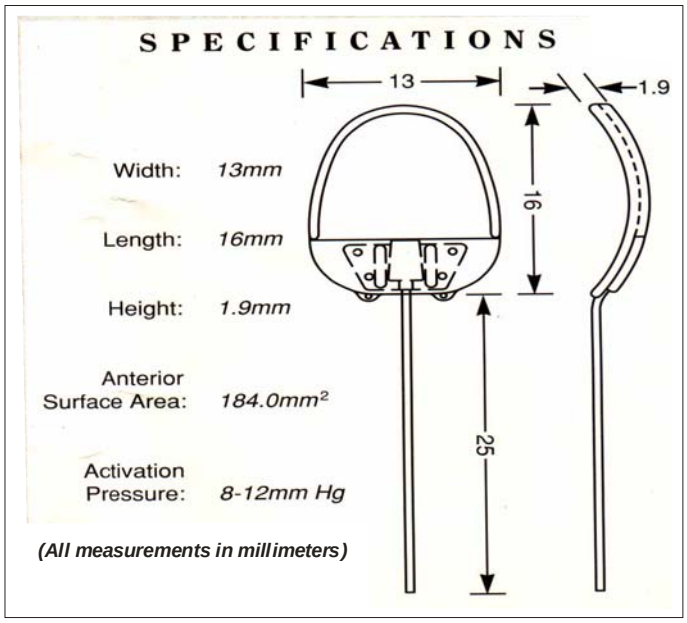

Fig. 1: The Ahmed Glaucoma Valve Implant

Step 3: The Ahmed Glaucoma Valve implant is irrigated with 2 ml of balanced saline solution (BSS, Alcon, Fort Worth, USA) through the tubing to open the valve mechanism (Priming). (Figure 4)

Step 4: The plate is secured to the superficial sclera using two interrupted non-absorbable sutures of 5-0 Merseline posterior to the insertions of the rectus muscles with the anterior edge of the implant at least 8 mm posterior to the limbus. These sutures were applied to prevent the migration of the plate and therefore of the tube. (Figure 5 – 7)

Step 5: The tube is trimmed to extend from 1 to 3 mm beyond the posterior surgical limbus (Figure 8).

Step 6: A paracentesis opening is made at the limbus in the inferotemporal quadrant with a sharp tapered blade and a Viscoelastic agent (Sodium hyaluronate 1.4%) was used to deepen the anterior chamber. A 23-gauge needle is used to enter the posterior surgical limbus parallel to the iris plane and the anterior chamber in the superotemporal quadrant. If a peripheral iridectomy is present from a previous surgery, the needle tract is placed slightly to one side of the iridectomy. The tube is inserted with a smooth forceps through the needle tract ensuring that no iris or corneal touch was present. The tube is secured against the sclera using a figure of eight suture of 9-0 nylon. The scleral flap is approximated at the two posterior corners with a 10-0 nylon suture. (Figure 9 – 12)

Step 7: Two running sutures of 8-0 polyglactin (vicryl) is used to secure the conjunctiva and Tenon layers to the peripheral cornea and to close the two wing incisions, respectively. Subconjunctival injections of antibiotics and corticosteroids are given at the conclusion of surgery.

Due to the frequent non-availability of donor corneoscleral grafts in our hospital set-ups, we inserted the Ahmed valve tube after dissecting out a partial thickness scleral flap (like a trabeculectomy flap). This simple modification in technique as compared to the technique described in literature (Figure 13), probably resulted in the obtundation of the hypertensive phase commonly described in western literature because the partially dissected scleral bed also probably contributed to the hypotensive effect as a result of the egress of the aqueous through the same.

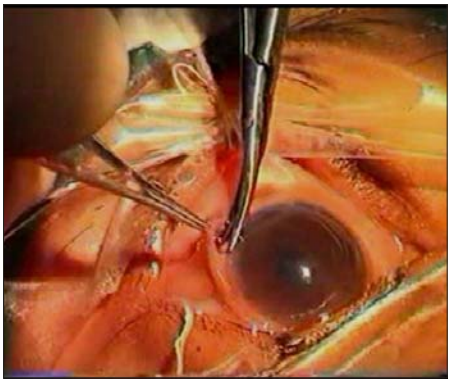

Fig. 2: Dissection of the conjunctiva to raise a flap

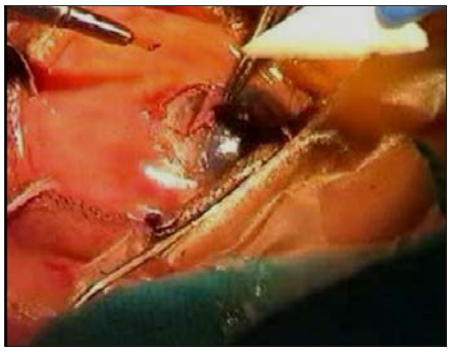

Fig.3: Dissection of a Partial Thickness Scleral Flap

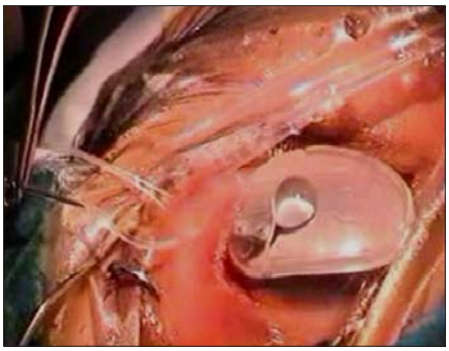

Fig.4: Priming of the tube

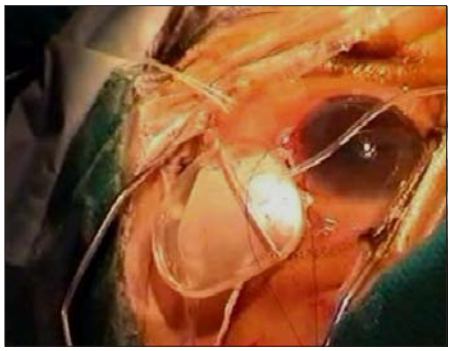

Fig.5: Insertion of Pre-placed sutures through the tube

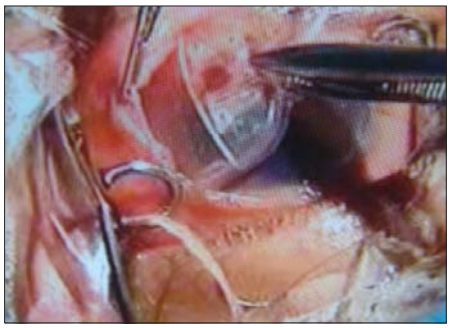

Fig.6: Insertion of the tube into the conjunctival space

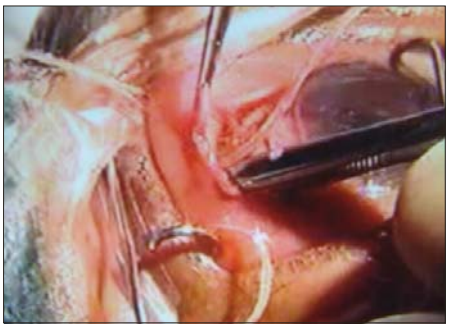

Fig.7: Placement of the valve in the sub-conjunctival space

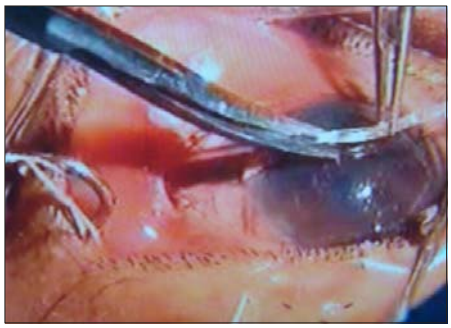

Fig.8: Trimming of the tube

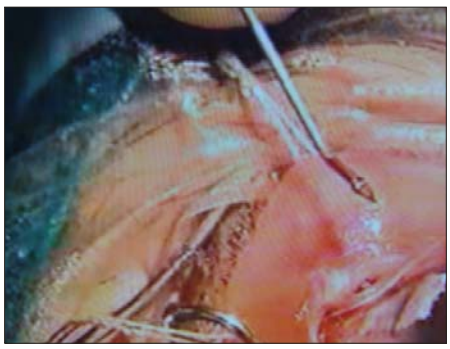

Fig.9: A bent 23 Gauge needle used to enter the anterior chamber

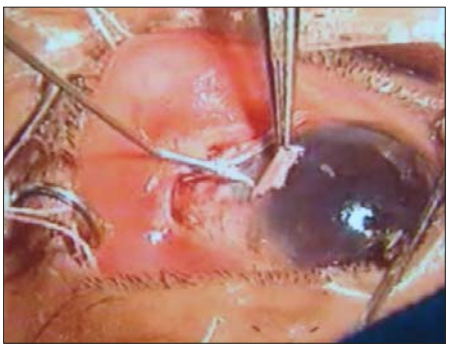

Fig.10: Entry into the anterior chamber

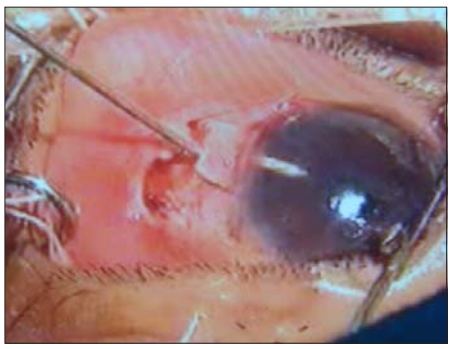

Fig.11: Anterior Chamber Entry

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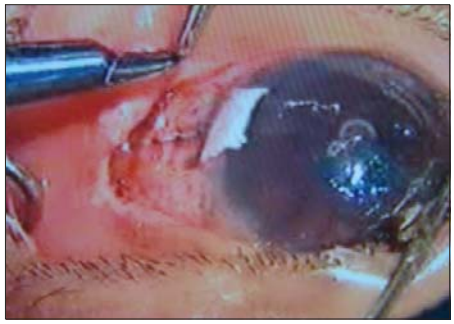

Fig.12: Insertion of the tube in the anterior chamber. The tube is sutured to the scleral bed.

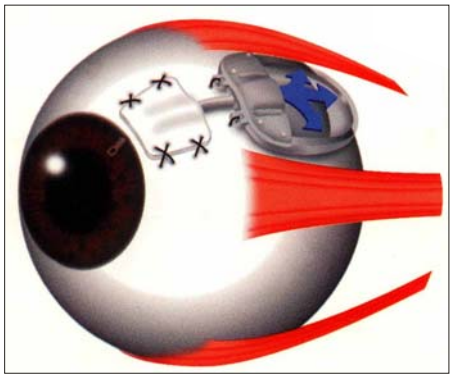

Fig.13: Insertion of the AGV Implant covered by donor scleral grafts

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Practical Tips for a Good Capsulorrhexis

Harbansh Lal, MS**, Anita Sethi,** MD, FRCS, **Piyush Kapur,** DNB, MNAMS

Continuous Curvilinear Capsulorrhexis (CCC) is the most important step for successful completion of phacoemulsification. It is the continuity of the rhexis which allows the capsule to safely withstand wide fluctuations in IOP during phacoemulsification. Here are some tips for performing a good CCC.

Proper instrumentation

1. ***Cystitome*** : - Usually made from a 26 gauge needle by bending it twice; The first turn is at the bevel which is turned out. The turn is usually at 1/3 of the bevel length making an obtuse angle about 110^0. The 2nd turn is about 2mm from the needle base making an angle about 100^0. (Fig. 1). Making the angles slightly obtuse rather than at 90^0 improves the visualization. Ensure that the sharp edge is not damaged while bending the needle.

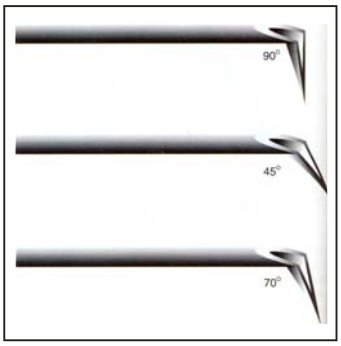


Figure 1

2. ***Forceps***:- Mc Pherson's forceps can be used but it is ideal to use an Utrata's forceps for a better grip.
3. Good akinesia.
4. ***Adequately pressurized eye***:- Position the eye ball such as to get a good red reflex. One may require inferior and superior rectus sutures if the eye is rotated downwards due to the block. If the cataract is mature or the reflex is not clear due to any reason, the capsule can be stained for easy identification and easy maneuverability. Trypan blue is the most commonly used dye for capsular staining.
5. ***Good red reflex***:- Before entering the AC, chamber should be filled with visco elastic till lens iris diaphragm moves backward and the anterior capsule is flat /concave. The IOP should be approximately 35-40 mm of Hg. The rhexis should never be performed in a shallow chamber with a convex lens iris diaphragm.
6. Use **high magnification** while handling the capsule so as to improve the visualization, taking care that the depth of focus remains adequate.
7. Pupil should be well dilated. If the dilatation is not very good, intra-cameral adrenaline can be injected in a 1:10 dilution, before injecting the viscoelastic.

Initiation

- Keeping the direction of the tunnel in mind, Cystitome is introduced without pushing the eyeball.
- If one finds it difficult to enter the tunnel with the cystitome, lifting the roof with a rounded iris repositor can open the tunnel.
- The capsule is punctured in the center and the cut extended radially. While trying to make the cut the needle must be not be pushed too deep into the cataract as this may disturb the cortical fibers and thus interfere with the visibility of the cut edge.
- While lifting the flap, the needle should be placed at the junction of 2/3rd and 1/3rd and not at the periphery of the cut as it this may result in a peripheral extension of the initial flap on pushing it up. (Fig. 2)

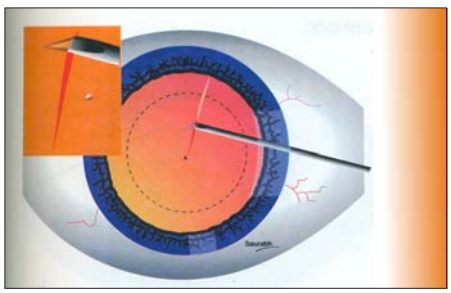
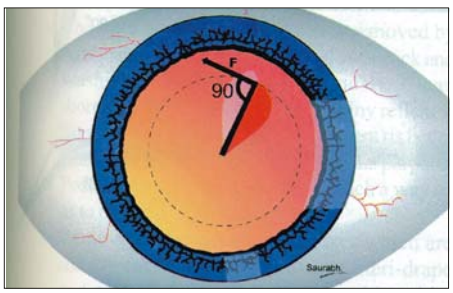


Figure 2



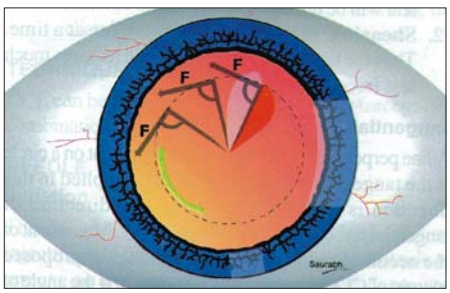


Figure 3

Continuation of CCC

- Forces should be directed tangentially to the proposed margin of CCC. (Fig. 3)

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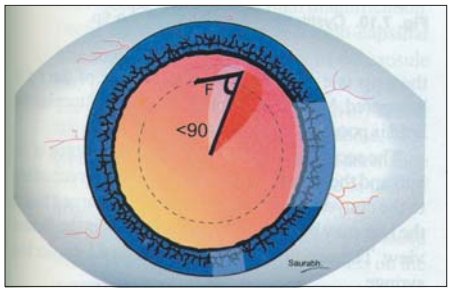


Figure 4

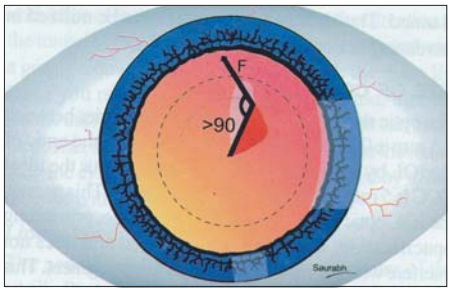


Figure 5

- The needle is kept on the line of the proposed CCC approximately 1 mm away from the cut end, as a too peripheral or a too close contact would rather give a poor control.
- If the angle of the force is more the 90^0 to radius of curvature the CCC will tend to go out and if the angle is less than 90^0 the resulting CCC will be smaller in size. Thus this concept can be used to increase or decrease the size of CCC (Figs 4 & 5).
- In cases with poor nuclear support from the back (eg hypermature, shrunken cataract), forceps is preferred over the cystitome.
- The flap should always lie stretched and pointing towards the proposed line of rhexis. There should be no fold between the cut end and the needle.

Tackling the subincisional part

The sub-incisional area is more difficult to tackle as the flap tends to flow out through the incision. Visibility may also be hampered if the tunnel is long and manipulation may cause the chamber to become shallow.

- Before reaching the sub-incisional area fill the chamber with visco-elastic and spread the flap well away from the incision so as it lies flat over the uncut capsule.
- Spread the flap well away from the incision so as it lies flat over the uncut capsule.
- Using the full length of incision, the needle is angulated from the corner of the incision and the flap is pushed towards completion.
- The forces are directed tangentially and the direction changed every 2 clock hours.
- For the beginners it is preferable to take small and multiple small strokes of movements to have a better control.

Rhexis in young patients

- Always use a more cohesive viscoelastic like Healon GV or viscoat
- The capsule is generally very elastic, so the forces should be centripetal
- Aim for a smaller rhexis
- Forcep rhexis is preferable over the use of cystitome.

Difficulty in CCC

If the flap is not moving smoothly the following conditions should be kept in mind

- Subluxated lens, Pseudo-exfoliation, Zonulodialysis, Fibrosed capsule

One may need to switch to Forceps CCC in these cases.

Sterilization and Disinfection Practices in Ophthalmology OT

Poonam Loomba, Bibhabati Mishra

There have been reports of a whole batch of patients operated on the same day going blind after cataract surgery. Numerous such incidents are reported worldwide due to hospital-acquired infections. Nosocomial infections can take place in any healthcare setting and are due to various reasons, one the important being negligence towards maintaining hygienic standards and use of faulty techniques. Therefore there is a need for proper sterilization and disinfection techniques.

Sterilization is the freeing of an article from all living organisms including viable spores. In other words it is the destruction of all forms of microbial life. It is accomplished by physical and chemical processes e.g. steam under pressure, dry heat, ethylene oxide, hydrogen peroxide gas, liquid chemicals etc. It is recommended that any equipment or instrument classified as critical which comes in contact with the bloodstream or subdermal tissues must be cleaned in between each use.

Disinfection is the freeing of an article from harmful microorganisms. Eliminates many or all pathogenic microorganisms except bacterial endospores and is accomplished by liquid chemicals. Chemical disinfectant must be used only if heat treatment is impractical or it may cause damage to the equipment. Disinfectants are used only on inanimate objects and not on living tissue. Chemicals used to kill micro-organisms on skin and living tissues are called antiseptics.

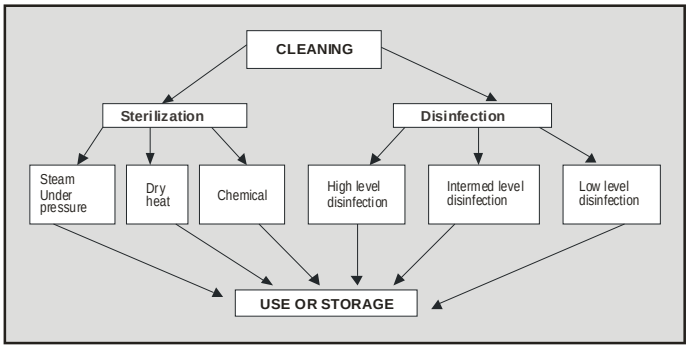
Decontamination is the process by which microorganisms are removed or destroyed in order to render the object safe. It includes

- Cleaning
- Disinfection and
- Sterilization

All hospitals and health care facilities should have a decontamination policy and help staff to decide which decontamination processes should be used for which item or equipment.

Cleaning is the first step towards decontamination of any equipment. It is followed by immediate use or proper storage of the equipment or item. Cleaning can be either manual or ultrasonic. For micro-instruments ultrasonic cleaning is recommended.

The risk of infection from any equipment can be classified into three categories which is helpful in choosing the proper level of sterilization or disinfection needed in order to protect the health care workers and the patients.

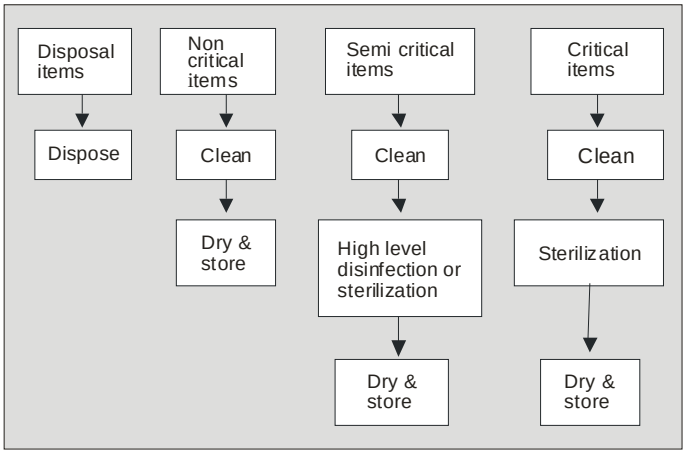


- **Noncritical** items such as stethoscopes and ophthalmoscopes which come in contact with normal or intact skin. Cleaning with a disinfectant and drying is usually sufficient.
- **Semicritical** items are those which do not penetrate skin but come in contact with mucous membranes. Cleaning with disinfectant followed by high level disinfection is usually adequate e.g. tonometers
- **High risk** items are those which penetrate body cavities and vascular system i.e. surgical instruments. These require cleaning followed by sterilization.
- **Single use** items: dispose after use.

Sterilization protocol

Surgical instruments usually require sterilization. Sterilization can be achieved by

- *Steaming under pressure* (autoclaving): used for instruments which are heat resistant



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- *Dry heat* (hot air oven): used for sterilizing glassware, powders and instruments that cannot be dissembled.
- *Chemical sterilization* is used for heat labile instruments where single use is not cost effective. Instruments and other items are sterilized by soaking them in a chemical solution followed by rinsing with sterile water. The immersion time to achieve sterilization is specific for each chemical steriliant. Most chemical disinfectants are used for high level disinfection. If an item is sterilized by chemical disinfection it should be used immediately after sterilization to be sure that it is sterile.
- *Ethylene oxide sterilization:* ETO is a flammable explosive liquid that when combined with carbon dioxide becomes a cost effective and efficient method of sterilization. It is used for sterilizing equipment like endoscopes, cameras, etc which cannot withstand temperatures more than 50-60°C. However it should be used under controlled conditions as it is extremely toxic and explosive. Vapour phase hydrogen sterilization is being developed as a more environment friendly and safe alternative to ETO.

Flaming and boiling are not considered effective sterilization techniques as they do not efficiently kill micro-organisms.

Method of Sterilization	*Concentration or Temperature*	*Activity level*
Heat	>250° F. (121° C), pre-vacuum cycle	Sterility
Moist Heat	271° F (132 C)	Sterility
Dry Heat	171°C x 1 hr. 160°C x 2 hr.	Sterility
Ethylene Oxide	450-500 mg/liter at 55-60 °C	Sterility

Some important items

Stainless steel instruments can be sterilized with any conventional method. Steam sterilization takes less time but can damage instruments more. Dry heat is least damaging to them but takes more time.

Diamond knife to be kept in a cabinet. Autoclave for 10 minutes. Only surgeon to remove knife and use. After use decontaminate and store.

Tonometers: Should be wiped clean and disinfected with either 3% hydrogen peroxide, 5000ppm chlorine, 70% ethyl alcohol or 70% isopropyl alcohol. After disinfection, rinse in water and dry before use.

Microscope lenses to be cleaned with ethyl alcohol according to manufacturers instructions.

Wide-field vitrectomy contact lenses are sterilized with ethylene oxide gas, and other lenses with autoclaving

Cleaning & sterilization of other surgical ocular lenses and rings:

- Cleaning: Upon removal from patient's eye, thoroughly rinse in cool or tepid water and wash with a few drops of mild soap on a moistened cotton ball. Then rinse with water and dry carefully with a non-linting tissue. and proceed with either disinfection or sterilization instructions.
- Disinfection: Soak in glutaraldehyde 2% or 3.4% aqueous solution with minimum exposure time of 20 minutes or bleach 10% solution. Then Rinse lens thoroughly to remove disinfection solution. 3 cycles of 1 minute, with cool or tepid water is recommended. Dry carefully and place in a dry storage case.
- Sterilization: ETO or steam autoclave.
- Phacohand pieces
- Flush with 60ml water followed by flushing with 60ml air
- Pack and autoclave for 20 minutes.

Disinfection protocol

All cases are considered "potentially infectious". No special "quarantine" procedures of operating rooms or operating room personnel involved with "septic" procedures are practiced or considered necessary. Clean up between clean and/or dirty cases is the same.

Protocol for disinfecting the OT can be discussed under the following headings:

A. Daily cleaning

1. To be done in each individual operating room beginning with the first case of the day and between consecutively scheduled surgical cases.
2. Using a disinfectant and a clean cloth, damp dust all lights and vertical surfaces of all furniture and fixtures in the room is done.
3. Clean any areas of the room, other than those specified, which have become soiled with blood, irrigation fluids, etc., during the just completed case.
4. With a cleaning solution the entire area as well as areas soiled with blood or bodily fluids are cleaned. After a 3-5 minute contact time for the disinfectant to act with a wet mop remove the cleaning solution from the floor. Move all furniture to the other side of the room and repeat the previous step on the newly exposed floor area.
5. Set out clean bucket, linens, covers on arm boards, clean linen hamper, and suction bottle.

B. Terminal cleaning

1. To be done in each individual operating room **every 24 hour period** that the room has been used for a surgical case. The decontamination process begins at the highest-level (light tracks, ceiling fixtures) and progresses downward (floor).
2. Using a clean cloth and thoroughly wipe down operating room lights and light tracks.
3. Move all furniture to one side of the room. Sprinkle the cleaning solution on the floor. This solution shall be allowed to remain on the floor (3-5 minutes) while the furniture is being cleaned.
4. Using clean cloth and disinfectant solution, wipe down all surfaces of all furniture. Room fixtures are, also, to be wiped down (windowsills, x-ray view box, tape dispenser, operating lights, control box, etc.).
5. All room equipment to be wiped down including the operating microscope, suction equipment, table parts etc.
6. Scrub and wet vacuum the floor and after moving all furniture to the opposite side of the room clean the remaining areas and return all furniture to its correct location.

C. Weekly cleaning

1. Total cleaning of any specific area to be done once a week.
2. Sponge mop the ceiling using appropriate disinfectant solution after shelving it dry.
3. Walls to be cleaned with appropriate disinfectant
4. Dust all vent covers.
5. Dust thoroughly the sterile supply cabinet within the operating room and check all gear for proper expiration date.

Disinfection/fumigation of the OT

Fumigation with formalin, formaldehyde was commonly used in India and still is used in many centers to decontaminate the OT. It is no longer recommended because of toxic nature of the disinfectant and the fact that it is an ineffective method. It cannot replace manual cleaning. Thorough cleaning with a disinfectant cleansing solution and scrubbing is the recommended method. Other newer methods of disinfection are now available which include chemical tablets, chemical sprays and spray guns. However these are only additional disinfectants and cannot replace proper cleaning.

Recommended frequency of OT disinfection

Item	*Before start of 1st patient*	*After each patient*	*Daily once*	*Weekly once*
OT table Entire table Sides & mat	✓	✓	✓	
OT lights & fixtures			✓	
Instrument trolley	✓	✓	✓	
Walls				✓
Floors	✓	✓		
Buckets	✓	✓		
Cupboards Open Closed			✓	✓
Stools	✓		✓	

Discarding of waste is done as per Biomedical waste guidelines. Segregation of waste is the key factor to proper waste disposal and very health care facility should have the requisite black, yellow and red bags.

Monitoring of the processes

It is essential to monitor the efficacy of sterilization and disinfection being done

Sterilization procedures are tested by the following methods:

- *Mechanical* indicators which are a part of the autoclave process itself allowing you to check the temperature, time etc.
- *Chemical* indicators which are available as tapes with lines, pellets, strips etc
- *Biological* indicators

Weekly testing with biological indicators is recommended

Disinfectant testing is done in microbiology labs using "in use" test. A fresh batch of disinfectant should be tested for its efficacy.

Only by means of meticulously following and continuously re-evaluating the methods of sterilization and disinfection can we achieve an infection free environment.

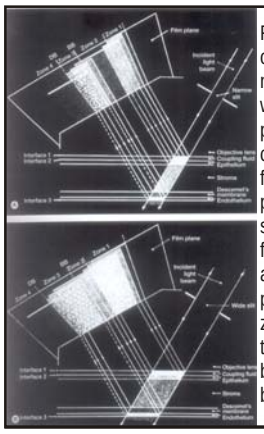
Specular Microscopy

Jaya Gutpa, MBBS**, Ashu Agarwal,** MBBS, MS**, S.C. Gupta,** MBBS, MS

The clinical specular microscope yields a corneal endothelial image

Optical principles of specular microscopy

It is an epi-illuminated microscope that projects a slit of light onto the posterior corneal surface at nearly normal incidence. Most of this light is transmitted into aqueous humor. However a small fraction of this light, 0.02% is reflected from the aqueous humor - endothelial cell interface back into cornea. In the normal cornea, virtually all of this small portion of light is specularly reflected, that is reflected in mirror like fashion so that the angle of reflection is equal to angle of incidence. Only negligible amounts of light reflect at other angles. The specularly reflected light is collected by the objective lens of photomicroscope and when the instrument is focused on posterior corneal surface, this light forms an image of corneal endothelium. The image may be viewed directly and photographed.



Representation of an optical section when a narrow slit (A) or a wide slit (B) of light passes through various corneal layers and is focused on the posterior corneal surface. As drawn, the film plane is positioned at right angles to the plane of the paper. The zones are defined in the text. BB, bright boundary; DB, dark boundary.

A currently available advanced clinical specular micro the konan NonCon Robo.

According to Laing, if the beam is narrowed sufficiently four zones of reflection can be seen,

Zone 1 is the brightest region and is formed by the interfaces formed by the lens, coupling fluid and epithelium.

Zone 2 is a larger region and represents light reflected from the stroma.

Zone 3 is the endothelial region.

Zone 4 represents light reflected from the aqueous humor.

The boundary between endothelial region (zone 3) and aqueous (zone 4) is almost dark and is termed the "dark boundary".

The boundary between endothelial region (zone 3) and stroma (zone 2) is usually bright and is termed the "bright boundary".

If the angle of incidence of the illuminating source is increased, less overlap occurs and a wider slit can be used. As a result, a larger field of endothelial cells can be seen. The wider beam however illuminates more of corneal stroma and epithelium resulting in a greater amount of scattered light, thus decreasing contrast and obscuring endothelial cell detail.

The early specular microscopes were narrow field scopes and provided a field of view of only 0.04 mm2. The current wide field, has a view of 1mm2

Advantages of Current Specular Microscopes

1. The present specular microscopes have a wider field of view and thus provide better examination of endothelial mosaic.
2. The addition of highly sensitive video cameras and recording systems, as well as a variety of optic improvements such as scanning mirror system have improved the resolution of endothelium.
3. These specular microscopes have utilized optic improvements to minimize annoying reflections from incident light.

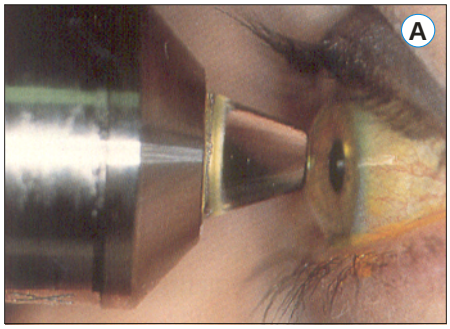
Depending on the instrument used, the projected light can be in the form of a stationary slit, a moving slit, or a moving spot. The optical design can be either confocal or non-confocal. The design of the equipment can be either higher magnification and resolution using contact objective lenses or lower magnification and resolution using non-contact objective lenses.

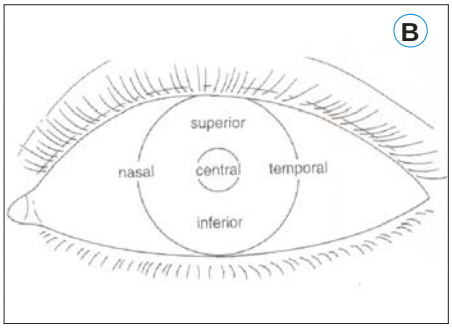
(The contact specular microscope eliminates epithelial light reflection, because the objective lens and dipping cone lie directly on the corneal surface. The noncontact specular microscope objectively aligns itself relative to the cornea by using the Purkinje images until the proper specular reflection mode is achieved and then objectively focuses back to the endothelial surface, the resulting endothelial photograph is displayed on the video monitor screen.)

Venu Eye Institute & Research Centre,
New Delhi

Patient Preparation

Currently available contact and non-contact wide field specular microscopes are easy to use with little patient discomfort. The procedure is first explained to patient to relieve any anxiety. There is no pain involved. In a contact specular microscope the procedure is very similar to that of Goldman-Applanation Tonometry. One or two drops of proparacaine anesthetic should be used before the eye is contacted. Once the cornea is contacted, a few epithelial irregularities may be seen; however these usually disappear within a few hours.





(A): A: The applanation cone should be placed centrally with the light shining through the pupil. B. The cornea should be systematically scanned to ensure complete
(B): Evaluation of the endothelial mosaic, centrally, superiorly, inferiorly, nasally, and temporally

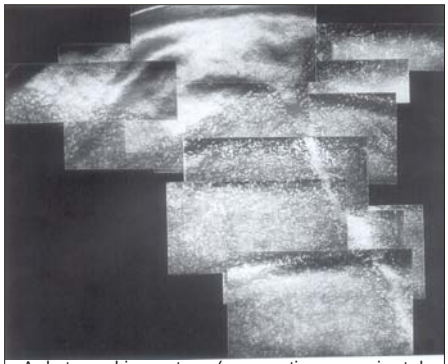
Positioning the eye in a straight ahead position is best achieved with a fixation light.

Optimal photographs are obtained when the cornea is relatively thin and clear with minimal scarring or edema. Light reflexes from iris can obscure the endothelial mosaic and are best eliminated by dilating the pupil.

Regional Specular Microscopy

The beam of light is directed through the pupil to ensure the placement of the cone on the most central portion of cornea. Systematically scanning superiorly, inferiorly, nasally and temporally will ensure a thorough evaluation of the monolayer.

If an area greater than 1 mm2 needs to be documented a photographic montage of the entire area can be made by taking multiple photographs with overlapping fields



A photographic montage (representing approximately mm^2 of the cornea) in a patient with iridocorneal endothelial (Chandler) syndrome. Note the superior portion of the cornea with relative normal corneal endothelium surrounded abnormal endothelial cells demonstrating typical "reversal patter" appearance.

Methods of evaluation of Corneal Endothelium

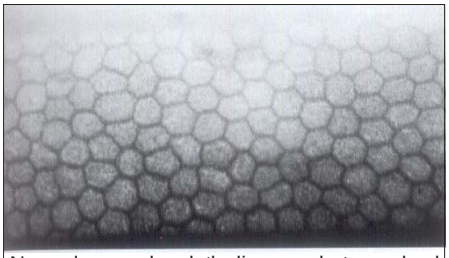
Qualitative Analysis

Quantitative Analysis

Analyzing specular micrographs can be done qualitatively by looking at cellular morphology and giving an interpretation or quantitatively by counting cell density and performing morphometric analysis.

Qualitative Analysis

The normal specular micrograph should demonstrate a regular endothelial mosaic of hexagonal cells of approximately the same size. Cell boundaries should be well-defined.



Normal corneal endothelium as photographed by specular microscopy. A quasi-regular array of hexagonal cells all having nearly the same area is seen.

Complete qualitative analysis requires knowledge of cell conformation, cell boundaries and their intersections, configuration of dark boundary and the presence of acellular structures.

The acellular structures may be both intra or intercellular and also dark or bright in appearance.

Enlarged stressed cells appear bright contained in a single endothelial cell. Pigmented endothelial deposits appear bright spanning several endothelial cells. Endothelial cilia and intracellular vacuoles or blebs appear as intracellular dark bodies.

Guttae are excrescences of Descemet's membrane, appear as intercellular circular black areas, approximately 5x the diameter of a normal endothelial cell. They can also be seen in far periphery of young individuals (Hassall Henle warts)

Quantitative Analysis

Quantitative Analysis of a specular photomicrograph is the objective description of the attributes of a selected cluster of individual endothelial cells from a specular photomicrograph.

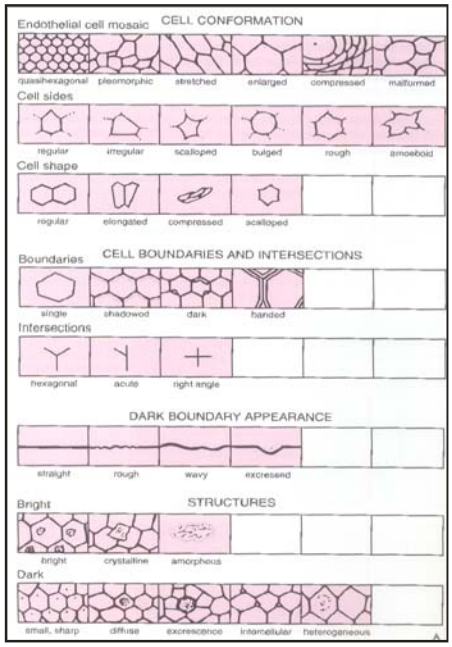
Eg. Include cell density (measured as cells/mm2) mean cell area (measured as mm2/cell), and pleomorphism (usually measured as a percentage of 3, 4, 5, 6, 7 or 8 sided cells).

1. ***Density:*** Normal endothelial cell density decreases with age, it being 3500 cells/mm2 in children and gradually declining to about 2000 cells/mm2 in older eyes. An average

value for adults is 2400 cells/mm2 (1500 - 3500) with a mean cell size of 150 - 350 μm2. Corneas with low cell density (fewer than 1000 cells/mm2) might not tolerate intraocular surgery;

2. ***Coefficient of variation:*** The mean cell area divided by the standard deviation of mean cell area, a unitless number, normally less than 0.30. Polymegathism is increased variation in individual cell areas and is typically increased in contact lens wear. Corneas with significant polymegathism (>0.40) might not tolerate intraocular surgery .

3. ***Percentage of hexagonal cells:*** The percentage of cells with 6 apices should ideally approach 100%. Lower percentages indicate a diminishing state of health of the endothelium. Pleomorphism is increased variability in cell shape. Corneas with high pleomorphism (more than 50% non-hexagonal) might not tolerate intraocular surgery.



If the magnification of specular micrograph is known, quantitative analysis can be performed using either fixed frame, variable frame or comparison cell analysis.

In fixed frame analysis, all the cells lying completely within a given area (in this case a square frame) are counted. Usually the total number of cells lying on the boundary is divided by two or only cells lying on two sides of square are counted. The estimate of the total number of cells within this given area is then used to calculate cell density and mean cell area.

In variable frame analysis, the borders of an entire group of cells are outlined with the aid of a computer. As a result, the frame outlining the group of cells has an irregular border. This method is more accurate than fixed frame analysis because only whole cells are counted and it is not necessary to include portions of cells located on frame boundary

In comparison cell analysis, the endothelial cell mosaic is compared to a cell pattern of known size.

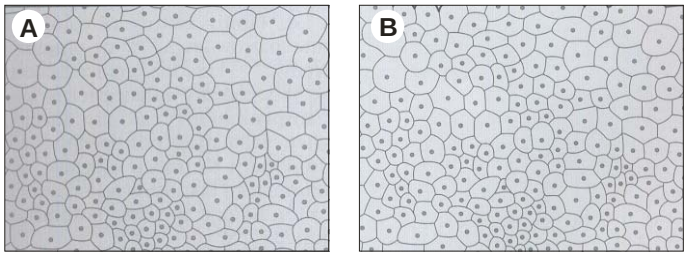
Morphometric Analysis

The variation in individual cell area (polymegathism) and cell shape i.e. cells with a different number of sides (pleomorphism), may provide a better estimate of endothelial cell integrity and function.

A specular photograph is chosen on the basis of cell boundary clarity and is enlarged to 400 times the original magnification. Before the specular photograph is printed, a calibration negative of a micrometer scale is taken with the same specular camera and placed in an enlarger to ensure accurate cornea to print magnification. A hundred individual cells are outlined with a fine point felt tipped pen and are numbered consecutively to minimize sampling and analysis error. Individual cells are digitized by marking each cell apex with a graphics tablet pen. The coordinates are entered into a digitizing tablet and analyzed by endothelial analysis software that has been previously developed.

Clinical indications for Specular Microscopy

1. Early diagnosis of Fuch's Endothelial Dystrophy.
2. In certain eyes before cataract surgery
   a) previous trauma
   b) pseudo exfoliation
   c) recurrent uveitis
   d) corneal edema in contralateral eye
   e) clear graft with operable cataract
   f) glaucomatous eye with cataract
   g) subluxated lens, choosing the IOL



(A): Fixed-Frame analysis. In this example, only the cells within the rectangle and those touching two adjacent borders were counted (dots). One could also divide the total number of cells lying on all four borders of the rectangle by two.
(B): Variable-frame analysis. The borders of a specific group of cells are outlined. The cells are then counted and the area calculated.

h) posterior polymorphous dystrophy

i) ICE syndrome, congenital glaucoma

j) use of various types and designs of IOL

k) effect of various irrigating solutions and intracameral products used during cataract on endothelium.

l) Different techniques of cataract surgery , related instruments and endothelial response.

3. Evaluation of donor endothelium .
4. Various refractive surgical procedures like LASIK, LASEK and their long term effect over corneal endothelium.
5. Contact lenses and phakic IOLs.

Eye Bank specular microscopy

Evaluation of corneal tissue can be performed on whole globes as well as corneas stored in tissue culture media .cell counts required for transplant surgery should be atleast 2000 - 2500 cells /mm^2.

KONAN'S eye bank specular microscope has a built in high resolution camera that gives high quality images of donor cornea with a built in cell analysis system. Its XYZ and rocking platform mechanism makes tracking of the endothelial cells easy. It also has a built in pachymeter.

Epithelial specular microscopy

Contact lens system enables photography of superficial layer of epithelial cells using specular microscopy. The normal corneal epithelium contains polygonal cells of varying brightness which can be dark, medium and light.

Elongated or enlarged corneal epithelial cells can be observed in wound healing processes such as penetrating keratoplasty and epikeratophakia.

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Capsule Endoscopy

Randhir Sud, Rajesh Puri

The capsule is the latest and the best technology for viewing the small intestine.

The most recent technology advance in endoscopy, The Capsule Endoscopy, also referred to as Wireless endoscopy, was approved for clinical use in America in late 2001. Our hospital, known for its endeavours in the field of medical science and technology is one of the 1st hospitals in this part of the world to acquire it in the year 2002

The capsule endoscope is designed to visualize and provide an examination of the entire 22 feet of the small intestinal mucosa for the first time, which till recently was done by contrast x-ray studies by indirect means, or directly by surgical laprotomy.

Components of "wireless endoscopy" technology

There are three components: the ingestible M2A™ Capsule, the size of a large vitamin,(11X26 mm) which is made up of a miniature color video camera, a light source, batteries, a miniature transmitter, and an antenna; Data Recorder including sensor array which is worn around the waist during the examination; and the RAPID™ Workstation which processes the data downloaded from the Given Data Recorder into a short video film clip. .

The Procedure

The patient comes to doctor's office after 6 hours of fasting. Adhesive leads (like those used in ECG) are placed on patient's abdominal wall and attached to the recorder. To initiate the video capsule endoscopy, the patient then swallows the capsule. Patient then leaves the doctor's office and returns after 7-8 hours for the removal of the recorder. There is no sedation involved. The capsule is disposable and will pass out with bowel movement. Patient is allowed to have clear liquids (water/ juice) after two hours, food and medications are allowed 4 hrs after swallowing the capsule.

The Capsule is shown above, prior to ingestion with a glass of water

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New Delhi

How does this tiny capsule endoscope work?

The image of the intestine is captured by the video camera and transmitted by radio frequency to an array of sensors worn around the patient's abdomen. The signals are recorded digitally on the Data Recorder, which resembles a portable "Walkman™" carried on the belt. The patient removes the belt and data recorder after approximately eight hours and returns the belt and recorder onto the RAPID™ workstation. The doctor can then examine the video (Patient Rapid Report) to look for abnormalities

Who should have the capsule endoscopy?

- Patients with history of obscure/ recurrent gastrointestinal bleeding or abnormal small intestine found on small bowel series.

Patients with chronic abdominal pain and their doctor suspects organic / anatomic cause in the small intestine.

- Chronic diarrhea, malabsorption
- Evaluation of the extent of Crohn's disease and celiac disease; visualization of surgical anastomosis.
- Surveillance of polyposis syndrome of the small bowel.

Contraindications

- Known or suspected obstruction/ stricture
- Pseudo-obstruction
- Cardiac Pacemaker
- Implanted Defibrillation
- Pregnancy

Outcomes

Capsule examinations should be reviewed by individuals experienced in viewing and interpreting endoscopic images, especially of the small intestine.

In two prospective, controlled, comparative studies between push enteroscopy and wireless video capsule endoscopy (one in chronic GI bleeders by EII et al from Germany, and another in obscure GI bleeders by Dementdts et al From Belgium) Capsule endoscopy was significantly superior to push -

enteroscopy. In another study by Gossum et al. from Belgium, in patients with obscure digestive bleeding, the diagnostic yield of the push enteroscopy was higher than that of the wireless endoscope (these three studies were presented in the First Criven Conference on Capsule Endoscopy held in Rome, Italy, March 17-19, 2002). The numbers in all studies are small, and larger studies are needed.

Study done by Eitan Scapa et al (Am J Gastroenterol 2002;97:2776-2779) abnormal findings were found in 29 of 35 (82.9%) patients. 20 of 29 (75.9%) patients had significant pathological findings explaining their clinical situation. Diagnostic yield was therefore 62.9% (22 of 35 patients). Among the various findings, the capsule detected ulcers, erosions, angiodysplasia, and submucosal lesions. The source of bleeding was found in 15 of 20 patients with iron deficiency anemia. There were no immediate significant side effects and none reported upto 1 month after ingestion of the capsule. The capsule was evacuated by all patients[9].

Costamangna et al performed a study in patients with suspected small bowel disease. This mall study (n=20) examined a heterogenous group of patients with obscure GI bleeding (n=13) suspected Crohn's disease (n=3) suspected sarcoma recurrence (n=1) diarrhea (n=1), familial adenomatous polyposis (n=1) and small bowel polyps (n=1). All patients underwent barium radiolography with small bowel follow through and then capsule endoscopy. The aim of the study was to compare the diagnostic yield of these 2 tests. Their outcome measures were whether the respective tests were "diagnostic" "suspicious" or "failed" (i.e. negative). The rates of a "diagnostic" tests were numerically higher for the capsule (45%) than the barium examination (27%), although no P value was reported. Among the subset with GI bleeding the capsule was statistically significantly better (31% vs 5%, P<0.05), although how this statistical analysis was performed is not described[10].

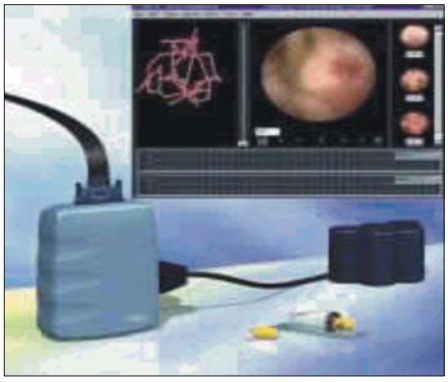
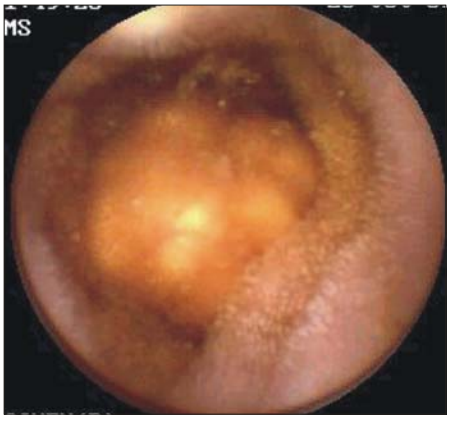


Image of sensor, and above image of small bowel as it appears on monitor while viewing DVD.

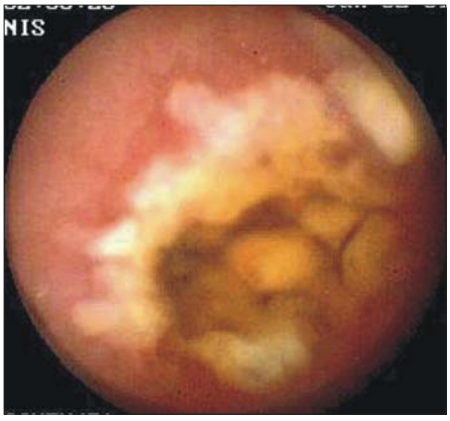
The Inner workings of the digested capsule

Conclusions

Capsule endoscopy is non invasive, painless, out patient procedure, not associated with significant complications. This provides direct visual inspection of the small bowel mucosa which is beyond the endoscopic visualization of the gastroenterologist but it needs further advancement to enhance diagnostic and therapeutic potential for use in pediatric population.



Polypoid Mass 80 year old patient with chronic GI blood loss requiring transfusion. Polypoid mass is seen in mid-abdomen.



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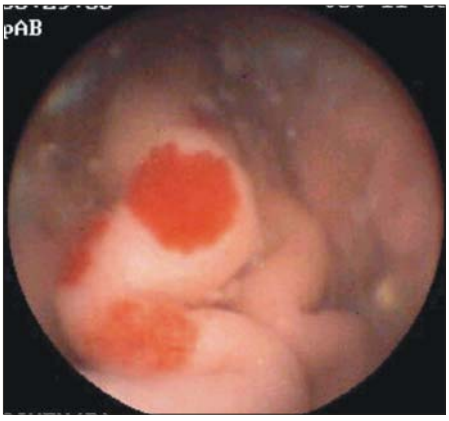

Hereditary Hemorrhagic Telangiectasia Multiple telangiectasia on a gastric fold.

Fluoroquinolones in Ophthalmology

Prof. N.R. Biswas*, Prof. of Pharmacology, **Prof. G.K. Das****, Prof. of Ophthalmology

Fluoroquinolones are potent synthetic agents active against a variety of bacterial species. The most active representatives of this class of compounds are norfloxacin, ciprofloxacin, ofloxacin, pefloxacin, enoxacin, fleroxacin, lomefloxacin, sparfloxacin, levogloxacin and gatifloxacin. They have few side effects and microbial resistance to their action does not develop rapidly.

Mechanism of Action

The two strands of double helical DNA must be separated to permit DNA replication or transcription. However, anything that separates the strands results in "over winding" or excessive positive supercoiling of the DNA in front of the point of separation. To combat this mechanical obstacle, the bacterial enzyme DNA gyrase continuously introduces negative supercoils into DNA. This is an Adenosine Tri Phosphate (ATP) dependent reaction that requires that both strands of the DNA be cut to permit passage of a segment of DNA through the break; the break is then released.

The DNA gyrase of bacteria is composed of two A subunits and two B subunits. The A subunits, which carry out the strand cutting function of the gyrase, are the site of action of the quinolones. The fluoroquinolone drugs inhibit gyrase mediated DNA supercoiling.

Antibacterial Spectrum and bacterial resistance

Fluoroquinolones are rapidly bactericidal and are considerably more potent against Escherichia and various species of Salmonella, Shigella, Enterobacter, Campylobacter and Neisseria.

Minimal inhibitory concentrations of ciprofloxacin and norfloxacin for 90% of these strains (MIC 90) are usually less than 0.02 mg/ml. Ciprofloxacin has good activity against staphylococci including methicillin resistant strains (MIC90 – 1mg/ml).

Most anaerobic micro organisms are resistant to the fluoroquinolones. Resistance to these drugs may develop during therapy especially with pseudomonas aeruginosa; there is cross-resistance among the members of the group.

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** UCMS & GTB Hospital, Delhi.

Fluoroquinolones are not affected by plasmid or enzyme mediated resistance. Bacteria become resistant to these agents by alterations in the alpha sub-unit. Fluoroquinolones possess the broadest spectrum of activity against indole positive and gram negative organisms.

NORFLOXACIN

Description

Norfloxacin is a synthetic broad spectrum antibacterial agent supplied as a sterile isotonic solution for topical ophthalmic use.

Norfloxacin inhibits bacterial deoxyribonucleic acid synthesis and is bactericidal. There is no cross resistance between norfloxacin and other classes of antibacterial agents. Therefore, norfloxacin generally demonstrates activity against organisms resistant to some other antimicrobial agents. Norfloxacin has in vitro activity against a broad spectrum of gram positive and gram negative aerobic bacteria.

Indications

Commonly used in conjunctivitis, keratitis, infected corneal ulcer, blepharitis, dacryocystitis.

Adverse reactions

Most common adverse reactions are local burning or discomfort, bitter taste. On systemic use nausea, headache and transient arthralgias may occur.

Dosage and administration

Topical: 1-2 drops(0.3%) 4 hourly. Severe infections: 2 drops every hour.

Oral: 400mg twice /day for 5 days.

CIPROFLOXACIN

Chemical name

1-cytopropyl-6-fluoro-1,4-dihydro-4-Oxo-7- (1-piperazinyl)-3-quino-Carboxylic acid

Description

Ciprofloxacin HCl is a fluoroquinolone antibacterial, active against a broad spectrum of gram-positive and gram-negative ocular pathogens. The bactericidal action

of ciprofloxacin results from interference with the enzyme DNA gyrase which is needed for synthesis of bacterial DNA.

Indications and usage

Bacterial infections of eye like blepharitis, corneal ulcer, stye, conjunctivitis.

Contraindications

A history of allergy to ciprofloxacin or any other component of the medication is a contraindication to its use.

Adverse reactions

Most commonly reported adverse reaction was local burning or discomfort. In corneal ulcer studies with frequent administration of the drug, white crystalline precipitates were seen in some patients. Skin rashes were reported in few cases.

Dosage and administration

Topical drops: Available in 0.3% concentration. One or two drops instilled into the conjunctival sac every two hours while awake for two days and one or two drops every four hours while awake for next five days.

Intravitreal conc. 150μg in 0.1ml

Subconjunctival: 20-40mg/ml

Parentral: 200-400mg I/V twice/day (It is available as a 100ml bottle containing 200mg of ciprofloxacin).

Oral: 500-700mg/day12 hourly

OFLOXACIN

Chemical name

(±) 9-fluoro-2,3 - dihydro - 3 - methyl-10- (4 – methyl – 1 - piperazinyl) -7-Oxo-7H-pyrido[1,2,3-de]-1,4-benzoxazine-6-carboxylic acid.

Description

Ofloxacin is a fluorinated carboxyquinolone anti-infective drug. Ofloxacin has in vitro activity against a broad range of gram-positive and gram- negative aerobic and anaerobic bacteria. Ofloxacin is bactericidal at concentrations equal to or slightly greater than inhibitory concentrations. It acts by inhibiting DNA gyrase, an essential enzyme which is a critical catalyst in the duplication, transcription and repair of bacterial DNA.

Indications and usage

Ofloxacin is used in the treatment of conjunctivitis caused by susceptible strains of the following bacteria: Gram-positive bacteria *Staphylococcus aureus, Staphylococcus epidermidis, Streptococcus pneumoniae.*

Gram-negative bacteria *Enterobacter cloacae, Haemophilus influenzae, Proteus mirabilis, Ps. aeruginosa.*

Contraindications

Ofloxacin is contraindicated in patients with a history of hypersensitivity to the drug or other quinolones.

Adverse reactions

Treatment of ocular burning or discomfort are sometimes reported. Other reactions may be stinging, redness, itching, photophobia, tearing and dry eyes.

Dosage and administration

Local: Instill one to two drops every two to four hours for the first two days and then four times daily in the affected eye.

*Systemic:*200-400mg oral, twice /day.

LOMEFLOXACIN

Description

It is a difluorinated quinolone derivative that is effective against both gram positive and gram negative bacteria. Cross resistance has been reported with other quinolones but not with any other group of antibiotics.

Precautions

Clinical studies of lomefloxacin drops during pregnancy and lactation are not available, hence should be used with caution in such cases. In order to avoid reduction of efficacy, no ophthalmic preparation containing heavy metals such as zinc should be used 15 minutes preceding and following the use of lomefloxacin. It should be used within a month of opening the bottle.

Adverse reactions

On systemic use rarely phototoxicity may occur.

Dosage and administration

Ophthalmic solution	:	0.3 percent . A loading dose of one drop every 5 minutes for 20 minutes followed by twice a day for 7-9 days
Fortified drops	:	20mg/ml(Shelf-life 15 days)
Subconjunctival dose	:	20-30mg/ml
Oral dose	:	400mg once daily for 5 days

SPARFLOXACIN

Description

Sparfloxacin, a third generation fluoroquinolone derivative with bacterial activity against a wide range of Gram-positive, Gram-negative, atypical and anaerobic pathogenic bacteria.

Indications

External ocular infections such as conjunctivitis, keratitis, corneal ulcers, blepharitis, dacryocystitis and acute meibomitis caused by susceptible bacteria.

Adverse reactions

Ocular tolerance studies in rabbits have not revealed any severe intolerance reaction.

Dosage and administration

Instill 1-2 drops in the affected eye(s).

Contraindications

Hypersensitivity to quinolone group of antibacterials or any components of the preparation.

Precautions and warning

Should irritation or hypersensitivity to any component of the formulation develop, discontinue use of the preparation and initiate appropriate therapy.

GATIFLOXACIN

Chemical name

8-methoxy fluoroquinolone.

Description

It is a fourth generation fluoroquinolone.

Indications and usage

Gatifloxacin has been found to be more effective than ciprofloxacin and levofloxacin for multiple drug resistant Staphylococci and infection caused by anaerobic bacteria.

Adverse reactions

Conjunctival irritation, increased Lacrimation, papillary conjunctivitis.

Dosage and administration

Topical : Available as 0.3% solution.

CASE REPORT

Gyrate Atrophy of Choroid and Retina

Ajit Kumar Paul, MS, DO, **Amit Maitreya,** MS, **Shyam Bhargava,** DOMS

Introduction

Gyrate atrophy of choroids and retina (GA) is a very rare form of hereditary retinal dystrophy accompanied by a defect in ornithine metabolism. The clinico-ophthalmological findings in GA include chorioretinal degeneration, myopia and cataract. GA is an autosomal recessive disorder the ocular changes may be due to either hyperornitheneamia or possibly hypoprolineaemia.

We report a case which presented with myopia, posterior subcapsular lens opacities and chorioretinal degeneration.

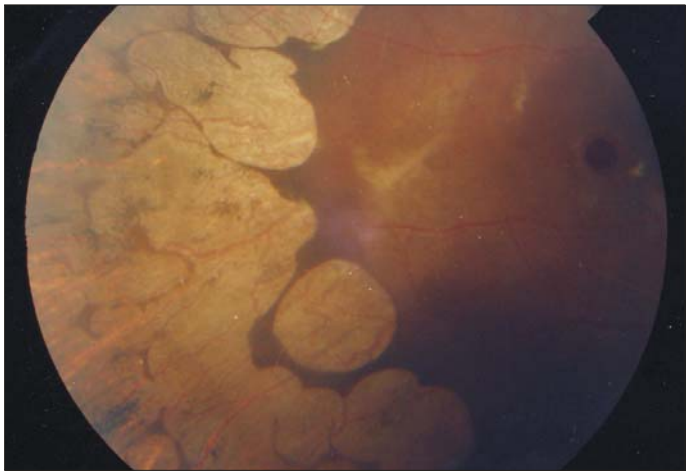

Fig.1: Peripheral patches of chorioretinal atrophy in gyrate atrophy

Case

A 10 years old male child presented with reduced vision in both eyes for last five years. His vision was counting fingers 2 meters in right eye and counting fingers 4 meters in left eye. He had axial myopia and best corrected visual acuity was 6/18 in right eye and there was no improvement of vision in left eye.

The anterior segment was normal except central posterior subcapsular lens opacities in both eyes. Intraocular pressure was 14.6 mm Hg in both eyes.

The fundus examination in both eyes showed circular patches of chorioretinal atrophy in the mid-periphery (Fig. 1), associated with vitreous degeneration. The atrophic lesions were confluent with scalloped border. There was a sharp contrast between normal and abnormal tissue. Macula in the left eye had cystoid edema with full thickness hole (Fig. 2).

Fluorescein angiography showed sharp contrast between normal and atrophic areas (Fig. 3). Routine blood tests were within normal limits, but plasma ornithine level was markedly elevated. ERG and EOG were flat.

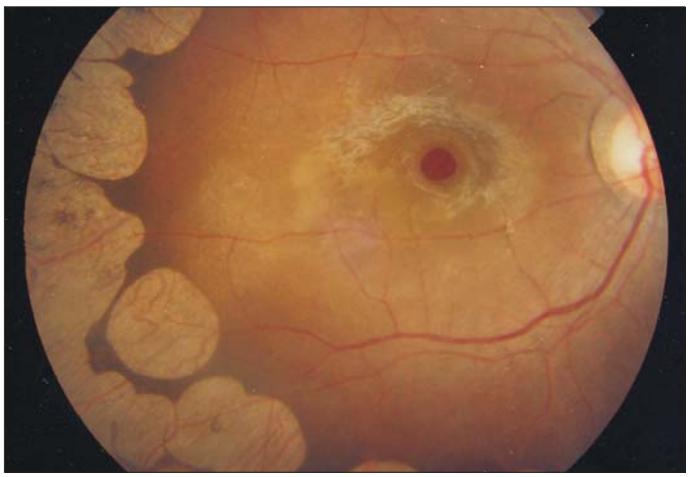

Fig.2: Patches of chorioretinal atrophy with macular involvement and hole formation in left eye.

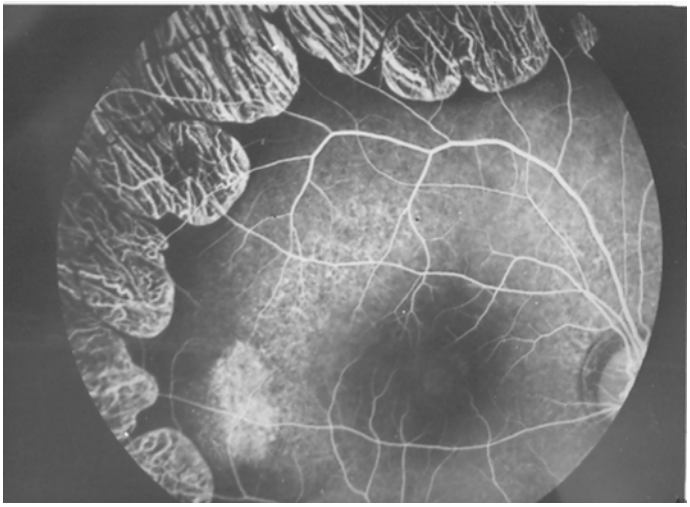

Fig.3: F.F.A. in advanced gyrate atrophy showing sharp contrast between normal and atrophic areas.

Treatment

Treatment is based on response to pyridoxine (vit. 136) may normalize plasma and urinary ornithine levels.

References

1. Chiristina Raitta et al – Gyrate atrophy of choroid and retina – British J. Ophthalmology 1990, 363-367.
2. David Steel et al – Anterior subcapsular plaque cataract in hyperornitheneamic Gyrate atrophy – British J. Ophthalmology

Chief Medical Officer,
Eye Hospital, Sitapur, U.P.

"To the Power of Infiniti" ©

Sudipto Pakrasi

A comprehensive critical review of the lens removal system & and my experience of the Infiniti Vision System

A new instrument stretches the limitations & barriers of what's possible in cataract removal today.

Introduction

Over the years, various advances in phacoemulsification continue to yield better outcomes, partly because progressive lessening of energy delivered into the eye along with reduction of turbulence allows faster recovery and is less likely to result in endothelial cell loss. Hence the move towards: "Customizing" the phaco settings depending on the merits of the individual cataract.

Switching a phaco machine is no joke for surgeons, but some believe choosing a platform is necessary … essentially looking forward to it for the anticipated future but there is one important reason to make a change - If significantly advanced technology becomes available only in a different platform, it may be a good time to start thinking about swapping your machine. Of course, we surgeons do not necessarily all agree unanimously on what significant advanced technology is, but hopefully, some of my comments will allow you to assess whether your phaco machine is ready to retire or to continue. This new technology requires surgeons to be persistent & assiduous in their research and in refining their techniques to ensure they are maximizing the value of their equipment while ensuring patient safety. Ultimately, optimized performance will come from adjusting parameters from patient to patient and from one step to the next on a single patient. We all know that even if it is possible to operate all cataract cases with a single setting, as any excellent, experienced phaco surgeon would be capable of, it is not in the interest of the surgical outcome to use higher energy levels & turbulence in situations where minimal setting of power may be necessary. Customizing cataract surgeries not only requires variation of your skill levels but also what your phaco system is capable of. The ability of an instrument to alter the flow rate & the parameters of vacuum within a fraction of a second is crucial to cataract surgery, much more that we ever realize! Ideal phacoemulsification requires that proper amount of flow & vacuum is maintained at exact moment - & these parameters must change continuously throughout the procedure - this is where the safety of a system comes into play! In this discussion I would be commenting about my experiences with the cutting edge technology in phacoemulsification today as to what are the strengths & advantages of the Infiniti Vision System. The comments are based on use & understanding of the system as I have developed over some time of using it. Since never before have I come across a system that can reach flow rate of 100cc/mim & vacuum levels of over 750mmHg, that too controllable in milliseconds!! - This definitely dictates that this awesome machine merits this review.

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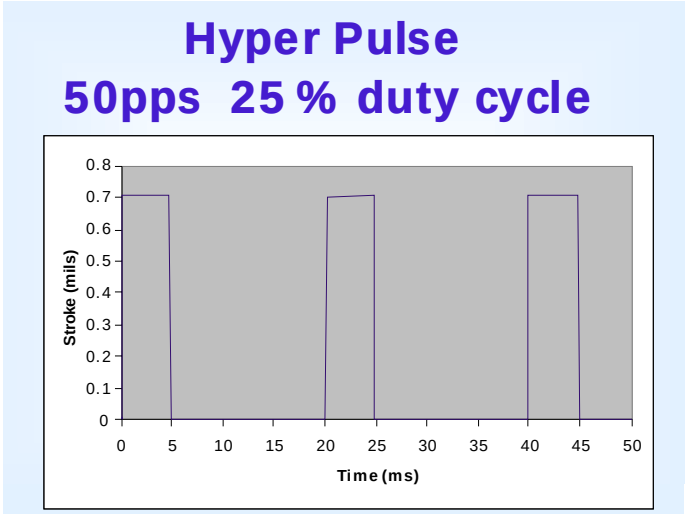
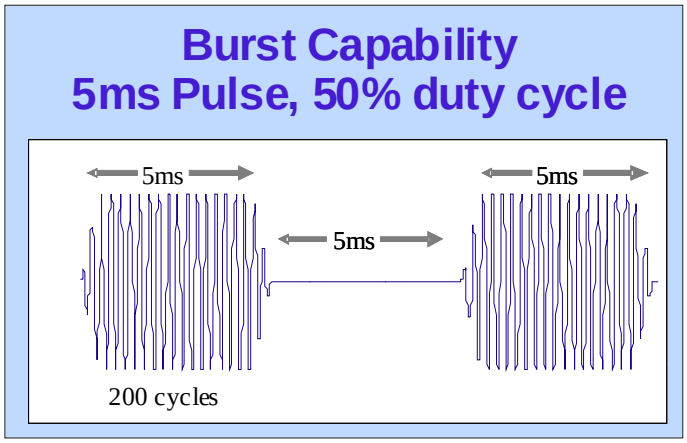




A Tri-Modal Platform - Offering customized cataract surgery

The Infiniti's features are noteworthy in several areas: It offers three different technologies for cataract removal in a single unit,

1. Advanced Ultrasonic phacoemulsification
2. Ultrasound with mechanical oscillation (NEOSONIX)-
3. AquaLase liquefaction - This uses a warm, naturally-balanced solution to safely break up and "wash away" the natural lens.

Three Options for Lens removal:

a) Advanced Ultrasound Phacoemulsification.

Ultrasonic phacoemulsification has long been the "gold standard" for phaco.

How Infiniti offers delivery of energy efficiently?

New phacoemulsification technology has allowed surgeons to significantly improve efficiency of energy delivered into the eye. Ultrasound energy removes the lens through the jackhammer effect of the metal phaco tip which is in direct contact with the lens. Improper & inefficient use of ultrasound results in a considerable amount of wasted energy that disperses into the eye unnecessarily. The basic rules of phaco surgery believes that by reducing the ultrasonic energy that is delivered in the eye and by minimizing the turbulence in the anterior chamber the stress on the endothelium will be minimized and may lead to a quicker & more efficient recovery. The Infiniti gives the surgeon more efficient & complete control over ultrasound, vacuum and flow settings to minimize this wasted energy and turbulence in the anterior chamber. The feature of '**Dynamic Rise**' with settings (-2 to 4) minimize the turbulence in the anterior chamber and shortening the rise time by stepping up the aspiration flow rate up to 100cc/min. only after partial occlusion is achieved. Hence the turbulence that would have occurred normally at this high flow rate is not effecting on the ocular tissues and once the occlusion breaks the flow rate is at its preset value reducing the risk of post occlusion surge. The safety concern of working at such high flow rates is taken care of by a software algorithm that before activating the 'dynamic rise', takes into account the Irrigation Pressure Sensor (IPS) and Vacuum Pressure Sensor (VPS) values and if and only if their levels are safe the dynamic rise shall be activated. This constitutes a very intelligent check in energy delivery.

The Infiniti permits the surgeon to apply microbursts of energy as short as 5 milliseconds or as long as 500 milliseconds. These applications may be performed as infrequently as once per 2.5 seconds, as often as 100 times per second (5-millisecond bursts and a 50% duty cycle), or anything in between. The ability to apply microburst is not new, but the shortest available bursts on other machines were 30 milliseconds. Concepts of Hyperpulse, Burst modes have taken the possibilities of advanced phacoemulsification to greater heights. These could be used in both liner or fixed modes. All parameters are completely customizable giving you immense possibilities & control on your hands. I do not believe that any other instrument can remove the extremely hard, leathery, brown or black types of nuclei more efficiently. This system not only provides a stroke length that is sufficient to remove a nucleus of any density, but it will consistently maintain the stroke length regardless of the load at the tip.

Advanced Ultrasound summary

I. Physicians connect with lens-removal instruments through their hands and feet. The handpiece must be comfortable, but most are too heavy. The titanium ultrasound handpiece is about half the weight of previous handpieces available and has been redesigned to be easier to hold and manipulate. The ultrasonic handpiece of most other machines weigh over approximately 98 g, but that of the Infiniti is approximately 41 g and is therefore easy to maneuver. Surgeons need not hold the handpiece in a death grip in order to retain control. As a result, they receive more tactile feedback and are able to execute more precise movements.

II. The irrigation line is now consistently oriented to the tip bevel, giving the surgeon better control inside the eye. No knotting or twists occur during holding the handpiece.

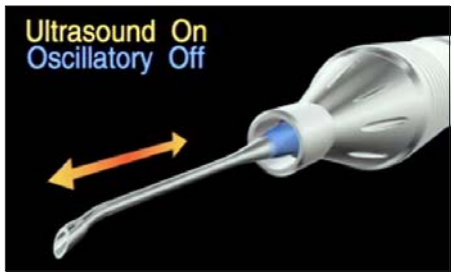
III. The system provides a much more accurate load sensing and response.

IV. The Infiniti has improved low end ultrasound delivery, and it gives you linear ultrasound control across the entire power spectrum, from low-end to high.

b) Advanced ultrasound with oscillation provided by the NeoSoniX handpiece.

The Infiniti offers a new method that uses both ultrasound and

mechanical oscillation to help break up the cataract faster, and may allow the surgeon greater control of lens tissue than traditional ultrasound. The NeoSoniX handpiece makes surgery faster and safer by allowing the tip to oscillate back and forth up to ±2°. It's the only handpiece that can combine sonic, nonlinear oscillations with linear ultrasound - or use either alone. When the tip is oscillating, ultrasonic energy is distributed, increasing the efficiency of delivery; it has the effect of moving the lens material on the tip, constantly repositioning the fragments. Some cataracts can even be removed using oscillation alone, reducing thermal energy as much as 99.9% compared to conventional ultrasound. You control both the amplitude of the oscillation and the threshold of ultrasound power at which it engages. The unique sonic oscillatory energy of this technology will benefit many surgeons.



Although the efficacy of nuclear material removal of the 100 Hz motion of the tip oscillating alone is not much, it is of immense value when these oscillations are combined with the ultrasonic vibrations. Oscillation automatically breaks occlusion and thereby causes the nucleus to dance on the phaco tip, thereby changing its orientation. This is particularly valuable for surgeons who use a one-handed technique and therefore do not have a second instrument within the eye. Studies have shown conclusively that phaco performed with NeoSoniX puts less energy into the eye than conventional ultrasound phaco. Since the handpiece combines linear ultrasonic motion with oscillatory sonic motion, it allows you to reposition tissue at the tip, which many surgeons have found to be an important advancement in surgical precision and control. By adding sonic (at 100 Hz) oscillatory energy to the cutting power of ultrasound, it provides enhanced surgical control for difficult cataract extraction

The result - Customized Lens extraction + less potential thermal trauma to the cornea + more pressure control to minimize risk of complications. This leads to better vision postoperatively and faster recovery than with previous lens removal systems offering ultrasound alone. The NeoSonix combined with traditional ultrasonic power bursts (in the Burst Mode) offers fantastic control and ease of procedure and is my personal preference, though it performs very well with the hyper pulses also.

Using the bent Kelman tip will greatly enhance the ability of the tip to cut through efficiently - the only problem associated with the handpiece is that it is too bulky for use by surgeons with small hands - this is due to the mechanical oscillatory motor being incorporated - a problem that will be changed soon as a newer more elegant & slimmer handpiece is due in some time. One precaution necessary in very hard brunescent cataract is that oscillations should not be used for sculpting as if will put a great deal of rocking force on the zonules. This is because the entire cataract mass will move as a single unit with the oscillations.

NeoSoniX summary

a) Offers a new method that uses both ultrasound and mechanical oscillation

b) Is the only handpiece that can combine sonic, nonlinear oscillations with linear ultrasound or use either alone to increase options for surgery

c) You control both the amplitude of the oscillation and the threshold of ultrasound power independently

d) NeoSoniX widens the trough more quickly during sculpting, except in very hard cataracts

e) Minimizes risk of thermal burns

f) Oscillation automatically breaks occlusion and reposition for more efficient lens removal

g) Oscillations may be used alone in softer cataracts without any ultrasound to minimize energy release in the eye

a) AquaLase Liquefaction Device

A completely new lens removal method, called the AquaLase Liquefaction Device, uses pulsed surgical solution to safely break up and remove the natural lens material. This method represents the first departure from the industry standard for almost 20 years, and is only available with the Infiniti Vision System. It breaks up the clouded lens with pulses of warm, naturally balanced solution to "wash away" the lens. The AquaLase handpiece generates 4-microliter pulses of surgical solution (BSS) that can be used to break up lens material. Pulses are warmed at 55 degrees and propelled by a smooth, rounded-bevel polymer reflective tip that disperses fluid for enhanced safety and "tissue specificity." No mechanical motion is involved. This action appears to have no effect elsewhere in the eye. For example, there is no radiating ultrasonic pressure wave. The high-energy pulses cause gentle delamination and emulsification of selected tissue. The force of the pulse is dampened in the surrounding fluid so nearby tissue isn't disrupted (like putting a water pipe under water, does not generate the same force of the water jet as in the air above that water level, because that water

dampens the jet force). For softer density nuclei, in my experience & opinion, it's kinder and gentler to the eye than ultrasound phacoemulsification. Harder cataracts continue to require ultrasound because the liquid-based system is not strong enough to break them up. The amount of surge in the Infiniti system has been cut in half, while it can build holding pressure three times as fast than as other contemporary systems. Another key change is the addition of disposable polymer tips, which are gentler to the capsule than the metal tips. The new tip could safely aspirate along the posterior capsule and within the capsular bag without endangering its integrity.

AquaLase, in its current form, will not help us in this area. Future uses for AquaLase could include removal of epithelial cells and someone someday may decide that that is a better way of removing a cataract because there's no ultrasonic energy being expelled within the eye. Therefore, they may change platforms based on that kind of technology, which is not available on any of other instruments. The corneas are absolutely remarkably clear the next day!

AquaLase is designed to be easy to learn and use, however, the surgeon has to change orientation to so as to adapt to the technique. But do note that surgery with the system is time consuming - lasting initially about twice as long as standard phacoemulsification procedures.

AquaLase summary

1. Minimizes risk of thermal incision burns almost completely.
2. Provides the familiar aspiration and irrigation functions.
3. Gives the surgeon total control of all parameters.
4. Is a great innovative tool for softer cataracts
5. Short learning curve.
6. Reduction in capsule ruptures.
7. May reduce endothelial cell loss by working inside bag.
8. Offers very effective capsule cleaning capabilities = Clearer, cleaner capsules.
9. High marketing value.
10. Sustainable competitive advantage.

Better Understanding and Application of Phaco Fluidics

Primary Role of Fluidics

Before we proceed ahead, we need to understand a few very important concepts:

What is the primary role of fluidics? It is removal of material from the eye, while maintaining a stable anterior chamber and avoid surge so as to avoid collapse of the anterior chamber during the procedure.

Follow ability (Aspiration Flow Rate) means the ability of the fluidics system to attract material towards the tip.

Holding force (Vacuum and Tip Size) is the ability of the fluidics system to maintain material at the tip.

What is Surge? It is an effect caused by a fluidic imbalance, which is increased by a compliant fluidic system.

What causes surge? Surge will occur when AFR exceeds Irrigation

Ways to avoid Chatter

During the process of ultrasound phacoemulsification, the lens material must be in direct contact of the phaco tip otherwise phacoemulsification will never occur efficiently. A balance between the repelling forces of ultrasonic movement of the tip and the attractive forces of the flow and vacuum that brings and holds the material against the tip is necessary for maintaining the contact of the lenticular material with the phacotip. In case the ultrasound power is too high as compared to the vacuum, equilibrium is not achieved, and the lens material loses contact with the tip. This reflects wasted energy, and is known as **'chatter**, while also inducing turbulence in the anterior chamber that can lead to corneal endothelial cell loss, hence delaying visual recovery. To increase the efficiency of the surgery, we should first increase the attractive forces which will draw the material constantly towards the tip. This is achieved by raising the flow rate to reach the occlusion at a quicker rate with dynamic rise time. A high vacuum level will maintain contact with the lens material of the tip which will improve the ultrasound efficiency during the phaco procedure. But, the high vacuum is limited by the surge flow that occurs on occlusion break leading to an unstable anterior chamber – this remains the biggest predicament in most of the systems available till now. Each machine has its own limits for vacuum. By controlling the repelling forces on the other side of the equilibrium equation, the energy delivery can also be optimized further. Ultrasound power should be reduced to a level at which it will emulsify the lens, but will not be able to repel the fragments. These "minimal-power phaco" levels are produced by the **digital ultrasound driver** of the Infiniti, which maintains accuracy at low power levels. Increased control yields predictable, reproducible results, even when emulsifying extremely hard nuclear material, when control is most important. Repulsion can also be reduced by modulating the "ON Time" or **duty cycle**, which is the percentage of time when the ultrasound is active per cycle. This is a very intelligent application where with lower duty cycles, the shorter ultrasound pulses have less time to repel the nucleus and there are longer pauses between the pulses during which the attractive forces have more time to keep the nuclear material at the phaco tip. Modification of duty cycles will allow application of higher vacuum with hyperpulses of 5 – 10 ms with much greater power, which will make removal of the nuclear material much more efficient without compromising that procedure safety

What effects does surge cause? Surge can cause Chamber Fluctuations, Mini-collapse, Movement of PC and Iris Flutter. All these may adversely affect surgical outcomes.

Other factors that influence surge include the Bottle Height, Pump Speed, Phaco tip size, Vacuum level, Incision size and shape, Air in the aspiration line, Rate of air getting through drip chamber vent and of course, the patient's eye

What is Compliance? Compliance is the ability of an object to yield elastically when a force is applied

What is the effect of compliance? The more compliance that is designed into a fluidic system, the slower the responsiveness, performance and more opportunity for surge. Non-Compliance is the ability of an object to maintain rigidity when a force is applied. The more Non-compliant a fluidic system is, the more responsive its performance will be and less chance for surge.

Defining Dynamic Rise Time

Dynamic is ability of sensing an increase or decrease in vacuum, that is change based on an increase of both vacuum and infusion pressure. Rise Time means time to reach maximum preset vacuum/gain occlusion. Dynamic Rise means the ability to alter pump speed/AFR on sensing a change in vacuum level in other words; it is the ability to alter pump speed/AFR to alter time to maximum vacuum. Other units have rise time adjustment but it is a universal setting and cannot be manipulated, (always faster or slower)

The higher the aspiration flow rates, the quicker the material is drawn towards the phaco tip, but this also determines how fast the vacuum levels rise. Hence the flow rate really is responsible for how quickly the events happen inside the eye. If I want the events not to happen very quickly so that I remain in control, but also desire that the vacuum rises very quickly the moment occlusion occurs, I have another point of control - that is the Dynamic Rise time. I can either slow down or really hasten the slope of the vacuum rise curve. So I may want the DRT very high during chopping so that I can hold the lens material for chopping or during the removal of epinucleus, I will want the DRT to be very slow - for events to happen slowly.

The benefits of Dynamic Rise Time is that it reduces turbulence, hence needs lower flow rate parameters. It also adjusts time to occlusion b.y Modifying vacuum build but it activates earlier in the process. These lead to Rapid holding, leads to better cutting. To summarize, DRT adjusts time to preset vacuum, thereby activates early in the occlusion process and customizes tissue acquisition. It obviously results in rapid holding = better cutting, and reduces turbulence (non occluded), due to which lower flow rate parameters possible.

Applications of increased Dynamic Rise Time are in various chop techniques, segment removal and it facilitates the use of lower initial AFR leading to calmer chambers and safer engagement of nuclear fragments

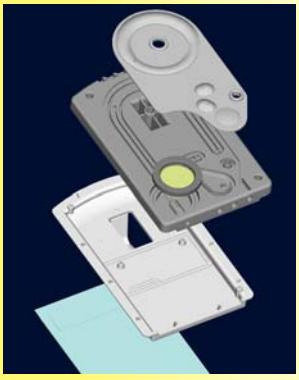
Applications of decreased Dynamic Rise Time include sculpting when at higher AFR's, bowling techniques and in complicated cases

Benefits of Pump Systems: The fundamental difference of the Venturi pump is that it is not occlusion dependent, has a fast rise time and Flow and Vacuum linear co-dependents. While, the Peristaltic pumps separate Flow and Vacuum control, the AFR determines rise time and because of this, one can safely use higher vacuum levels.

New Fluid Management System (FMS)

Redefining Fluidic Control: In designing a dependable system, there should be increased precision and accuracy. This is done by the following: rigid fluidic path design, precise mating of consumable to pump head, consistent calibration of in line APS and an increased vacuum monitoring. To top it all, you need to make fluidic control by developing a better ability to adjust the Software

Cassette Components



- Elastomer
- Base
- APS Diaphragm
- APS Ring
- Cover
- Drain Bag
- Tubing Manifolds

Impact of Vacuum

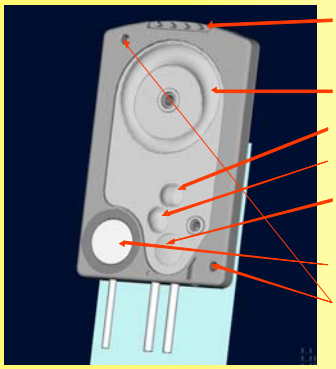
To understand the physics of lens removal, the ability to apply vacuum force to the lens greatly reduces the need to apply mechanical forces in order to remove the lens. The fluidics of previous systems have limited our ability to apply vacuum; I am referring to the ability of a given system to maintain pressure within the eye immediately after vacuum force has successfully removed the lens (remember surge?). The Infiniti has fluidic abilities never before witnessed in our profession. With this technology and the 1.1-mm Tip, I routinely use over 650+ mm Hg of vacuum to remove nuclei, and I normally require very minimal or no ultrasonic energy to extract cataracts of up to grade 2+. On other machines, with higher compliance tubing and cassettes, those parameters would completely collapse the anterior chamber as soon as the lens material is aspirated, due to the surge. Avoiding this complication requires a machine that can firstly, nearly or completely eliminate incisional leakage and secondly, instantly shut off the pump and prevent the aspiration system from continuing to create a vacuum. In other words, there should be the least possible compliance or elasticity in the aspiration system. The Infiniti meets all these criteria. The Infiniti's fluidics includes numerous new features and improvements over previous instruments, providing extremely quick response and maintaining a very high level of stability in the chamber.

The redesigned fluidics improves performance by allowing for faster set-up, as well as a smoother transition between patients. All fluids are contained within a closed system, reducing the risk of contamination. Cleaning cycles are eliminated thanks to containment of all the aspirated biomaterial in a fluidic device that's simply discarded following a procedure, since all cassettes are disposable.

algorithm and the Console pump mechanism. Higher vacuum levels will result in greater shrinking or compression of the tubing and other compliant parts of the fluidic system (compliance). To counter this effectively, the Infiniti's innovative redesigned FMS minimizes the compliance in the entire fluidic channel by incorporating narrow bore aspiration tubings, elastomer membrane and pvc fluidic pathways within the FMS making it possible to achieve higher vacuum levels at a higher speed and, therefore, to vastly increase the attraction forces. Chatter is more common when emulsifying dense nuclear material. My vacuum setting with the Infiniti using the ABS tip is normally 650+ mm Hg.

Keeping in mind the above discussion, the design of the INFINITI Vision System includes a Fluidics Management System (FMS) offering unsurpassed performance with capabilities unavailable on any other ophthalmic surgery platform. Thanks to its non-compliant design, the FMS offers greater chamber stability and enhanced control. With the inclusion of its Non-Invasive

Fluidic Management System



- Cassette identification pins
- Pump roller interface
- Vent valve interface
- Irrigation pinch valve
- Infusion pressure membrane
- Vacuum Pressure Sensor
- Alignment holes

Pressure Sensor, the FMS is a completely closed system, dynamically monitoring and managing real-time vacuum and flow information to enable precise surgical control and consistent performance. The FMS delivers important new capabilities, such as the ability to achieve flow and vacuum levels not previously possible. In maintaining unprecedented chamber stability, its features include a single-piece membrane, incorporating the pump interface, irrigation and vent valves and an irrigation pressure sensor. These combine to create state-of-the-art ocular fluidic stability. The ability of an instrument to alter the flow and vacuum parameters within milliseconds is crucial to lens removal, more so than most of us realize. Without excellent fluidics, extracting a cataract is like having a top of the line racing car that lacks tyres: there is excellent potential but an inability to execute the job. Ideal phacoemulsification requires the correct amount of flow and vacuum at every moment, and those parameters must change continuously throughout the procedure.

The FMS samples the vacuum precisely and responds to both directional and quantitative changes in pressure by altering the flow rate. The system can drop the flow rate from 100 cc/ min to 0 cc/ min in several milliseconds. When no nuclear material is on the phaco tip, having a great deal of flow and vacuum is counterproductive, and excessive turbulence is created for no purpose. By hitting the brakes or the accelerator, so to speak, in accordance with the surgeon's needs - the unique fluidics of the Infiniti increase the safety of the phacoemulsification procedure and also dramatically improve surgical efficiency.

Improved fluid venting - The Infiniti fluid-vents via a 15cc reservoir in the asp line and does not require fluid to be pulled from the irrigation line

Infusion Pressure Sensing (IPS): This is a unique mechanism introduced - The question is Why IPS? Well, obviously you are operating with increased safety with a future smart software. The advantages of the IPS are - to detect empty bottle and it reacts to irrigation line crimping and detachment from handpiece. The IPS gives increased fluidic intelligence with respect to Dynamic Rise.

Improvements in Fluidics include:

I. Advanced reduction in surge.At 600 mm Hg, the Infiniti system has minimum surge during an occlusion break. This is the result of a combination of hardware and software advances. For example, all fluid pathways in the instrument are composed of a rigid elastomeric membrane that improves fluid compliance.

II. Improved pump.Up gradation into Infiniti means changing to a much more responsive and dynamically controlled pump. The new pump gives you control over more parameters, including dynamic rise time. Some surgeons favor the classic peristaltic system, which slowly raises the flow rate and vacuum in response to pedal depression and/or tip occlusion. Others are accustomed to the "live vacuum" of a venturi system, which typically has a lag time on the order of 120 milliseconds between pedal movement and machine response. The Infiniti has an adjustable rise time of seven settings that span these response times. In fact, this system can function with a rise time that is faster than that which is available on any other machine. Surgeons should set the rise time to correspond with their own comfort zone, and they may adjust it thereafter as they wish. Noninvasive pressure sensor: It features a noninvasive pressure sensor that provides real-time vacuum information to the computer, making it possible to use higher vacuums.

TEAR SHEET - 5

Sterlization & Disinfection

Method	Achieves	Timing	Destroys	Advantages	Limitations	Power Source	Suitable for	Minimum Temperature
General autoclave	Sterlization	Approximately 45 minutes Follow manufacturer's instructions	Bacteria Spores Viruses Fungi	Low running cost Minimal maintenance Suitable for busy unit, Drying cycle present	Difficult to obtain spare parts in developing countries	Electric (single or 3 phase)	All metal instruments, Drapes Gowns, Dressings Toughened plastic, Glass	121^{0}C
Bench top autoclave	Sterilization	20 minute cycle	Bacteria Spores Viruses Fungi	Quick and efficient Small, bench-top size	High running cost Difficult to obtain spare parts in developing countries. No drying cycle, Sensitive to voltage fluctuations	Electric (single phase)	All metal instruments Toughened plastic, Glass	134^{0}C
Hot Air Oven	Sterilization	2 hours cycle	Bacteria Spores Viruses Fungi	Minimal maintenance Drying	Expensive, Slow, Instruments get extremely hot and cannot be used immediately, Must not be used in a confined space	Electric (single phase)	All metal instruments Toughened Glass	180^{0}C
Ethylene C_2H_4O	Sterilization	Follow manufacturer's instructions	Bacteria Spores Viruses Fungi	Bulk quantities Suitable for delicate items and items which must be kept dry	Very expensive, Dangerous, explosive, Carcinogenic Only suitable for large tertiary centres with appropriate facilities	Electric with C_2H_4O gas cartridges	Plastic eye Ophthalmic instruments and phaco probes Delicate tubing Vitreoectory Lenses	Varies with equipments used
Formalin	Sterilization	12 hours	Bacteria Spores Viruses Fungi	Low running costs Suitable for delicate items that are susceptible to rust, Cabinet can hold a large quantity of instruments, Usually readily available	Airtight containers required Irritant to skin, and eyes and if inhaled Gloves and eye protection advisable, Items must be rinsed in sterile water before use, Slow	Electricity for heat source if a large cabinet is used (eg: an adapted refrigerator not used for cooling)	All metal instruments Toughened plastic, Glass, Delicate tubing	Room temperature 20^{0}C Well ventilated
Ionising Irradiation	Sterilization	Follow manufacturer's instructions	Bacteria Spores Viruses Fungi	Bulk quantities Suitable for delicate items & items which must be kept dry	Usually only available and used by large manufacturing companies	Gamma rays	Needles Syringes Sutures Toughened plastic	
Boiling	High level disinfection	Minimum of 10 minutes	Bacteria Viruses Fungi	Low running cost, Quick and efficient, Easy to teach, Suitable for all situations, Minimal maintenance, Readily available	Does not kill spores, Blunts scissors and knives, Causes rusting of instruments	Electric (single phase) Gas Kerosene/ Paraffin Charcoal Wood	Heavy metal instruments, Plastic, Glass Needles, Sutures	100^{0}C

Method	Achieves	Timing	Destroys	Advantages	Limitations	Suitable
Glutaraldehyde 2%	Sterilization Disinfection	Sterilization in 10 hours Disinfection in 10 minutes Follow manufacturer's instructions	Bacteria Spores Viruses Fungi		Irritant to skin, eyes and if inhaled Gloves and eye protection advisable, May leave greasy residue Items must be rinsed thoroughly before use	All metal instruments Plastic Glass
Isopropyl alcohol 70% (Methylated spirit)	Disinfection	10 minutes The quantity used for soaking must be changed daily	Bacteria Spores Viruses (but not entero or adeno viruses)	Low cost Readily available Good for use on indirect ophthalmoscope lenses	Highly flammable Corrosive (do not leave metal instruments soaking longer than 10 minutes) Tonometry items must be rinsed and wiped before use Evaporates Does not kill enter or adeno viruses	All metal instruments Schiotz tonometer, applanation prism tip, Indirect ophthalmoscopy lenses
Sodium hypochlorite	Disinfection	10 minutes The quantity used for soaking must be changed daily	Bacteria Spores Viruses	Readily available at reasonable cost	Highly volatile and corrosive (do not use metal container to soak items) Bleach	Applanation prisms; only the tip of applanation prism should sit in solution and must be rinsed and wiped dry before use on the eye
Chlorhexidine	Disinfection	10 minutes The quantity used for soaking must be changed daily	Bacteria Spores Fungi	Low cost Readily available	Evaporates Does not kill viruses Blunts scissors and knives	Metal instruments Plastic, Rubber, Schiotz tonometer and applanation prism tip
Povidone iodine	Disinfection	10 minutes The quantity used for soaking must be changed daily	Bacteria Spores Viruses (but not entero or adeno viruses) Fungi	Low cost Readily available Versatile	Stains fabrics and surfaces Discolours instruments Solution is dark, difficult to see items in soak, Irritant to skin, Does not kill entero or adeno viruses	All metal instruments, Sutures, Blades

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