Ophthalmic Manifestations of Orbital Mycosis

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Orbital mycosis is a condition characterized by opportunistic infections, fungal in origin, that has the capacity to be potentially life threatening. Some of these fungi establish them-shelves in the body when the patient is immuno-compromised, uncontrolled diabetes being a very important cause and then spread rapidly throughout the body at a very fast pace. Some of the other fungi inhabit a body, which may not be necessarily compromised, remain indolent for a very long time and may cause non-specific symptoms, and then may rapidly spread whenever the body's immunity is compromised to a certain degree. It is very important for an ophthalmologist to have a high clinical suspicion of these conditions, so that effective treatment can be started early. This triage can at times be life saving.

The typical clinical features that characterizes these conditions are that of a painful, unilateral orbital apex syndrome causing total ophthalmoplegia, corneal anesthesia and multiple cranial nerve palsies (Figure 1). In addition, orbital cellulitis and ptosis may be present (Figure 2). The patient may have sudden loss of vision and under the setting of unilateral or bilateral central retinal artery occlusion, the chances of the patient having rhino-orbital mucormycosis is very high. In fact sudden onset CRAO with progressive ophthalmoplegia, associated with an altered sensorium (contributed both by the ketoacidotic status of the patient and the fulminant spread of the infection intra-cranially), can be considered to be the clinical hallmark of mucormycosis. The pupils may show a relative afferent defect in the early stage followed by a bilateral slowing of the pupil cycle time in the later stages. Anisocoria may set in subsequently, denoting compression of the third nerve somewhere along its pathway, either intra-cranially or in the orbit.

A high clinical suspicion of mucormycosis is of importance because the delay caused by investigations required to confirm the diagnosis by a biopsy or by imaging may result in the intra-cranial spread of the fungus and subsequent loss of life. It is a good idea in such cases to start treatment presumptively on the basis of the clinical findings and simultaneously perform the necessary investigations to confirm the diagnosis. This is one area where it is better to err on the side of over-treatment than under-treatment.

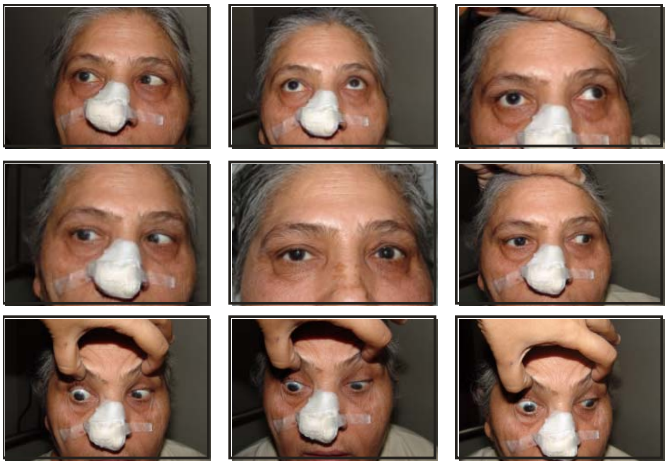

Fig. 1: Uncontrolled diabetic patient with sudden loss of vision due to bilateral CRAO. In addition, the patient demonstrated a right sided third nerve palsy. The sudden onset of the symptoms, in the background of the clinical setting, lead to a high suspicion of mucormycosis, for which the patient was subjected to an endoscopic biopsy. The MRI scan and CT scan of the patient (Figure 3) were corroborative. The timely clinical management lead to a relatively early arrest of the progressive condition, through the loss of vision remained permanent.

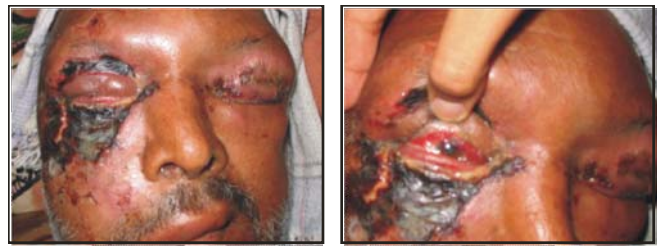

Fig.2: Another patient, with post traumatic reactive hyperglycemia, with extensive bilateral orbital cellulitis, bilateral complete ophthalmoplegia with ptosis and right sided facial nerve palsy. The patient had bilateral loss of vision due to CRAO. The black eschar over the eyelid is characteristic of Aspergillus Nigra. A superficial skin biopsy from the black eschar proved the presence of the same.

Details of rhinocerebral mucormycosis is elucidated below as follows:

Mucormycosis

Mucormycosis is a fungal infection with the organisms of the genera Mucor, Absidia and Rhizopus that are normally present in air, soil, vegetable matter, skin orifices, manure and bread mold.

Orbital mucormycosis is a severe debilitating condition mainly seen in immuno-compromised patients

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that can have devastating systemic fall-outs. Most patients have predisposing systemic disease; most typically the infection occurs in the diabetic patient with ketoacidosis but can also occur in patients with renal failure, gastroenteritis and lymphomas. Rarely it can occur in a normal host. An association between desferoxamine therapy for iron or aluminum excess and mucormycosis has also been described in patients of renal failure on chronic hemodialysis.

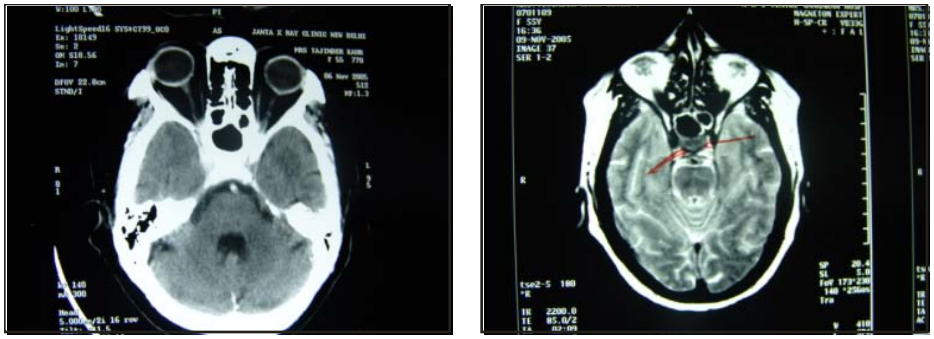

Fig.3: The CT scan and MRI scan of patient 1 demonstrating relatively clear orbits and ethmoidal sinuses but the presence of the fungal mass in the area adjacent to the cavernous sinus (thus producing the clinical signs suggestive of an orbital apex syndrome). This patient had rhino-orbital mucormycosis as proven after taking an endoscopic biopsy.

Rhinocerebral mucormycosis presents as rhinitis, a parapharyngitis, or a sinusitis and spreads by invasion of blood vessel walls, causing a necrotizing vasculitis with thrombosis of vascular lumina and infarction. The other clinical features have been elucidated above.

Mucormycosis can be complicated by gangrene of periorbital tissues as well as of hard palate and nose with an eschar like crusting. Obstruction of central retinal artery, ciliary and choroidal circulation can also occur.

Diagnosis

The diagnosis of mucormycosis is made on the basis of a high index of suspicion, based on the clinical setting and by obtaining specimens of nasal turbinate, sinus or infected orbital tissue. Large, branching non-septate will be readily apparent on Haemotoxylin / Eosin or methenamine silver staining. Hyphae can also grow on appropriate culture media.

CT of the head, the orbit and the paranasal sinuses usually shows sinusitis with or without bone destruction and will be indistinguishable from other causes of orbital cellulitis (Figure 3).

MRI of the brain and orbit may show carotid occlusion and/or absent flow in superior ophthalmic vein.

As mentioned above, the above features along with the clinical setting in which the patient presents should evoke a high clinical suspicion of the condition. This suspicion can be life saving.

Management

The treatment of mucormycosis involves control of ketoacidosis and other systemic disease. Sinus drainage must be attained.

Intravenous amphotericin B available as FUNGIZONE is administered I mg i.v. as test dose followed by a loading dose of 20 mg i.v. with increments of 10-15 mg at an interval of 2 hours. The total dose should not exceed 1.5-2 mg/kg/day.

Radical and aggressive surgical debridement of infected tissue including exenteration, if necessary is advocated. Debridement is important since local thrombosis caused by fungal invasion prevents amphotericin from reaching necrotic infected tissue.

Adjunctive therapies include

1) Hyperbaric oxygen 100% at 2.5 atmospheres for 90 minute for approximately 6 weeks
2) Local irrigation of orbital and sinus tissue with amphotericin B and
3) Intraconal amphotericin B

The prognosis for survival remains poor. Mucormycosis remains a fatal disease with a survival rate of only 14%. However with amphotericin B and debridement it has improved to the tune of 50%. This implies nonetheless that still a significant number of patients will die of this disease and emphasizes the need for early diagnosis and management.

There are certain other fungus that may be present in an immunocompetent host for a very long time and may be responsible for a very fulminant foray when the patient is immunocompromised. Some of these fungi are:

Aspergillosis

Aspergillosis is a fungus of the Ascomycetes class that is a ubiquitous organism that colonizes both the respiratory and gastrointestinal tract. It rarely causes infection except in the immuno-compromised host.

Patient profile & clinical features: Orbital aspergillosis has two characteristic presentations.

It can present in the immunocompromised patient as fulminant sinusitis and rapid progression into the orbit and cranium that produces a necrotizing vasculitis with necrosis of nasal, sinus mucosa and bone. Dissemination of infection can produce lung, liver and spleen invasion with an overwhelmingly poor prognosis despite local

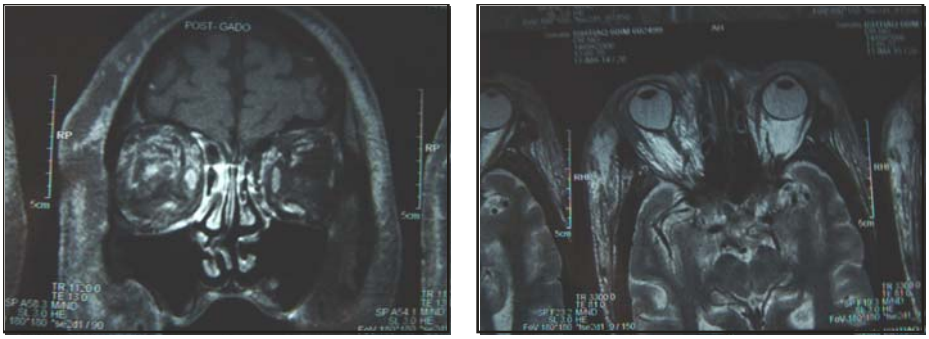

Fig.4: Gadolinium enhanced MRI scan of the patient shown in Figure 2 demonstrating heterogenous areas of contrast enhancement, within the thickened soft tissues of the scalp and eyelids on the right side of the face. There is evidence of right sided ethmoid sinusitis, enhancement of the retrobulbar tissues and the optic nerve on the right side, with distortion of the ocular walls. The above radiological findings co-related with the diagnosis of right sided facial and orbital cellulitis, endophthalmitis and optic neuritis. A skin biopsy, as mentioned above confirmed aspergillosis nigra.

debridement and intravenous amphotericin B. In some patients it can present insidiously with chronic erosion through most anatomic barriers and invasion through the orbital bones and cranium, producing both orbital signs and neurological sequelae.

Alternatively it can present in the healthy host in a non-invasive form. In these cases, a colony of organisms forms a fungal ball or mycetoma in a sinus and give rise to chronic sinusitis. This type of aspergillosis is more common in hot, humid climates. These patients will present with nasal congestion, postnasal drip and chronic sinus pain along with recurrent bouts of acute sinusitis. A mass is seen that arises from adjacent sinus that may have sclerotic margins and can produce an adjacent inflammatory reaction within the orbit. Mild proptosis / epiphora may be the only presenting symptom (Figure 5A). This form responds well to surgical debridement with restoration of normal sinus drainage and does not require systemic antifungal therapy.

Biopsy & imaging

Biopsy of the tissue within the orbit will show invasion of mucosa, submucosa and bone in cases of invasive fungal sinusitis or a granulomatous reaction without mucosal / bone invasion in noninvasive form.

Septate fungal hyphae of relatively uniform width apparent on routine Haemotoxylin / Eosin staining may not be evident in the noninvasive form.

Computed tomography in patients with both forms of disease will demonstrate areas that are almost metallic in density. These foci of irregularly calcified bone on CT may be pathognomic. On MRI, these areas appear bright on T1 weighted images and have decreased signal intensity on T2 weighted images that may be related to the presence of ferromagnetic materials such as iron and manganese within the fungal concretions (Figure 4, Figure 5 B).

Management

Treatment for aspergillosis in the immuno-suppressed patient is both medical and surgical with antifungal agents (amphotericin B) and radical debridement and sinus surgery. Flucytosine and rifampicin may have a synergistic effect.

Rhinosporidiosis

Patient profile: Rhinosporidiosis is a chronic granulomatous infection of the mucous membranes that usually manifests as vascular friable polyps that arise from the nasal mucosa or external structures of the eye. Initially described by Seeber, rhinosporidiosis is endemic in India, Sri Lanka, South America, and Africa. Most cases of rhinosporidiosis occur in persons from or residing in the Indian subcontinent or Sri Lanka. Most persons with rhinosporidiosis have had bathing or working exposure to stagnant water.

Rhinosporidiosis is an infection that is typically limited to the mucosal epithelium. Infection usually results from a local traumatic inoculation with the organism. Disease progresses with the local replication of *R seeberi*. The etiologic agent of rhinosporidiosis, *R seeberi,* traditionally has been believed to be a fungus. Recent 18S ribosomal ribonucleic acid (rRNA) gene analysis has placed *R seeberi* into a novel group of aquatic parasites of the class Mesomycetozoea, some of which cause similar diseases in

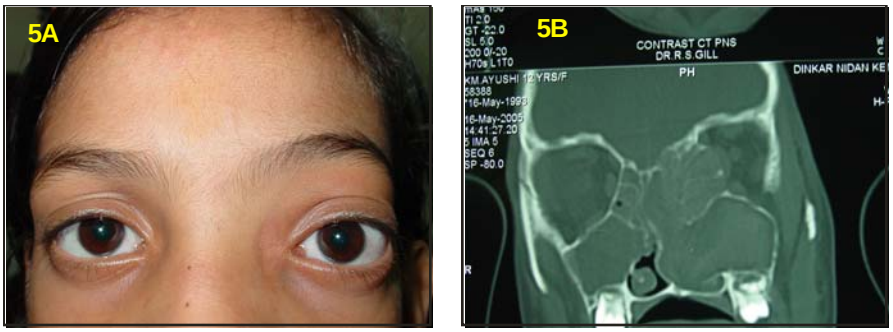

Fig.5A: A young patient with long standing epiphora and gradually increasing axial proptosis with fullness of face on the left side not affecting vision. Fig.5B: A bone free window of the CT Scan demonstrates the bilateral extensive sinus mass (in both the maxillary and the ethmoid sinuses) causing bony destruction, compression of the lacrimal drainage system on the left side (resulting in the epiphora) and progressive damage of the orbital walls on the left side. This slow, indolent clinical presentation is characteristic of orbital aspergillosis.

amphibians and fish.

Clinical features: Infection of the nose and nasopharynx is observed in 70% of persons with rhinosporidiosis while infection of the palpebral conjunctivae or associated structures (including the lacrimal apparatus) is observed in 15%.

- Nasal disease may present with unilateral nasal obstruction or epistaxis. Other symptoms may include local pruritus, coryza with sneezing, rhinorrhea, and postnasal discharge with cough. Patients often report a sensation that a foreign body is present in their nasal canal.
- Eye involvement initially is asymptomatic. Increased tearing may be reported as the disease progresses. Photophobia, redness, and secondary infection may occur
- Soft polyps may be observed on the nose or eye. These polyps are pink to deep red, are sessile or pedunculated, and are often described as strawberrylike in appearance. Since the polyps of rhinosporidiosis are vascular and friable, they bleed easily upon manipulation.
- This appearance results from sporangia, which are visible as gray or yellow spots in the vascular polypoid masses.

Diagnosis: is made by identifying the typical structures of *R seeberi* directly on microscopic examination. This includes examination of smears of macerated tissue or histology of prepared biopsy sections.

- The organism can be observed with typical fungal stains (eg, Gomori methenamine silver [GMS], periodic acid-Schiff [PAS]), as well as with standard hematoxylin and eosin (H&E) staining.
- Smears can also be observed with potassium chloride (KOH) preparation.

Medical Care: Rhinosporidiosis is not responsive to medical treatment. Anecdotal treatment of 3 patients with a course of Dapsone taken for a year has been reported, but no controlled studies have been performed. The treatment of choice is surgical excision.

Surgical Care: Local surgical excision is the treatment of choice. Recurrence has been reported with simple excision. Wide excision with electrocoagulation of the lesional base has been promoted to decrease recurrences.

Although mucor and aspergillus account for most of orbital fungal infections, other fungi have been sporadically reported to infect the orbit are:-

- Petriellidium (Allerscheria) boydi
- Curvularia fungus
- Scedosporium apiospermum
- Blastomyces dermatidis
- Histoplasma dubossi
- Sporotrichum scheki

The above was a very brief description of the different kinds of fungal infections that may be present in the orbit, the manifestations of which may vary between an innocuous presentation to one that is potentially life-threatening.

It is very important to remember that most of these fungi are opportunistic organisms and spread rapidly when the patient's status is compromised due to some reason.

Progressive ophthalmoplegia, often total is one of the most important clinical manifestations of the condition, followed by proptosis, ptosis and epiphora depending on the location of the fungal mass.

The carry home message is that clinical suspicion of a fungal infection whenever a patient presents with these symptoms and signs is of utmost importance.

Surgical management, both palliative and curative alongwith systemic antifungals is the mainstay of treatment.

Suggested Reading

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Lid Retraction

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Normal eyelids protect the globe from desiccation and trauma, exhibit specialized movement and allow for vision and movement of fluid bathing the cornea. The upper eyelid typically covers the superior cornea by 1 mm to 2 mm (Fig.1). Likewise, although there is individual variation, the lower eyelid typically sits just below the inferior corneal margin, at the limbus.

Definition

Lid retraction may be defined as abnormally high/ low lid position in primary position of upper/ lower lid respectively that exposes the superior/ inferior sclera (Fig.2). This implies that when either the upper eye lid is displaced superiorly, or the lower eyelid is displaced inferiorly, the patient is said to have lid retraction.

It is not exophthalmos, and is not as specific as a sign; since in addition to being caused by thyroid disease, it can also be caused by a state of arousal or as compensation for ptosis in the other eye.

Lid Innervation & Supply

The levator palpebrae superioris muscle is innervated by the third cranial nerve and Müller's muscle is innervated by the oculosympathetic system. A muscle equivalent to the superior Müller's muscle (Inferior Tarsal muscle) is found in the lower lid.

Vascular supply is by anastamoses of branches of internal and external carotid arteries, and lymphatic drainage by submandibular, parotid and anterior cervical lymph nodes.

Etiopathology

In the Upper Lid, the mechanisms of retraction could be due to:

- Overactivity or contracture of levator muscle (Specially in thyroid ophthalmopathy)
- Abberant or increased innervation of levator muscle
- Decreased inhibition of levator muscle
- Sympethatic hyperactivity of mullers muscle

In the lower eyelid,

- Fibrosis of the inferior rectus muscle/inferior tarsal muscle, exerting a retracting action to the lower lid via its capsulopalpebral head.
- In the cases of lower eyelid trauma and postsurgical trauma, intralamellar scarring or anterior lamellar shortening may vertically shorten the eyelid.

The other pathological factors in lower lid retractions are:

- Compromised support system
- Shrinkage of any tissue layer (skin / muscle/ retractor)
- Aging
- Overdone Transcutaneous blephroplasty

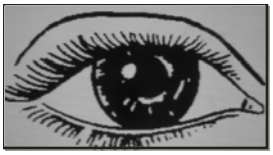

Fig.1: Normal position of upper & lower lid.

Fig.2: Lid retraction

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Classifications

On the basis of clinical findings, we can classify Lid retractions as:

- Mild /moderate/ severe
- Upper Lid/Lower Lid
- Unilateral/ Bilateral/ both

Published case reports subclassify eyelid retraction into three categories:

- Myogenic
- Neurogenic
- Mechanical

Other categories may be listed as follows:

- Congenital or aquired
- Transient or constant
- Apparent or fixed
- Inflammatory
- Traumatic
- Postoperative
- Involutional
- Metabolic
- Pharmacological

Inflammatory causes of lid retractions are:

- Thyroid eye disease
- Orbital pseudotumour

- Cicatricial conjunctival disease
- Chronic dermatitis

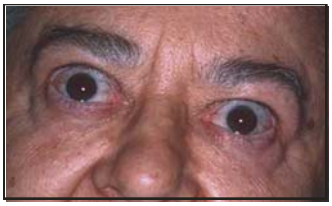


Fig.3: Thyroid Eye Disease

Thyroid eye diseases are most common cause of lid retraction seen in clinical practice. (Fig 3)

The mechanism for lid retraction in thyroid-related ophthalmopathy in Upper lid includes

- Levator muscle contraction from inflammation and fibrosis of the levator muscle.
- Levator adhesions to the orbicularis muscle and orbital septum
- hyperactivity of the sympathetic nervous system in hyperthyroidism with activation of Mueller's muscle
- Secondary overaction of the levator-superior rectus complex in response to involvement and tethering of the inferior rectus muscle.

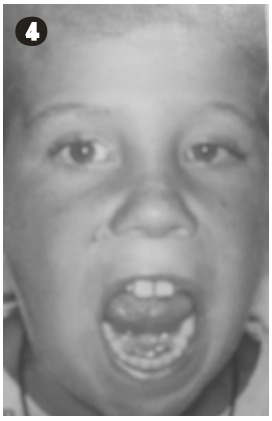
In the lower eyelid

Fibrosis of the inferior rectus/ inferior tarsal muscle, exerting a retracting action to the lower lid via its capsulopalpebral head, is the probable mechanism.

Involutional/ Congenital/ Neurogenic

Abberant regeneration of Third Nerve

- Acquired - Slow growing intra-cavernous aneurysm or meningioma can press upon the 3rd nerve. In acquired aberrant regeneration of 3rd nerve, lid may retract on attempted adduction, elevation or depression of the involved eye. Hence, the presence of primary aberrancy without 3rd nerve palsy should prompt cranial MRI with contrast MRI angiography.
- Congenital - Marcus gunn jaw winking phenomenon (Fig 4)- commenest form of trigemino oculo synkinesis



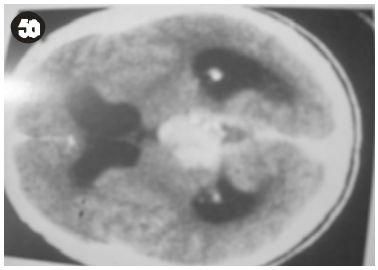


Fig.4: Marcus Gunn Jaw winking **Fig.5(a):** Pretectal syndrome **Fig.5(b):** Pineal tumour is demonstrated in a CT Scan of a patient with pretectal syndrome

Duane's syndrome (synkinetic lid retraction)

Midbrain lesion (pretectal syndrome) (Fig 5) -lid retraction mostly results from damage to supranuclear posterior comissure.

- Supraneuclear lesion (disinhibition of levator muscle,) vertical gaze palsies, light near dissociation of pupil, convergence retraction nystagmus, skew deviation. Collier's sign or post fossa stare,(bilateral lid retraction)
- Nuclear lesion (+/- lid syndrome) - ipsilateral ptosis, contra lateral eyelid retraction

Sympathetic overactivity -

- Claude Bernard syndrome- - cyclic spasm of pupil & lid retraction (associated with facial hyperhydrosis & headache)
- Anxious & psychotic pts

Facial nerve palsy

Myasthenia Gravis - the classical features are:

- Ptosis with contralateral pseudo retraction (Fig 6)
- Cogans lid twitch sign-transient lid retraction lasting seconds after a seccade from downgaze to primary position
- Transient lid retraction lasting seconds or minutes after either looking straight ahead or upward for several seconds possibly due to post-tetanic facilitation of the levator muscle

Rare causes - Parkinsonism, Fisher syndrome, Poem syndrome (peripheral neuropathy, organomegaly, endocrinopathy, M protein and skin changes)

Mechanical

- Prominent globes
  - high myopes
  - buphthalmos
  - proptosis
  - craniostenosis, paget'disease
- Cicatricial scarring of lid

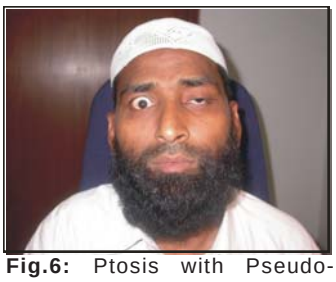


Fig.6: Ptosis with Pseudo-retraction

- Contact Lens wear / lost Contact Lens under eyelid
- Neoplastic(eyelid tumour)
- infection-herpes zoster ophthalmicus & scleroderma

Postoperative

- Blepheroplasty overcorrection
- Eyelid tumour resection & reconstruction
- Orbital floor fracture repair

- Inferior rectus recession
- Orbicularis myectomy
- Trabeculectomy with prominent bleb
- Catarct extraction
- Scleral buckle
- Frontal sinusotomy

Metabolic

- Cirrhosis liver
- Hypo/hyperkalemic periodic paralysis
- Uremia
- Cushing syndrome

Pharmacologic

- Sympathetic agents-phenylephrine.apraclonidine
- Corticosteroids

Traumatic

- Eyelid laceration
- Orbital floor fracture
- InferiorRectus disinsertion

Miscellaneous

- Optic nerve hypoplasia
- Down's syndrome
- Microphthalmos
- Essential hypertention
- Meningitis
- Sphenoid wing meningioma
- Lymphoma in superior cul de sac

Transient

- Normal infants-80% of normal infants (eye propping reflex)
- Preterm infants - due to immature myelinisation of extrageniculate visual pathway
- Maternal hyperthyroidism
- Dorsal mesencephalic lesions (collier's Lid retraction sign)
- Multiple sclerosis(third n fascicle involved)
- Bilateral episodic lid retraction in petitmal /myoclonic seizures
- Oculogyric crisis
- Voluntary/non organic finding
- Myasthenia gravis
- Post tetanic facilitation of levator muscles.

Clinical Evaluation

The evaluation of lid retraction should begin with a complete medical and surgical history. Prior infectious, inflammatory, metabolic (e.g., thyroid disease), neoplastic, and traumatic disease should be documented. A patient should be questioned regarding any previous eyelid, extraocular muscle, or orbital surgery.

A complete ocular examination should be performed including visual acuity, visual field testing, pupil examination (for anisocoria in light and dark, light and near reaction), motility examination, Hertel exophthalmometry, slit lamp biomicroscopy, IOP measurements, and ophthalmoscopy. The amount of lid retraction should be documented. Evidence for pseudoretraction should be elicited (e.g., hypoglobus, contralateral ptosis, myasthenia gravis). The absence of other localizing signs or symptoms should be documented (e.g., lack of anisocoria, lid scarring, dorsal midbrain signs, ophthalmoplegia). Mechanical etiologies can generally be excluded by a careful external and slit lamp examination. Motility examination should be performed to exclude aberrant regeneration of the third nerve and myasthenia gravis.

In clinical practice, the most common entities related to upper eyelid retraction are:

1. thyroid-related lid retraction
2. overcorrection from ptosis surgery
3. facial nerve palsy
4. traumatic disruption of the levator muscle with scarring.

In the lower eyelid, the most common entities are:

1. thyroid-related lid retraction
2. lower lid external blepharoplasty
3. external subciliary approach to blow-out fractures
4. traumatic lid disruption

Investigations

The presence of proptosis, lid lag, lid edema, or ophthalmoplegia with the retraction should prompt evaluation for thyroid eye disease. Laboratory testing (e.g., thyroid stimulating hormone) for systemic thyroid disease or a history of autoimmune thyroid disease (e.g., Graves' disease or Hashimoto's thyroiditis) may be confirmatory. Some patients with thyroid ophthalmopathy have no serologic evidence for thyroid disease. Thyroid autoantibodies may be useful in testing for euthyroid Graves' ophthalmopathy. Orbital ultrasound or orbital computed tomography may confirm thyroid eye disease(Fig 7).

Autoantibodies against various eye muscles membrane antigens are detected in 96% patients of lid

Fig.7(a): Patient of Thyroid eye Disease with Right eye axial proptosis **Fig.7(b):** Lateral view of the same patient with axial proptosis **Fig.7(c):** CT Scan of the same patient

retractions, but may be present in 20% of normal patients. 'A 64-K Da' membrane antigens is most specific for eyelid retraction

Mangement

The treatment of lid retraction should be aimed at the underlying etiology.

Botulinum toxin injection can be used to reduce the lid retraction in symptomatic cases (Fig 8).

Surgical treatment of the lid retraction may be useful for cosmetically unacceptable disease. If orbital decompression or strabismus surgeries are also required, then it is generally recommended that lid surgery be reserved for the final surgery as orbital decompression or strabismus surgeries may alter the position of the lid postoperatively

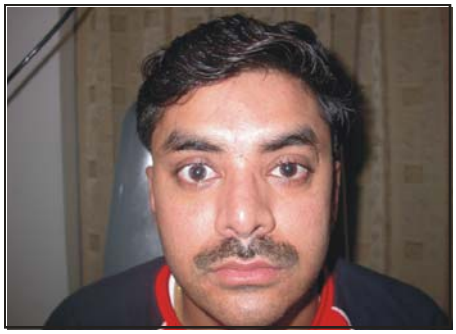


Fig.8(a): R/E Idiopathic Lid Retraction

Fig.8(b): R/E Overcorrection after Botulinum Toxin Injection

Fig.9(a): levator aponeurosis recession through external approach

Fig.9(b): Postoperative result

Surgical treatment

Prior to correction of lid retraction, the immediate treatment goal is to protect the cornea with preservative-free tear supplements, lubricatisng ointment or gels, punctal plugs, moist chamber shields and taping the eyelid during sleep.

The surgical approaches for treatment for dysthyroid eyelid retraction are classically divided into five groups, each of which is performed through an external or conjunctival approach (Fig 9):

1. Excision of Mueller's muscle
2. Levator aponeurosis weakening or recession
3. Excision of Mueller's muscle combined with levator aponeurosis weakening or recession
4. Marginal myotomy of the levator aponeurosis
5. Use of spacers such as tarsus, sclera, hard palate, ear cartilage, or AlloDerm (LifeCell, Branchburg, NJ), dermal fat graft, skin graft, SOOF (Subocularis ocular fat).

As a general principle for Upper Lid retractions:

- Up to 3 mm eyelid retraction, many clinicians suggest performing a graded Mueller's muscle resection.
- For larger amounts of lid retraction (3 mm to 4 mm), complete extirpation of Mueller's muscle, combined with stripping or recession of the levator aponeurosis or marginal myotomy of the levator aponeurosis and Mueller's muscle, with/ without adjustable sutures and interposition of spacers has been recommended.

For Lower Lid retractions

Though, no conclusive approach is present, the lower eyelid retractors may be approached through an infraciliary incision or conjunctival approach.

- For less than 2mm of retractions, recession of Lower Lid retractors is advised
- For larger retractions (>2mm), Lower Lid retractor lengthening may be done. This may be combined with implantation of spacers like ear cartilage graft, tarsal conjunctival grafts, hard palate grafts, or AlloDerm grafts between the tarsus and capsulopalpebral fascia with superior placement of the lateral canthal tendon. The purpose of the anterior superior placement of the lateral canthal tendon is to counteract the lower lid retraction and proptosis.

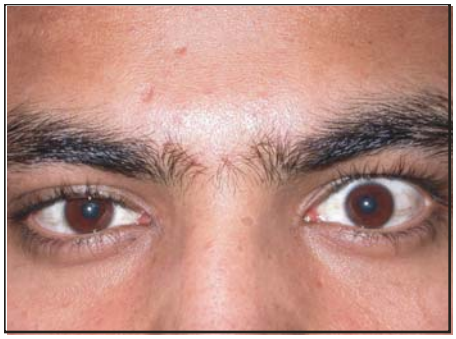


Fig.10(a): Left eye Lid retraction

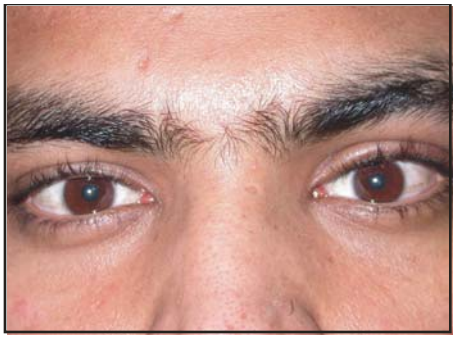


Fig.10(b): Postoperative

Other supplemented options may be:

- Mid face lift
- Augmentation of bony support below the eye

For retractions with other etiologies, the general surgical principles followed are:

- In traumatic scarring, excision of scar, and closure of healthy tissue
- Tissue transfer - Z plasty or VY plasty
- In ant lamellar shortening, release the scar and place full thickness skin graft
- Newer techniques still under development
- For facial nerve palsy - Mullers muscle excision and lateral tarsorhaphy. In greater degree of Lid Retraction, lid loading with gold weight, palpebral spring, temporalis muscle transfer, or levator recession.

A graded recession of levator-muller muscle complex, more temporal & central than nasal, leaving the orbital septum intact, severing all the fibrotic bands between Mullers muscle and conjunctiva, gives satisfactory outcome.

Photographs courtesy, Dr. R. Anand (Consultant, Sant Parmanand Hospital)

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Colour Vision Abnormalities & Occupational Requirements

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Colour vision testing forms an integral part of medical examination in various occupations. Colour deficient people report a range of colour related difficulties in every day life.[1] Exclusion from employment is made when the level of safety and efficiency, expected by employers and society out weighs the rights of an individual to fairness and equal opportunity to employment.

Colour recognition varies with the type and severity of colour deficiency.

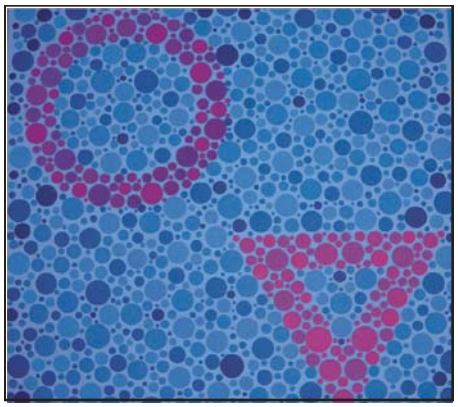

Fig.1: HRR plate for R-G colour defect.

Criteria for selection are laid down after determining the needs of the occupation.

Defective colour vision can be congenital on acquired. The acquired deficiency may occur as a result of ocular or general pathology, intracranial injury, or by the prolonged use of some therapeutic drugs.

The congenital colour deficiency is further classified depending upon the presence of cone pigments (Table 1). The prevalence of congenital red green colour deficiency is about 8% in men and between 0.4 to 0.5% in women.

The red green defects are transmitted as X linked inheritance and Tritan defects as autosomal inheritance.

Congenital and acquired colour deficiency differ in several ways (Table 2). Classification of acquired colour vision deficits was made by Kollner in 1912 (Table 3). Kollner's rule is described as stating that 'Defects of blue yellow vision are caused by retinal disease and defects of red green vision are due to optic nerve disease'. The notable exceptions are cone receptor dystrophies and dominantly inherited juvenile optic atrophy (DIJOA) where tritan defects are found.

Table 1: Classification of Congenital Colour Deficiency[2]

No. of colour matching variables	*No. of cone pigments*	*Type*	*Denomination*	*Discrimination*
1	None	Monochromat	Typical (rod) monochromat	None
1	One	Monochromat	Atypical, incomplete (cone) monochromat	Limited ability in mesopic viewing conditions
2	Two	Dichromat	(a) Protanope (lack red) (b) Deuteranope (lack green) (c) Tritanope (lack blue)	Severely impaired
3	Three	Anomalous trichromat	(a) Protanomalous (b) Deuteranomalous (c) Tritanomalous	Continuous range from slight to severe impairment

Clinical Test Design and Administration

John Dalton's coloured ribbon test was possibly the first clinical test for colour deficiency. Various tests now available are spectral anomaloscopes, pseudoisochromatic plates, hue discrimination and lanterns. The Ishihara Chart and Edridge green lantern are the recommended tests for most of the occupations in India.

Ishihara pseudo-isochromatic plates (Japan)

These are viewed at 2/3rd of a meter with 4 seconds the maximum time allowed for each plate. MacBeth easel

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Table-2: Differences Between Congenital and Acquired Colour Defeciency	
Congenital	*Acquired*
◆ Present at birth	◆ Onset after birth (after 3 months)
◆ Type and severity same throughout life	◆ Type and severity changes with time.
◆ Type of deficiency can be classified and diagnosed precisely	◆ Characteristics may combine those of more than one type of congenital colour deficiency
◆ Both eyes equally affected	◆ Monocular differences in severity frequently occur
◆ Binocular examination satisfactory	◆ Monocular examination is required
◆ Visual acuity normal (except in monochromatism), normal visual fields	◆ Reduced visual acuity and /or visual field deficits
◆ Predominantly red / green	◆ Predominantly tritan
◆ Increase prevalence Male	◆ Female=Male

lamp is an ideal illuminant. Illuminant should be equivalent to source C, incident at an angle of 450 to the plate surface. Ishihara test is a standard test for identifying red green colour deficiency. It is not designed to identify tritan deficit. The full or standard version of test has 38 plates (Table-4).

The American optical Hardy, Rand and Rittler plates (HRR) (USA)

They identify protan, deutan, tritan and 'tetartan' defects and grade their severity.

There are 24 plates with vanishing designs containing geometric shapes (circle, cross and triangle). There are 4 introductory plates, 6 for screening (4 R-G and 2 tritan), 10 plates for grading the severity of protan and deutan defects and 4 plates for grading tritan defects. (Figure 1)

Lantern Tests

Colour vision lanterns are vocational tests which employ colour naming. Different lanterns have been developed to fulfill national colour vision requirements for transport services and the armed forces.

Holmes Wright Type A lantern is used by the UK armed services and by the British Civil Aviation authority. There are 3 luminance settings and test can be carried out in normal room illumination or in the dark after dark

Table 3: Acquired Coloured Deficiency Classification		
Type 1 Red green	Similar to protan defect	Progressive cone dystrophies (e.g. Stargardt's disease), Chloroquine toxicity
Type 2 Red green	Similar to deutan defect but with reduction of relative luminous efficiency for short wavelengths	Optic neuropathy e.g. retrobulbar neuritis assoc. with multiple sclerosis), Ethambutol toxicity
Type 3 (tritan) blue	(a) Similar to a tritan defect but with reduction of relative luminous efficiency at both spectral (b) Similar to a limits tritan defect but with relative luminous efficiency to shorter wavelengths (Pseudo-protanomaly)	◆ Progressive rod dystrophies ◆ Retinal vascular lesions ◆ Peripheral retinal lesions (e.g. retinitis pigmentosa, diabetic retinopathy, Glaucoma) Macular edema (CSR, diabetic maculopathy, ARMD)

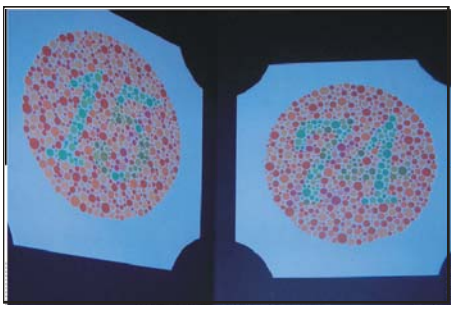

Fig.2: Ishihara chart- Screening plate with Transformation design.

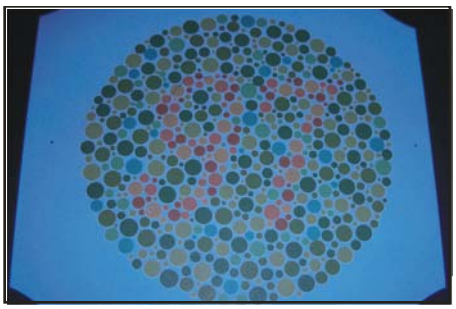

Fig.3: Ishihara chart- Screening plate with Vanishing design.

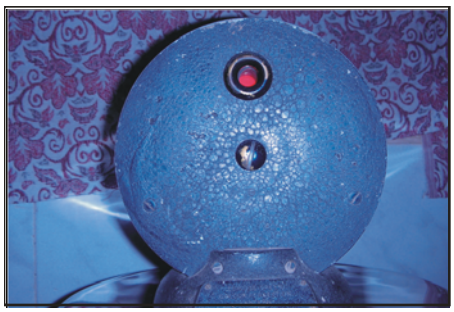

Fig.4: Edridge Green Lantern.

Table 4: 38 Plate Ishihara Test - Design		
Plates	*Function*	*Design*
1	Introduction	Seen correctly by all. Demonstrates the visual test. Identifies malingering
2-9	(Transformation) screening -figure 2	A number is seen by colour normals and a different number is seen by R.G. deficiency people.
10-17	(Vanishing)-figure 3	Number not seen by R-G colour deficient
18-21	(Hidden digits) screening	No not seen by Normals but seen by R.G deficient people
22-25	Classification of protan and deutan deficiency	Protans only see the number on the right side of each plate and deutans only see the number on the left. People with severe RG color deficiency, cannot see either number.

adaptation. In normal room illumination, the colours at high luminance are used. The subject is shown 9 pairs of colours 3 times and each pair is shown for 5 seconds[3].

Holmes Wright type B lantern is used by British Marine and Coast Guard Agency and Farnsworth lantern by US armed services.

Edridge Green Lantern (Figure 4)

It was introduced in 1891 to select railway workers. It has 5 rotating discs each with eight apertures. Disc 1 has different aperture sizes and disc 2, 3, and 4 contain filters. There are eight colours: two reds, two greens, white, yellow, blue and purple. Superimposition of filters can result in additional colours.

Careers and Occupations Known to Apply A Colour Vision Standard[4]

Normal colour vision

1. Commercial airline pilots
2. Air traffic controllers
3. Technical and maintenance staff at international airports
4. Aircraft pilots and engineers in the armed services

Table 5: Edridge Green Lantern-Colour Vision Grading		
Grade	*High grade of colour perception*	*Lower grade of colour*
1. Distance between the lamp and the candidate	16 ft	16ft
2. Size of aperture	1.3mm	13mm
3. Times of exposures	5 seconds	5 seconds

5. Naval officers on surface ships and all submarine personnel
6. Masters and watch keepers on merchant marine vessels
7. Customs and excise officers
8. Train drivers, railway engineers and maintenance staff
9. Workers in industrial colour quality assurance and colour matching
10. Workers in fine art reproduction and photography
11. Some electrical and electronic engineers

Slight colour deficiency acceptable

1. Firefighters
2. Police officers
3. Some electrical and electronic engineers
4. Some ranks in armed services
5. Hospital laboratory technicians
6. Merchant seamen

Colour Vision Standard in Railway Engineering by Ministry of Railways (India)[5]

The recommendations for 'satisfactory colour vision' constitutes recognition of signal red, green and white with ease and without hesitation. Both the Ishihara plates and Edridge Green Lantern are to be used for testing colour vision.

Colour perception should be graded into higher and lower grade depending upon the size of aperture in the lantern as described below:

For the Railway Engineering Services (civil, electrical, signal and mechanical) and other services connected with the safety of the public, high grade of colour vision is essential but for others lower grade is sufficient.

For the IPS and other Police services, Group 'A' and 'B', Indian Railway Traffic Service Group A posts in Railway Protection Force and for other Services concerned with the safety of the public, high grade of colour vision is essential. For IAS, IFS and other Central Civil Services Group 'A' and

Table 6: Vision Standards for Combined Medical Services (India)				
	Indian Railway Medical services (Technical)		*Services other than IRMS (Technical)*	
	Better eye	Worse eye	Better eye (corrected on)	Worse eye
1. Distant vision	With or without glasses upto ±4D6/9 or 6/6	With or without glasses upto ± 4D 6/9 or 6/12	6/6 or 6/9	6/12, 6/18 or nil
2. Near vision	With or without glasses upto ± 4D J1	With or without upto ± 4D J2	J1 J2	J2, J3 or nil
3. Type of correction permitted	Spectacles, IOL / corneal surgeries viz (LASIK, excimer etc.) may be permitted. Vision should be stable and should come up to the required standard. Ophthalmic board to clear fitness.		Spectacles, IOL, LASIK Laser surgery	
4. Limits of refractive error permitted	± 4D In case where power > -4D, a special ophthalmic medical board to clear the case ruling out pathological myopia		Fundus is normal and without pathological myopia	
5. Colour vision requirements	High grade colour perception (Ishihara and Edridge lantern 1.3mm aperture)		Low grade colour vision is acceptable	
6. Whether binocular vision needed	Binocular vision is necessary in case of squint. In deserving cases a special ophthalmic medical board to clear cases on case to case basis.		No	

Table -7: Colour Vision Standards in the UK Armed Forces	
Colour vision classification	*Standard*
CPI: Superior colour vision	No error on the Holmes -Wright A lantern at Low luminance in complete darkness at 6m (20 feet)
CP2: Normal colour vision	Army and RAF: Correct recognition of all the transformation and vanishing plates of the Ishihara test Royal Navy: correct recognition of 13 of the 16 transformation and vanishing plates of the 38 plate Ishihara test.
CP3: Slight colour deficiency	No errors on the Holmes - Wright A lantern at High luminance in complete darkness at 6m
CP4: Moderate Colour deficiency	Army and RAF: Unable to obtain CP3 Royal Navy: Correct recognition of coloured wires.
CP5 : Severe deficiency	Royal Navy only: unable to obtain CP4.
CP3, 45 determined after failure of the Ishihara plates	

'B' non technical lower, grade of colour vision should be considered sufficient.

Colour Vision standards in Road Transport

In India, at least low grade colour perception is required even for driving private vehicle.

In Europe, there are no colour vision standards for private vehicles but drivers of public service vehicles need to meet a colour vision standard and those of heavy vehicles have to pass Farnsworth D15 test.

Colour vision standards in armed forces

In the UK colour perception is determined in five categories in the Royal Navy and in four categories in the Army and RAF.

By and large Indian armed forces also applies similar standards of colour vison with some modifications.

In conclusion, while giving a career's advice, a screening test is used to establish whether colour vision is normal or abnormal. If abnormal, the severity is determined. It is not important to distinguish between a dichromat and anomalous trichromat but essential to classify protan and deutan deficiency.

The handicap experienced in performing practical tasks in descending order is protanopes > deuteranopes > protanomalous trichromats > deuteranomalous trichromats. Therefore, since colour judgement is an integral part of work in many occupations, colour vision testing can help matching the requirement of an occupation to different types and severity of colour deficiency.

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Selective Laser Trabeculoplasty

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OAG treatment concentrates on lowering the IOP to prevent damage to the optic nerve. The most common treatments for OAG have been the use of medications in the form of eye drops and laser treatments. Laser treatments and some medications allow for faster drainage, while other medications reduce the production of aqueous humor. If these methods fail to decrease IOP, conventional surgery may be required to create a new drainage channel.

Since medications and eye drops can cause undesirable side effects or simply fail to control glaucoma, and because patients frequently fail to take their medications, laser surgery may be a better alternative. The scientific data supporting the fact that a lower variation in IOP in the whole day can lead to a better preservation of visual fields has actually added a greater urgency to finding therapy other than the medications since medications are bound to be missed resulting in an inadequate diurnal control.

Lasers in open angle glaucoma

Laser technology first became available in the early 1960s. Its application to the anterior chamber angle structures solely for the purpose of reducing intraocular pressure (IOP) was described in the United States by Worthen and Wickham in 1973. Krasnov described a "micropuncture" technique using a Q-switched ruby laser in 10 patients with chronic open angle glaucoma (OAG). A temporary IOP reduction was noted in all patients. Ticho and Zauberman used argon laser directed at filtration apparatus to improve the outflow facility of glaucomatous eyes. In 1979, Wise and Witter reported moderate IOP reduction and few complications after argon laser irradiation of the trabecular meshwork (TM) in patients with OAG. Subsequently, argon laser trabeculoplasty (ALT) has been embraced as a treatment modality in eyes with medically uncontrolled OAG.

Over the years, investigators have modified their laser parameters in the hope of further maximizing therapeutic effects while minimizing adverse results. In 1995, a new approach to laser trabeculoplasty categorized by selectively targeting pigmented TM cells without producing mechanical and thermal damage to the adjacent tissue was introduced. This new treatment achieved with a wavelength of 532 nm Nd: YAG was termed selective laser trabeculoplasty (SLT).

Centre For Sight
B 5/24 Safdarjang Enclave,
New Delhi

Argon laser trabeculoplasty (ALT) is an established mode of treatment in OAG. In this technique, tiny, evenly spaced burns are made in the trabecular meshwork with an argon laser. These laser burns stimulate the drainage of aqueous humor. However, scarring of the trabecular meshwork occurs as a result of ALT burns, and may limit its success and the ability to retreat the eye should the procedure need to be repeated in the future.

Mechanisms of Argon Laser Trabeculoplasty

The lowering of IOP after laser trabeculoplasty is mediated by improved outflow facility, but the precise mechanism is still unknown. Two theories, the mechanical and cellular (biologic), attempt to explain the ocular hypotensive effect. According to the mechanical theory, laser trabeculoplasty improves the outflow of aqueous by photocoagulation of TM with widening of intertrabecular spaces in the adjacent nontreated TM. Laser photocoagulation produces coagulation damage to the TM with shrinkage of collagen elements, the inner trabecular ring, separation of trabecular sheets, opening of the aqueous channels between trabecular sheets, and traction on Schlemm's canal. The cellular theory of the ALT-induced IOP-lowering centres on the possibility that laser irradiation induces physiological changes in the trabecular cells such as migration of macrophages into the treated areas that ultimately debulk the extra cellular matrix. Van Buskirk et al first reported differences in glycosaminoglycan turnover, cell density, and cellular biosynthesis measured by S-sulfate incorporation in laser-treated autopsy eyes. Increased trabecular cell division after ALT has been demonstrated using tritiated thymidine uptake in a human organ culture system. Cell division at sites distant to the laser burns and migration of cells into the burn areas were also documented histopathologically. Other researchers reported that laser-treated TM cells have more phagocytic activity. They also demonstrated increased cellular division as well as alteration of extracellular matrix. Presumably, these changes play a role in improving aqueous outflow facility.

Selective laser trabeculoplasty (SLT) is an advanced type of laser surgery and approach to managing patients with OAG. Instead of generally burning tissue as in ALT, SLT selectively targets pigmented cells in the trabecular meshwork. Both SLT and ALT produce equivalent drops in IOP, however the more sophisticated SLT procedure does not have the associated damage to other tissues and adverse scarring effects. For this reason, where ALT is limited, SLT may potentially be repeated many times. SLT has also been found to be effective when ALT and other forms of treatment have failed.

Mechanisms of Selective Laser Trabeculoplasty

SLT is based on the principle of selective photothermolysis, which relies on selective absorption of a short laser pulse to generate and spatially confine heat to the pigmented targets. This is achieved using a Q-switched, frequency-doubled 532nm Nd:YAG laser The exact mechanism of SLT is not completely understood. Unlike ALT, which produces crater formation, coagulative damage, fibrin deposition, and disruption of trabecular beams and endothelial cells, SLT preserves the fine structure of the TM. The frequency-doubled Nd:YAG laser emitting 532 nm with a pulse of short duration (3 nanoseconds) and low fluency (energy/area) is designed to selectively photolyze pigmented TM cells without inducing collateral thermal damage. The relaxation time defines the absolute time required by a chromophore to convert electromagnetic energy into thermal energy. Melanin has a thermal relaxation time of approximately 1 μs, whereas the pulse duration of the SLT is 3 nanoseconds. This means that the pulse duration of SLT is too short for the melanin to convert the electromagnetic energy to thermal energy. No heat is released and this spares the surrounding nonpigmented tissues from damage. The lack of thermal and structural damage to the TM makes SLT potentially repeatable.

Difference in ALT and SLT Technique

During ALT, the spot size is set to 50 μm with a duration of 0.1 second and power ranges between 400 and 1000 mW. The Goldmann 3-mirror goniolens or Ritch lens is used to identify the angle structures. Burns are applied to the junction of the pigmented and nonpigmented TM. The spots are spaced approximately 150 μm (3 burns width) apart. Power is titrated to produce the appearance of a small bubble or blanching at the site of laser application. Some physicians elect to treat with 50 burns over 180° of TM, whereas others opt for 100 burns over 360°.[18, 22]

SLT uses pulse duration of 3 nanoseconds and a frequency-doubled, Q-switched 532-nm Nd:YAG laser with a spot size of 400 um. Laser energy levels are usually set between 0.6 mJ to 0.9 mJ. A Goldmann 3-mirror lens or Latina lens is used to focus the laser on the entire TM. Fifty spots are placed confluently over 180° adjacent to each other without overlapping. The energy should be reduced by 0.1 mJ if there is bubble formation or blanching reaction.

ALT vs. SLT

Features	*ALT*	*SLT*
1.Spots	50	50
2. Spot size	50m	400m
3. Energy	500 mW	1.0 mj
4. Fluence	40,000 mj/mm2	6 mj/mm2
5. Exposure Time	0.1 s	0.0000000003 s
6. Thermal Damage	Yes	No

SLT Treatment Protocol

- Pretreatment with an alpha-adrenergic antagonist and topical anesthetic
- Goldmann (or Latina) lens with 0 magnification is placed onto the eye with methylcellulose
- Aiming beam is focused on the TM so that the 400 micron spot cover the ENTIRE antero-posterior height of the TM.
- Most physicians set the laser at 0.6 mJ and then titrate up using 0.1 mJ steps until champagne bubbles are seen about 50% of the time. Significant tissue blanching is an indication to reduce energy unlike ALT treatment.
- Treatment consists of approximately 50 confluent laser applications to 180 degrees of the inferior TM.
- Topical Steroid or NSAID for 3-5 days
- IOP check 1 hour post Treatment
- Follow up : Day 1, Week 1, Month 1, Month 3, and every 3 months thereafter

Benefits of SLT

- Proven effective as Primary or Adjunctive Therapy for OAG
- Can be used in primary therapy instead of, with, in conjunction with, or for eliminating medications
- No side effects
- No patient compliance issues
- No medication costs
- No burning or scarring in the TM
- Bilateral response

Selective Laser Trabeculoplasty Conclusions

Tabak *et al* conducted a prospective randomised trial simultaneously treating one eye of a patient with SLT and the other with ALT. They found an equivalent decrease in IOP at 4 weeks (ALT n=17, SLT n=22) in both the groups. Longer follow up was not reported. Pirnazar *et al* conducted a retrospective study comparing ALT (27 eyes) with SLT (30 eyes) and found no difference in IOP drop at 1, 6, and 12 months post treatment.

ALT has been a standard therapeutic intervention in open angle glaucoma. The 5 year success rate with ALT is reported to be 50%, with a decrease of 6% to 10% per year. The drawbacks of argon gas laser, however, include high cost, large power supply system, large size, low electrical to optical efficiency, and plasma tube degradation with time. As a possible alternative to this laser a number of other wavelengths are being tested. The laser used in this study is a Nd:YAG laser, which is a solid state laser. It has the advantages of less cost, smaller size, longer duration, and high electrical to optical efficiency. Although a number of previous studies have been done using Nd:YAG laser trabeculoplasty in animal models and in human

glaucomatous eyes, these studies used Nd:YAG either in the continuous wave or free running mode with a wavelength of 1064 nm. SLT uses a Q switched, frequency doubled Nd:YAG (532 nm) which combines the advantage of solid state lasers with the emission of monochromatic green wavelength light. In this system, infrared radiation is filtered and only the visible component (532 nm) is used. This uses an effect similar to monochromatic argon green light (514 nm). An additional advantage of 532 nm laser over 1064 nm laser is that optical absorption by melanin increases with the decrease in wavelength, thus lower threshold energy is required for a similar effect.

Frequency doubled Nd:YAG laser with pulse of short duration and low fluence (energy/area) has been found in tissue cultures, to selectively target pigmented TM cells while sparing adjacent cells and tissues from collateral thermal damage. It may thus have the advantage of better maintaining the architecture of the TM compared with ALT. The exact mechanism of action of this selective laser trabeculoplasty is not known. However, since minimal mechanical damage is thought to occur, a predominately cellular theory has been proposed to explain an improvement in outflow facility. According to Hollo, following ALT, the uveoscleral meshwork is severely destroyed in the area of the laser spots and the surrounding collagen fibres are heat damaged. A membrane is formed by migrating endothelial cells, which covers the meshwork between the laser spots and is responsible for the late pressure rise and treatment failure after ALT. This endothelial membrane and thermal damage was not seen after 532 nm Nd:YAG laser trabeculoplasty. Noecker *et al* studied the morphological changes after SLT and ALT in human postmortem eyes. They found that there was no coagulative damage to the human TM after SLT compared with ALT. This may offer a theoretical advantage for treatment with laser or topical medications if needed in the future.

SLT uses a pulse duration of 3 ns compared with ALT which has a pulse duration in the range of 1 ms or greater. According to Latina and Park, at pulse duration between 10 ns and 1 µs energy is deposited within the target (pigmented TM cells) more rapidly than it can diffuse away, hence minimising damage to the surrounding non-pigmented TM cells. Hence with pulse duration of 3 ns, SLT selectively confines the energy to the pigmented cells, whereas in ALT, heat gets dissipated from the pigmented cells to the surrounding tissues, damaging the non-pigmented cells within the irradiation zone. One interesting observation in our study was almost nil to mild visible reaction on the TM in response to the SLT impacts. In contrast, after ALT there was a bubble formation or blanching seen. This may be the result of deeper tissue penetration of the Nd:YAG laser energy in comparison with argon laser energy, which is deposited near the TM surface.

This is also found that the anterior chamber reaction 1 hour post-laser was significantly greater in the SLT group than in the ALT group. A possible explanation for this may be the large spot size used for SLT 400 µm *v* 50 µm in ALT. The large spot size in SLT is used to maintain a low fluence (energy/area) which is essential for the selectivity of this laser. Because of such a large spot size, the laser beam probably has an effect on the pigmented cells not only in the TM but also in the ciliary body and surrounding iris. This may be responsible for the increased anterior chamber reaction.

An intriguing finding in patients with previous ALT there was a statistically greater drop in IOP after SLT than after repeat ALT. This could probably be explained on the basis that ALT may have a predominantly "mechanical" action while SLT may mainly have a "cellular" effect, thus adding an additional mechanism to further reduce the IOP.

In summary, SLT appears to be equivalent to ALT in lowering intraocular pressures in patients with open angle glaucoma. There is a slightly greater post-laser anterior chamber reaction at 1 hour after SLT. Interestingly, patients with previous failed ALT had a better outcome when treated with SLT *v* ALT. These results are encouraging and suggest that SLT should be investigated further as an IOP lowering treatment in open angle glaucoma, especially in patients with previously failed ALT. Nevertheless these results need to be verified with a phase III clinical trial.

Indian Experience

The Indian experience spread over various regions report a success of around 75%.

The percentage of patients who are able to be controlled by medicines less than they were using before or are able to get off medicines, vary in various studies personally communicated to me from our Indian friends who all have a maximum exposure or follow up of about 6 months, from 50% to 75%. Our own study has values similar to these.

However the most significant advantage is that it does not cause any major side effect and is easily repeatable. The average amount of IOP lowering expected in these cases is around 5-7 mm.

Overall Indications of Performing SLT

1. NEWLY diagnosed open angle glaucoma
2. Patient of open angle glaucoma not controlled on maximum medications
3. Patient of OAG who wants to reduce medications
4. Secondary glaucoma to be treated with caution as they may not be so effective and they may have a spike of IOP.

The need of the hour is to watch the long term use of this procedure carefully as it may not go the same way as the ALT which did control the IOP for a year or so but the effect waned later. Overall I would say that it is an exciting new opportunity and one would use it judiciously in the beginning till the long-term results are clear in the Indian population.

Bimanual Microincision Cataract Surgery Combined with Trabeculectomy – A New Technique for Combined Surgery

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Both glaucoma and cataract are diseases with an increasing prevalence with age, and thus one often finds that they are coexistent in the elderly patient population. The association of glaucoma with cataracts has become more frequent because of increase in life expectancy and the increased risk of cataract development in the patients with glaucoma. The presence of cataract can affect the ability to assess glaucoma progression, and cataract extraction affects the intraocular pressure and effectiveness of glaucoma surgery. On the other hand, glaucoma surgery significantly increases the risk for the development of cataracts. For this reason, and to reduce the trauma induced by two surgical procedures, the prevailing trend is to perform a combined procedure, taking care of both pathologic conditions[1]. Recent developments in bimanual small incision phacoemulsification, the latest improvements in trabeculectomy, the increasing use of intraoperative antimetabolites in the form of Mitomycin C (MMC) and implant drainage devices have favored this trend for doing a combined surgery.

The goal of treatment in a glaucoma patient with cataract, is to achieve an adequate long-term control of intraocular pressure (IOP), avoid postoperative IOP spikes which are deleterious to the health of the optic nerve head, obtain an optimal visual rehabilitation and improve the quality of life of the patient. All these need to be done with the least amount of surgical trauma and least risk and cost savings for the patient with the use of the combined procedure.

Evolution of various techniques for the combined procedure

Both the cataract and filtering surgery was initially started as large incision extracapsular cataract extraction on either side of the scleral flap, then with the evolution of small incision surgery, phacotrabeculectomy or in combination with manual small incision cataract surgery (SICS trabeculectomy). The use of single site for the combined procedure is usually associated with increased post operative inflammation[2] which can be detrimental to bleb function and hinder adequate control of IOP in the patient. This led to the development of 2 site phacotrabeculectomy with the superior incision being used for the filtering procedure while the cataract is removed from the temporal clear corneal incision. Nowadays the more commonly used procedure is the 2 site phacotrabeculectomy[2] which usually achieves the dual function of visual rehabilitation as well as long term IOP control in the glaucoma patient. The advent of phakonit[3,4] saw the cataract surgery to be performed via 2 paracentesis incisions alone but the lack of development of IOLs that could be inserted through such small incisions did not saw the procedure becoming more popular among ophthalmologists. The advantage of microincision cataract surgery in reducing the cataract incision size to 1-1.2 mm via 2 paracentesis incisions enabled us to undertake the combined procedure from the same site. The incision size has been directly correlated to the disruption of blood aqueous barrier and post operative inflammation which can lead to bleb fibrosis.

Glaucoma patient- special considerations

The glaucoma patient needs more thorough pre operative evaluation than the cataract patient with certain special needs that should be a regular part of the preoperative evaluation to optimize visual function as well as IOP in the post operative period. Evaluation of the ongoing medical therapy, diurnal IOP control on medication, corneal endothelial count, gonioscopy, stereoscopic disk evaluation and visual fields (if possible) is mandatory. Conjunctival inflammation due to topical drug therapy, a low corneal endothelial count[5], miotic pupil, poor response to mydriatics, posterior synechiae, weakened zonules (esp. in eyes with pseudoexfoliation) and the raised IOP are some of the important factors which increase the degree of difficulty for the surgeon and may be responsible for a poor postoperative outcome. The decision to do a cataract surgery alone, or a combined procedure or to do a filtering surgery alone is decided by evaluation of the following factors:

- IOP control on current treatment
- Required target IOP for the patient
- Number of medications needed to achieve target IOP
- Extent of glaucomatous damage (disk and visual fields)

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- Compliance to medical therapy
- Allergic reactions/significant side effects of topical therapy
- Socio economic status of the patient
- Access to medical care facilities
- Effect of disease on quality of life of the patient.

When to undertake combined procedure

Careful case selection prior to undertaking the patient for combined procedure is important. Indications for a combined procedure include[6]:

- When in spite of maximal tolerable topical medical therapy and/or laser trabeculoplasty, glaucoma control is poor in a patient with mild/moderate glaucoma.
- When the patient does not tolerate the medical therapy or is not compliant.
- When the patient cannot afford long-term medical therapy.
- Advanced glaucomatous damage which cannot tolerate postoperative IOP spike.

Combined surgery is best avoided in patients with secondary glaucoma, extensive conjunctival scarring, normal pressure glaucoma, advanced glaucomatous optic neuropathy and previous failed trabeculectomy.

Special surgical considerations

Drugs such as pilocarpine and prostaglandin analogs must be stopped atleast 2 weeks prior to the surgery. All these cases should be done under peribulbar regional anesthesia because of prolonged surgical time and increased intra ocular manipulations expected in these patients. The surgeon should arrange for iris hooks which are often required for intraoperative pupillary dilatation, especially in eyes with primary angle closure glaucoma and endocapsular rings should be kept handy if surgery is being planned in a case with pseudoexfoliation syndrome. In patients with glaucoma, the corneal endothelium is already compromised. One should be prepared to handle a non dilating pupil either mechanically with iris hooks or multiple small sphincterotomies, or stretch pupilloplasty using 2 sinskey hooks or viscomydriasis using viscoadaptive or viscocohesive substances like Healon GV (14mg/ml Sodium Hyaluronate). A dispersive viscoelastic device such as chondroitin sulfate or viscoadaptive like Healon 5 (23 mg/ml of sodium hyaluronate) should be used to maximize corneal endothelial protection. In addition BSS plus with glutathione may be used to maintain integrity of the endothelial cells during surgery. During the course of cataract surgery, care should be taken to completely remove any viscoelastic used. Retained viscoelastic can cause significant intraocular pressure spikes in the immediate postoperative period which may further compromise a glaucomatous optic nerve. One may need to go behind IOL[7] to completely aspirate the viscoelastic especially Healon 5 and one might need to increase the aspiration flow rate to fully aspirate the same. These patients should be put on ocular hypotensive therapy in the postoperative period to prevent any post operative IOP spike.

MICS Trbeculectomy- Surgical technique

The technique for bimanual MICS combined with trabeculectomy was first described by the authors (Dada et al, BMC Ophthalmol. 2006 Mar 19;6:14) and is as follows:

A corneal traction suture (8-0 vicryl) is passed at 70-80 percent corneal depth and the suture is secured with an artery clamp to pull the globe downward (fig 1). 3 clock hours of limbal peritomy is done to fashion a fornix based conjunctival flap. Mitomycin C in a concentration of 0.2-0.4mg/ml is applied diffusely (fig 2) in the subconjunctival space using 3-4 small Merocel wicks and then washed off copiously after 3 minutes of contact time. A partial thickness scleral flap is fashioned with the use of a sharp blade, the base of which should be 5 mm in length. The flap should be 50% scleral thickness and should come upto 1 mm into anterior clear cornea (Fig 3, 4). Two 1.2 mm clear corneal side port incisions (fig 5) are made at 10 o' clock and 2 o' clock with a MVR knife. Air is injected into the anterior chamber followed by 0.1 cc trypan blue (0.06%) under the bubble (fig 6). The dye is washed off and the chamber filled with viscoelastic. A 20 G vitreo retinal forceps is used to perform capsulorhexis and with the other hand viscoelastic is continuously injected (bimanual capsulorrhexis)[8] (fig 7) and gentle hydrodissection is then performed. An irrigating chopper or an irrigating cannula

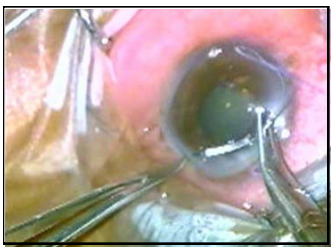

Fig.1: Corneal traction suture

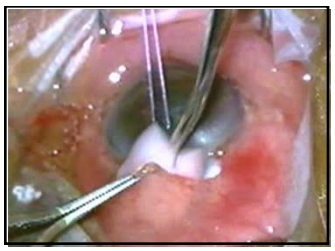

Fig.2: Subconjunctival MMC application

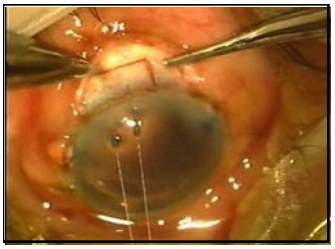

Fig.3: Partial thickness scleral flap creation

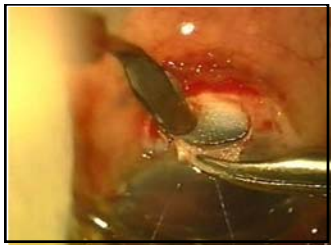

Fig.4: lamellar scleral flap dissection

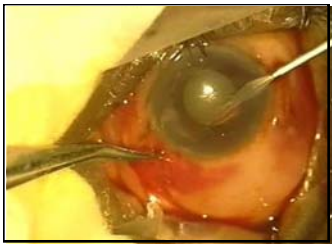

Fig.5: 1.2 mm paracentesis incision

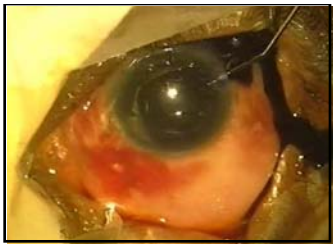

Fig.6: Capsule staining with trypan blue

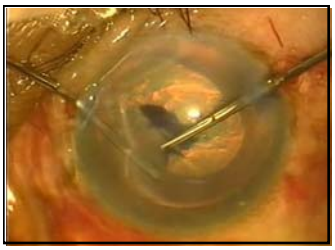

Fig.7: Bimanual capsulorhexis

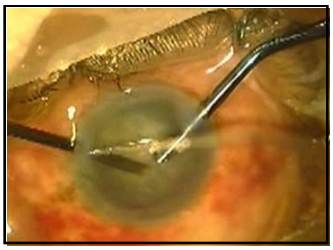

Fig.8: Bimanual phaco being performed

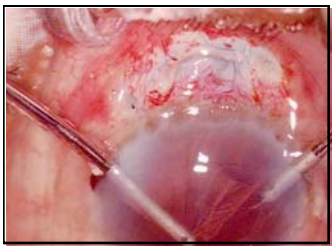

Fig.9: Bimanual IA

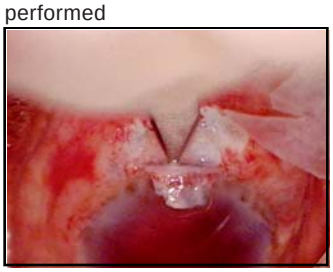

Fig.10: 2.75 mm microkeratome entry

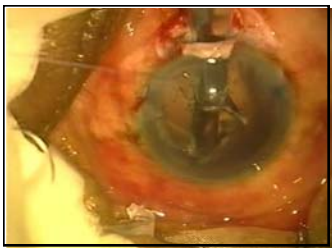

Fig.11: Foldable IOL insertion through trabeculectomy fistula

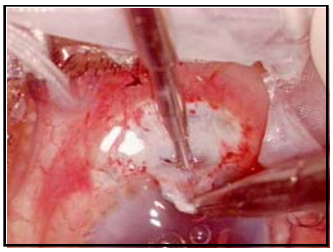

Fig.12: Trabeculectomy with Kelly's Descemet's punch

is inserted via the 2 o′ clock port and then a sleeveless 20 G phaco tip is inserted through the 10 o′ clock port (fig 8). The infusion is maintained with two bottles of balanced salt solution connected together via a "Y" shaped tubing to increase the infusion (TURP tubing- trans urethral resection of prostate) raised upto 140 cm. One can also use an air pump connected to the infusion bottle or an anterior chamber maintainer to prevent any surge. Bimanual phacoemulsification is then performed (fig 8) using standard stop and chop/ phaco chop nucleotomy technique. The two important points to note are that the wound with the phaco tip needs to be constantly irrigated (fig 8) to prevent a thermal burn or this can be achieved by cutting the phacotip sleeve into half so that the irrigation directly falls onto the wound site. A hyperpulse mode[9] that does not generate heat with a 30:70 (30% on and 70% off time) duty cycle is preferred at phaco power 20-40%, vacuum of 100-150 mmHg, bottle height 110-140 cm. An important thing to remember is that the phaco needle has to be withdrawn from the corneal paracentesis wound prior to the chopper because irrigation into the anterior chamber is coming via the chopper and not the phaco handpiece. This may create difficulty in the initial learning period as this step is exactly opposite to the conventional teaching in conventional coaxial phacoemulsification. The cortical matter is removed with a bimanual irrigation aspiration handpiece (fig 9). After cortical removal, viscoelastic is injected into the anterior chamber. A 2.75 mm keratome is used to enter the anterior chamber under the previously outlined scleral flap (fig 10). A standard hydrophobic acrylic foldable IOL can then be inserted into the capsular bag through this incision using a holder and folder or an injector system (fig 11)). The scleral flap is then elevated and a 2 × 2 mm fistula made with a Kelly's Descemet's punch (fig 12, 13). An iridectomy is performed (fig 14) and the scleral flap closed with 10-0 monofilament sutures. The IOL can also be inserted through the opening created by the punch. Viscoelastic is removed from the anterior chamber and the capsular bag using bimanual irrigation aspiration via the two side ports (fig 15). The final appearance at completion of surgery after reforming the anterior chamber with sterile air is shown in fig 16. One can also use the 4 throw adjustable suture technique[10] to close the scleral flap using 10 0 monofilament nylon as an alternative for post operative titration of the bleb function at the slit lamp. The fornix based flap is finally brought down and hitched to the peripheral cornea using two 8-0 vicryl sutures. One can also assess the bleb function by injecting trypan blue into the anterior chamber and looking for the staining of the bleb[11] to provide an

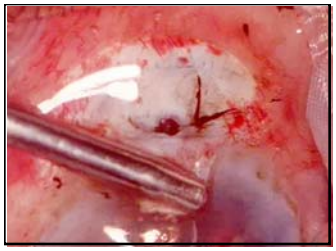

Fig.13: Trabeculectomy ostium

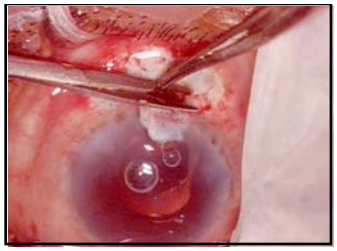

Fig.14: Peripheral iridectomy

Fig.15: Bimanual viscoelastic aspiration

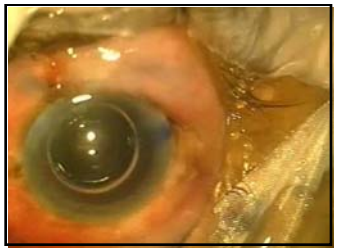

Fig.16: Final appearance with diffuse bleb

intraoperative clinical tool to assess filtration adequacy (fig 16). The surgery is concluded by sub conjunctival injection of dexamethasone 4 mg, gentamycin and atropine 0.1mg. Postoperative regimen includes 1 per cent prednisolone acetate eye drops (6 times/day), 0.3 per cent ciprofloxacin eye drops (4 times/day) and 1 per cent tropicamide (bid).

Advantages of using Mics Over Conventional Phacoemulsification

Traditional phacoemulsification studies report an endothelial cell loss of 8 to 10%, compared with preliminary studies that show less cellular loss when MICS is used. Tsuneoka et al[13] had analyzed 637 eyes that were operated on by the bimanual cataract technique, with a 1.4 mm clear corneal incision and observed a mean endothelial cell loss of 7.8% with different cataract grades. These data were obtained using conventional ultrasound without the actual micropulsed system ("cold phaco"), which in theory reduces the total energy used and results in less tissue trauma and less endothelial cell loss. Verges et al have observed similar results when MICS was used with a third continuous irrigation site: 6.9% endothelial cell loss, or with two incisions with an appropriate irrigating chopper, 4.5% endothelial cell loss. In a recent specular microscopic study comparing head on the MICS with coaxial phacoemulsification by Mennucci R et al[14] in 80 eyes using the standard stop and chop nucleotomy in both the groups, there was no statistical difference in the amount of corneal endothelial loss in MICS when compared to coaxial phacoemulsification. Total ultrasonic energy is one main factor inducing inflammation during cataract or combined surgery. Because of new systems, MICS techniques reduce considerably the amount of energy used, and the phacoemulsification needle does not increase the temperature. There is less tissue trauma and less inflammation. Actual data show that conventional phacoemulsification obtains 3 to 6 seconds of effective phaco time compared with the MICS technique, which obtains a mean effective phaco time of less than 3 seconds.

Hydrodynamic flow in the anterior chamber is one main factor in endothelial damage and inflammatory reaction. The total fluid volume used during phacoemulsification was different when MICS and conventional phacoemulsification were compared. The mean total volumes were 161.38 mL in the MICS group and 211 mL in the conventional phacoemulsification group for a similar cataract hardness of 4+. Also, MICS has less chamber fluid leakage, and turbulence is therefore reduced in comparison with the conventional technique, resulting in less endothelial cell loss and lower postoperative corneal edema. Therefore, lower fluid volume use during surgery, less turbulence, and better followability result in less tissue trauma. In combined glaucoma and cataract surgery, surgical trauma is one of the major risk factor in failure; hence, MICS may be considered a better option than standard phacoemulsification.

Another major advantage of MICS trab over 2 site phacotrabeculectomy is the fact that the surgeon can perform both the procedures superiorly without having to make intra operative adjustment for the sitting position, operating microscope, surgical instruments etc as in 2 site phaco trab thereby reducing the surgical time.

The third advantage is that the conventional hydrophobic acrylic foldable IOLs with a good track record in coaxial phacoemulsification can be implanted via the scleral ostium thereby preventing the paracentesis incision to be enlarged for implanting these IOLs. The IOLs which have come up in recent times for MICS (ultrathin rollable IOLs) have yet to convincingly demonstrate their efficacy in retarding the PCO formation in the long term.

Disadvantages of MICS

Every procedure carries along with it its unique sets of difficulties and disadvantages too. This is also true for MICS. There is an initial learning curve involved by being able to undertake capsulorrhexis with a needle or with vitreo retinal forceps. The rhexis in these cases becomes more difficult due to less space available due to crowded anterior segment, convex lens surface, small pupil and positive vitreous pressure, not to mention the small palpebral apertures in chronic angle closure patients. Intra operative shallowing of the Anterior chamber always remains a possibility due to less amount of inflow being coming from the irrigating chopper though this has now being taken care of by the use of a gas forced infusion system or the use of a separate anterior chamber maintainer during the surgery. There are also increased chances of corneal wound burn especially if phaco power is used in the continuous mode. This has now been taken care of by the newer generation phaco machines which allow phaco power modulation via the burst/ hyperpulse strategy to reduce the overall phaco time as well as allowing the phacotip to cool down in between the pulse to prevent corneal wound burn. Micro-coaxial phaco and Aqualase surgery combined with trabeculectomy may offer alternative and better surgical outcomes in the future as compared to bimanual MICS.

Conclusions

The technique of combining MICS with trabeculectomy and insertion of a foldable IOL through the trabeculectomy fistula is a feasible and valuable technique[12] for cases which require combined cataract and glaucoma surgery. Further long term studies with regard to the efficacy and safety of the procedure are required both in regard to IOP control, bleb function and visual

acuity as this procedure becomes the standard of care for this subset of challenging cases.

Future directions

The future will witness the development of foldable/ rollable IOLs capable of being inserted via sub 1 mm incision to truly reap the advantage of MICS. The progress in phaco power modulation[9], laser phacoemulsification and aqualase technology will no doubt make MICS increasingly popular in the foreseeable future.

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Management of Sub-luxated Lenses-An Overview

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Sub-luxation signifies partial displacement of the lens from its central position in the pupil (Fig1).

Ectopia Lentis) may occur as an isolated ocular finding (Simple Ectopia Lentis) or it may be associated with systemic disorders like Marfans syndrome & its variants, Homocystinuria, Weil-Marchesani syndrome, Spherophakia, Atopic dermatitis, Hyperlysinemia, Ehlers Danlos syndrome, & Sulfite Oxidase deficiency[1]. It has also been reported in association with ocular disorders such as Ectopia Lentis et Pupillae, Congenital Glaucoma, Aniridia & Megalocornea[2].

Trauma, Pseudo-Exfoliation, High Myopia, Hypermature Cataract, Syphilis, Ectasias, Glaucomas, previous Scleral Buckling surgery, and Staphylomas contribute to the group of "acquired" Sub-luxations.[3] Iatrogenic subluxation following zonular dialysis, detected intraoperativly, is another important and common cause of acquired subluxation.

Zonules are composed of Cystiene rich Glycoproteins, the chief component being Fibrillin. Poor secretion of Zonular Fibrils, Cystiene Deficiency or a Fibrillin gene defect are some of the theories to explain the Zonular weakness in Congenital diseases whereas excess Zonular stretching, Zonular damage and weakness occur in the Acquired Sub-luxations[3].

Search for Cause

A thorough clinical examination including a full cycloplegic refraction, slit lamp examination and a dilated fundus examination should be performed at presentation to assess the extent of Sub-luxation and decide on the treatment approach. Intra-Ocular Pressure (IOP) measurement & Gonioscopy examination are to be done, to rule out any associated Glaucoma, which is common in cases of Sub-luxations with a pupillary block. Anterior segment Ultrasonographic-bio-microscopy is a useful investigation to accurately view the extent and site of Zonular deficiency. Typical ocular signs to look for are irregular red reflex, Iridodonesis, Phaco-donesis, high Refractive error, displacement of central "Y" sutures of the crystalline lens, visualization of the lens edge and Zonules, and a relatively deep or an irregularly deep anterior chamber.[1]

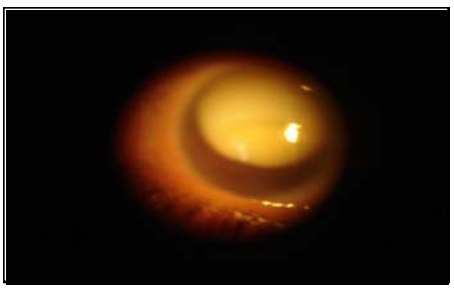

Fig.1: Morgagnian cataract subluxation with aniridia

A search for the systemic etiology of the Sub-luxation is important in managing a case. A thorough family history sometimes, points to genetic/ hereditary etiologies. A complete cardiovascular checkup including echocardiography, and in some cases Aortography may be needed. In symptomatic cases musculoskeletal evaluation rules out associated connective tissue disorders. Sodium nitroprusside test (in urine) for Homocystinuria, FTA-ABS for syphilis are some of the other investigations to be kept in mind. Thromboembolic episodes during general anesthesia can be prevented by anticoagulants if homocystinuria is diagnosed pre operatively.[4]

Management in "Clear" Sub-luxated lens

Medical management

- A minimally Sub-luxated clear lens requires only observation if the patient is asymptomatic. A significantly Sub-luxated lens causes visual disturbances due to induced refractive errors, usually an irregular astigmatism, or a myopic shift caused by a loss of Zonular traction & forward Sub-luxation.

The management includes- a complete refraction, recording of the uncorrected and best corrected visual acuity (dynamic, & under full cycloplegia), observation of the undilated central papillary position especially noting the size of phakic and aphakic gap, & the preferred visual Axis. Appropriate Spectacle correction, aphakic glasses, contact lenses (especially in unilateral Sub-luxations), or prisms can be prescribed. Partially occluding contact lenses can also be given to occlude the phakic or aphakic part, as needed.

- Medical intervention can be in form of cycloplegics to enlarge the aphakic part or miotics to minimize diplopia and decrease the pupil aperture. *Miotics pose the danger of pupillary block and should be used with caution.*[4]
- Laser therapy in the form of Argon or Nd Yag optical iridotomy / iridoplasty may be used to enlarge the aphakic part. Nd Yag zonulolysis to further displace the lens to enlarge the aphakic gap has also been suggested. Complications like iritis, increase in intraocular pressure, lens damage, dislocation or remigrations should be kept in mind with these laser procedures.[2]

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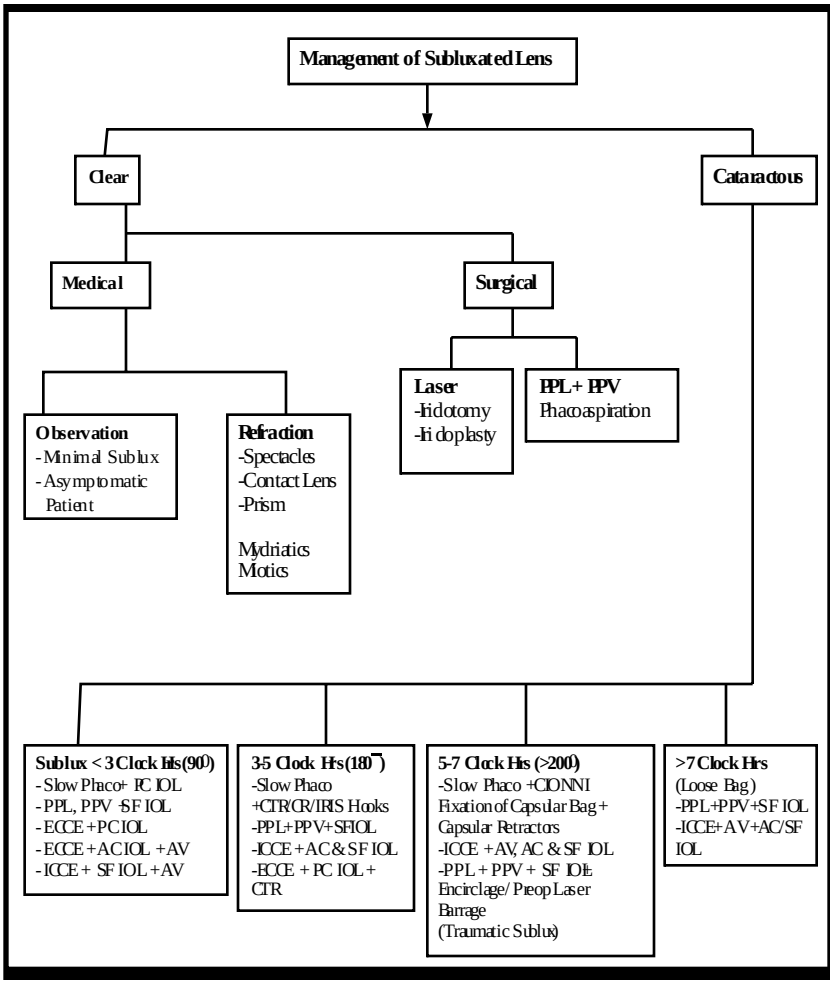
Surgical management

Surgical removal of the Sub-luxated/ Dislocated lens is indicated in:

- Unsatisfactory visual correction (when the above measures are unsuccessful),
- intractable secondary glaucoma,
- irregular high astigmatism ,
- intolerance to contact lenses

Lensectomy (Pars Plana route/ Limbal route)

The choice of modality may depend on the age at presentation & the degree of Sub-luxation. The surgical approach is usually an automated Lensectomy using either the Pars Plana or a Limbal approach, combined with anterior Vitrectomy. A Pars Plana Lensectomy is preferred over a Limbal route for lens extraction. There is always the danger of posterior dislocation during Limbal extraction, with subsequent complications. Children less than 2 years are usually left Aphakic especially in bilateral cases. Post operative contact lenses are used in unilateral Aphakes for visual rehabilitation to prevent Amblyopia.



Phacoaspiration

In patients with less than 3 clock hours of Sub-luxation, Phacoaspiration can be attempted with the help of Capsule Retractors (CR) and Capsular Tension Rings (CTR). A Posterior-Chamber-Intra Ocular-Lens (PCIOL) can then be implanted safely. More severe Sub-luxations are managed preferably through a Pars Plana route and a sutured PCIOL, or a Scleral-Fixated-Intra-Ocular-Lens (SFIOL) can be implanted. Phacoaspiration with CR or the newer CTR (Cionnis) may be used for in the bag fixation of a PCIOL.

Follow up

Post operative follow up is required not only for visual rehabilitation, but also to detect long term complications such as Glaucoma, Posterior Vitreous Detachment ,Cystoid Macular Edema and Degeneration, Epiretinal membrane and Retinal Detachment.[1] Amblyopia management is an important consideration. The risk for these complications has been suggested to be the same as for other lens removal procedures.

Management in "Cataractous" Sub-luxated lens

Surgical extraction is mandatory in these cases and the choice of surgery depends upon the degree of Sub-luxation. Conventional management has included IntraCapsular cataract extraction or Pars Plana Vitrectomy/ Lensectomy. These techniques are associated with a number of surgical complications. In contrast, Phacoemulsification with the proper use of Capsular Stabilization Devices allows essentially closed eye surgery with less tractional forces on the Zonules.

The different surgical modalities, based on the degree of Sub-luxations are:

Less than 3 clock hours(90degree) Sub-luxation ,less than one quadrant of Zonular disruptment or less than 2-3 mm of lens displacement:

- "Slow phacoemulsification" with intraocular lens implant can be attempted keeping the following points in mind [5]:

1. Make a large rhexis.
2. Do gentle hydro-procedures.
3. Minimal rotation of the Nucleus to minimize Zonular stress.
4. The nucleus may be prolapsed in the anterior chamber for Phacoemulsification in the Iris Plane (protect the corneal endothelium with good viscoelastic).
5. Decrease the Vaccum, Flow rate and Irrigation levels to prevent undue turbulence in the anterior chamber and Zonular disturbance.

6. Use the "Stop and Chop" or the "Direct Chop" for minimal manipulation of the Zonules.
7. The Intraocular lens should be inserted in the bag preferably and dialing should be avoided. The Haptic can be put in the Sulcus and the Optic in the bag.
8. A large Optic size of 6.5-7mm should preferably be used.

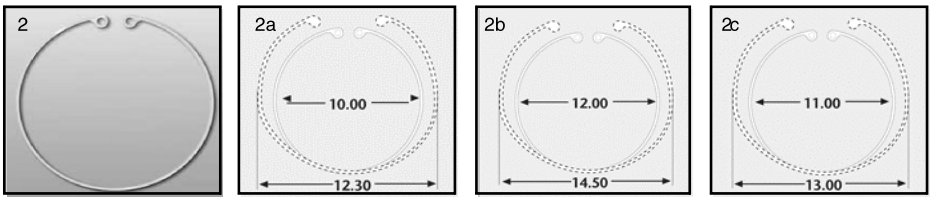


Fig.2: Standard Capsular Tension ring(Morcher) **Fig.2a:** Type-14,MR-1400, for normal eyes,expanded-12.3 mm, compressibility-10 mm, bulbous length < 24mm. **Fig.2b:** Type-14 A, MR-1410, for high myopic eyes, expanded-14.5, compressibility-12mm, bulbus length > 28mm. **Fig.2c:** Type-14 C, MR- 1420, for normal or myopic eyes, expanded-13, compressibility-11mm, bulbus length 24-28mm.

Atypical considerations, in certain systemic associations:

Cases of Marfans syndrome and Homocystinuria are prone to Retinal Detachment. Appropriate treatment of any Retinal breaks prior to cataract surgery, as well as a repeat Retinal examination after the Cataract surgery is a must .Since these diseases have a progressive systemic pathology, Intraocular-Lenses are not implanted in these cases, in lieu, of the changing intra-ocular growth. Postoperative visual rehabilitation is done with Aphakic spectacles or Contact Lenses.[4]

Other surgical options are:

- Pars Plana Lensectomy with Vitrectomy with SFIOL

In cases of Sub-luxation with a Nuclear Sclerosis Grade 4 or a compromised Cornea we should not go for Phacoemulsification and the following procedures are considered safer options:

- ExtraCapsular Cataract extraction with a PCIOL implantation.
- ECCE with an Anterior-Chamber-IOL with Anterior Vitrectomy.
- ICCE with SFIOL with Anterior Vitrectomy.

3-5 clock hours (upto 180 degrees) of Sub-luxation, more than 1 quadrant of Zonular Disruption

Phacoemulsification with Intraocular Lens Implant with CTR/ Iris or Capsular support hooks is the preferred modality, in such cases, to stabilize the Capsular bag. We have to keep the following additional points in mind:

a. Stain the anterior capsule with Trypan Blue in all cases to improve visualization during Capsulorhexis.

b. Use higher generation Viscoelastics like Sodium Hyaluronate to form the anterior chamber.

c. Use Utratas forceps for the Capsulorhexis.

d. A thorough Anterior Vitrectomy is important in case of Vitreous disturbance at any stage.

e. The Hydrodissection should be gentle.

f. CTR (Morcher rings, Fig. 2a,2b,2c) made of PMMA can be inserted after Hydrodissection, or even before the Capsulorhexis (after the first nick in the anterior capsule) if the bag is very unstable. These rings redistribute the Capsular tension forces to the remaining intact Zonules. They cannot be used in larger Zonular defects. Another, precaution, is a gentle Irrigation Aspiration, as the CTR traps the residual Cortex. They can be implanted with the help of an injector (Foldable CTR) or customized forceps for the newer modified CTR with appendages. They keep the Capsular bag stretched optimally and any post surgical constriction of the bag is prevented.

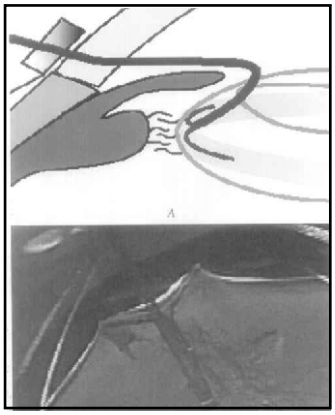


Fig.3: Capsular stabilization device in situ.

g. Iris hooks or the recently available "Capsular Support Systems" are inserted after making 4 side ports at 2.30, 5.8, and 10.30 with a MVR blade.

Capsular retractors are elongated titanium hooks to support the peripheral Capsular fornix. (A big advantage over iris hooks,which support just the anterior Capsular rim). Special nylon hooks have also been designed with a "T" bifurcation(Fig.3) to expand the Capsular equator and the edge of the Capsulorhexis, simultaneously. Iris hooks may be used as an alternative, (Fig.4a,b,c) but they are sharp and may damage the anterior Capsular margin.[6]

The Capsular retractors provide excellent Capsular support and do not trap the Cortex like the CTR. After Phacoemulsification, the CTR can be placed before inserting the PCIOL. Capsular Tension segments (Fig.5) are now available which do not trap the residual Cortex.

h. "Slow Motion" Phacoemulsification is a new concept, keeping all parameters lowest possible, advocated to minimize the stress on the Zonules.

i. Irrigation and Aspiration procedures are the biggest threat to Zonules, and a few tips to remember are:

- Good Hydroprocedures help to facilitate Epinuclear flipping and subsequent Cortex removal.
- Tangential traction should be applied on the Cortex with the I/A tip rather than central stripping.
- Strip tangentially "towards" the Dehiscence, rather than away from it.

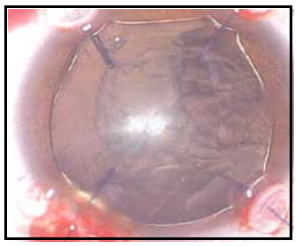


Fig.4a: Iris hooks.

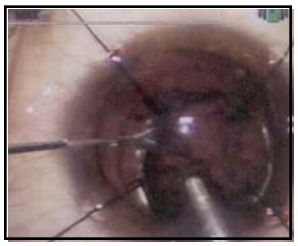


Fig.4b: Phacoemulsification with iris hooks, stabilizing the lens.

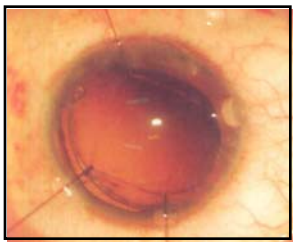


Fig.4c: Capsular bag stabilized with iris hooks.

- It is safer to leave the residual Cortex which is stuck up and try a repeat I/A after the PCIOL implantation.

Hydrophobic Acrylic Lenses are associated with less Anterior Capsular Fibrosis,compared to silicon lenses.[6] Single piece lens design with broad stiff Poly-Methyl-Meth-Acrylate Haptics are considered better as they exert centrifugal tension against Capsular contraction compared to the soft pliable Haptics of single piece lenses.

Other surgical options are

- Pars-Plana-Lensectomy with Pars-Plana-Vitrectomy with SFIOL.
- ICCE with ACIOL/SFIOL.
- ECCE with CTR stabilization of the bag and PCIOL implantation.

5-7 clock hours of Sub-luxation

- Phacoemulsification can be attempted with the help of a combination of Capsular support system (iris hooks/ Capsular retractors) with fixation of Capsular bag by a Cionni CTR (Fig.6). This ring is shaped like the CTR, but with an additional appendage for scleral fixation of the bag for improved stability.
- ICCE with anterior Vitrectomy & ACIOL/SFIOL is a more commonly followed surgical option especially in hard cataracts.
- Pars-Plana-Lensectomy with Vitrectomy with SFIOL.

Loose Bag

The surgical options in cases with a large Zonular Dehiscence (>7 clock hours) are:

- A Pars Plana Lensectomy with Vitrectomy with a SFIOL implantation.
- ICCE with Anterior Vitrectomy with ACIOL/SFIOL especially in hard cataracts.

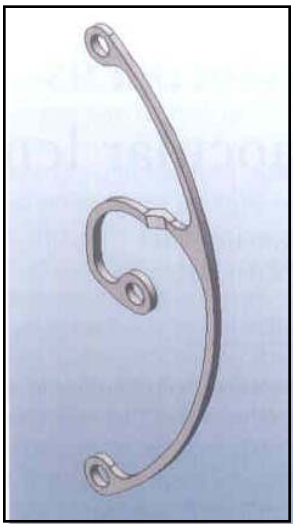


Fig.5: Capsular tension segment.

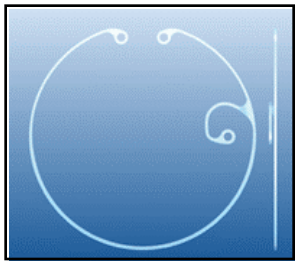


Fig.6: Cionni's ring.

Pars plana lensectomy and vitrectomy can be combined with encirclage in traumatic subluxations.

The above guidelines can be also be used effectively to manage an intraoperative zonular dialysis depending on the stage of surgery at which it occurs and detected .

Complications

Intra-operative complications include posterior capsular rupture, nucleus drop, CTR drop with the bag, and IOL drop. In addition there are the usual complications encountered during lens extraction. Glaucoma, Iritis, Hyphaema, delayed IOL Sub-luxation or Decentration, Capsular Phimosis, Capsulorhexis contraction, Anterior Capsular Fibrosis[5], Vitreous Haemorrhage, Retinal Detachment, and Macular Oedema may be encountered post-operatively.

The surgical procedure must be planned weighing the advantages, disadvantages, and the risks involved. Surgical back-up and facilities available to prevent untoward complications should be reviewed, before going ahead.

Conclusion

Although Sub-luxated Lenses have always posed a challenge to ophthalmic surgeons, the aim to achieve optimum visual rehabilitation can be achieved by a thorough pre-operative workup, proper execution of the most suitable modality of medical or surgical treatment and a conscientious follow up.

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The Fishhook Technique

A Hennig, MD

In industrialized countries phacoemulsification has become the routine procedure for cataract surgery. Also in developing countries more and more cataract surgeons want to go for phacoemulsification. However, due to various factors, mainly the cost for a phaco machine and for consumables including foldable IOL, as well as the density and hardness of nuclei, phacoemulsification is done only on selected patients and on those who are able to pay high treatment charges. Up till now, phacoemulsification does not play a significant role in the reduction of cataract blindness.

As an alternative, different sutureless non-phaco cataract surgical techniques were developed, where either the whole nucleus or the nucleus divided in parts, is removed through a self-sealing tunnel.[1-7] One of these techniques is the Fishhook Technique.

The Fishhook Technique

This technique was developed at Lahan Eye Hospital in Nepal in 1997, where since then it has become the routine cataract surgical procedure. Till July 2006 more than 300,000 cataract surgeries have been performed in Lahan with this technique and many more in other eye centres around the world.

1. Tunnel construction

The tunnel can be done at 12 o'clock or temporal, ideally at the steepest corneal meridian to keep the post-operative astigmatism at a minimum.

The size of the tunnel depends on the age of the patient and the anticipated size of the nucleus. Very big brown nuclei in older patients may require an opening of 8 mm, whereas cataracts in younger patients need incisions only as large as the IOL.

The tunnel construction can be done with either conventional tunnel instruments (razor blade fragment, crescent knife, keratome) or with a diamond knife.

A good sclera holding forceps helps to perform the following three steps:

a) Frown Incision

A "frown" shaped scleral incision goes halfway into the sclera. At its closest point it should be at least 2 mm from the limbus.

b) Sclero-corneal tunnel

The sclero-corneal tunnel should be done in half scleral thickness and needs to end at least 1 mm into the clear cornea to ensure a self-sealing effect and no iris prolapse during surgery.

c) Opening of the anterior chamber (AC)

The opening of the AC is performed with a sharp pointed instrument (keratome or diamond knife) with cutting movements from outside to inside.

2. Capsulotomy

A linear capsulotomy can be performed with a cystotome, a keratome or a diamond knife.

Preferred but more difficult is a continuous curvilinear capsulorhexis (CCC), which guarantees the best possible IOL centration. It can be performed with Utrata forceps or a cystotome. It needs to be large enough for the nucleus to get through.

3. Hydrodissection and nucleus extraction

In case of a linear capsulotomy, a forceful hydrodissection is done to mobilise the nucleus. Then the nucleus is slightly lifted at the side of the tunnel.

In case of CCC, a gentle hydrodissection is performed beneath the remaining anterior capsule. The fluid pressure pushes a part of the nucleus out of the capsular bag. Then the elevated nucleus is rotated towards the tunnel. After injection of viscoelastics in front and behind the nucleus, the fishhook, made from a 30 G needle (Photo 1), is carefully inserted between nucleus and posterior capsule and the tip turned so that it inserts into the central lower nucleus tunnel. Without lifting the nucleus into the AC, it is just extracted out of the capsular bag and the tunnel (Photo 2, 3).

4. Completing the surgery

Remaining cortex is removed by hydroexpression and with the help of a Simcoe cannula.

A PC IOL is inserted into the capsular bag and remaining viscoelastics replaced with irrigation solution.

Lahan Eye Hospital,
Nepal

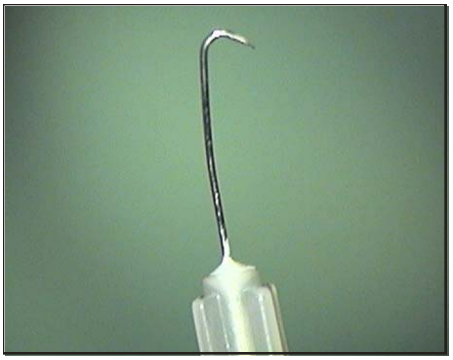

Fig.1: "Fishhook" made from a 30 G inch needle

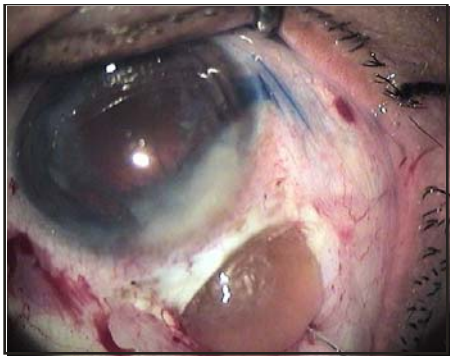

Fig.2: The Fishhook extracting the nucleus

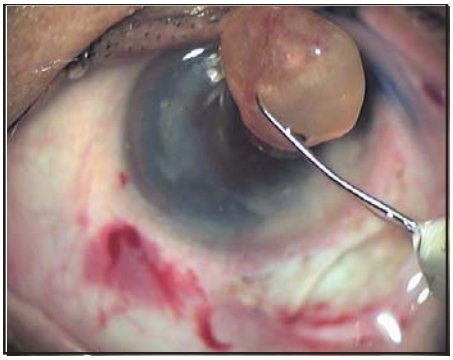

Fig.3: Extracted nucleus, side view

Outcome

In the hands of experienced eye surgeons the Fishhook Technique has a very low complication rate and provides excellent immediate uncorrected post-operative visual acuity.[8] This is underlined by another outcome study on high volume surgery, where six surgeons performed 2,111 sutureless cataract surgeries within six days.[9]

Which is the best sutureless non-phaco cataract surgical technique?

A correct answer could be found only through randomized clinical trials comparing the different techniques. However, the advantage of the Fishhook Technique is that the nucleus does not need to be brought into the anterior chamber. It is extracted with the hook out of the capsular bag straight through the self-sealing tunnel. Thus there is reduced risk for endothelial damage.

Another advantage is that extracting the nucleus with the hook through the self-sealing tunnel requires a smaller tunnel size.

The Fishhook Technique has also proved to be suitable for high volume surgery. In our Lahan Eye Hospital an experienced surgeon performs 15-20 cataract operations per hour.

Many cataract surgeons changed from other sutureless cataract techniques to the Fishhook Technique and feel very comfortable with this technique and the outcome.

A CD with a detailed Instruction Course on the Fishhook Technique is available on request from Joseph Eye Hospital, Tiruchirapalli: jehtry@eth.net

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Intraoperative Floppy Iris Syndrome

Saurabh Sawhney DOMS, DNB **Aashima Aggarwal** MS, DNB

Phacoemulsification entails highly precise manipulations of the intraocular structures. If even one step goes astray, there is great potential for things cascading out of control, especially if the surgeon is relatively inexperienced. It is, therefore, very useful to have some idea of possible difficulties that one may encounter, and plan accordingly. One such entity that has been discovered recently is the *intraoperative floppy iris syndrome* (IFIS). It is perhaps the newest syndrome to be described in ophthalmology.

The discovery of IFIS is credited to Drs David F. Chang and John R. Campbell[1], who initiated prospective as well as retrospective studies based upon observations regarding a possible association of floppy irides with tamsulosin, a drug used by patients with prostatic hypertrophy.

Definition

IFIS is defined according to a triad of signs:

1. A floppy iris that billows in response to normal irrigation currents in the anterior chamber.
2. A marked propensity for the iris to prolapse to the phaco and sideport incisions.
3. Progressive pupillary constriction during surgery.

Clinical Features

IFIS differs from routine causes of small pupils and associated iris prolapse in that mechanical pupillary stretching or partial-thickness sphincterotomies that usually work so well otherwise, are ineffective in IFIS. This makes IFIS more dangerous than the 'routine' small pupil surgery. A second problem is that it is usually possible to make a reasonable capsulorrhexis with the help of viscoelastic induced mydriasis, but this mydriasis is not sustained once phaco begins, and by this time it is usually too late to safely employ iris hooks etc. In fact, IFIS pupils tend to constrict further with time, further complicating matters.

IFIS manifests in a wide spectrum, and the presentation may vary in severity between the two eyes of the same patient[2]. A classification of pupillary behavior during surgery has been suggested as part of the study protocol followed by S. Manvikar and D. Allen[2].

Type 1 Pupil: good mydriasis preoperatively.

Type 2 Pupil: good mydriasis preoperatively but pupils constrict later during surgery.

Type 3 Pupil: a mid-dilated pupil initially that sometimes constricts later.

Type 4 Pupil: poor dilation at the beginning of surgery.

Although Flomax (tamsolusin) is the prime culprit identified, it has been suggested that other drugs may also be involved[3]. Association with diseases that cause endothelial dysregulation, such as congestive heart failure, diabetes and hypertension has also been speculated, although a different study[4] published around the same time definitively rules out diabetes as an association.

Management strategies

Managing IFIS begins with awareness. Once proper history has been taken and the surgeon knows that the patient is taking or has been on tamsolusin, IFIS can be anticipated. According to Dr. Chang, while hard data is yet unavailable, it would seem that IFIS does not occur until patients have been on tamsolusin therapy for approximately 4 to 6 months. The discontinuation of tamsolusin about two weeks before the cataract surgery seems to help a bit, but not consistently, and Dr. Chang has reported IFIS in a patient in whom tamsolusin had been stopped 3 years before the surgery. Tamsolusin induced IFIS seems to be semi-permanent in nature, possibly due to muscular atrophy and loss of tone of the dilator muscles of iris.

Three broad strategies have been described in the literature to handle IFIS. The first of these is the use of mechanical pupil dilating devices such as rings or iris retractors. This strategy has the backing of Dr. Chang himself, who states that ***'iris retractors or a pupil expansion ring are the most reliable means of maintaining a safe papillary diameter during surgery'***.

The second strategy is to use stronger mydriatics preoperatively or intraoperatively. S Manvikar and D. Allen have reported that intraoperative pupilllary constriction was reversed with intracameral phenylephrine, which also prevented iris prolapse and billowing and further pupillary constriction in patients who had medium to small pupils preoperatively[2]. Other recent studies also report that the preoperative administration of atropine or the intracameral use of phenylephrine effectively prevented the occurrence of IFIS [5,6].

The third strategy is the use of different types of viscoelastics to effectively tamponade the iris and perform phacoemulsification. Dr. Chang mentions that Healon-5 can be used effectively to dilate the pupil and prevent iris

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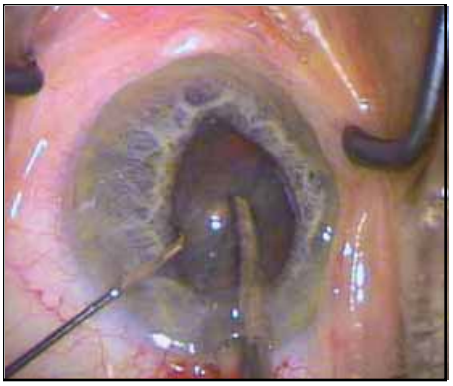

Fig.1: Iris billows in response to ordinary intraocular currents (photograph courtesy David F. Chang)

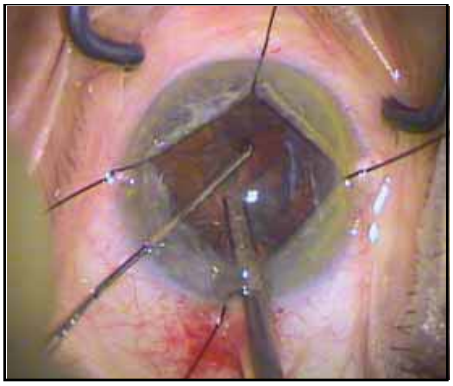

Fig.2: Iris retractors in place. The subincisional retractor goes through a separate stab incision (photograph courtesy David F. Chang)

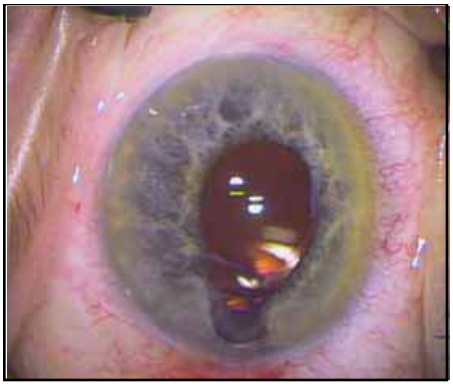

Fig.3: Characteristic billowing and prolapse of the iris are evident after IOL insertion and removal of iris retractors (photograph courtesy David F. Chang)

from prolapsing, and cites the support of Dr. Robert Osher and Dr.Douglas Koch in this approach. Dr. S.A. Arshinoff describes a multi-agent technique to tackle IFIS.

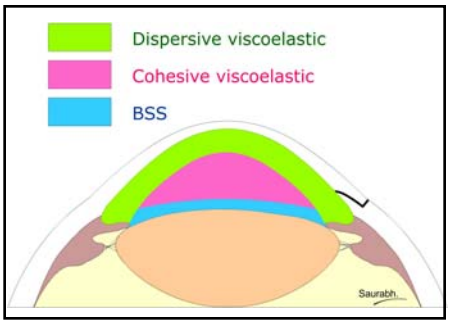

Fig.4: Viscoelastic placement in Arshinoff's strategy for IFIS (after Arshinoff)

Arshinoff's strategy to manage IFIS[7]

The incisions should be tight to prevent fluid egress and movement of the floppy iris towards the main incision or the side port. A longer tunnel helps to keep the iris out. The anterior chamber is filled through the phaco incision with sodium hyaluronate 3%–chondroitin sulfate 4% (Viscoat) until the anterior chamber is 75% to 80% full. Healon-5 is then injected onto the surface of the anterior capsule, thereby pushing the existing gel towards the corneal dome. The injected Healon should reach only upto the papillary edge. This serves as a physical fracture line between the two gels and keeps the iris steady and prevents miosis. The outer soft shell is important because dispersive viscoelastics tend to stay in the eye longer, and the Healon-5 will serve to limit the access of fluid to this outer shell, prolonging its life.

A water pocket is next made over the lenticular surface by injecting BSS under the Healon-5 layer. This provides safe passage for hydrodissection fluid to exit the eye and a working space for phacoemulsification later. Hydro-procedures are to be performed using short bursts of fluid.

The capsulorrhexis is kept a little smaller than the pupil, which confines fluid currents to the centre and minimizes iris disturbance.

While performing cataract surgery, care is taken to keep the aspiration rate as low as possible. Aspiration should only be turned on when nuclear material is actively being aspirated in order to minimize disturbance of the shell.

If the soft shell is disturbed during surgery, it can be easily formed again. Dr. Arshinoff reports excellent iris stability with this technique.

About tamsolusin

Tamsulosin (Flomax; Boehringer-Ingelheim Pharmaceuticals, Inc., Ridgefield, CT) is one of several systemic alpha-1 blockers. It highly specific to alpha-$_1$ receptor subtype A, which is found in the musculature of the urinary bladder and dilator muscles of the iris. It improves urinary outflow by relaxing the smooth muscle in the prostate and bladder neck. Flomax is also prescribed for some women with urinary retention, and therefore IFIS is seen in males as well as females.

Since tamsolusin is a very well tolerated drug otherwise, and proper surgical planning for cataract patients with IFIS yields satisfactory results, it is yet too early to banish it from our therapeutic armamentarium. However, both ophthalmologists and urologists need to be educated about the possibility of IFIS in tamsolusin users.

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The Next Generation Fluoroquinolone Antibiotics and Ocular Prophylaxis

Ashok Garg MS

Can we really better prevent post-operative ocular infections with the next generation of fluoroquinolone antibiotics?

True Ophthalmolgic Emergencies

There are a handful of acute infectious ocular emergencies that truly threaten vision. Coupled with extreme time sensitivity, these afflictions send fear through the heart of every ophthalmic surgeon on the planet. Ocular infections considered to be truly emergent include:

- Post operative endophthalmitis
- Post traumatic endophthalmitis
- Endogenous endophthalmitis
- Infectious keratitis
- Post lasik interface keratitis
- Post trabeculectomy blebitis
- Hyperacute Gonococcal conjunctivitis
- Acute retinal necrosis syndrome
- Macular toxoplasmosis
- Severe toxoplasmosis vitritis
- Orbital cellultis
- Sphenoid sinus thrombosis

Despite common clinical practice, it has been exceedingly difficult to unequivocally establish the efficacy of modern topical antibiotics as preventive agents in our crusade for complication free elective surgery, at least with a squeaky clean prospective, randomized clinical study. Due to the fortunately low incidence of blinding corneal and vitreous disease, statistical significance would require exorbitantly expensive trials enrolling thousands of subjects. Thus, in the best interest of our patients, we must decide what is truly best for surgical candidates within the context of our own practice. We remain vigilant for vision threatening infections. Bacterial keratitis and endophthalmitis are the most emergent.

Is there a True Need for Peri-Operative Antimicrobial Prophylaxis?

The vast majority of ophthalmic surgeons agree that peri-operative antibiotics can prevent post-operative infections. This sentiment is also shared, at least somewhat, but other surgical specialties. In 1974, Allen reported a remarkable 23 fold decrease in post-operative endophthalmitis following extra-capsular cataract surgery when peri-operative topical chloramphenicol was prescribed[1]. This landmark study truly convinced most surgeons that antibiotics were necessary for all of their elective surgery patients. Prospective studies have been few and far between. Gills and Gimbel collected data on thousands of post-operative cataract surgery patients in the phacoemulsification era demonstrating a trend towards endophthalmitis prevention with intra-operative irrigating solution antibiotic administration. Ciullashowed that the only demonstrably effective method for endophthalmitis prevention in the phacoemulsification population was the traditional pre-operative povidone iodide scrub. Nevertheless, an emerging trend towards increased incidence of endophthalmitis with clear corneal incisions strongly implicates a role for prophylactic topical antimicrobials.

Is the Rising Incidence of Post-Infectious Endophthalmitis Reversible?

A recent landmark retrospective review of over 9000 phacoemulsification patients at Utah's Moran Eye Center unveiled a shockingly significant 3 fold higher rate of endophthalmitis in patients treated with peri-operative ciprofloxacin drops when compared to those treated with topical ofloxacin. These sequential cases were largely performed by resident physicians, but within the context of the same institution, surgical facility, and attending faculty. Nagaki in Japan has found a 6 fold increase in endophthalmitis with the switch from scleral tunnel to clear corneal incisions. This data also suggests that continuously therapeutic aqueous levels of antimicrobial are important in controlling bacterial introduction into the anterior chamber after surgery has been completed, likely through paroxysmal communications between the anterior chamber the and ocular surface through a sutureless temporal corneal incision. Thus, although sterilization of the ocular surface and meticulous sterile technique are clearly required of the cataract surgeon, the role of topical antibiotics has not definitively been proven essential. This proof would be prohibitively expensive considering the costs of prospective randomized clinical trials, and the exceedingly rare incidence of endophthalmitis. Nonetheless, there is alarming new data suggesting that the risk of post-operative endophthalmitis has risen, perhaps as a result of the significant move to clear corneal temporal incision by many surgeons.

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Do Surgeons Really need Next Generation Fluoroquinolone Antibiotics for Surgical Prophylaxis?

The current ophthalmic media is teeming with reports of new generation topical ophthalmic antibiotics. Clinicians anticipate even better protection with even less toxicity. Despite remarkable improvements in the spectrum and efficacy of systemic antibiotics, these innovations may not necessarily translate into benefits for patients at risk for ocular infection. Nevertheless, ophthalmology has always taken leads from colleagues in the infectious disease community, bringing established systemic antibiotics into the topical ophthalmic marketplace. The newest agents approved for topical ophthalmic use include Levofloxacin 0.5% (Quixin, Santen, Napa), Gatifloxacin 0.3% (Zymar, Allergan, Irvine), and Moxifloxacin 0.5% preservative free multi-dose (Vigamox, Alcon, Fort Worth). The introduction of Levofloxacin 1.5% (IQuix, Vistakon, Jacksonville) preservative free multi-dose drop further congests the marketplace in the United States. As a result of these introductions as well as patent expirations, ofloxacin 0.3% (Ocuflox, Allergan) and Ciloxan 0.3% (Ciloxan, Alcon) have become available as generic preparations, undoubtedly raising important questions about such issues as vehicle quality, preservatives, efficacy and cost savings.

A now broader spectrum of activity is assumed to provide superior protection with the development of newer fluoroquinolone molecules, be they fourth generation, next generation, new age or whatever. Clearly, these newer drugs have significantly lower MICs for gram positive organisms as well as some additional classes of pathogens, including mycobacteria, chlamydia, and anerobes. Gram negative activity, however, has remained universally vigorous among all of the available topical fluoroquinolones. As resistance develops to currently popular agents, treatment failures, and even prophylaxis failures will ensue. Because the majority of emergent ocular infections are gram positive, particularly post-operative endophthalmitis, the enhanced coverage and broadened spectrum is welcomed.

How Important are Solubility and Penetration?

Antibiotic levels and MICs on the ocular surface, intracamerally, and in the serum can be confused. Mean Inhibitory Concentrations (MICs) are established by the NCCLS (National Committee of Clinical Laboratory Standards) and are derived from *in vitro* data obtained under strictly standardized conditions. These standards are based upon concentrations of antibiotic in the serum: there are no standards for topical ocular therapy that represent the concentrations of antibiotics in ocular tissues. Thus, ocular surface concentrations from a single drop may exceed several fold the maximum achievable serum concentration. Furthermore, interactions between the tear film, the ocular surface, and sustained release capacitance effects created by absorbed drug in the conjunctiva and uvea may also affect peak and trough bioavailability. Surface kill curves may be more relevant to conjunctivitis or pre-operative sterilization, intra-stromal corneal levels more applicable to refractive surgery, while aqueous humor levels may be more important during post-operative cataract healing. These levels may differ in potency from tissue to tissue, from drug to drug, and from bug to bug. As a result, detailed analyses of target tissue bioavailability with respect to each pathogen is necessary in order to make any conclusions about the best fluoroquinolone for a given indication.

As ophthalmologists we must consider once again the best solution to ophthalmic infections and prophylaxis for our patients within the plethora of pharmaceutical change. Given current and anticipated data regarding sensitivity, kill curves, inhibitory quotient, and penetration, we can make intelligent assumptions about antimicrobial activity on the ocular surface as well as within the eye. Genuine improvements in anticipated treatment success should clearly reward our patients. New fluoroquinolones, the next generation, hopefully will provide this added reassurance.

Orally administered fluoroquinolones can generally provide effective intravitreal concentrations, even in the absence of inflammation. Sparfloxacin, trovafloxacin, gatifloxacin, moxifloxacin and levofloxacin all reach effective MICs within the vitreous when given by mouth. There are no human studies to evaluate this strategy for either the prevention or treatment of endophthalmitis, however.

Most ophthalmic microbiology experts agree that ocular surface and lid organisms cause the lion's share of post-operative endophthalmitis. It is also likely that organisms can be introduced intracamerally not only at the time of surgery, but also afterwards through the cataract wound, particularly with clear corneal incisions. Thus, antibiotics with rapid kill curves but poor penetration into the aqueous humor will only prevent intraoperative inoculation of surface flora. Topical agents with excellent solubility and penetration will also prevent post-operative contamination of the anterior chamber by providing continuous inhibitory concentrations despite momentary gaping of the unhealed wound due to rubbing, blinking, or unusual nocturnal positions. Once the wound has sealed, certainly by post-operative day 10, the risk of inoculation should decrease markedly.

Highly soluble molecules achieve effective intracameral concentrations, as suggested by comparative data indicating effective intraocular MICs following topical administration of levofloxacin. Thus, an agent with higher albeit effective MICs on the ocular surface may in fact achieve much lower concentrations below the effective MICs in the eye compared to a more soluble agent with lower MICs on the surface. Thus has been the case of Ciprofloxacin drops compared to more soluble, commercially available agents. This phenomenon of

potency at the intended target tissue is described by the Inhibitory Quotient, or IQ: the ultimate concentration of antibiotic at the site of action. The IQ = Concentration of drug at active site ÷ MIC_{90}. Thus an adequate IQ is equal to or greater than 1. Although directly comparative human studies are now in progress with the recent approval and release of topical Gatifloxacin and Moxifloxacin, initial animal data demonstrates the superior penetration and aqueous concentrations attained with topical Levofloxacin and Moxifloxacin when compared to Gatifloxacin, Ofloxacin, and Ciprofloxacin .

Who is the Universally Accepted Decision maker for Antibiotic Generation Nomenclature?

There remains considerable confusion regarding the current generation nomenclature system, particularly for fluoroquinolones. Nalidixic acid, first synthesized in 1962, is considered by most to represent the first generation, even though it is not a fluorinated molecule. Ofloxacin and ciprofloxacin are generally considered to be second generation. Thereafter, opinions unfortunately vary. Several articles describe a reasonable criterion for classification, but prove contradictory with one another.

Antibiotics can be classified in several ways, the most commonly accepted being spectrum of anti-microbial activity, as utilized with the cephalosporins. This system of course relies upon *in vitro* data. Another viable method utilizes instead the chemical structure or more specifically, the molecular structural activity relationships, relying upon chemical data. Finally, variations of this theme might include both characteristics as well as penetration into selected body compartments or tissues, thereby relying upon clinical efficacy data. The nomenclature for antibiotic generation assignment clearly falls within the realm of systemic applications, and has never been determined by ophthalmology. Thus, our specialty is dependent upon the wisdom of our infectious disease and pharmacology colleagues to provide us with useful classification guidelines. An authoritative text dedicated to fluoroquinolones describes moxifloxacin as a fourth generation antibiotic, with gatifloxacin as a third generation and levofloxacin as a second-generation fluoroquinolone. The author recalls separating fluoroquinolones into generations in a manner similar to the cephalosporin generations, based upon broadened spectrum of action, while acknowledging the fact that the system of nomenclature remains clearly arbitrary. The patent for moxifloxacin, interestingly enough, deems it a third generation drug. Thus even more confusion to decipher. Some sources describe both gatifloxacin and moxifloxacin as 4th generation fluoroquinolones, while others classify them both with levofloxacin as 3rd generation, with trovafloxacin deemed the only agent with sufficient spectrum of action worthy of the 4th generation moniker.

Ophthalmologists can Combat Antibiotic Resistance Every Day

Clinicians and specifically ophthalmologists and optometrists can effectively battle resistance in the office setting. The bottom line, regardless of nomenclature synthesized in the universe of human imagination, is killing pathogens. Since the time of sulfonamides and Alexander Fleming, antibiotic resistance has proven itself a universal nemesis. Physicians prescribing systemic antibiotics are the chief creative engine behind antibiotic resistance, particularly in congested, crowded, or high pathology environments like nursing homes or intensive care units. Improper use by patients or erroneous prescriptions by doctors also contribute. In addition, over the counter availability of numerous antibiotics in countries without vigorous prescription regulation also contributes to resistance, as well as massive use by the agriculture and veterinarian industries. Topical ocular use is unlikely, however, to contribute to the overall worldwide problem with antibiotic resistance, due to the relatively miniscule numbers of organisms exposed on the ocular surface. Nevertheless, exposure of the naso-pharynx to topical ophthalmics through naso-lacrimal drainage raises ongoing questions regarding systemic resistance.

There is a wide variety in risk profiles for the development of resistance, since some antibiotic classes are more likely to allow antibiotic resistance to develop. Pneumococci, for example, become resistant to Fluoroquinolones and macrolides more rapidly than to ceftriaxone, a third generation cephalosporin, in an *in vitro* model. Whether or not this is applicable to clinical situations, let alone ocular disease remains to be established. Nevertheless, eye care professionals prescribing antibiotics should beware that fluoroquinolone resistance is developing in the community, and furthermore, that improper topical administration of antibiotics can create resistant flora. Thus, less that QID dosing, administration lasting less than the recommended 7 days or longer than 3 weeks, and dilution with other concomitant medications can create resistance during treatment for conjunctivitis or prior to surgery. Sound advice, therefore, would include switching antibiotics prior to elective surgery if either a resistant organism is identified upon pre-operative culture, or if the particular patient was known to have self administered the intended prophylactic antibiotic improperly prior to surgery.

Each Surgeon must make Individualized Decisions

Ophthalmic topical antibiotics can provide outstanding surface sterilization and therapeutic intracameral and intra-stromal bactericidal concentrations. Improved protection with next generation topical fluoroquinolones against peri-operative infections or conjunctivitis has already been documented *in vitro* and in animal models. Fluoroquinolones are firmly established

as the drug class of choice for these indications, due to superlative spectrum and toxicity profiles when compared to other available topical agents. Topical prophylactic antibiotic use, even though never unequivocally proven to prevent post-cataract endophthalmitis, has become an integral part of the peri-operative regimen for most surgeons. Although this is not an established community standard for care, continuous pressure to provide this added protection comes from numerous fronts: colleagues, patients, pharmaceutical companies, risk management underwriters, and a growing body of scientific evidence. Therefore, selection of the most appropriate and effective agent is central to providing the best possible care for our patients. This intense concern for better outcomes and fewer complications applies not only to cataract surgery, but also to refractive surgery patients as well as patients suffering from bacterial conjunctivitis. Newer fluoroquinolone agents offer improved spectrum, better solubility, greater penetration, and thereby superior efficacy. One matter is certain, and that is that resistance will emerge . The quest for new antimicrobials and better therapeutic and prophylactic strategies follows.

Fourth generation, or better the next generation of fluoroquinolones, regardless of numerical assignment, raises expectations even higher, hopefully to the ultimate benefit of our patients. Clinical data directly comparing the next generation, levofloxacin, gatifloxacin and moxifloxacin, is growing. As clinicians, we await unbiased *in vivo* human clinical data collection and purposeful scientific analysis, the essence of the annual ARVO meeting each spring. Newer medications including topical azithromycin are entering the market regularly. With each new antibiotic introduced into the marketplace, into the systemic therapeutic milieu, and into ophthalmic clinical practice, new resistance issues arise . As always we as surgeons can be pleased that continuous pharmaceutical advances have been made to hopefully counter the rising tide of endophthalmitis, avoid the tragedy of blinding infection after elective refractive surgery, and provide truly efficacious broad spectrum coverage for bacterial keratitis and contagious bacterial conjunctivitis.

Laser Indirect Ophthalmoscope

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Laser indirect ophthalmoscope (LIO) is basically an indirect ophthalmoscope fitted with a co-axial fibreoptic cable for laser delivery. LIO has greatly enhanced the capability of ophthalmologists to deliver laser to almost any point of the retina. LIO is available for both the green (532nm) and the diode (810nm) laser. A common LIO which can be interchangeably used with either type of laser (both green and diode) is also available.

How to use

The LIO is also fitted with a red aiming beam as any other laser delivery system. The level of this aiming beam in the circle of light of the indirect ophthalmoscope is adjustable. It is usually kept in the upper half of the field but can be adjusted according to where the laser spot is desired. The main aim is to focus this aiming beam accurately at the point on the retina where the laser reaction is required. This has to be done by adjusting the distance of the 20 dioptre lens held in front of the patient's eye and the laser aperture on the indirect ophthalmoscope placed on the doctor's head. The more accurate the focus the lesser would be the energy required to get a laser reaction. Also the spot size of the laser can be varied to an extent by varying the distance between the laser head on the indirect ophthalmoscope and the hand holding the condensing lens. Generally if the aiming beam is well focused most LIO's are designed to give a spot size between 300-400 microns. The laser is activated by foot switch control. Routine indirect lenses (most have antireflective coating) can be used for LIO. While doing LIO it is advisable for other people present in the room to wear safety goggles.

To facilitate laser in the far periphery one can use the routine indentor to bring the peripheral retina into good view. One must be careful here as LASER reaction is usually achieved at a much lower energy on indented retina and the laser power needs to be adjusted accordingly. As per our experience the laser power in the green laser LIO is kept almost the same as in the slit lamp delivery system, however for the diode laser LIO a bit higher power is required to achieve adequate reaction. Also the diode laser is more painful for the patient. In certain green laser LIO's the protective filter alters the natural fundus colours. However we have not faced this problem with the LIO which can be interchangeably used with both the green and diode laser.

LIO is not the preferred mode of laser delivery for macular pathologies as the magnification cannot be increased in an LIO and the eye is not being stabilized with a contact lens and thus can result in an accidental macular burn.

Applications

1) Very useful for doing laser for peripheral vitreo-retinal degenerations. With LIO one can laser easily upto the ora serrata. Rarely does one need to do cryotherapy now for these degenerations.
2) Laser in cases of retinopathy of prematurity. LIO is much safer than cryo as extensive areas of the retina need to be treated. There is no need for full general anaesthesia while doing laser. Also there is no post treatment chemosis and discomfort to the infant.
3) Augmenting pan retinal photocoagulation till the far periphery
4) Lasering in hazy media. Like cases with some vitreous bleed where parts of the retina are visible. Laser can be easily delivered to these visible areas with LIO.

   Lasering in post-operative cases where the patient might not allow application of contact lens.
5) Lasering at the end of vitreo-retinal surgery. It can serve as an alternative to endolaser.

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Retcam: Wide-field Digital Retinal Imaging: A New Paradigm

Sudipta Ghosh MBBS, DOMS, DNB

The RetCam is a high resolution, wide-field contact digital fundus camera. It is a unique integrated system that combines first-ever bedside wide-angle viewing, full resolution image selection from real-time digital video with a comprehensive relational database. It is a mobile, self-contained system that can be easily moved around the hospital or office. It provides state-of-the-art Wide-Field Pediatric Retinal Imaging. The machine allows for a greater viewing area of the eyes, and helps keep the scanning to a minimum.

Retcam Configuration

The RetCam system consists of several components mounted on a stable, high quality cart with large casters for easy, safe transportation from one location to another. The cart has two storage drawers to provide convenient storage of the camera unit, accessories and supplies.

Figure 1 gives the diagrammatic representation of the various components of the RetCam.

1. *3 CCD Chip Video Camera:* The heart of the RetCam is the 3 CCD medical grade video camera. It is light weight, hence easily can be moved around. It has a long cable attached to it for easy patient access. Along with the video camera, a holder is present which holds the five changeable lenses.

2. *Lenses:* The RetCam is combined with a family of lenses 130°, 120°, 80°, 30°, and Portrait field-of-view, and provides real-time image of the pediatric retina. Seeing such a wide area with these lenses makes diagnostics easier.

Fig.1: The Retcam Unit with Changeble Lenses

- 130° lens known as the Retinopathy of Prematurity (ROP) lens, is used in premature infants.
- 120° lens known as the Children's lens is used for imaging pediatric to young adults.
- 80° lens is used for higher contrast pediatric and young adult imaging.
- 30° lens also known as the High Mag Lens, is used for 30° field-of-view for finer details.
- Portrait lens is a flat field lens used for area and external imaging.

3. *Large LCD display:* A key feature of the RetCam is the large, flat 17" color display that is easy to view during the examination, an ideal as a teaching tool for other physicians and hospital staff. The real-time image allows viewing the retina with ease, along with a 20 second video capture feature. A comprehensive database keeps track of each imaging session for the patient, allowing for later side-by-side or review of the case images. The Fluorescein Angiography option is also available along with this.

4. Lighted control panel enables to click onto options for imaging with the RetCam.

5. Image Unit Holder allows single handed lens change with ease.

6. Camera light box with SVHS video output jack.

7. FA light box which is optional for fluorescein angiography.

8. Storage drawer to store lenses, tools, supplies and other accessories.

9. Dual DVD-RAM a 9.4GB space to save the images and patient records instantly as a digital file.

10. Ink-jet Color printer used for physical photographic output of the images for inclusion to the patient's report. The photo documentation of the frozen digital image eliminates interobserver variability.

11. *Powerful RC II OS Software:* The features of the software include-

- Instant digital video capture,
- Instant digital image capture,
- Mutiimage data recall and display,
- Side-by-side image comparison,
- High resolution 24 bit color image,
- Intranet, internet and network connection capabilities.

12. *Tri-function foot control:* Individual foot pedals are used for easy light intensity and focus adjustment. It also has a switch button for convenient video or image capturing.

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Fig.2: The Hand-held Imaging Camera

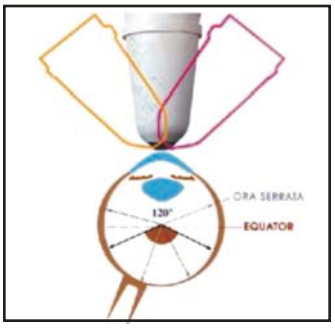

Fig.3: The Field-of-view (FOV)

Fig.4: The Retcam Imaging Procedure

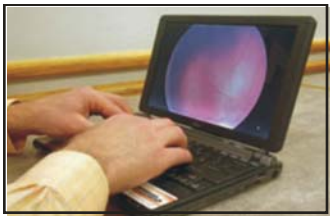

Fig.5: Telemedicine: Viewing of Images by Internet

Optics of The Retcam

It has an instantaneous field-of -view (FOV) aswell as a ready access to a superb field-of-regard (FOR). The FOR is at a minimum from equator to equator. With scleral depression the ora serrata can also be imaged, while without depression, FOR is about 200 degrees, retina being about 225 degrees.

Clinical Applications of the Retcam

The RetCam is the pediatric imaging tool of choice in the operation theatre, Neonatal Intensive Care Unit (NICU) and Pediatric Intensive Care Unit (PICU) for documenting and managing Retinoblastoma, Retinopathy of Prematurity, Shaken Baby Syndrome and other pediatric eye diseases.

Among the many challenges facing premature infants Retinopathy of Prematurity (ROP) is a potentially blinding eye disorder. Premature and low birth weight infants are at risk for ROP because the blood vessels supplying the retinas are not completely developed and continue to grow in an abnormal disorganized pattern. If undiagnosed, ROP may lead to bleeding, scarring of the retina, retinal detachment and visual loss.

The imaging technique by the RetCam possibly saves time on taking a longitudinal history of the baby and more accurately track the progression of the disease. A pictorial history also increases the chance of a timely and accurate diagnosis. In the PhotoROP trial, the RetCam Digital Imaging System had 100 percent sensitivity and 97 percent specificity.

The RetCam is also used to diagnose other diseases like diabetes, leukemia and other pediatric blinding disorders with potentially great accuracy.

Conclusion

This versatile Widefield Digital Retinal Imaging System offers superior documentation, visualization, education and early detection whether screening for Retinoblastoma, ROP, Shaken Baby Syndrome or anterior segment imaging. The RetCam is a system that can be a welcome addition to any Ophthalmology or Paediatric Department.

Preliminary studies have shown that the Retcam has a positive predictive value of 96.6%. One of its advantages is that it is possible to train non medical staff to use it and either interpret the findings or mail them electronically for grading of the severity of disease. The RetCam imaging system has given an altogether new horizon for telemedicine where the clinician no longer needs to be in the same room, or even the same country, as the patient.

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A peep in the past: Albrecht von Graefe

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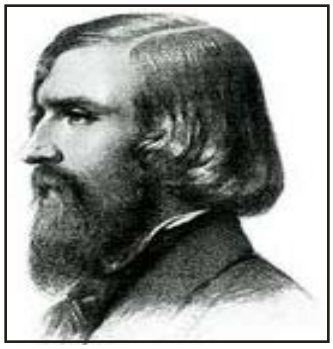

Friedrich Wilhelm Ernst Albrecht von Graefe is recognised as the founder of scientific ophthalmology. He was born on May 22, 1828 and was the son of Carl Ferdinand von Graefe the Prussian Surgeon-general and director of the university surgical clinic in Berlin. He was an intelligent scholar and graduated with honours at the age of 15 years. He then went to Berlin in 1843 to study philosophy, logic, natural sciences and anatomy. Some of his teachers were Johannes Müller, Johann Lukas Schönlein, Moritz Heinrich Romberg, and Eduard Wolff.

Graefe received his medical degree in Berlin on August 21, 1847. In 1847 he passed the state examination and went to Prague. In Prague he was strongly influenced by the professor of ophthalmology, Carl Ferdinand von Arlt (1812-1887). They entered a lasting friendship based on mutual respect and love.

During his stay at the Moorfields Eye Hospital in London he made the acquaintance of William Bowman and George Critchett. In London a happy coincidence brought him together with the Dutch physiologist Franz Cornelis Donders who found a friend and inventive colleague in research in Graefe.

On returning to Berlin in 1850, he founded his own clinic and soon had a busy practice. This was the same year that Hermann von Helmholtz announced his great invention, the ophthalmoscope, which Graefe was the first to use routinely. He said of it: "Helmholtz has opened a new world to us". Graefe's great care for his patients and his genius as a scientist gave his clinic great repute, not only among his patients, but also among his colleagues all over the world. He was very rich and used to treat poor patients for nothing.

In 1852 Graefe moved his clinic to Karlstrasse 46, Berlin and submitted a thesis entitled "On the action of the ocular muscles" to the University of Berlin and qualified for teaching. Shortly after this, his lecture on the "Operation for squint" caused a sensation. He was an excellent teacher and Karl Weber commented "One was spell-bound in his clinic, as if in a magic place. The multitude of new facts and viewpoints never heard before, the fascinating presentation and glowing enthusiasm acted like a revelation." He was appointed associate professor of ophthalmology in Berlin in 1857 - the first German professor of ophthalmology, being elevated to full professor in 1866.

He maintained lively scientific and friendly associations with those grand men of ophthalmology who, with him, laid the foundation of modern ophthalmology: Hermann von Helmholtz, the genial physicist and optician, von Artl, the great clinician, Cornelis Donders, the founder of the new doctrine of refraction, William Bowman, the anatomist, and Friedrich Horner . Among the students who flocked to him from all over the world, were Argyll Robertson and Theodore Billroth.

In 1854 Grafe, aged 26, founded the journal Archiv für Ophthalmologie. In the first issue (January 1854) 400 of the 480 pages were authored by him. By publication of volume 16, he had contributed 2500 pages. Because of his great reputation, he was soon able to recruit Arlt and Donders as co-editors. The journal is still published under the title of Graefe's Archive for Clinical and Experimental Ophthalmology, published by Springer.

In 1857 he gathered a number of ophthalmologists for a meeting in Heidelberg, where German Ophthalmic Society was established in 1863, greatly contributing to Heidelberg becoming the most important meeting point for ophthalmologists from all over the world.

By the age of 39 Graefe was an international figure and dominated the 3rd International Congress of Ophthalmology held in Paris in 1867. He read four papers including a classic description of choroid tubercles, but his most notable contribution was exposition of his "modified linear extraction" as a new technique for the operation of cataract. He also invented a special knife, which is still used for cataract-surgery. Graefe's most important field of work was impairment of vision without organic lesions of the eye. He diagnosed sudden visual loss due to retinal artery embolism, optic neuritis and was one of the first to treat glaucoma successfully. He described a large number of new findings,

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among them iridectomy in glaucoma.

His contributions to ophthalmology were multiple. His name is eponymously remembered in the von Graefe sign in exophthalmic goitre and the von Graefe extraction knife. Ophthalmology developed through the application of the ophthalmoscope by von Graefe. His clinical contributions included the physiology of the oblique muscles and the symptoms of ocular paralysis, silver nitrate treatment of conjunctivitis, description of the various types of hemianopias, the efficacy of iridectomy in acute glaucoma, occlusion of the central retinal artery by emboli, the recognition of papilloedema, and the recognition of optic neuritis rather than paralysis of the optic nerve as being a cause of central visual failure.

Graefe was tall, slender and elegant, with a handsome face, long dark hair and a full beard. He was modest in his lifestyle. His massive workload left time for little else. In 1861 he developed tuberculous pleurisy, but his condition went into remission and he married Anna Gräfin Knuth the next year. His pulmonary tuberculosis was reactivated, and in 1870, aged only 42, Graefe succumbed to the disease.

In his short career von Graefe performed more than 10,000 eye operations. He was undoubtedly the most important ophthalmologist of the 19th century.

Unusual fungal infection of a Scleral buckle

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Scleral buckling is routinely done for retinal detachment. Like in any other surgery, there is a risk of infection after scleral buckling. The most frequently isolated organisms have been Staphylococcus epidermidis and other coagulase-negative staphylococci,[1,2] followed by Staphylococcus aureus, Mycobacte-rium chelonei, Corynebacteria and Proteus mirabilis.[3,4,5] Fungal infection of scleral buckle is rare.

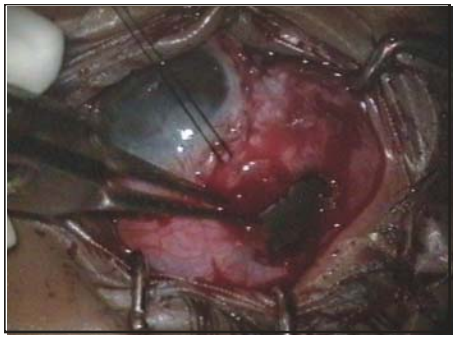

Fig.1: Intra-operative photograph of the right eye showing the superotemporal quadrant with the discolored scleral buckle.

Fig.2: Culture bottle of Sabouraud's dextrose agar with chloramphenicol and cycloheximide media, showing velvety creamy growth of Microsporum audonii fungus.

We report an unusual fungal infection of the scleral buckle caused by Microsporum audouinnii,[6] and managed by removal of the scleral buckle along with broad-spectrum antibiotics, antifungal and anti-inflammatory medication.

Case Report

A 35-year old male, presented to us with pain and discharge from the right eye for the last three months. He had a history of scleral buckling procedure done in the right eye followed by recurrence of retinal detachment. He subsequently underwent vitrectomy surgery with silicone oil injection, followed by attached retina and removal of the silicone oil. He had poor vision in the left eye since childhood.

On examination the best-corrected visual acuity in the right eye was hand movements close to face and inaccurate projection of rays in the left eye. Slit lamp examination of the right eye showed localized conjunctival congestion in the upper temporal quadrant with granuloma formation and an exposed dark brown tissue. The cornea showed stromal edema and scarring involving the upper half of the cornea and aphakia was noted (Fig-1). Left eye anterior segment was unremarkable. Applanation tonometry was deferred in the right eye due to pain and it recorded an intraocular pressure of 12 mm of Hg in the left eye. Fundus examination of the right eye showed attached retina with buckle effect and chorioretinal atrophy in the macular area. Fundus examination of the left eye showed extensive chorioretinal atrophy with pigmentary alteration throughout the fundus suggestive of spontaneous reattached retina.

As the brown tissue in the superotemporal quadrant resembled choroid in color, the possibility of ischemic necrosis of the sclera with choroid shining through or buckle exposure was made and the patient was taken up for surgery with preparation for a scleral patch graft.

The patient underwent surgery under general anesthesia, involving conjunctival opening and traction sutures to expose the supero-temporal quadrant. Granuloma was removed and sent for culture and sensitivity. The brown tissue was found to be rigid and discolored scleral buckle. All the quadrants were exposed and the entire 360-degree scleral buckle, buckle sutures and encircling band were removed and sent for culture and antibiotic sensitivity. The scleral bed underlying the buckle was healthy. Thorough antibiotic wash was done and the conjunctiva was closed.

Microbiological examination showed the growth of Microsporum audouinnii[6] fungus on Sabouraud's dextrose agar with chloramphenicol and cycloheximide media, after three weeks of aerobic incubation at 37 degrees. (Fig-2).

Post-operatively the patient was treated with topical and systemic broad-spectrum antibiotics, antifungals and anti-inflammatory medication.

At six months follow-up the patient was asymptomatic. On examination his best-corrected visual acuity in the right eye was hand movements close to face and inaccurate projection of rays in the left eye. Slit lamp examination of the right eye showed corneal scarring and aphakia and the left eye was unremarkable. Fundus examination of both eyes was as before. (Fig-3)

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Discussion

As in all types of surgery, infection remains a potential serious complication in retinal detachment procedures. The factors which increase the risk of infection after scleral buckling procedures for retinal detachment are - longer duration than most of the other eye operations and foreign material buried in the surgical wound.[7] Infection after scleral buckling procedure often causes pain, tenderness, purulent discharge, conjunctival and circumcorneal congestion, sub-conjunctival hemorrhages, granuloma formation, conjunctival/episcleral fistula and exposure of the scleral buckle requiring removal of the scleral buckle along with topical and systemic antibiotics for the control infection.[8]

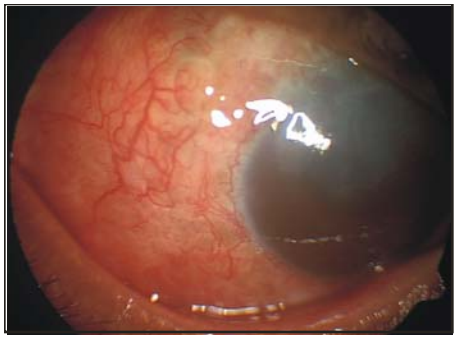

Fig.3: Slit lamp photograph of the right eye after scleral buckle removal.

A recognized but frequently overlooked potential source of contamination is the operative field.[9] Infections associated with scleral buckles tend to be persistent due to the production of extracellular polysaccharides or glycocalyx by the bacteria which form a biofilm on the scleral buckle and helps the bacteria to adhere and survive on the surface of the scleral buckles despite antimicrobial treatment.[10]

Fungal infection after scleral buckling has been reported in the past, however in our case there was buckle infection by Microsporum audouinnii fungus, [6,11] which is a rare dermatophyte, anthrophilic with spindle shaped macroconidia. The fungus grows as cream to tan colonies with a pink or brown underside, the main site of infection is scalp and it spreads by man to man contact due to poor hygiene .The fungal infection of the scleral buckle caused exposure and brownish discoloration of the silicone buckle material.

We would like to highlight the fact that fungal infection though rare, can occur after scleral buckling procedure and should be kept in mind if a patient is not responding to antimicrobial agents. To the best of our knowledge, there is no previous reported case of fungal infection of the scleral buckle by Microsporum audouinnii species.

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