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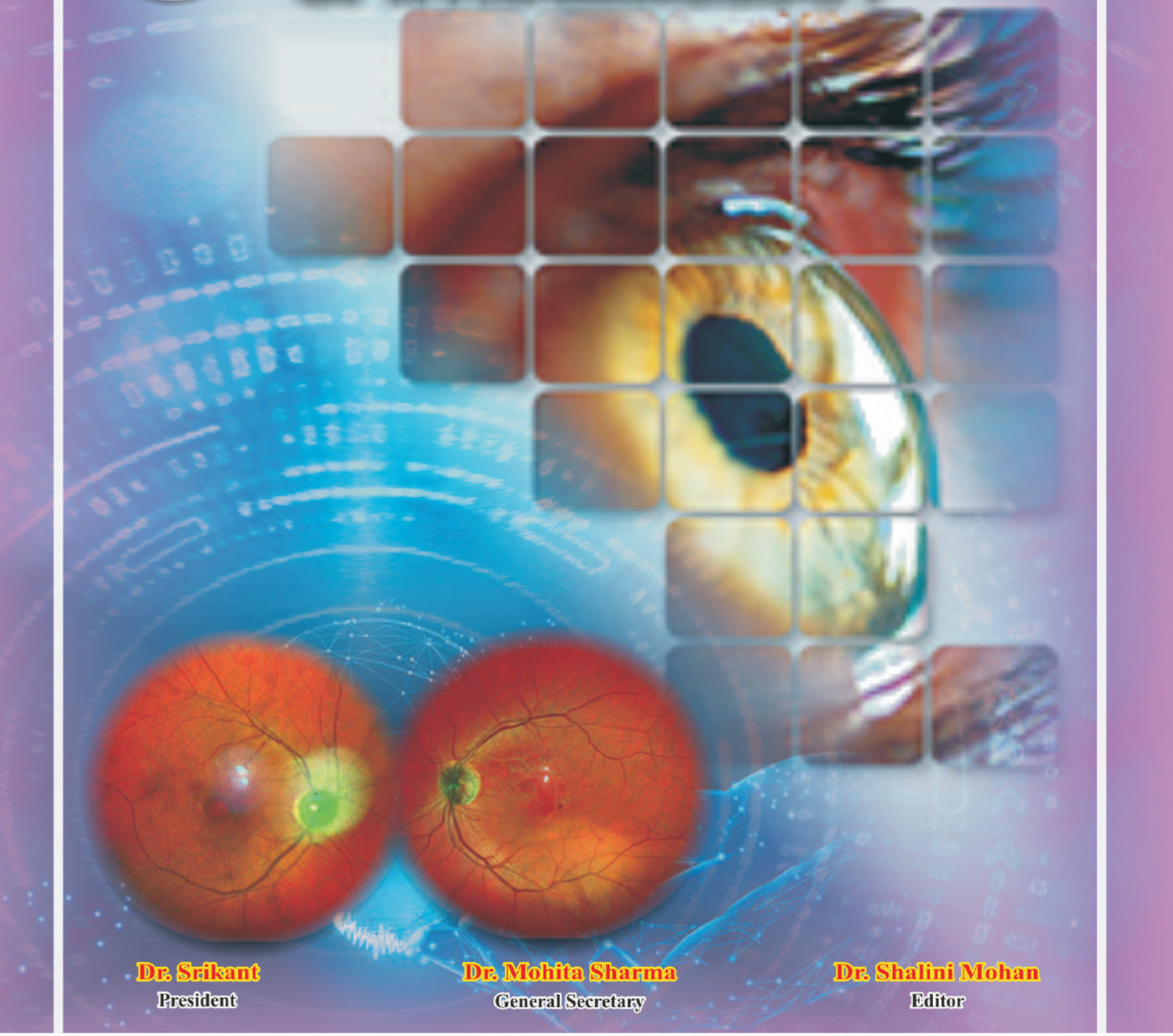

The Scientific Journal of U.P. Ophthalmological Society

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UP JOURNAL OF OPHTHALMOLOGY

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Cover Photo

Full thickness Macular Hole Right Eye and Macular Edema Left Eye.

Courtesy : Dr Kshitij Raizada, Lucknow

"WHEN GOING GETS TOUGH, THE TOUGH GETS GOING"

" The art of living is neither careless drifting on the one hand nor fearful clinging to the past on the other.It consists in being sensitive to each moment, in regarding it as utterly new and unique,in having the mind open and wholly receptive."

Above mentioned words of Alan W. Watts hold so much wisdom and guidance especially in this current chaotic covid era, which has not only burdened the medical resources but has also severely impacted our mental health. Indeed seeking knowledge and learning proves to be an effective tool in combating the fear of unknown and brings in cultivating faith and hope of a peaceful future.

I congratulate the editor Dr, Shalini Mohan for her sincere efforts in improving the sccientific material and for the upcoming issue of UPIJO.

Wishing all the readers a great scientific treatise and an insightful learning experience. Happy learning.

Dr. Shrikant, MS
President, UPSOS
Former Professor & Head, Regional Institute of Ophthalmology
Institute of Medical Science BHU, Varanasi
Presently Prof. & Head Department of Ophthalmology
Heritage Institute of Medical Sciences, Varanasi

And The Show Must Go On.....

Dear Friends,

New year is about to embark and we all are eagerly waiting with new hopes and new aspirations waiting the Pandemic to vamoose and craving for the new ray of hope to make our lives normal.

Despite all odds in this year 2020..... We could make our life meaningful and interesting by developing new hobbies along with reviving the older ones. The art of life which is constant adjustments to surroundings could be achieved by us and we adapted for the best in present situation. The learning and teaching which was halted temporarily could be regained by online lectures/webinars. The conferences that were heart and soul of academics could be organized in magnificent way similar to an onsite congress. Simultaneous lectures of diverse specialty in different halls complemented with live surgery accompanied by General body meeting and spiced up with trade was indeed a commendable effort.

Life is a constant learning process and we proved it yet again.

Happy to present before you another issue of UP Journal of Ophthalmology having articles of great interest for the readers. I invite constructive criticism to improve upon it. Thanks to President Dr Shrikant, Secretary Dr Mohita Sharma, CSC Dr Deepak Mishra and whole editorial board along with executive body members for their constant support.

Wishing you all a very Happy and Prosperous New Year.

Dr Shalini Mohan

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"COVID ERA"

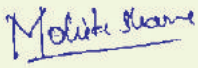
Dear Members,

Welcome to COVID times !! In an era where almost everything seems to have come to a standstill the UP Journal of Ophthalmology continues to come out and impart scientific knowledge to all its members. This journal signifies that life can never stop and scientific upgradation is a continuous process.

As a State society UPSOS is committed to imparting scientific knowledge. On behalf of the whole executive committee my Congratulations to the editor and the editorial team.

As doctors we took the hippocratic oath and promised to serve humanity. My appeal to all our dedicated members is to continue to work whole heartedly and simultaneously be updated about all precautions which can keep you safe. Take special care of yourself especially from the ophthalmology point of you. And since workload is less ours being mostly an elective branch, spend more timing reading good journals like this one. You also have the opportunity to do what you never got the time to do. In this one important thing is studies and publishing. So let's get started on this academic front too. And hope to see more contributions of structured study results from our own state of Uttar Pradesh.

Stay safe, stay healthy and stay working



Dr Mohita Sharma,

General Secretary, UPSOS

Laser Refractive Surgery – Expanding Horizons

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Chairman Scientific Committee : Uttarakhand State Ophthalmological Society, UKSOS
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Refractive surgery is now a well–established sub specialty of the ophthalmology.

It is for the ophthalmologists to add it in his skills for the sake of eliminating

the suffering of millions of visually handicapped persons. The W.H.O. estimates that there are 1 billionpeople have some form of preventablevisual impairment with refractive error and cataract as leading causes. The condition is much worse in developing countries.

Even many ophthalmologists are not aware about the latest development in the field of refractive surgery.

The Lasik vision correction changes the life for the better at much younger age, with health, economic and occupational benefits that occur over life.

We are fortunate to have availability of variety of refractive procedures in our armamentarium, of which we can select the optimum procedure for our patients. Getting most of the available options, we have to keep in mind the possibilities and limitations of each procedure.

Where we stand today

There have been tremendous developments in refractive surgeries, but very few patients may be unhappy. A range of futuristic innovations is coming down the pipeline.The focus has shifted from just visual acuity to the best quality of vision.

Healthy skepticism is a must when assessing new technologies, ensuring our enthusiasm is based on sound scientific evidence.

THE WAR OF FLAPS

The laser refractive surgery started with surface ablation – PRK. It was much superior to radial keratotomy. It was followed by Lasik, in 1990 by Pillakaris and Burrato.The technique dominated laser refractive surgery for long time and is still most popular. The pain, scarring and delayed healing, common with PRK was not there.

But Lasik has still some problems, though not common, likely flap striae, button holing, partial flap, debris, epithelial ingrowth, DLK, late trauma, ectasia etc.

There has been lot of improvements in technique developed over the time.

The FemtoLasik hasfurther improved the safety of procedure. The flaps are thinner, planer and with better-fit properties due to new angulation of side cut. The customization of flaps is possible in regard to size, thickness, side cuts and hinge position.

This was followed by SMILE, in 2006 It is all femtosecond procedure. The problem of flap related complications is not there. The biomechanical strength is supposedly better than Lasik. But it has some limitation. The hypermetropia correction and customized treatments are not possible at present.

With improvement in flying spot excimer spot technology, epithelial mapping, mitomycin C and optimized removal of epithelium, surface ablation(ASA) is gaining popularity. The upper limit of treatment is now up to 10 diopter of myopia. The recovery, predictability and stability of correction is much better now.

BETTER DIAGNOSTICS

Imaging techniques for assessing the structure and function of the cornea and anterior segment are crucial for diagnosing and treating a wide variety of refractive errors and giving information of other abnormalities of eye.

A lot of newer technologies had made the laser vision correction more precise, and safer than ever. The anterior surface of cornea can be measured by placido disc based topography.

The Pentacam andGalileiutilizes the Scheimpflug image, which is a cross-sectional image showing the cornea, anterior chamber, iris, and lens.

AS –OCT is helpfulto know the health of cornea and to measure the residual stromal bed beneath a LASIK flap when determining whether or not there is sufficient stroma remaining to perform a flap lift and enhancement

Aberrometer is used to measures refractive aberrations of the eye.The iTrace system combines corneal topography with wavefrontaberrometry.

The biomechanics of the cornea evaluated by spectral analysis of waveforms from Ocular Response Analyzer and Corvis-ST

LASERS

From broad beam excimer laser, we have now moved to flying spot high-speedexcimer lasers. It is complimented by very active multi dimensional eye tacking giving us precise treatment pattern. Online Pachymetry, attached slit lamp has given added advantage. The profile of laser treatment has improved a lot over the years.

TREATMENT CAPABILITIES

The aim of refractive surgery is optimum visual quality and not just good visual acuity. Now we have a wide array of laser refractive treatment. The wavefront optimized treatment, wavefront guided treatment,topography guided treatment like Contoura Vision, Custom Q treatment, SMILE, advance surface ablation – StreamLight and SmartSuface, given us a capability to provide real personalized treatment to each eye undergoing laser vision correction.

ASA is one of the most effective tools in the surgical armamentarium of refractive surgeon. It is still underutilized, but is very promising and exciting with superior results

SMILE and ASAprovides flap less treatment, Contoura vision is the most personalized vision correction system.

The laser refractive surgery is also being commonly used to treat refractive surprises following cataract surgery and in selective cases of amblyopia management in children.

I am sure that refractive surgery will continue to evolve and from corneal ablative procedure, we will move on corneal additive procedures. The future of refractive surgery is very bright.

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The researchers who have made substantial contributions to the work reported in the manuscript, but who are not the contributors, are named in the Acknowledgment.

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Panel Discussion on ARMD

UPSOS Correspondent : **Mohit Khattri**
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Expert Panel

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LVPEI, Hyderabad

Dr Nishikant Borse (NB)
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Susrut Eye Foundation & Retina Centre
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In our clinical practice, ARMD is often seen and with myriad presentations. With advancement in imaging techniques and development of new drugs, we need to be updated and guided by the experts in field to be able to tackle the disease better.

Q.1 What minimum investigations you would like to do for every AMD patient?

CS: OCT in every case. Baseline FFA in most. OCTA & ICG on a need basis.

RN: Good 90D examination. This is something many ophthalmologists skip and directly advise tests. OCT is necessary in every wet AMD diagnosed on clinical examination. I advise OCTA for every intermediate and advanced dry AMD patients too. However, for those who do not have OCTA in their practice, look out for the double-layer sign of RPE in standard OCT. Double layer sign has a high correlation with CNVM.

NB: OCT

AM: 1st investigation to order : OCT & DFA

Investigation to consider : ICG In clinically suspected IPCV , RAP & Refractory CNV

Q.2 Where do you place the role of OCT ANGIOGRAPHY in AMD diagnosis?

CS: *Ocult CNVs where FA is inconclusive

* Pachychoroid neovasculopathy

*PCV

*CNV assoc with Mac Tel.

RN: It is not crucial in the diagnosis or management of treatable wet AMD. OCTA has a great role in specific conditions, including non-AMD CNVM, such as myopic CNVM or CSCR related CNVM.

NB: 10% of atypical presentations of AMD need OCTA for better diagnosis & for prognostication.

Also in poor responders an OCTA is important to find the reason for poorer response and to plan further management.

AM: OCTA is emerging as a rapid , non-invasive imaging modality that provide detailed structural and flow information on retinal & choroidal vasculature .We use in patients where DFA is not feasible ,contraindicated or patient is reluctant to undergo invasive tests .The use of OCTA has improved detection of CNV in challenging cases. Comparison of OCT & OCTA imaging helps to differentiate active CNV from quiescent CNV & to choose appropriate therapeutic management : Anti VEGF injection in active CNV and simple monitoring for quiescent CNV (Sensitivity of OCTA is very high in type 1

& type 2 CNV in AMD)

Q.3 How do you differentiate PCV from AMD?

CS: Clinical presentation – more exudation & hemorrhage.

OCT : Peaked Notched PEDs: Double layer Sign indicates a BVN

OCT-A : BVN often very well delineated.

ICG : Delineates polyps better.

RN: On ICG. We can talk a lot about theory on OCT features in IPCV, but there is no substitute for ICG for PCV, not even OCTA.

NB: In most cases typical clinical & OCT pictures help in diagnosis. In case of doubt an OCTA/ICG does help.

AM: The index of suspicion of PCV is higher for a younger patient presenting with symptoms and signs of Wet AMD. Clinically a reddish orange, nodular or spheroid, polyp like structure noted in PCV. Multiple lesions (with exudative maculopathy, massive sub retinal haemorrhage,PED,exudation & sub retinal fibrosis) and no drusen suggests PCV.

Multiple location surrounding the peripapillary region rather than isolated to the macula

Diagnosis of PCV is based on ICG (presence of polyp, BVN) and OCT (tall peaked, notched & multiple PED)

Q.4 Do you prescribe supplements for dry AMD?

CS: Yes

RN: No. I do not believe in them.

NB: Yes

AM: Yes I use in intermediate or advanced disease to reduce the risk of vision loss

Q.5 Which is your frontline choice of drug as intravitreal injection for Wet AMD?

CS: Ranibizumab and Aflibercept

RN: Ranibizumab

NB: Aflibercept

AM: Ranibizumab and Aflibercept

Q.6 What's your follow up schedule of patients after injection?

CS: Loading dose followed by treat & extend. Follow up can be extended from 1 month to 3 months if possible. If recalcitrant /recurrence continue monthly follow up & inject PRN.

RN: Monthly follow up until dry.

NB: One week after the first injection & then monthly. In case of severe cases a 2 weekly follow-up is advised to monitor the disease activity.

AM: Next day and then 3 weeks

Q.7 How do you find the new drug Brolucizumab in Wet AMD management?

CS: Have not used it so far. Will probably start using it in cases not responding well to frontiline molecules or in case tending to recur very rapidly after their use. There have been reports of retinal vasculitis post Brolicizumab which has limited its use as first choice drug. Once that factor is taken care of & longer duration of action of upto 16 weeks is seen in real world situation it could become frontline choice.

RN: I have limited experience. It has great drying efficacy, better than aflibercept. However, safety profile needs a careful watch.

NB: Fabulous drug with a great potential in terms of potency as well as longer action.

AM: Quite promising as I got very good results in my first 5 cases. Long follow will give us the real life picture of effectivity & safety of this new drug.

Q.8 What's the role of lasers in AMD management today in your practice?

CS: Role of lasers is very limited.

(1)Extrafocveal CNV which can be safely treated without damage to fovea.

(2)Exramacular polyps–not so rare

Usually laser treatment is combined with anti-VEGF injection.

RN: No role of thermal laser. I peform PDT in PCV, and thermal laser in extrafoveal polyp. Unfortunately, Visudyne for PDT is not available now.

NB: Extrafoveal CNVM / Extrafoveal leaking polyps in IPCV.

AM: I don't do Laser in AMD. Only is few cases of extra foveal IPCV lesion I do Laser

Q.9 When do you switch from one drug (injection) to other in Wet AMD?

CS: If there is no or minimal response after 3 injection. Important to first reconfirm, we are dealing with AMD and not something else like adult vitelliform, CSR or MacTel (without /or CNV), PCV.

We can then switch from, say Ranibizumab to Aflibercept or Vice Versa or now even Brolucizumab.

RN: After 2 injections of no response.

NB: If there is no response /poor response after 3 continuous injections.

AM: After 3 loading dose if there is sub optimal or no response I switch to other drug

Q.10Do you prefer to dry up the lesion completely or you prefer to leave some fluid?

CS: The aim is to dry up the lesion in most situations. Leaving fluid is not a preference. However in type I CNVM if some fluid persists after repeated injections, visual acuity is stable & no other sign of acitivity like fresh hemorrhage we decide to tolerate that fluid with a close follow up.

RN: Completely dry for intraretinal fluid. I leave extrafoveal subretinal fluid in the absence of intraretinal fluid. I do not treat PED without retinal fluid at this time.

NB: Dry Up as far as possible.

AM: I prefer to dry up the lesion unless & until some small amount of SRF persists after repeated anti VEGF injections.

Q.11 What are the indications of surgery in AMD in your practice?

CS: The only indication currently for surgery in AMD is large submacular hemorrhage. The procedure of choice with us is intra-vitreal TPA & Gas to displace the hemorrhage. If the hemorrhage is massive, one has to do a vitrectomy, large peripheral retinotomy & evacuation of the blood & injection of silicon oil.

RN: Submacular hemorrhage or breakthrough vitreous hemorrhage.

NB: Bilateral scarred CNVM... I do an autologous RPE transplant with scar removal in one eye.

AM: I rarely do surgery (only in massive sub retinal haemorrhage or break through bleeding I do surgery)

Good News

As per the Guidelines on Safe Ophthalmology Practices in Covid-19 Scenario issued on 28th December 2020 by Ministry of Health and Family Welfare, Government of India,

'Collection/retrieval of eye balls/Corneas from home settings is allowed with all precautions being taken to prevent spread of infection to retrieval technicians and to the recipient of corneas. Corneas may be utilised for therapeutic as well as optical purposes'

The document can be accessed on following link:

https://aios.us5.list-manage.com/track/click?u=5b1666c401fa04c2eac1d0763&id=88f9574df7&e=5403adef5e

The staff manning these entry points should ensure appropriate personal protection as entailed in guidelines already issued. (available at:

https://www.mohfw.gov.in/pdf/AdditionalguidelinesonrationaluseofPersonalProtectiv eEquipmentsettingapproachforHealthfunctionariesworkinginnonCOVIDareas.pdf

In case of a suspect or confirmed case in the premises, the protocols for attending to suspect or confirmed case and disinfection available at:

https://www.mohfw.gov.in/pdf/GuidelinesonpreventivemeasurestocontainspreadofCOVID1 9inworkplacesettings.pdf

Re-Visiting Disinfectants for the Ophthalmologist

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Abstract :

When Joseph lister used carbolic acid in the treatment of surgical wounds & reported remarkably lower incidence of infections, he ushered in the era of disinfectants and asepsis. Subsequently, use of alcohols, bleach was discovered. Since then, having come a long way in the use of disinfectants & now we have good number of disinfectants in the health industry. Most new commercial brands introduced have combinations of these disinfectants.

Their use in the clinics has been pushed to the fore by the current Covid-19 epidemic. This article attempts to revise the various steps used in the journey to asepsis, list different disinfectants used in health care, the rationale behind their use & advantages & disadvantages of each.

Prevention of cross infection from patients to the physician, from one patient to another and from physician to patient is of utmost importance in clinics, hospitals & health care setups. Disinfection even in the clinic, though always a standard of care, has never been pushed to the forefront of medical discussion as much as it has been during the current pandemic of Covid -19. Transmissibility from asymptomatic patients, ability of the virus to remain alive on fomites for prolonged periods of time and rapid spread of the disease are reasons why clinicians all over the globe are looking closely at disinfection in the OPD. Different brands have suddenly sprouted in the market with claims of killing Corona Virus. Do we need anything different from what we have always done? Through this article, different chemical disinfectants which are currently used, their microbicidal activity & use in ophthalmic setting is analysed.

What is the difference between cleaning, disinfection & sterilisation?

Cleaning: It is removal of organic & inorganic debris from clinical instruments, areas & surfaces.

Disinfection: It is the process of eliminating microbes except spores from inanimate objects.

Sterilisation: It is the process of complete elimination of all forms of microbial life including spores.

Cleaning:

Cleaning is usually achieved with mechanical processes with/ without detergent effect, & removes organic/inorganic matter persistence of which, helps proliferation of bacteria. Cleaning decreases the load on disinfectants.

Also, efficacy of certain disinfectants is decreased in the presence of organic matter. Cleaning before disinfecting/ sterilising increases efficiency.

Water, soap/detergents are common cleaning agents.

Some agents perform both, cleaning & disinfection, at specific concentrations. (Sodium hypochlorite @0.1% & above, isopropyl alcohol & Ethyl alcohol @ 70% & above).

Some other cleaning agents are:

Bleaching powder (Calcium Hypochlorite)
Ammonia solution
Tetrachloroethylene (drycleaning)

Disinfection:

Antimicrobials used on inanimate surfaces – usually liquids – are called "disinfectants".

Antimicrobials used in living tissue like skin or mucous membrane are called "antiseptics".

The order of resistance of microorganisms to disinfectants from most resistant to least resistant is:

Prions>Cryptosporidium oocysts>Bacterial spores> Mycobacteria>Parasite cysts> Small non enveloped viruses> Trophozoites>Gram negative bacteria>Fungii>Large non–enveloped viruses >Gram positive bacteria> Enveloped viruses.

Depending on the extent & type of microbicidal activity involved, three levels of disinfection are recognised.

Table 1- Classification of Disinfectants.

level of disinfectant	Bacterial & Fungal spores	Mycobacteria	Nonenveloped virus	Fungii	Enveloped Viruses	Vegetative Bacteria	Examples
Low level	No	No	No	+/-	Yes	Yes	Quaternary ammonium compounds
Intermedia-te level	No	Yes	+/-	Yes	Yes	Yes	Isopropyl alcohol
High level	Maybe	Yes	Yes	Yes	Yes	Yes	Glutaraldehyde
Chemical Sterilant	Yes	Yes	Yes	Yes	Yes	Yes	Glutaraldehyde

Some high level disinfectants, on prolonged exposure, are sporicidal & are also called chemical sterilants.

Factors affecting disinfection:

Type & size of microbial load, exposure time, concentration & microbicidal range of disinfectant, nature of the object (material, lumen, crevices etc), pH, presence of organic matter are some factors which affect efficacy of the disinfectant.

In 1968, Earle H. Spaulding[1] proposed that based on the risk of transmitting infection, reusable instruments & objects of patient care could be categorised into critical, semi critical & non-critical & then matched to methods of sterilisation& disinfection.

Table 2- Spaulding's Classification of Medical Devices

Medical Devices	Definition	Recommended Sterilisation/ Disinfection	examples
Critical	Very high risk of transmitting infection if contaminated	Sterilisation	Surgical Instruments, IOLs, Glaucoma Implants
Semi-Critical	Comes into contact with mucous membrane &/or Non-intact skin	High Level Disinfection	Tonometer tips, Tips of Ultra sound Pachymeter probes, Gonioscopes, Contact laser lenses
Non-critical	Comes into contact with intact skin.	Intermediate or low level disinfection	Trial frames, trial lenses, BP cuffs, slit lamps,
Non critical surfaces	Very little direct contact with patient	low level disinfection	switches, tables, patient chairs, OPD floors

Abbreviations : IOL-Intraocular lens, BP-blood pressure

Chemical Disinfectants commonly used are :

- Alcohol.
- Chlorine and chlorine compounds.
- Formaldehyde.
- Glutaraldehyde.
- Ortho-phthalaldehyde (OPA)
- Hydrogen peroxide.
- Phenols
- Iodophors.
- Peracetic acid.

Alcohols:

Ethyl & Isopropyl alcohol are commonly used alcohol disinfectants.

Alcohols are anti microbials because of their ability to cause denaturation of protein. Water enhances the efficacy of alcohols by causing quicker denaturation of proteins and increasing the contact time by delaying evaporation. [2,3] Hence, absolute ethyl alcohol is less bactericidal than a mixture of alcohol and water. Their efficacy decreases in presence of protein rich material. The optimum concentrations of ethyl & isopropyl alcohol are 60-90% diluted in water. [3,4] They are not sporicidal.[5] Ethyl alcohol does not inactivate hepatitis A virus[6] or the polio virus. [7] Alcohols are very effective against lipophillic viruses but not all hydrophillic viruses.[8]

Alcohol disinfectants & tonometer tips:

Of the studies which evaluated tonometer disinfection against adenovirus, all studies that tested 1:10 dilute bleach concluded that it was effective against adenovirus.[9,10,11,12] Four studies tested 70% isopropyl alcohol as a disinfectant for adenovirus.[8] Two of these studies [9,10] found that 70% isopropyl alcohol and 3% hydrogen peroxide were effective against adenovirus,[8] but these used lower virus concentrations & immediately wiped adenovirus [8] from the tip. Two other adenovirus studies demonstrated that 70% isopropyl alcohol and 3% hydrogen peroxide were not effective in eliminating adenovirus. In summary, studies suggest that elimination of adenovirus is best achieved by using 1:10 dilution sodium hypochlorite. Use of 70% isopropyl alcohol (e.g., alcohol wipes) is not sufficient to eliminate adenovirus (especially in desiccated form or at high concentrations)

Ethyl alcohol 60% & isopropyl alcohol 75% formulations inactivate SARS-CoV-2. [13,14]

Table 3- Overview of Commonly used Disinfectants:

Disinfectant	Concentration	Level of disinfectant	Recommended exposure time	used for	Advantages	Disadvantages
Glutaraldehyde	2%	High / CS	-20 min 3-12 hours for spores	-Surgical instruments used for septic cases. -Surface disinfection in OT. Gonioscope disinfection -Disinfecting fiberoptic scopes	-Relatively inexpensive. -Excellent material compatibility including optical instruments like endoscopes.	-Requires activation. -Odour. -Irritant to the eyes. -Slow mycobacteri -cidal activity
Orthopthaldehyde OPA	0.55%	High / CS	12min but longer for spores.	same as glutaraldehyde	-No odour. -Faster mycobactericidal activity. -Excellent material compatibility.	-Slow sporicidal. -Stains skin & mucous membranes. -More expensive -Irritant to the eyes
sodium Hypochlorite	1% 500 ppm.	High		tonometer tips, Gonioscopes Laser lenses Surface disinfection	Cheap. Easily available. Fast acting.	-Corrodes metals. -Has to be freshly made.
Hydrogen Peroxide	3-25%	High	5 min-few hours (for sporicidal effect)	Contact lenses. Tonometer tips. Surface disinfection.	-Easily available -Decompose into harmless products	Incompatible with certain metals. -Corneal toxicity if not rinsed off.
Quaternary ammonium compounds	0.1-2	Low	few seconds to minutes.	Disinfecting floor, furniture, walls	-No functional or cosmetic damage to surfaces.	-
Isopropyl alcohol	60-75%	interme-diate	few seconds to minutes	Hand rubs. Wiping surfaces of equipments like slit lamp. Alcohol wipes for Pachymeter probes, tonometer tips. (not FDA recommended)	-Easily available. -Non corrosive.	Does not inactivate Polio, hepatitis A virus. Rapid evaporation.
Peracetic acid	0.2%	High	30-45 min for disinfection 6 hours for sterilisation	-Surgical instruments used for septic cases. -Disinfecting fiberoptic	-Faster -Sporicidal at low temperatures	-More expensive -Corrosive towards metals. -Eye irritant

Chlorine & Chlorine Compounds:

Hypochlorites& among them ,sodium hypochlorite (NaOCl), is

the most widely used chlorine disinfectant. Sodium hypochlorite is bactericidal, virucidal, fungicidal, mycobactericidal.

In water, NaOCl forms hypochlorous acid (HOCl) & hypochlorite ion. The microbicidal activity, however, is mainly due to Cl–in hypochlorous acid. [17,18.]

Other compounds that release chlorine and are used in the health-care are demand-release chlorine dioxide, sodium dichloroisocyanurate, and chloramine-T. The advantage of these compounds over the hypochlorites is that because chlorine is retained longer they exert a prolonged bactericidal effect.

Use

Sodium Hypochlorite solution is used for disinfecting tonometer heads[20] and for disinfection of countertops and floors. Its role in disinfection has been brought to the fore in the current pandemic. 1% solution of sodium hypochlorite is recommended for disinfection of health care facilities particularly for surface cleaning. The prepared solution can be used for 24 hours. For small spills of blood on noncritical surfaces, the area can be disinfected directly with sodium hypochlorite. Because hypochlorites and other germicides are less effective in the presence of organic matter, [21, 22,23,24,] for large spills of blood the surface should be cleaned before disinfecting with 1:10 solution of Sodium Hypochlorite .[25]

However Sodium Hypochlorite is corrosive to metals & releases chlorine gas when mixed with ammonia or acids.

Formaldehyde

It is an aldehyde and used in healthcare as a 100% saturated solution of formaldehyde in water which is 37% formaldehyde by weight. It has to be diluted to 2-8% solution for disinfection and 2% for air fumigation.

The aqueous solution is bactericidal, tuberculocidal, fungicidal, virucidal and sporicidal. [26, 27, 28] and is a high level disinfectant.

Though formaldehyde is cheap, easily available & a high-level disinfectant, because of its irritating fumes, odour, dermatitis & asthma like respiratory symptoms caused by long term exposure & its role as a suspected human carcinogen in nasal cancer and lung cancer, its use is now restricted [29]

Glutaraldehyde

Glutaraldehyde is bactericidal, tuberculocidal, fungicidal, virucidal and sporicidal. It is a chemical sterilant & high level disinfectant . Aqueous solutions of glutaraldehyde are acidic & not sporicidal. Alkalinating agents which increase the pH to 7.5-8.5 make the solution sporicidal. This process is called "activation". However, the biocidal effectiveness of activated glutaraldehyde diminishes because of polymerization of active sites at alkaline pH.

Glutaraldehyde has good compatibility with surfaces, is noncorrosive to metal and does not damage optical instruments, rubber or plastics. It can however cause respiratory irritation & contact dermatitis. It also fixes organic tissue to surfaces.

Ortho-phthalaldehyde

Ortho-phthalaldehyde (OPA 0.55%) is also an aldehyde & is bactericidal, tuberculocidal, fungicidal, virucidal. Sporicidal effect is improved if pH is increased to 8. It is a high-level disinfectant.

OPA has superior mycobactericidal activity to glutaraldehyde but inferior sporicidal effect.

Uses are similar to glutaraldehyde but OPA has some advantages over glutaraldehyde. It does not require activation & is stable over a wide range of pH(3–9). OPA, like glutaraldehyde, has excellent material compatibility & does not damage optical instruments. But it stains skin & mucus membranes gray and should be handled carefully.

Hydrogen Peroxide:

Hydrogen peroxide is active against bacteria, yeasts, fungi, viruses, and spores .[31,32]

7% stabilized hydrogen peroxide proved to be sporicidal (6 hours of exposure), mycobactericidal (20 minutes), fungicidal (5 minutes) at full strength, virucidal (5 minutes) and bactericidal (3 minutes) at a 1:16 dilution. [33]

Commercially available 3% hydrogen peroxide is a stable and effective disinfectant when used on surfaces. It has been used in concentrations from 3% to 6% for disinfecting soft contact lenses (3% for 2–3 hrs) & tonometer biprisms. [34]

Iodophors

Iodophors are a combination of iodine and an agent, providing a sustained-release reservoir of iodine and release small amounts of free microbicidal iodine.

Povidone-iodine (polyvinylpyrrolidone with iodine) is the most commonly used Iodophor.

Iodophors are bactericidal, mycobactericidal, and virucidal but can require prolonged contact times to kill certain fungi and bacterial spores. They are used as antiseptics & disinfectants.

Dilution of Povidone-iodine, weakens the iodine linkage & increases availability of free iodine in solution causing more rapid bactericidal action than a full-strength solution 680. Therefore, iodophors must be diluted in water according to the manufacturers' directions. Most PVP-I used for medicine is standardized to deliver between 0.5 percent and 1.0 percent free molecular iodine on dissolution. Thus the common pre–surgical 10 percent Betadine actually delivers about 1 percent of biocidal, free molecular iodine.

It is non toxic, stable & non irritating to the skin.

Phenols.

Phenol & its derivatives have been used for surface disinfection. Manufacturers' data demonstrate that commercial phenolics are not sporicidal but are tuberculocidal, fungicidal, virucidal, and bactericidal at their recommended use-dilution. Published reports show variable microbicidal activity. Many phenolic germicides are used as disinfectants on environmental surfaces (e.g., bedside tables, bedrails, and laboratory surfaces) and noncritical medical devices. Phenolics are not FDA-cleared as high-level disinfectants for use with semicritical items.

Peracetic Acid

Peracetic acid is a strong oxidising agent & is bactericidal, viricidal, fungicidal & sporicidal. Advantages of peracetic acid are that it lacks harmful decomposition products (i.e., acetic acid, water, oxygen, hydrogen peroxide), enhances removal of organic material, and leaves no residue. It remains effective in the presence of organic matter and is sporicidal even at low temperatures Peracetic acid can corrode copper, brass, bronze, plain steel, and galvanized iron. It is considered unstable, particularly when diluted; a 1% solution loses half its strength through hydrolysis in 6 days [42]

Quaternary Ammonium Compounds.

These compounds are widely used in the health industry. Some of them are benzalkonium chloride, cetrimonium, cetrimide.

They are bactericidal, fungicidal, and viricidal against enveloped virus but not mycobactericidal, sporicidal. They do not destroy non-enveloped viruses. Hard water decreases their effectiveness. Quaternary ammonium compounds, 70% isopropyl alcohol, phenolic, and a chlorine-containing wipe [80 ppm]) effectively (>95%) remove and/or inactivated multidrug-resistant S. aureus, vancomycin-resistant Entercoccus, P. aeruginosa from computer keyboards with a 5-second application time. [43]

Hence they are used for disinfection of noncritical surfaces & items such as floors, furniture, walls, blood pressure cuffs.

Disinfection of Diagnostic & Laser lenses:

Glutaraldehyde, Peracetic acid, OPA, sodium hypochlorite can all be used for disinfecting diagnostic, contact &non contact lenses.

Table 4 : VOLK OPTICAL - CLEANING & CARE GUIDE

Product Type ✓ OK to Use	Alkacide / Alkazyme	**Bleach Solutions (Sodium Hypochlorite)	Bode Mikorbac Tissues	CaviWipes	*Cidex OPA	*Glutaraldehyde	Perasafe	*Revital-Ox™ Resert XL® HLD	Tristel Duo
BIO Lenses (Black & All Colors)		✓	✓	✓	✓	✓	✓		✓
BIO Lenses (ACS)		✓	✓	✓	✓	✓	✓		✓
Classic Series Lenses (Black & All Colors)		✓	✓	✓	✓	✓	✓		✓
Super & Digital Series Lenses (Black & All Colors)		✓	✓	✓	✓	✓	✓		✓
Mirrored Lenses (3-Mirror Lenses, Mini 4-Mirror Lens, & SLT)	✓	✓	✓	✓	✓	✓		✓	✓
G-Series Gonio Lenses		✓	✓	✓	✓	✓		✓	✓

Disinfection & SARS-CoV-2:

It is sensitive to UV &heat.It can be inactivated at 56°C & also by liquid solvents like ether, 75% ethanol, chlorine disinfectant, peracetic acid & chloroform.

Slit lamp, auto refractor, OCT, Fundus camera, perimeter (not the bowl) should be cleaned with 75% ethanol or 3% hydrogen Peroxide.

Appliances directly touching the ocular surface such as tonometer tip, gonioscopes, ultrasound pachymeter probe should be soaked in 2% glutaraldehyde, washed with distilled water & then cleaned with 75% ethanol.[44]

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Cataract Surgery in Keratoconus: An Interesting Case

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A 52 year old male patient presented with complaints of diminished vision in both the eyes, the left eye since many years. He had never used glasses in the past and had not had a complete eye checkup too. As regards the left eye, he vaguely remembered being told that his left eye was very weak and that nothing could be done for it.

Vision in the Right eye was 6/36 P&Left eye was 6 feet finger counting , with both the eyes having nuclear grade 2-3 cataract. Intraocular pressure & fundi were normal in both the eyes.

Corneal topography (Figure I), Pentacam (Figure 2 & Figure 3) & Biometry with IOL master 700 (Figure 4 & 5, Figure 8) was performed for both the eyes.

Figure 1 : Corneal topography on Atlas Topographer

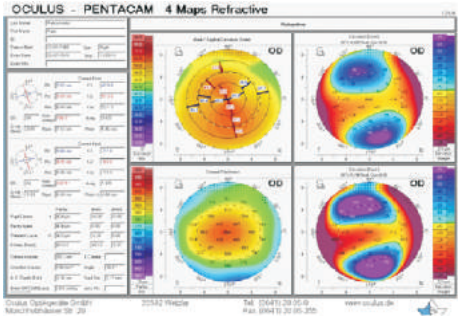

Figure 2 : Pentacam 4 map refractive map of the Right eye

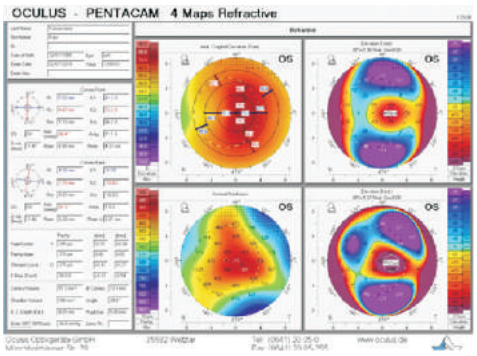

Figure 3 : Pentacam 4 map refractive map of the Left eye

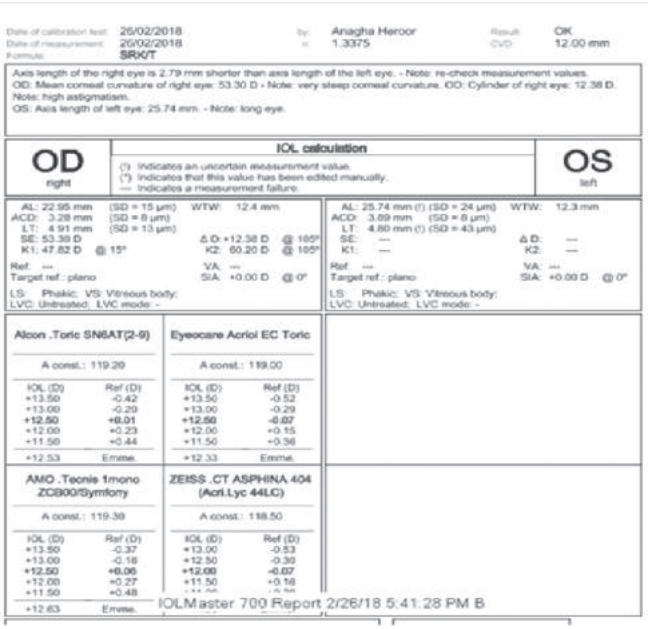

Figure 4 : IOL Master 700 report Right eye

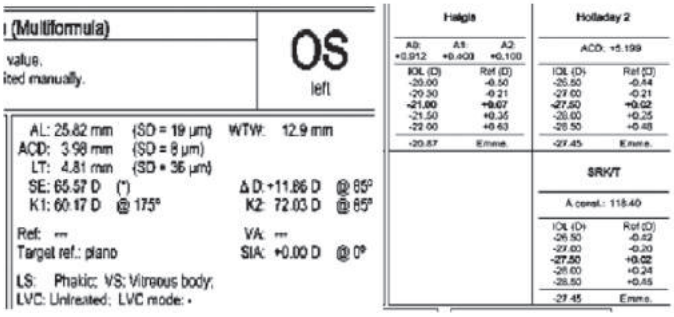

Figure 5 : IOL Master 700 report left eye

The keratometry readings in both the eyes in various instruments were as follows.

Instrument	RE K1	Re K2	LE K1	LE K2
Auto K	59.50 X 103	47.25 X 13	Not recordable	Not recordable
Topography	58.21@106	47.67@16	72.5@89	61.15 @179
Pentacam 4 map	57.3@106	47.8@16	72.2@89	61.2@179
IOL Master	60.2@105	47.8@15	Not recordable	Not recordable
Axial length	22.95 mm		25.82 mm	
ACD	3.28 mm		3.98 mm	
Lens thickness	4.91 mm		4.81mm	

The Right eye, being the better eye, was operated first. As the astigmatism was very high, it was decided to use a toric Intraocular lens.

The SRK T formula gave a 12.5 D power for the Alcon toric, Tecnis Toric & the IO care toric Intraocular lenses, but they could not correct the astigmatism completely. The Barett calculator showed a residual astigmatism of 7.09 D cylinder even with a T9 IOL with a 9 D power.(Figure 6) Hence, it was decided to use a customised Ultima Smart Toric IOL from the care group (Figure 7), which needs to be placed in the 0-180 axis, with a cylinder power of 18 D at the IOL plane and an anticipated residual astigmatism of 0.14 D @ 104 degrees and an incision at 180 degrees.

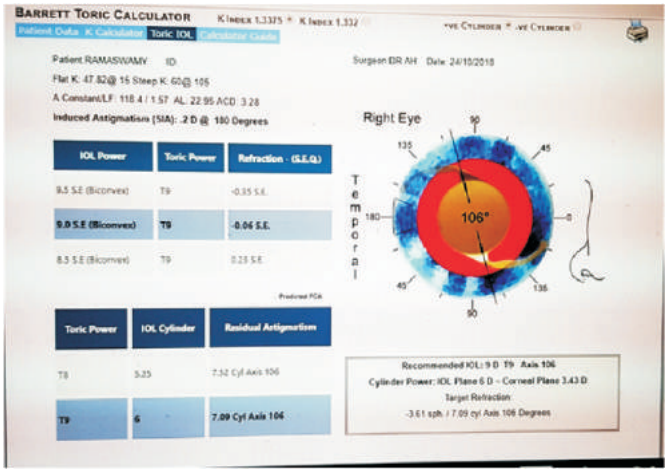

Figure 6 : Barrett toric calculator Right eye

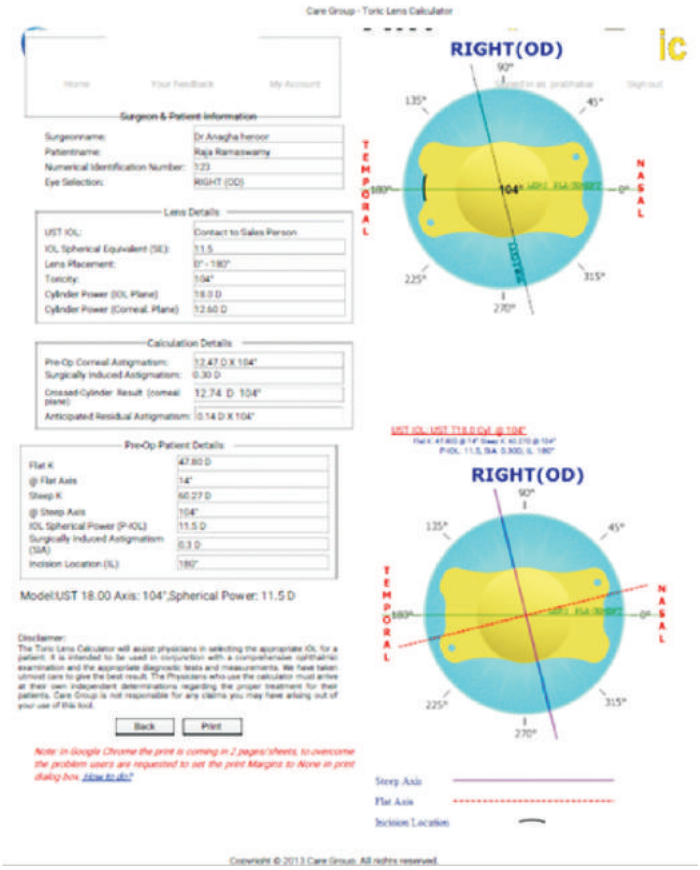

Figure 7 : Ultima smart toric calculation Right eye

We went ahead with the Right eye surgery with an excellent result. The patient improved to 6/9p with -1.0 D cyl @ 105.

The left eye was the bigger challenge.The patient had poor vision in the left eye since childhood though he was never diagnosed or treated. He hadno hopes at all and very low expectations, and he didn't want any other surgery except the cataract surgery. Hence, we just gave it a try as there was nothing to lose, so , under very severe guarded prognosis, we went ahead.

In the left eye, the Auto k and the IOL master 700 could not measure the K readings. Hence, the topography K readings were taken which were comparable to the pentacam readings in the EKR report at the 4.5 mm zone (Figure 4)and the 4 map report. The graph in the EKR report also showed a wide variability in the K readings from almost 50 D to 77 D which indicated a poor prognosis. The corneal wavefront showed a horizontal coma of 5.3 microns.

The topography readings were fed in the IOL master 700 and the IOL power was calculated, which gave an axial length of 25.82 mm. We wanted to confirm the axial length on the

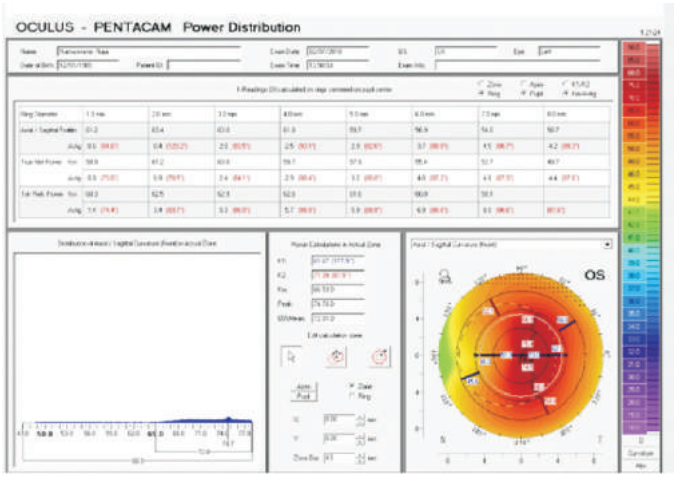

Figure 8 : Pentacam Power distribution map Left eye

immersion biometry which also showed a comparable reading of 25.7 mm. However, the ultrasound Ascan biometer did not accept a K reading of more than 68 D. Hence , K1 and K2 readings entered were reduced by 4 D each. It gave an IOL power of -20.5 D with the SRK T formula and an A constant of 118.7 (Figure 9). The IOL master , gave an IOL power of -20.5 D with the Haigis and -27 D with the SRK T and the Holladay II formulae for the Ultima lens that we were planning to use.

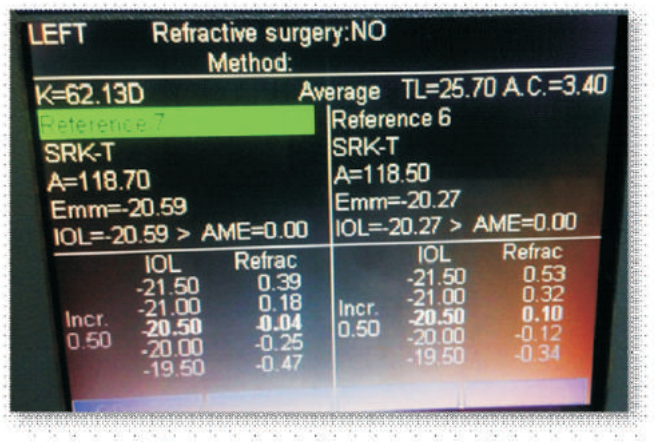

Figure 9 : Immersion Biometry Left eye

The Barrett Universal II (not more than 55D K), the Barrett Toric calculator (not more than 60 D K)& the Hill RBF calculator(not more than 52 D K and not less than -5 D IOL power) refused to accept such high K readings.

It was decided to use a customised Ultima smart toric IOL again in the left eye with a spherical IOL power of -20 D and +17 D cylinder @ 85 degrees at the IOL plane with an anticipated residual astigmatism of 0.21 D @ 85 degrees, with incision at 0 degrees & IOL aligned in the 0-180 degrees axis (Figure 10). The next day postop, the vision improved to 6/60 with a cylinder of -5.0 D cyl @ 140 degrees with an anti-clockwise rotation of 15 degrees. Hence, the patient was taken up the same day for an IOL rotation without using any viscoelastics and the IOL was aligned to the 0-180 degree axis. The vision improved to 6/36 with a manifest refraction of -2.0 D cyl at 160 degrees.

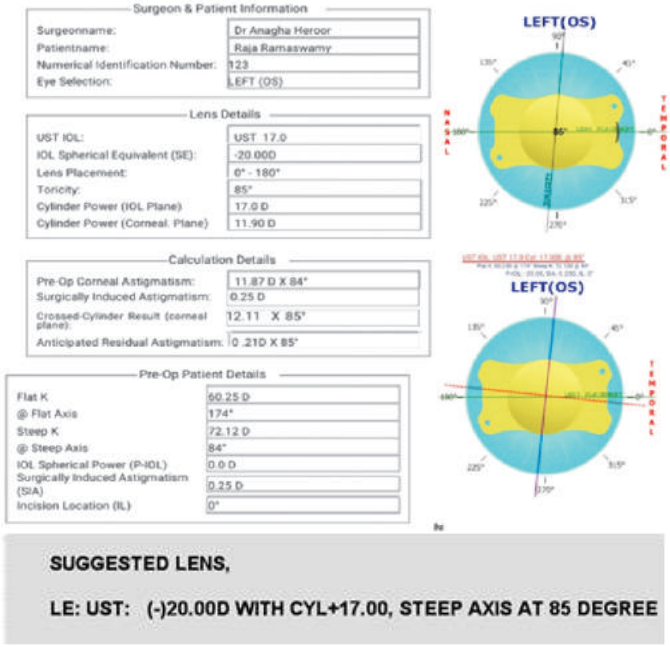

Figure 10 : Customised Ultima Smart Toric calculation Left eye

The total eye aberrometry done 1 month later showed the following readings

RE RMS HOA 0.57 microns

LE RMS HOA 1.07 microns.

The patient was extremely happy with the result. We were pleased that inspite of having very high astigmatism and an advanced keratoconus especially in the left eye, we were able to atleast debulk the astigmatism and give the patient a good visual outcome with fairly good functional vision.

Discussion:

There are usually 3 reasons for wrong IOL power calculations in keratoconus -index of refraction error, instrument error&formula error. Calculating the corneal power with the standard keratometric index (n =1.3375) can lead to erroneous results as the B/A ratio is disrupted. The very steep & asymmetric corneal curvature causes an error in the K reading & a variability in the K reading in different instruments.

In general, all formulas produced a positive mean Predicted error (PE), meaning that a hyperopic refractive outcome is likely to occur inmost keratoconus patients. In Stage

I & stage II of keratoconus (Krumeich classification), the SRK T formula was found to give the least error. Even in cases of stage I , most formulas achieved a percentage of eyes with a Predicted Error within +/-0.5 D close to 40%, a value that is much lower than that reported for normal eyes. In eyes with stage III keratoconus, almost all the formulae were unpredictable, with mean PEs and median absolute error higher than 2.5 D.[1]

All formulas tend to have a hyperopic surprise. The Barrett Universal II formula was the mostaccurate for mild to moderate disease.[2] Pentacam keratometry may help avoid hyperopic outcomes.

Overall, these results suggestgreat caution when targeting any refractive outcome ineyes with keratoconus, especially when the preoperativeK value is higher than 48 D.

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Ophthalmic News (Compiled from OBN Ophthalmic Breaking News)

Biodegradable Glaucoma Implant Study From PolyActiva

The latest announcement about glaucoma treatment study has come recently from a clinical-stage Australian ophthalmology biopharmaceutical company, PolyActiva Pty Ltd. According to the announcement, the company has completed its Phase I clinical study for its lead candidate, the Latanoprost FASR Ocular Implant.

The implant device was well tolerated in all 8 patients without any significant safety findings and the study also showed that the implant persists for the entire 6-month treatment period after which the implant biodegrades completely over six weeks. This biodegradation profile should enable repeat dosing with the implant.

The Latanoprost FASR Ocular Implant is designed to substitute for daily drop therapy by providing sustained treatment from a single implant administration over six months to treat glaucoma.

PolyActiva has now initiated a Phase II dose-ranging study at nine clinical trial sites in Australia. The study is designed to identify the minimum effective dose of latanoprost free acid and confirm the safety of the implant.

High-dose Sirolimus appears Safe, effective for Noninfectious Uveitis of Posterior Segment

This trial evaluated intravitreal sirolimus for noninfectious uveitis of the posterior segment. Researchers randomized 416 patients to receive sirolimus (44 µg or 440 µg) on days 1, 60 and 120 of treatment. By 5 months, corticosteroids were tapered successfully in approximately 69% of both groups. The 440-µg arm had better inflammation control, as measured by vitreous haze, compared with the 44-µg arm. Both doses were well tolerated and had minimal impact on IOP. Approximately 80% of sirolimus-treated patients maintained or improved BCVA by more than 5 letters. A higher 880-µg arm was terminated as it appeared to offer comparable benefits to the 440-µg dose. *Ophthalmology, October 2020*

OCT Angiography : Basic Concepts

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Abstract :

Optical Coherence Tomography Angiography (OCTA) is a non-invasive dye-free imaging technology that creates high resolution depth resolved angiographic images of vascular flow in retina. It is based on the principle of split spectrum amplitude decorrelation angiography algorithm. OCTA gives segmentation of layers as superficial capillary plexus, deep capillary plexus, outer retinal layer, outer retina to choriocapillaris, choriocapillaris layer and choroid layer.OCTA is also useful for visualization of choroidal neovascularization and the monitoring of age-related macular degeneration (AMD) by observing the morphologic changes of choroidal vessels. It is an efficient tool to keep evidence of regression and progression of the disease in follow up cases of AMD patients on anti-VEGF treatment. OCTA plays an important role in the diagnosis of early and advanced changes in diabetic retinopathy (DR). It has the advantage to examine the superficial and deep capillary plexuses separately. The segmentation of layers in OCTA in a case of DR is important in the micro evaluation of the status of the retinal vasculature and for prognostication. Disadvantages of OCTA are that images do not show leakage, dye pooling and tissue staining. It has limited field of view, artifacts, and limited choroidal penetration. OCTA is a useful tool to be used in correlation with structural cross-sectional scans in determining treatment decisions.

INTRODUCTION:

The risingcall towards non-invasive methodsof retinal imaging led to the development of the imaging modality in 2015 called theoptical coherence tomography angiography (OCTA).

OCTA providesmany advantages over conventional angiography in terms of both patient comfort as well as technical superiority. Patient comfort is in the form of shorter acquisition time and in being non-invasive. Thus, it is free of the associated systemic adverse effects and anaphylactic reactions.

OCT ANGIOGRAPHY:

OCTA is a non-invasivedye-free imaging technology that creates high resolution and depth resolved angiographic images of vascular flow in retina. It is able to do so in a span of few minutes by using motion contrast. [1-3]

Unlike fundus fluorescein angiography (FFA),which is an invasive dye based procedure, OCTA is a non-invasive procedure free from complications.This investigative technique provides the advantage ofvisualizing deep capillary vessels while FFA depicts mainly superficial capillary vessels.

PRINCIPLE OF OCTA:

OCTA is based upon the principle of the split spectrum amplitude decorrelation angiography (SSADA) algorithm. It applies highspeed OCT scanning to detect blood flow. It carries out signal decorrelation between scans and analyses it to differentiate the flow of blood vessels from the other surrounding non-vascular tissue.[4-7]

SEGMENTATION OF LAYERS SEEN ON OCT ANGIOGRAPHY :

Segmentation of layers can be performed on OCTA

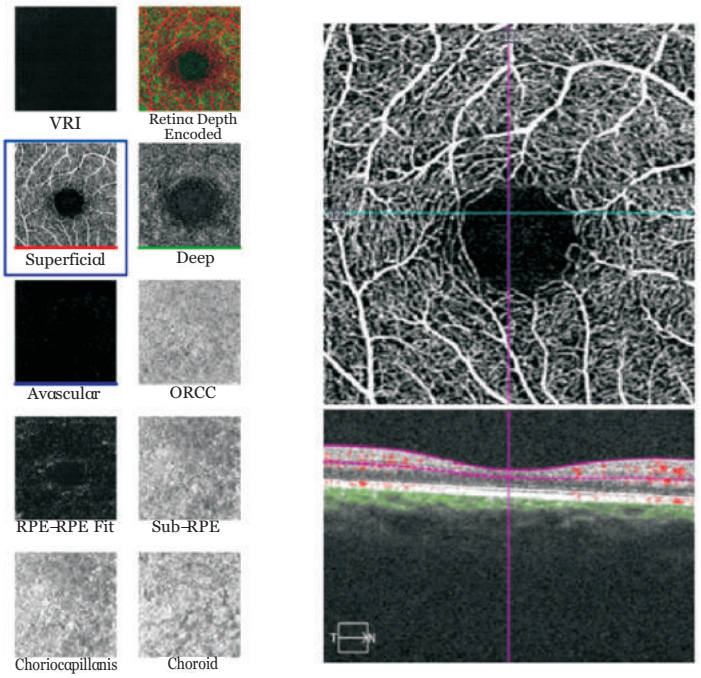

Figure 1: OCT-A showing the segmentation of layers of the retina

1. Superficial Capillary Plexus:

It is in form of continuous perifoveal arcade with regular meshes arranged in centripetal pattern around foveal avascular zone. It lies about 3µm from the internal limiting membrane (ILM). It supplies the retinal nerve fibre layer, ganglion cell layer and superficial part of inner plexiform layer. Its thickness is approximately 10µm. [8-9]

2. Deep Capillary Plexus:

It is in form of close knit pattern of vessels around the avascular zone. Its thickness is approximately 60µm. It lies around 15µm from the Inner Plexiform Layer. It supplies the deep part of inner plexiform layer, inner nuclear layer, outer plexiform layer and superficial part of outer nuclear layer. [8-9]

3. Outer Retinal Layer:

It is an avascular layer, does not show any vascular plexus normally. Any vascularity seen in this layer can be pathological neovascularisation arising from beneath. It ranges from deep outer nuclear layer to external limiting membrane. It is nearly 30 µm away from retinal pigment epithelium (RPE) and its thickness is approximately 30µm. [8-9]

4. Outer Retina to Choriocapillaris (ORCC):

It is present between the outer boundary of outer plexiform to 8µ below Bruch's membrane. It is used to detect progression of choroidal neovascularisation for the determination of the type of wet age related macular degeneration (AMD) as well as to monitor the response of therapy. [10]

5. Choriocapillaris layer:

It is imaged 10µ beneath the Bruch's membrane. The angiogram ofthis layer is generally homogenous. There is presence of black shadowing of vessels in this layer. [11]

6. Choroid layer:

OCTA gives us the advantage to visualize choroid vasculature in depth. Changes in the choroidal vessels can be picked up in early course of disease. However, OCTA has limited choroidal penetration. [11]

ROLE OF OCT-A IN WET AGE-RELATED MACULAR DEGENERATION (AMD)

One of the most important clinical applications of OCTA is supposed to be the visualization and monitoring of choroidalneovascularization (Figure 2). It has been seen that

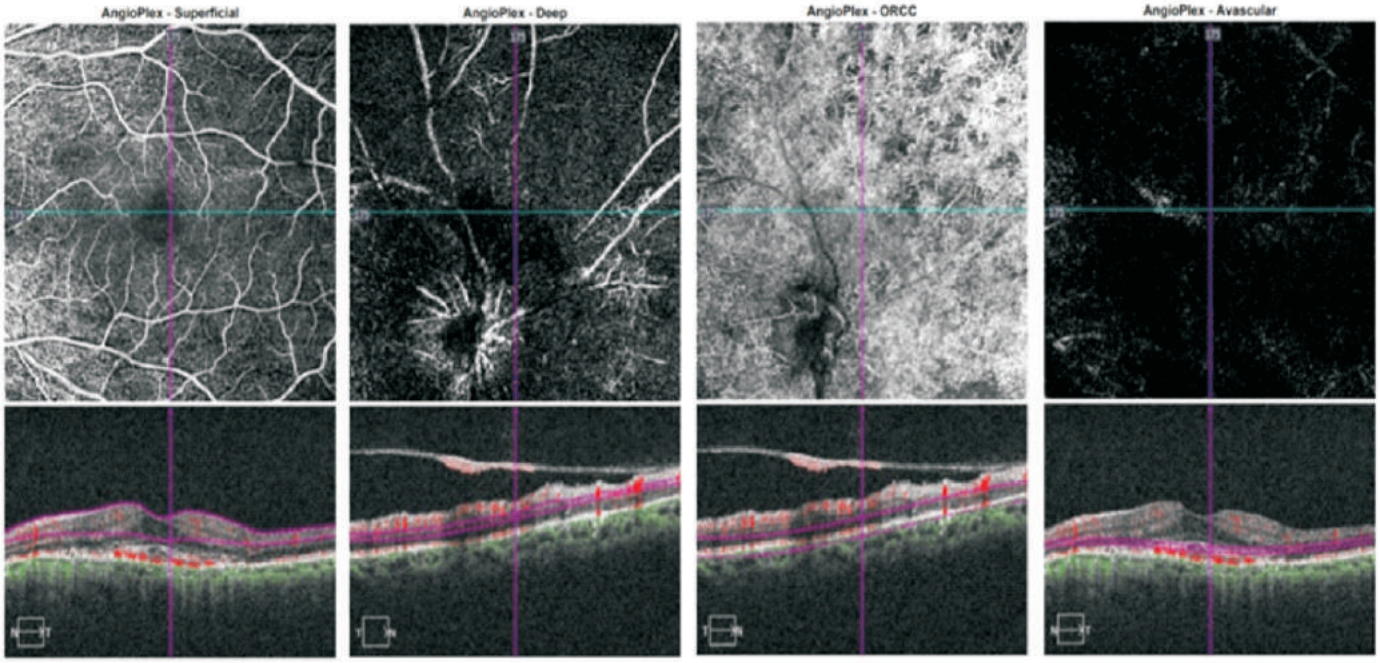

Figure 2: OCT-A of a case of wet AMD showing superficial, deep, ORCC and avascular layers respectively.

with the use of OCTA early choroidalneovascular membrane (CNVM) can be detected earlier than FFA, in which it is generally difficult to detect. [12]

The neovascularcomplex of retinal angiomatousproliferans (RAP) appears as a small tuft of bright high-flowtiny vessels with curvilinear morphology located in the outerretinal layers with a feeder vessel communicating with the inner retinal blood vessels detecting CNV. [13-14] OCTA is able to identify a distinct neovascular complex in these RAP lesions.

Intravitreal injection of anti-vascular endothelial growth factor (anti-VEGF) is the mainstay of therapy for the management of CNVM in wet AMD today. [14-15] OCTA is also useful for the

monitoring of AMD by observing the morphologic changes of CNV vessels over weeks after treatment with intravitrealanti–VEGF. It is an efficient tool to keep evidence of regression and progression of the disease in follow up cases of AMD patients on anti–VEGF treatment.

ROLE OF OCTA IN DIABETIC RETINOPATHY

OCTA plays an important role in the diagnosisof early and advanced changes in diabetic retinopathy (DR). In patients with DR, OCTA reveals retinal changeslike capillary dropout in the superficial and deepplexuses, foveal avascular zone (FAZ) enlargement and the presence of microaneurysms.OCTA has the advantage to examine the superficial and deepcapillary plexuses separately which helps us to outline retinalinvolvement in different diabetic lesions. Increase in the size of theFAZ has a correlation with severity of disease and is best seen in the superficial plexus, whereas capillarydropout and microaneurysms are best visualized in thedeep plexus.[16] However, microaneurysms are visible on OCTAonly in the presence of intravascular flow; therefore in cases of decreased flow or thrombosis they will remain undetected. Thedetection of preretinal and pre-papillary neovascularizationcan be done with the help of OCTA as new vessels do not blurby leakage as seen in conventional dye-based angiography.

The segmentation of layers in OCTA in a case of DR is important in the micro-evaluation of the status of the retinal vasculature and for prognostication (Figure 3).

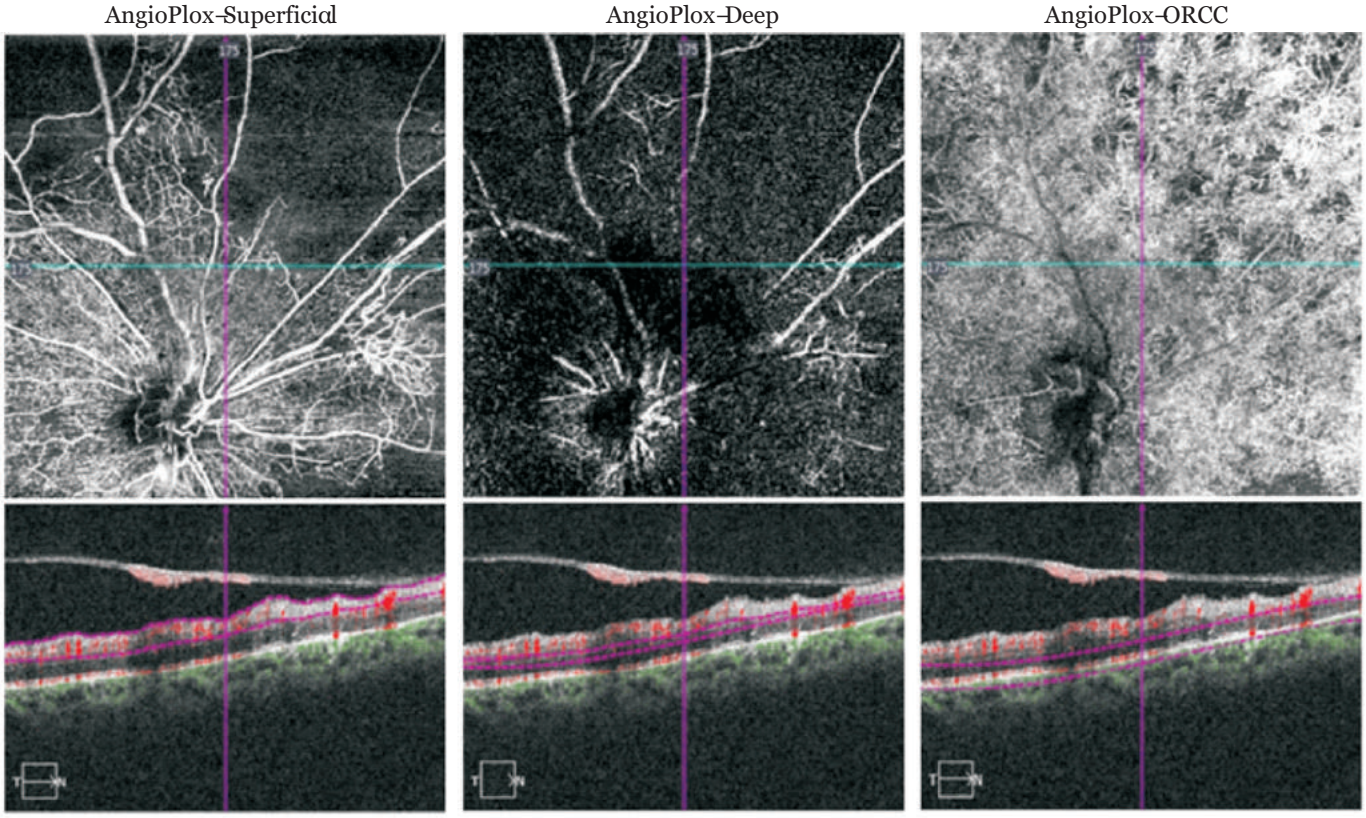

Figure 3: OCT-A of a case of proliferative diabetic retinopathy showing neovascularization elsewhere in superficial, deep and ORCC layer respectively.

Using SD-OCT and OCTA, NVEs have been proposed to develop in 3 stages: I—disruption of ILM; II—horizontal growth along ILM and III—multiple breach of posterior hyaloid (PH) and linear growth.[17,18] According to their morphology they have been classified by Vaz-Pereira et al as (1) flat, when confined to the PH face; (2) forward when lesions showed PH traversal and (3) tabletop when neovascular complexes (NVCs) were displaced anteriorly by vitreous traction but tethered to the retina. NVEs were also classified according to location in (1) above the ILM and (2) below the ILM types based on their intraretinal component.[17,18]

ARTIFACTS AND LIMITATIONS OF OCTA

Despite improvements in softwares in many models of OCTA, some significant limitations are still present and require further refinements of technology. Asit is based on SSADA algorithm that detects blood flow by movement, any movement

by the patient will give rise to a significant artifactand this will cause worsening of image quality.

Projection artifact also known as the tailing artifact,is the transit of blood cells in a superficial blood vessel that casts flickering shadows on the deeper tissue layer. This makes it difficult to distinguish from blood flow in deeper layer, causing duplication of vessels. This makes it difficult to differentiate normal physiological vessels from pathological vessels. The software provides a function to remove projection artifacts, but this can cause some loss of signal of pathological blood vessels.[19]

Segmentation artifact occurs in conditions that alter the anatomy of retinal architecture. OCTA allows us to have segmental visualization of superficial capillary plexus and the deep capillary plexus and the choriocapillaris. In pathological conditions where the retinal architecture is altered, it can give an incorrect segment interpretation of these layers and blood vessels in it.

Motion artifact can be seen with eye movements and blinking. Motion correction technology is provided that helps reduce decorrelation and gaps in the image it createsby identifying changes in consecutive images of the same location.[20]

As OCT angiography is dye-free, images do not show leakage, dye pooling and tissue staining, which are important features of certain disorders of inflammation and diabetic retinopathy. These need to be correlated simultaneously with structural cross sectional OCT scan.

OCTA technology has limitations in the form of limited field of view, artifacts, and limited choroidal penetration.[20,21]

The limited field of view has been improved with the introduction of widefield OCTA, which used montaging algorithms to provide a larger field of view.[22]

The artifacts in OCTA images such as blink, motion, projection and segmentation errors lead to difficulty in interpretation of the images.[21]

Thus, OCTA should not be used asan exclusive diagnostic modality and always needs to be used in correlation with structural cross-sectional scans in determining treatment decisions. Improvements in the form of software updates, scan acquisition rate with automated artifact removal and adaptation will be of help to further the role of OCTA in the management ofchorio-retinal pathologies in a much more advanced way.

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Premium IOLs Selection Criteria, Investigations IOl Models & Residual Correction : An Overview

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Abstract :

Cataract Surgery is the by far the 'most performed surgery' in the world. Now, more than ever before, the need for the ophthalmic surgeons to keep themselves abreast with the latest in refractive cataract surgery, is of utmost importance. Today, the patients demands are based on needs in tune with the modern gadgetaries and on knowledge about availability of different techniques and IOLs gathered from the internet. This article describes the selection criterias and the different advanced investigations necessary for extracting optimal results from premium IOL implantations. Whilst counselling is extremely important, pre operative examination of macula, optical biometry, wavefront aberrometry, corneal topography and dry eye evaluation are very crucial. Different IOL models are described in detail. Bifocal, Trifocal and Toric IOLs including Bifocal and Trifocal Toric, EDOF IOLs, marking for implantations and image guided operating systems add value to precision and perfection which affect the final visual outcome. Monetarily charging a premium and raising the expectation of the patient can only be met confidently if the surgeon is additionally well versed with the management of residual refractive error. It is equally important to know the future of premium IOLs so that we keep abreast with the latest in technology and then transfer it to the advantage of our patients.

Introduction:

Cataract surgery has seen the paradigm shift from being a restorative to now an established refractive procedure.

Technological innovation and specification in the intraocular lenses further evolved to improve the quality of the vision and life of the patient post-operatively. The use of Mono-focal intra–ocular lens has excellent distance visual outcome but the near and intermediate distance vision largely depends on additional spectacle corrections.

Toric IOLs, Multifocal and Accommodative IOLs are considered as premium IOLs. They are used mainly in patients having cataract with corneal astigmatism, presbyopia but without any other ocular comorbidities.

The most commonly used multifocal IOLs are the bifocal ones, which create two primary focal points, one for distance and one for near vision. The insufficient intermediate vision that these lenses offer has been one of their main drawbacks, especially due to the expanding needs of modern-day patients (e.g., use of electronic devices etc.). Trifocal IOLs were, thus, subsequently introduced, offering a third focal point for intermediate vision.

In an attempt to achieve good quality of vision at all distances, while avoiding undesirable photic phenomena, a new generation of IOL was introduced, the extended depth of focus (EDOF) IOLs.

Once you select your preferred procedures and technologies, you can determine patient suitability for any procedure and then decide which procedure or IOL you will use. Identifying a good patient for a premium IOL requires ample consultation time, during which you should make a reasonable assessment of personality type, quantify visual need and demand and determine the physical health of the eye.[1,2]

Patient Selection Criteria

The ideal patient is motivated to achieve spectacle independence for distance and near vision, understands the limitations of premium IOLs, and has realistic expectations. Patients should be informed about potential optical aberrations that could influence quality of vision. Some of these symptoms can later be improved through a process of neuroadaptation, but the patients must be aware of the possibility that these symptoms can permanently persist. Another important issue is

a possible second surgical intervention in the sense of bilateral premium IOL implantation, which could provide significantly better visual results in both multifocal and toric IOLs.[1,2,3] Different macular and optic nerve head diseases are associated with decreased contrast sensitivity.[1,4]

Astigmatism is an important preoperative factor, especially when considering that approximately 15%–20% of patients with cataracts have a preoperative corneal astigmatism of more than 1.25 diopter (D).[5,6] The presence of astigmatism in eyes with multifocal IOLs compromises all distance visual acuities, suggesting the need to correct astigmatism greater than 1.0 D. Furthermore, posterior corneal astigmatism should also be considered in surgical planning. Patients with irregular astigmatism are not good candidates for multifocal IOL due to questionable outcomes and refractive correction challenges. Limbal relaxing incisions or opposite clear corneal incisions can be performed during the surgery and laser refractive surgery can be used after the surgery in order to reduce astigmatism.[7,8,9] Regular astigmatism is most suitable for toric IOL implantation; however, irregular astigmatism in cases of keratoconus, or after keratoplasty, can also be successfully treated with toric IOL implantation. For patients with regular corneal astigmatism which require spectacle independence, toric multifocal IOLs should be discussed.

Any preexisting ocular comorbidities that could affect the vision are relative to absolute contraindications for premium IOL implantation. Therefore, a detailed preoperative ophthalmic examination is mandatory. Ocular pathologies, such as corneal pterygia and dystrophies and especially Fuchs endothelial dystrophy, should be carefully evaluated, taking into account the progressive nature of these diseases.[2,7] In young patients with amblyopia, functional improvement is possible with the use of premium IOL, but one should be careful because of uncertain postoperative refractive results. Several retinal diseases, such as retinitis pigmentosa and Statgart disease, are absolute contraindication for any premium IOL. In patients with uveitis, there is always a risk for early or late postoperative reactivation, and these patients should be avoided in premium IOL surgery. Patients with previous ocular surgeries should also be avoided in premium IOL surgery. Although not necessarily a contraindication, previous refractive ocular surgeries can induce significant amounts of higher order aberrations

that may preclude the use of premium IOLs, especially multifocal IOLs. Although the multifocal IOLs can be used as an aid for magnification in eyes with age-related macular degeneration (ARMD), the surgeon must be cautious as in multifocal IOLs there is a split between near and distance foci. In some cases, this could result in further contrast sensitivity reduction and even poorer vision than with monofocal IOLs. Additionally, macular diseases such as ARMD or diabetic maculopathy can progress after any cataract surgery. Care should be taken when considering for premium IOL implantation in patients with glaucoma or any optic nerve damage. Only glaucoma suspects and ocular hypertensive patients with no disk or visual field damage who have been stable for a longer period of time should be candidates for multifocal IOLs.

Patients with dry-eye syndrome and meibomian gland dysfunction are potentially extremely unsatisfied after cataract surgery, regardless of premium IOL type, due to tear-film abnormalities and subjective symptoms. These conditions should be treated aggressively before the surgery Premium IOL Decentration or rotation could lead to the reduction of premium IOL efficiency, resulting in significant visual disturbances. Therefore, ocular disorders with capsular instability (pseudoexfoliative syndrome or trauma induced zonulolysis) are absolute contraindications for multifocal and relative contraindication for toric IOL implantation. Mild zonular weakness is not strict contraindication for premium IOL implantation; however, adequate preoperative and preoperative assessment is essential.[2] In these eyes, implantation of capsular tension ring could provide stabilization of the capsular bag, and even contribute to better postoperative IOL centration. The function of the premium IOL is also dependent on postoperative pupil size and position, where patients with larger pupils may have more glare and haloes, but patients with small pupils may have difficulties in intraoperative IOL centration.[10], It is imperative therefore, all mentioned factors should be carefully considered before opting for premium IOL implantation.

Counselling:

Counselling starts with comprehensive understanding of the technologies and techniques associated with a procedure, before they can educate the patient for it. IOL technology is ever-evolving, with new products entering the market on a regular basis. However, the multifocal lens design can result in a higher incidence of unwanted visual phenomena such as contrast sensitivity loss, glare and halos.[11,12]

The most important component of post-operative success with a premium IOL is preoperative counselling. As innovative as these new IOL options are, patients should be properly counselled that they aren't perfect—and may not be a perfect match for them. For starters, they will want to know a large out–of-pocket cost which is usually associated with premium IOLs. Be aware, large price tag may actually elevate their expectations, too. Implantation of multifocals without discernment or discretion may yield many disgruntled patients.

Patients who elect a presbyopia-correcting IOL must be motivated to be spectacle independent.

The conversation should include a careful evaluation of patient's needs, lifestyle and personality. Asking about lifestyle, work, and hobbies will give information about the types of visual tasks patient performs. Patients with unrealistic expectations or an overly critical personality are less likely to fare well with premium IOLs.

Counsellor should assess patient's refractive error, and current visual acuity should be considered. Hyperopes who have significant cataracts will gain the most from presbyopia–correcting IOLs, with uncorrected vision improvement at all distances. Mild myopes who rely on their near vision for specific tasks may have something to lose and could be dissatisfied with the result. About 35% to 40% of eyes undergoing cataract surgery have astigmatism equal to or more than 1.0D and about 20% have astigmatism greater than 1.5D[8-10] These patients should be counselled for toric trifocal after proper assessment.

Eyes with corneal conditions—such as keratoconus, anterior basement membrane dystrophy or corneal scars—are not good candidates for premium IOLs due to the risk of higher-order aberrations and irregular astigmatism.

Patients with a history of refractive surgery often prefer to maintain spectacle independence. A second refractive procedure can be offered as an enhancement if residual refractive error is significant after cataract surgery. Patients should be thoroughly educated on risks in these cases, though typically risks are lower than that of a lens exchange.

Counsellor should be aware, best way to avoid premium IOL pitfalls is by predicting and preventing them prior to surgery. However, even with careful planning, patients can end up dissatisfied. The most common cause of dissatisfaction in patients with multifocal implants is residual refractive error, followed by dry eye, glare and halos.[13,14]

It should be counselled preoperatively, any residual refractive error may be addressed with laser vision correction; however, it is vital to allow for adequate healing and stabilization of corneal topography prior to any refractive surgery. Refractive surprises may occur unpredictably, but are more likely in eyes with particularly short or long axial lengths, a history of previous refractive surgery or both. Surgical practices may include laser vision correction enhancement in their premium IOL packages in case of a "refractive surprise." Patients usually do well with premium IOLs once the residual refractive error is corrected.

In case of toric trifocal, if residual astigmatism is caused by rotation off the intended axis, the patient should be sent back to the Operation Theater and the lens should be rotated into the correct position within the first few weeks after surgery.

Neuroadaptation plays an important role in multifocal outcomes, especially positive dysphotopsia. No effective treatment for these symptoms is available. Four to 12% of cases in which bothersome glare, halos or starbursts are present are due to an IOL defect. These patients should be discouraged for Trifocal/ EDOF.

Investigations before Premium IOL implantation:

The expectations of a patient opting for premium IOL would definitely be more than those opting for routine IOLs. As clinicians, it is our duty to perform relevant investigations and then advise for the best suited Premium IOL for each patient. Following are the investigations to be advised in selection and planning of Premium IOLs.

Macula Oct:

There is growing evidence for the importance of more detailed evaluation of macula even with clinically normal appearance. Spectral Domain Optical Coherence Tomography (SD OCT) is non – invasive and sensitive test for evaluation of macular structure.

Studies conducted in patients undergoing cataract surgery with normally appearing macula have shown that routine use of OCT prior to cataract surgery can detect subtle macular disease, which may alter course of treatment or lead to modification of consent.

Moreira Neto et al. investigated 98 patients undergoing cataract surgery; they diagnosed preoperative maculopathies in 21.4% of the patients with SD-OCT, which was a larger percentage than that detected with binocular indirect ophthalmoscopy (11.2%). Similar results have been obtained from other studies.[15,16]

The most common macular conditions threatening vision encountered were epiretinal membrane (ERM) and myopia associated complications. Perimacular/foveal drusen, fovea plana, atrophy of retinal pigment epithelium are among the other conditions which can hamper the visual outcome. Patients having poor prognosis are not satisfied with the results. There are certain diseases which are progressive, for example the diagnosis of drusen identifies patients at risk for development of age related macular degeneration (ARMD) where Multifocal IOL will not be a good choice to advocate. Moreover, it also helps in preoperative counselling of these patients for necessary follow ups.

Hence, a routine use of OCT macula in Premium IOL cases can pick up these subtle macular disease which can be contraindication to the use of these IOLs.

Biometry:

This is the most essential tool for IOL power calculation prior to cataract surgery and also helps in selection of Premium IOLs.

Today we have shifted from Manual (Ultrasound) Biometry to Optical Biometry. In Manual Biometry, Keratometry readings are taken from manual or auto keratometer and entered in the A scan machine along with measurement of axial length and calculates the IOL power for the selected formula. Apart from being tedious and time consuming process, there are changes of human error and hence, getting inaccurate IOL power. It also has user bias based on skill of the operator. A wrong data entry can give a wrong IOL power especially in Toric IOLs. Optical biometry is comparatively faster, more accurate, non-invasive (non-contact), easy to operate and less chances of human error. A single machine measures all the parameters and calculates the IOL Power. Today, Ultrasound Biometry is mostly restricted to cases where optical biometry cannot be performed due to opaque optical media.

Advanced technologies related to optical biometry such as partial coherence interferometry (PCI), optical low-coherence reflectometry (OLCR), and swept-source optical coherence tomography (SS-OCT) have increased the precision of biometric measurements.[17,18] The accuracy of modern formulae depends upon their predictability of effective lens position (ELP). For the most part, this has been accomplished by increasing the number of variables—including preoperative anterior chamber depth (ACD), lens thickness (LT), corneal diameter (white to white, WTW), central corneal thickness (CCT), preoperative refraction, and age—as well as basic variables such as axial length (AL) and corneal power (K). It is advisable to take two readings on same or different machines for more accuracy and to avoid refractive surprises.

With the advancement in technology, it has been possible to make eyes absolutely emmetropic by putting IOL of exact power. This is possible because of new formulae evolving each day. In normal eyes (22-26 mm axial length), the formula of choice is SRK – T, while the Hoffer Q in short eyes (< 22 mm) and the SRK – T and Holladay 1 with Wang – Koch axial length modification in long eyes (>26 mm) is preferred. The advent of Barrett Universal II vergence formula has given a single formula that is applicable across wide range of axial length. It performs equally well in Asian population and has been found to be the most accurate formula in prediction of post-operative refraction in Indian eyes. The Hill–RBF and the Super Ladas formulae using artificial intelligence also hold the same promise.

Image-guided Systems:

Image-guided systems are new technology. It is a surgeon's companion wherein it helps in surgical planning and execution. They also provide digital image guidance for toric IOL alignment without preoperative manual marking. The most common current surgical-guidance systems are the Alcon Verion Image-Guided System and the Zeiss Callisto Eye and Z align.[19,20] Another similar system is TrueVision 3-D (3 dimensional) Surgical System (TrueVision Systems, California).

These image-guided systems enables calculating the power of Premium IOLs (toric or multifocal IOL) using different formulas, selecting the optimum location of corneal and limbal incisions by providing an astigmatism planner, selecting the preferred diameter and centration of capsulorrhexis as well as IOL centration and position after the visual identification of the optical axis.

Amongst the image-guided systems, the Alcon VERION system has additional benefit of taking its own keratometric readings along with other biometric ocular parameters which include corneal radii, the magnitude of astigmatism, limbus position and diameter, WTW and pupillometry. It predicts the actual postoperative power in terms of sphere and cylinder. Other machines give it in terms of spherical equivalent which may be misleading. It is a reliable system for measurement of keratometry values and astigmatism. The keratometric power, magnitude and steep axis of astigmatism have no significant difference and there is good agreement among Verion, IOL Master 700 and Pentacam. It also captures a high resolution preoperative reference image of the eye which can be used to document the center of the undilated pupil, corneal reflex position or eccentricity of the visual axis, scleral vessels and iris structures. The VERION digital marker (VDM) located in the operating room allows the surgeon to see in real time a digital tracking overlay picture after the intraoperative registration. This system also corrects cyclotorsion by recognising scleral vessels and landmarks of the iris. The surgeon receives visual guidance for the important surgical steps like corneal incisions, capsulorhexis, IOL centration and IOL alignment of toric IOLs. Moreover, it calculates surgically induced astigmatism (SIA) and optimizes the constant of IOL in cases of post-operative follow up and repeated measurements taken by the system.[21-22]

The Zeiss Callisto Eye has similar functions where the keratometry and other biometric parameters are measured with the help of IOL Master 500 or 700. This system also provides markless alignment of toric IOLs.

TruePlan is a surgical planning application that collects and stores all diagnostic variables that are necessary for the creation of a customized surgical plan which is afterwards sent to the TrueGuide in the operating room. TruePlan can collect data from a variety of devices, such as i-Optics Cassini corneal LED topographer, OCULUS Keratograph 5M and OCULUS Pentacam AXL, as well as Haag-Streit Lenstar.

Aberrometry :

Wavefront aberrometry is helpful in screening of candidates for

multifocal IOL and for precision in Toric IOLs. As cataract surgery has become more of refractive surgery, we have to rule out other ocular co-morbidities to prevent patient dissatisfaction. One of the co-morbidities is aberration in optical system especially the higher order aberrations which produces visual disturbances even with a good visual acuity.

iTRACE is a ray tracing aberrometer combining wavefront aberrometry and placido based corneal topography. Hence, it is superior to other aberrometers in providing results individually for corneal and internal (lenticular) aberrations in addition to total aberrations.

It also helps in evaluating Angle Kappa which is angle between the visual axis and pupillary axis. High angle kappa is considered a contraindication for implantation of multifocal or extended range of vision IOLs as decentration of these premium lenses often result in poor post-operative visual outcomes. It also provides the measurement of 'Angle Alpha' which is measured at the nodal point of the eye. It is the difference between the center of limbus (optical center of cornea) and the visual axis. It is considered a confidence metric because knowing this number helps the surgeon predict how well the MFIOL will align optically with patient's visual axis.

The iTrace workstation incorporates an in-built Toric IOL planner, which calculates the IOL power and also provides axis of placement. Integrated Zaldivar toric calliper with toric calculator can be used to assess the accuracy of preoperative reference axis marking.

Intraoperative wave front aberrometry devices such as Optiwave Refractive Analysis (ORA) and Holos IntraOp perform a real time assessment of phakic, aphakic or pseudophakic refraction to provide feedback for toric IOL alignment. ORA is increasingly being used to estimate the toric IOL power and axis of placement based on the aphakic refraction, especially in post refractive surgery cases. It permits refinement of the axis by providing direction and magnitude of rotation required to achieve minimal residual astigmatism.

Corneal Topography And Tomography:

Routine biometry considers only the optical part of cornea which is central 3 mm. Hence a corneal topography is required to study the larger area of anterior surface of cornea and corneal tomography to study the entire cornea. Newer technologies such as slit-scanning videokeratoscope, Scheimpflug device, anterior segment OCT (AS-OCT) measures anterior and posterior corneal shapes. Topographic analysis eliminates pathological (Fruste) Keratoconus and irregular corneas. Pentacam based on Scheimpflug imaging allows quantifying the corneal irregularity (Total corneal irregular astigmatism), which will be at best lower than 0.300 m. Multifocal implantation is possible upto 0.500 m but contraindicated beyond. Similarly Toric IOLs are also not a good choice in irregular astigmatism. In contrast, Asymmetric but regular astigmatism gives excellent results.

Keratometric readings take into account only the anterior corneal surface. The posterior corneal surface has against-the-rule astigmatism pattern as compared to anterior corneal surface.[23,24] Therefore, in eyes with with-the-rule astigmatism, keratometric astigmatism overestimates total corneal astigmatism, whereas in eyes with against-the-rule astigmatism underestimates total corneal astigmatism.[23-25] This is explained by the fact that corneal thickness profile is not uniform. Hence, manifest astigmatism following Toric IOL implantation can be reduced by proper attention to both corneal surfaces. The complete evaluation of cornea helps in better planning and correction of astigmatism when we are considering Premium IOLs. It prevents unpleasant results and patient dissatisfaction.

Pupillometry :

Pupillometry is often overlooked, but is very important in IOL selection. It is measurement of size and reactivity of pupil. Pupil size affects vision with any IOL, but even more so with multifocal IOLs (MF IOLs). The post-operative visual disturbances are directly related to pupil size. Patients implanted with MF IOL often complain of light reflections or blurred rings which are basically ghost images. These ghost images worsen at night due to increase in pupillary size. Interaction with pupil size varies depending on various IOL brands. With multifocal IOLs, which limit their diffractive rings to the central zone of the optic like the Alcon ReSTOR with apodized refractive-diffractive design, reading vision is better with smaller pupils, while distance vision is better in dim lighting conditions, which may decrease night driving dysphotopsias. The AMO Tecnis multifocal IOL has diffractive rings through the entire optic, resulting in improved reading vision in low light situations when pupil sizes are larger. The key here is to select IOL for individual patient depending upon the size of the pupil, daily activities and desires of the patient.

It has been observed that a smaller pupillary size causes worse near vision. Hence, a limitation of 2 mm in photopic and 5 mm in scotopic will avoid any pupillary refractive disorder postoperatively.

Dry Eye Evaluation:

The examination of ocular surface and tear film is often missed out in routine examinations. Managing dry eye in the perioperative period plays an important role in having good outcome. Most of the patients being operated for cataract surgery are elderly with pre-existing minimal dry eye which worsens after surgery. A simple corneal staining and tear film break up time during slit lamp examination can help in

diagnosis. Other investigations can be done when in doubt.

Dry eyes can also alter the keratometry and topographic readings used for IOL calculation. It can also produce false aberrations in aberrometry. Priming patients preoperatively about their dry eye level and explaining the steps taken to improve it before planning cataract surgery helps them better deal with the minimal increase in postoperative dryness. The dryness and ocular surface need to be treated so they are as normal as possible before investigations and surgery. These patients also need a closer follow-up postoperatively until the ocular surface stabilizes.

TORIC MONOFOCAL IOLS:

Toric intraocular lenses (IOLs) are the procedure of choice to correct corneal astigmatism of 1 D or more in cases undergoing cataract surgery.

Toric intraocular lenses (IOLs) were first introduced in 1992 by Shimizu et al. as 3-piece nonfoldable polymethyl methacrylate implants to be inserted through a 5.7 mm

incision. Technological advancements in terms of IOL material as well as design have resulted in better rotational stability and precise visual outcomes.

Patient Selection:

Ideal case selection is a prerequisite before surgery to ensure patient satisfaction as well as optimal outcomes. The decision to implant a toric IOL is governed by the magnitude and axis of corneal astigmatism, patient expectations, type of IOL, and the presence of other ocular comorbidities.

At present, standard toric IOLs are available in cylinder powers of 1.5 D to 6.0 D (1.03 D to 4.11 D at the corneal plane) and are intended to correct preexisting regular corneal astigmatism ranging from 0.75 D to 4.75 D. Extended series and customized toric IOLs to correct higher cylinder powers are also available. Even in cases with low astigmatism with a magnitude of around 1 D, the superiority of toric IOLs over monofocal IOLs has been demonstrated in terms of better-uncorrected distance visual acuity (UDVA).

Marking Techniques:

Accurate alignment of toric IOL is a prerequisite to achieve successful outcomes. Various methods have been described to place the preoperative reference and axis marks and may be broadly categorized as manual methods, iris fingerprinting techniques, image-guided systems, and intraoperative aberrometry-based methods.

Manual techniques

The three-step technique is commonly used for toric IOL alignment, which involves the preoperative marking of the reference axis, intraoperative alignment of the reference marks with the degree gauge of the fixation ring and intraoperative marking of the target axis. The reference marks are commonly placed in the 3'o, 6'o, and 9'o clock positions to improve predictability. The marking may be performed with a skin-marking pen, or with the help of various devices such as a thin slit-beam, weighted thread, pendulum marker or Nuijts-Solomon bubble marker. This is followed by the intraoperative alignment of these reference marks to the degree gauge on a fixation ring, and the target axis is then marked with a corneal meridian marker.

A change in patient position from sitting to supine may induce significant cyclotorsion, and up to 28° of cyclotorsion has been observed in 68% cases. Hence, the patient should be sitting erect with the back resting against a wall and a straight-ahead gaze while marking the reference axis to avoid inadvertent errors. The cornea should be dry, and adequate topical anesthesia should be administered to improve patient comfort during marking.

The three-step marking method is fairly accurate, and a mean error of 2.4° ± 0.8° has been observed during axis marking with a bubble marker, with a total error of 4.9° ± 2.1° in toric IOL alignment. Both bubble marker and pendulum marker are easy and reproducible techniques with fairly accurate results. A comparative evaluation of four different marking techniques including coaxial slit beam, bubble marker, pendular marker, and tonometer marker observed minimum rotational deviation with the pendular marker and least vertical misalignment with the slit lamp marking technique. The least accurate results were observed with the tonometer marker, whereas the other three methods provided fairly accurate results. Slit-lamp assisted pendular marker has been observed to give more accurate results than using a horizontal slit-beam alone or a direct nonpendular marker.

The manual marking methods have inherent sources of errors, such as smudging of the dye, irregular, and broad marks.

Moreover, they are associated with a significant learning curve, and intersurgeon variability may be observed in the accuracy of marking.

Osher ThermoDot Marker (Beaver-Visitec International, BVI, Waltham, Mass.) has been developed to eliminate the ink-associated problems in reference axis marking. It employs a bipolar cautery to create an ink-free, precise reference mark during surgery. Anterior stromal puncture using a 26-gauge bent needle stained with sterile blue ink has been described for reference axis marking, to obtain precise reference marks with no smudging.

Functional outcomes

A UDVA of 20/40 or better is achieved in 70%–100% of cases undergoing toric IOL implantation. Spectacle– independence

for distance vision has been reported in 60%–97% of patients with toric IOLs.

Lower degree of mean residual astigmatism is observed with toric IOLs as compared to nontoric IOL's with or without limbal relaxing incisions. Residual astigmatism may result from preoperative measurement errors, marking errors, posterior corneal astigmatism, ELP, and postoperative IOL rotation. A randomized control trial observed residual astigmatism of 1.0D or less in 88% cases and 0.5D or less in 53% cases undergoing toric IOL implantation.

IOL rotation may be observed as early as 1 h after surgery, and a majority of rotations occur within the initial 10 days. Early IOL rotation likely results from incomplete OVD removal, whereas late postoperative rotation, is influenced by the IOL architecture, design, and axial length. The axis of IOL implantation is associated with postoperative rotation, and an increased incidence of rotation has been observed in cases with vertical axis of IOL implantation (with-the-rule astigmatism). Capsulorhexis extension or inadequate IOL coverage also contribute to postoperative rotation.

The axis of implanted toric IOL may be assessed at the slit-lamp with a rotating slit and rotational gauge. This method requires adequate mydriasis to visualize the IOL optic marks.

BIFOCAL AND BIFOCAL TORIC IOLS

The idea of multifocal IOL was first conceived by Hoffer in 1983 while the first bifocal IOL was implanted by Dr. John Pierce in 1986. Since then a large variety of multifocal IOLs have been developed.

Bifocal IOLs effectively utilizes mainly three principles to enhance the quality of vision as shown in many clinical studies

Table 1 : Multifocal IOLs

Manufactures/ Brand name	Type of Optic	Optic diameter (mm)	IOL materials	Add at IOL plane (D)	Light distribution
ReZOOM (AMO)	Refractive	6 mm	UV blocking Hydrophobic acrylic	+ 3.0 D	Pupil dependent
ReSTOR (ALCON)	Apodized anterior	6mm	UV blocking Hydrophobic	+ 3.0 D, + 2.5 D	Pupil dependent
	Diffractive surface refractive base		acrylic		
Tecnis MF (AMO)	Posterior diffractive surface	6mm	Hydrophobic acrylic	+4.0 D +3.25 D +2.75 D	41% for distance 41 % for near
AT LISA 809 (Carl Zeiss)	Posterior diffractive surface	6mm	Hydrophilic acrylic 25% with hydrophobic	+3.75 D	35% near 65% distance
Acridiff (Care group)	Apodized refractive Diffractive	6mm	UV blocking Hydrophobic acrylic	+3.25 D	Pupil independent
ACRIVA REVIOL (VSY biotechnology)	Refractive-diffractive	6mm	Hydrophobic acrylic	+3.75 D	Pupil independent
Eyecryl Actv (Biotech)	Refractive-diffractive	6mm	UV blocking Hydrophobic acrylic	+3.75 D +3.0 D	Pupil independent

namely

A. Multizonal Refractive [26,27] –use concentric or annular ring–shaped zones of varying dioptric powers on the anterior surface.

B. Diffractive [27,28] –basically have concentric microscopic steps on the posterior surface of lens utilizing Huygens-Frsnel principles.

C. Hybrid IOLs –(using both principles)

Principle of Apodisation (gradual reduction in height of diffractive steps from centre to periphery) has been utilized as further refinement in some multifocal IOL.

There are two focal points created along the optical axis to provide good uncorrected distance and near vision as well as functional intermediate vision using the concept of

simultaneous vision but at the same time reduced effective light energy reaching each focal plane often lead to loss of contrast sensitivity and the superimposition of multiple images on the retina results into unacceptable halos and glare. These visual disturbances are main causes for dissatisfaction in the patients using these lenses. However, these dysphotopsia have been observed to reduce after the bilateral implantation because of bilateral summation effect and more importantly by neuroadaptation mechanism after the gap of some time.

Bifocal IOLs have evolved from various modification and designing principle right from rigid PMMA platform to foldable silicone to acrylic. Bifocal IOLs in the current scenario mostly utilizes fully diffractive (Tecnis/acrilisa) or apodized diffractive and refractive (Acrysof Restor) with aspheric lenses.

On comparative evaluation, Diffractive multifocal IOL performed better than the refractive multifocal IOL in uncorrected near visual acuity (UNVA), reading acuity, reading speed, smallest print size, spectacle independence, halo, and glare rate.

Cochrane review and meta-analysis both demonstrated higher rates of spectacle independence with multifocal IOL compared to monovision strategy using monofocal IOL.[29,30] However, subjective visual disturbances including glare and haloes were both more common and bothersome in patients receiving multifocal IOLs compared to monovision.

Compared to multifocal IOLs, monofocal IOLs are not considered to cause reduction in contrast sensitivity, and thus may be a better choice in patients suffering from glaucoma, macular degeneration, or other diseases causing reduced contrast sensitivity.

Although, satisfactory outcome in terms of spectacle independence for distance and near vision have been reported in patients using bifocal IOLs but the newer advent of EDOF lenses and Trifocal IOLs have demonstrated superior results in terms of unadded intermediate VA.[31,32]

But as per few literature, Mix-and-match implantation of diffractive multifocal IOLs with different add power provides an excellent wide range of vision, as well as high levels of visual quality and patient satisfaction.[33,34]

So, to conclude, Conventional bifocal IOL is still preferred in patients who demand good near vision, do not drive, cannot afford trifocal IOL/ EDOF IOL and have bifocal IOL in another eye. Preferred addition is +4 D in nondominant eye and +3.25 D in dominant eye.

TRIFOCAL AND TRIFOCAL TORIC IOLS

Introduction:

The quest for Spectacle independence has created innovation to Trifocal and Trifocal Toric IOLs from Multifocal bifocals and its toric versions.

Table 2 : Trifocal IOLs

Specification	Biotech Optiflex Trio	Zeiss AT LISA tri	Fine Vision Physiol	Alcon Panoptics	Acriva^{UD} Trinova
Optic	Diffractive Refractive Aspheric Trifocal	Trifocal + Bifocal Combination	Trifocal Convolution	Quadrifocal– Enlightened IOL Technology	Trifocal Sinusoidal Vision Technology, Foldable, Single Piece, Aspheric,
Light Yield	88.30%	85.70%	85%	88%	92%
Light Distribution in Day light (Pupil size- 2.0- 2.5 mm)	40% Far, 30% Int 30% Near	40% Far, 35% Int, 25% Near	50% Far, 30% Int, 20% Near	60% Far, 20% Int, 20% Near	41% Far –30% Int, 29% Near
Light Distribution in Dim light (Pupil size- 5.0- 6.0 mm)	51% Far, 23% Int, 26% Near	60% Far, 10% Int, 30% Near	70% Far, 6% Int, 24% Near	70% Far, 15% Int, 15%Near	45% Far 25% Int, 30% near
Intermediate and Near Addition (IOL Plane)	3.50D – 1.85D	3.33D – 1.66D	3.50D – 1.75D	3.25D – 2.17D	3.00D–1.50D
Theoretical Reading Distance	38 cm –72 cm	36 cm –72 cm	34 cm –68 cm	35 cm –55 cm	38cm– 80cm
Material	Hydrophobic Natural Yellow	Hydrophilic acrylic with hydrophobic surface	Hydrophilic acrylic	Hydrophobic	Achromatic, Hydrophobic Surface, UV, Violet, and Blue Filter

Diopter Range	7.0 D –30.0 D	0.0D – 32.0D	10.0D – 35.0D	10.0D – 32.0D	0–32 D
Total Number of Rings	12	28	20	15	12 ridges
Diffractive zone Diameter	4.0	4.34	5.1	4.5	
Size of center Ring (9 mm)	1.12	1.06	1.16	1.15	
Angulation	0	0	5	0	

Different types of trifocal IOLs with different haptic and optical designs are currently available, all attempting to offer excellent vision at far, intermediate, and near distances while providing a low incidence of photic phenomena and high patient satisfaction in contrast to Refractive or Diffractive Multifocal IOLs. The main disadvantage of refractive multifocal IOLs is their pupil dependence and the loss of energy is the main disadvantage of diffractive IOLs.

As Dr. Piovella said, "The trifocal IOL has fewer rings on the optic surface, which reduces the potential for visual disturbances that can be difficult to manage in demanding patients. In addition, it is independent of pupil diameter up to 4.5 mm. Therefore, it provides good quality vision in younger patients who tend to have a larger scotopic pupil."

Theoretical simulations carried out by Holladay et al. demonstrated that aspheric lenses may undergo a decentration of up to 0.4 mm and a tilt of up to 7° before they start to show a lower performance than their spherical counterpart. Piers et al.'s10 studies revealed an even higher tolerance to malposition, the resulting threshold values being 0.8 mm of decentration and 10° of tilt. Central Continuous Curvillinear Capsulorhexis is most important factor in IOL centration postoperatively. IOL decentration and rotation following its implantation, can be due to different factors, such as IOP, haptic pressure upon the capsular bag and the remainder of viscoelastic material, capsular bag size, or the lenses' design and material.

Trifocals and Trifocal torics are being accepted with good patient satisfaction in different studies. Patient requirement and habits are important consideration before considering particular types. Most trifocals provide good near, distance vision and variable intermediate vision. Taller people may get different models than shorter people considering their specific requirements. Good pre-operative chair time is important for optimum results. Also, many trifocals are new and will require further careful evaluation to establish their utility.

Table 1 Comparison of the three types of IOLs in terms of quality of vision at different distances, reading performance, contrast sensitivity, and optical phenomena

Type of IOL	Distance vision	Intermediate vision	Near vision	Reading performance	Contrast sensitivity	Optical phenomena
Bifocal IOLs	+++	+	+++	+++	+++	+++
Trifocal IOLs	+++	+++	+++	+++	++	++
EDOF IOLs	+++	+++(+)*	++	+++	+++	++

A (+) sign indicates performance of the IOL in terms of vision, reading performance and contrast sensitivity. The more (+) signs indicate higher performance. In case of optical phenomena more (+) signs indicate higher frequency of optical phenomena. *, EDOF IOLs outperform trifocal IOLs in terms of intermediate vision under mesopic conditions, but they exhibit similar results under photopic conditions. EDOF, extended depth of focus; IOL, intraocular lens.

EXTENDED DEPTH OF FOCUS (EDOF) INTRAOCULAR LENS:

The basic principle behind EDOF IOLs is to create a single elongated focal point to enhance the depth of focus or range of vision. A proprietary diffractive echelette design is used in EDOF IOLs and forms a step structure. The height, spacing, and profile of the echelettes are optimized to achieve constructive interference of light from different lens zones, thus producing a novel light diffraction pattern. In addition, proprietary achromatic technology and negative spherical aberration correction improve the image quality. With technological advancement, EDOF IOLs showed good visual outcomes with less contrast reduction and fewer photic

phenomena commonly associated with multifocal IOLs. However, according to some studies, EDOF lenses worked less efficiently for near vision than did trifocal IOLs. Currently, several types of EDOF IOLs are commercially available, including the Tecnis Symfony (Johnson and Johnson Vision), Mini WELL (Sifi Medtech), IC-8 (AcuFocus Inc) and Wichterle Intraocular Lens-Continuous Focus (Medicem). Until 2018, the Tecnis Symfony was the only United States Food and Drug Administration (FDA)-approved EDOF lens.

Quality of Intermediate and Near Vision

Trifocal lenses were developed to improve the quality of intermediate vision through the incorporation of a third focal point that was missing in bifocal IOLs. Several studies have investigated whether implantation of trifocal IOLs held its promise to improve intermediate vision compared to bifocal IOLs. Liu et al. in his study concluded that after a follow-up period of 3 months, there is no statistical difference ($P>0.05$) for near and distance vision in bifocal and trifocal IOLs. On the other hand, the uncorrected intermediate visual acuity (UIVA) measured at 80 cm was significantly better in the trifocal IOL group compared to the bifocal IOL group ($P<0.01$).

EDOF IOLs, also referred to as extended range of vision (ERV), have the ability to create a continuum of foci through the implementation of spherical aberration and the presence of optically active transitional zones. Consequently, an extended area of focus is created, enhancing the quality of intermediate vision. The Tecnis Symfony (Abbott Medical Optics, Inc., Abbott Park, IL, USA) was the first EDOF-labeled IOL approved by the U.S. Food and Drug Administration in 2016.

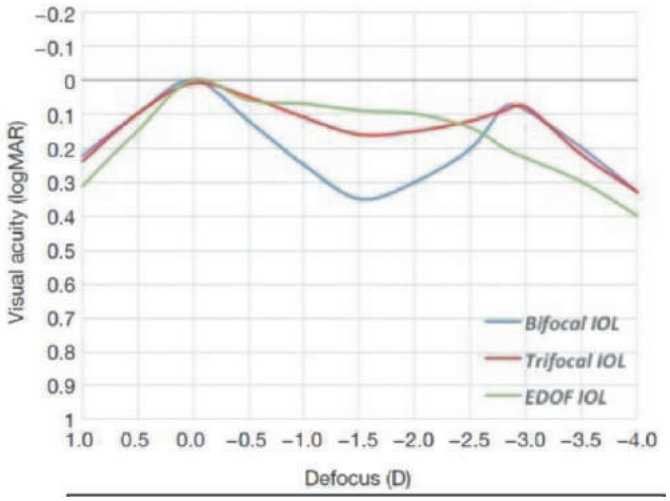
EDOF lenses exhibit similar results in terms of distance vision when compared to trifocal or bifocal IOLs. Several studies reported no statistically significant difference between the EDOF lens and the trifocal lenses in either monocular ($P=0.717$) or binocular ($P=0.837$) uncorrected distance vision.

The performance of trifocal and EDOF lenses appears to be similar also in the context of intermediate vision. Cochener et al. reported the absence of a statistically significant difference between the two groups of lenses, with a tendency for better outcomes with the EDOF IOL, when targeted for emmetropia. In the prospective study by Mencucci et al., implantation of the EDOF lens resulted in better outcomes in terms of intermediate vision under mesopic conditions. However, in photopic conditions, there was no statistically significant difference in uncorrected intermediate vision outcomes between the EDOF and the trifocal IOLs. Thus, it seems that the illumination settings may play a crucial role in the performance of each IOL type when intermediate vision is concerned.

Both EDOF and trifocal IOLs achieve spectacle independence for intermediate and distance vision. In terms of near vision, several studies shows that trifocal IOLs are superior to EDOF IOLs. In fact, Mencucci et al. showed a higher usage of spectacles for near vision in patients who were implanted an EDOF IOL, compared to those who were implanted a trifocal one. However, the level of post-operative satisfaction was the same for both patient groups.

The Defocus Curve

The evaluation of the defocus curve is of great importance as it offers the practitioner and the patient information about the



Graphic representation of the defocus cures for the three types of IOLs.

expected visual performance of the IOL over the entire distance spectrum. The position of the peaks in the defocus curve is related to the main focal points of the IOLs, hence these curves express the performance and optical imaging of each IOL as a result of its individual design. Typically, the bifocal IOLs are associated with a V-shape defocus curve pattern with the highest visual acuity at 0.00 D, resulting in better performance at distance vision, a second peak between −2.00 and −2.50 D and a sharp gap for intermediate vision.

Shen et al. conducted a metanalysis and concluded that the trifocal IOLs achieve a better result at defocus of −1.50 to −0.50 D and present a significantly better intermediate vision when compared to bifocal IOLs.

EDOF IOLs produce a smooth, uninterrupted, and dome-shape like defocus curve, which provides good quality intermediate vision and tapers off at reading distance. Thus, EDOF IOLs provide better vision at −1.00 and −1.50 D defocus compared to bifocal IOLs and worse near vision than trifocal IOLs at −2.00 to −4.00 D defocus (i.e., between 50 and 25 cm).

The multifocal and EDOF IOL performance has also been shown to depend on pupil size. Since pupil size may affect

everyday tasks such as driving at night or viewing in sunlight. EDOF IOLs provided the best vision at 2 mm pupil diameter. Trifocal IOLs showcased better pupil independence than both bifocal and EDOF IOLs.

Contrast Sensitivity

Post-operative contrast sensitivity is regarded as a good surrogate marker of visual function. Cochener et al. had described the theoretical superiority of EDOF over the trifocal IOLs in terms of contrast sensitivity due to the compensation of chromatic and spherical aberrations by the EDOF IOL design. Mencucci et al. confirmed this hypothesis and demonstrated that the EDOF is associated with enhanced contrast sensitivity, under both photopic and mesopic conditions, when compared to the trifocals.

When the comparison involves an EDOF and a bifocal lens, there is absolutely no statistical difference in terms of contrast sensitivity.

Reading Performance

Mencucci et al. compared the reading skills of patients who were implanted the trifocal IOLs and the EDOF IOL under both photopic and mesopic conditions. No statistically significant differences were found in the reading performance among the patient groups (P>0.05). The authors proposed that although trifocal lenses exhibited better outcomes for near vision, the enhanced contrast sensitivity of the EDOF lens possibly compensates for the worse near vision with this type of lens, thus leading to similar reading performances.

Optical Phenomena

The design of multifocal IOLs is based on the division of light into different foci. Although the addition of new focal points has improved intermediate vision, the focused image is always overlaid by one (bifocal) or two (trifocal) secondary out-offocus images, coming from the added foci of the IOL. Thus, an important aspect of multifocal or EDOF IOL implantation is the occurrence of undesired optical phenomena, which may compromise quality of vision. Optical phenomena include Graphic representation of the defocus cures for the three types of IOLs. halos, flashes, starbursts, glare and shadows. Due to their subjective nature, a quantitative assessment of these phenomena is difficult to illustrate. Evaluation of optical phenomena varies across different studies, which makes valid comparisons of different IOLs almost impossible.

Multiple studies have reported no statistically significant difference in the optical phenomena of various multifocal IOLs, with the visual disturbance that patients experience being none or mild. Halos seem to be more common than glares, especially in larger pupillary diameters (i.e., 4.5 mm). The frequency of all the optical phenomena decreases as time goes by, likely due to neural adaptation.

Comparisons between EDOF and trifocal IOLs showed no difference in the dysphotopic phenomena in the two groups. Less than 1% of patients experienced symptoms and of those who did, very few reported disturbances in their everyday life. Savini et al. compared EDOF and bifocal IOLs and found that Halo size and intensity were more prominent in patients with bifocal IOLs while EDOF IOLs seemed to induce fewer night halos.

Conclusions:

Over the past few years newer IOL technology has transformed the cataract surgery and raised the patient expectations of excellent distance, intermediate and near vision. The choice of IOL should depend on each patient's needs according to their work and daily habits (e.g., use of computers, electronic devices etc.). The main IOL types that have been developed include bifocal, trifocal and EDOF IOLs. In general, trifocal IOLs enhance intermediate vision in comparison to bifocal IOLs, due to the addition of a third focal point, while maintaining good distance and near vision. The EDOF lenses provide better contrast sensitivity and decrease spectacle dependence for distance and intermediate vision. EDOF IOLs are also being associated with less visual disturbances than bifocal IOLs. However, EDOF lenses are inferior to the trifocal ones in terms of near vision, though this difference does not seem to alter patient satisfaction levels.

Management of residual refractive error after cataract surgery

Introduction:

Postoperative residual refractive error after cataract surgery in the modern day ophthalmology is a cause of concern and disrepute and should be dealt with judiciously with an individualised approach for every specific patient scenario. Residual error can be broadly categorised into myopia, hyperopia and astigmatism. This article discusses enhancement strategies which consist of two general categories: corneal ablative procedures, and exchange, addition, or manipulation of IOLs .

Even in the hands of the most experienced and meticulous surgeon, refractive surprises can occur due to myriad factors which includes preoperative fallacious biometry, intraoperative improper IOL positioning , manufacturing deficiencies. Emmetropia (spherical equivalent – 0.5 to + 0.5 D and <1.0 D astigmatism) is the target refraction in most cataract cases. A "physiological" astigmatism of up to 1.0 D either with or against the rule may be useful to increase the depth of focus thus increasing the quality of vision in daily life. Astigmatism of up to 1.0 D may also be considered as a physiological measure to reduce uncorrected presbyopia for eyes with intact retina and

optic nerve.

Counselling of the patient, treatment of dry eyes and prescription of appropriate glasses or contact lens takes care of the majority of post operative residual refractive errors.

Next important step is to Identify the cause of refractive surprise

1. A formal subjective refraction is essential as auto–refraction is prone to error.
2. A thorough dilated examination is necessary to identify surgical causes such as tight corneal sutures , placement of the IOL in the sulcus or subluxation. Look for a distended capsular bag due to retained viscoelastic that can cause a myopic shift. The presence of corneal pathology such as corneal scarring or oedema can influence the refractive outcome. Post-operative cystoid macular oedema can cause a hyperopic shift.
3. Review the refractive history as well as the biometry, the IOL selection process and the surgical records. Wrong patient biometry, transcription errors, selecting the lens from the ACIOL column, incorrect A-constant or incorrect formula can all lead to insertion of the wrong IOL
4. Check the axial length by repeating the biometry which might not have been done accurately prior to surgery due to a dense cataract. Ultrasound measurements are prone to error as contact with the cornea may compress the eye and lead to underestimation of axial length.
5. Check for abnormal keratometry. The presence of high Ks or astigmatism can indicate pre-existing undiagnosed keratoconus. Previous refractive surgery is not always volunteered by the patient. LASIK flaps can be hard to detect and absent in previous LASEK/PRK.
6. If there has been no error, the refractive surprise can be attributed to effective lens position and a similar error is likely to occur in the fellow eye.

Surgical options for correction of refractive error following cataract surgery:

Lens-based procedures -

Lens based procedures are preferable in some situations and have certain advantages If there is a large postoperative refractive surprise, lens based procedures are more effective in reducing high degrees of spherical error. The original cataract wound can be reopened and the IOL implanted soon after the initial surgery (IOL exchange). There is no need for special settings such as those required for laser refractive surgery.If the lens to be removed is foldable it can be cut and removed through a small incision (Figure 1) The piggyback technique involves the implantation of two IOLs in the posterior chamber of the same eye or one in the bag and one in the ciliary sulcus. It is easier than exchanging the original IOL as sometimes the original IOL is strongly adherent to the capsular bag and its removal may cause rupture of the capsular bag and zonular damage, which may lead to cyclodialysis, retinal tears and macular edema. Another advantage of a piggyback IOL is its reversibility.

Many different types of piggyback lenses have been used. The Add-On variety, with its large optic size and rounded anterior optic edge design reduced iris trauma. Sulcoflex variety placed in the ciliary sulcus is also a safe and predictable option. Sulcoflex multifocal piggyback IOL can be used to tackle hyperopic -presbyopic surprise in a high myopia patient.

In case of residual astigmatism after toric IOL implantation which could be due to total corneal astigmatism estimation error, Toric IOL calculator error, Surgically induced astigmatism or rotational error. it is assumed that a magnitude of 3.5% hypo correction occurs per each 1° of misalignment of the lens, and at 45° of rotation its influence is neutralized, and above 45° additional astigmatism is induced. Realignment of the toric IOL is needed in 0.65%–3.3% cases, with more than 10° of rotation from the target axis. The UDVA is significantly worse in misaligned multifocal toric IOLs as compared to monofocal toric lenses.

The calculation of the ideal IOL axis is performed using ray tracing aberrometry (iTrace) or according to Berdahl & Hardten formula (astigmatismfix.com), which considers the characteristics of the IOL implanted, the axis on which it is positioned, and the residual manifest refraction..Using this technique the IOL can be redialled to the desired axis in the early postoperative period, preferably the first week.In a study by Oshika et al., 6431 eyes are implanted with toric IOLs, and realignment was performed in 0.653% of cases .

Its not recommended to exchange a monofocal IOL with a Toric IOL in case of post operative high astigmatism as a surprise because its difficult to predict the induced astigmatism in the process of wound enlargement. In such condition, corneal ablation is recommended. Femtosecond laser-assisted intrastromal keratotomies may also be attempted to correct residual astigmatism.

Corneal ablative procedures:

Laser refractive surgery avoids additional intraocular surgical procedures, provides better accuracy than IOL exchange or piggyback lens techniques especially for cylinder outcomes and gives higher predictability of results. LASIK /PRK seems a safe option even in post YAG capsulotomy patients. Additional optic enhancements can be done in future once LASIK flap has been done.

LASIK enhancement is more effective and predictable after monofocal IOL implantation as compared to a multifocal IOL. Wavefront-guided treatments with iris registration may provide better outcomes than conventional LASIK.

LASIK enhancement for refractive surprise after cataract surgery has few limitations .In large refractive error, thin corneas, corneal opacities and dry corneas, corneal ablative procedures cannot be carried out. Pre-existing cataract incisions also create problems during flap creation sometimes.

CONCLUSION:

The best method to tackle postoperative refractive surprise is to prevent it by following strict preoperative protocols. Once it happens, LASIK/PRK is a better and safer alternative to IOL manipulation techniques except in high errors and suspicious corneas.

Future of Premium IOLs

In this world that is in a constant state of technological evolution the quest is to give our patients access to future improvements in lens design. At some point in the future, we will likely solve the puzzle of accommodation.

Adjustable and exchangeable lenses are within the realm of possibility for the future of IOLs. We can look forward to some innovative technology.

Examples of Adjustable Lens Technologies

Three New IOL Related Technologies on the Horizon.

1) Ring less multifocal IOL

First step towards that direction has been made with the new Eyhance IOL from Johnson and Johnson. It provides definite advantage in terms of reducing glare and haloes – which is one of the main problem with multifocal IOLs.

2) Postoperative Refractive Adjustment

Postoperative Refractive Adjustment is a post-op laser treatment where the surgeon is able to alter the diopter size of an already implanted IOL using a femtosecond laser and an optical focusing system. The laser doesn't change the thickness or shape of the IOL, however, it changes the hydrophilicity of the lens. So far it's been tested on Acrylic lenses from all the major manufacturers and has had great accuracy in achieving the desired change in diopter. If this system is approved for public use in the future, it would dramatically change the game, eliminating the needs for explanting IOLs with miscalculated diopters. As the patient ages, there is potential for an annual adjustment of the IOL's diopter for the best possible vision from that IOL. Something to think about!

RxLAL. RxSight (formerly Calhoun Vision) right now has the only FDA-approved technology that allows non invasive alteration of lens power. The labeling of the company's Light Adjustable Lens (RxLAL) is for correction of up to 2.00 D of postoperative sphere and/or -0.75 to – 2.00 D of residual postoperative refractive cylinder. According to FDA data, patients achieved 20/20 visual acuity at 6 months at a rate twice as high as patients receiving standard IOLs.

Perfect Lens.

Another company, Perfect Lens, is approaching noninvasive adjustment of IOL power through a different mechanism. The company's developers have found a way to alter the power of a hydrophobic IOL through a technology called phase wrapping. In this process, a femtosecond laser applies a pattern of spots to the lens, thus creating a lens within the lens, using Fresnel optics. The laser energy changes the relative hydrophilicity of the acrylic lens, thereby changing the refractive index. The technology can theoretically be used with any hydrophobic acrylic lens, and it has been shown to create highly accurate power changes of up to 3.60 D. It can correct sphere and cylinder and even create or reverse multifocality. The desired characteristics could be written onto the lens postoperatively.

Merck is developing yet another technology, dubbed LicriEye, for postoperative lens power adjustment. This technology is based on a proprietary reactive mesogen material called Licrivue. Mesogens are compounds that display properties similar to those of liquid crystals. The material is flexible and has been used in other applications such as in LCD and OLED displays to help improve the optical quality of images. The mesogens can be altered postoperatively using non invasive methods.

3) Small-aperture IOL

AcuFocus has now created a monofocal intraocular lens (IC-8) that uses the "pinhole effect" principle to alleviate distortion and expand depth-of-field in an IOL implant. The basic principle is similar to the KAMRA corneal inlay in which only allows central, focused light to reach the retina, removing the blur caused by peripheral defocused light. The results (in theory) would mean the highest quality of vision over the broadest continuous range of any premium IOL currently available. This essentially means that this technology could compete directly with the multifocal market, providing a high-quality dynamic range of focus in a monodical lens.

4) The Omega Gemini Capsule

The Omega Gemini Capsule is essentially an artificial capsule that is implanted into the eye in order to create a

stable environment to house other ophthalmic technologies such as IOL implanted, medication delivery, and augmented reality technology. The Gemini Capsule props the capsule open, is 3 dimensional and creates artificial "walls" within the capsules, enforcing the stability of the

implantable space. Omega's future hope is that Gemini will provide the ability to house implantable technology (in addition to IOLs) for the future, things like augmented reality devices.

There are two modular IOL technologies now in development, the Harmoni Modular IOL (ClarVista Medical) and the Precisight (InfiniteVision Optics). Both ClarVista and InfiniteVision have created multicomponent IOL designs that consist of a base plate with haptics that accepts proprietary exchangeable optics. The optics can be removed while the baseplate and haptics remain in place. This will make the process of exchanging or upgrading IOLs easier to recommend in the event of a refractive surprise, multifocal intolerance, or the emergence of a technology upgrade.

Conclusion The future is coming. Perhaps it is already here. We must do everything in our power to leverage the collective creativity of physicians, engineers, and materials scientists to continue moving the needle. The human lens is a work of wonder, and we need better designs to mimic its natural functions as well as less invasive ways of correcting refractive misses.

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Patients have varied and Nuanced perspectives on Surgical Glaucoma Management

Investigators interviewed patients with moderate to severe open-angle glaucoma to understand their priorities and treatment preferences. The concerns of the 28 surgery-naïve participants were relatively similar to patients with milder glaucoma. They were apprehensive about the impact of glaucoma on their vision-dependent daily activities, the avoidance of visual symptoms and reduction of treatment burden. Patients also expressed anxiety about their visual prognosis and contemplated their tolerance for surgical treatment. Based on these findings, the authors urge researchers to expand glaucoma trial outcomes to include functional patient-centered outcomes. *Ophthalmology Glaucoma, September 2020*

Retinal Nerve Fibre Layer Involvement In Diabetic Retinopathy

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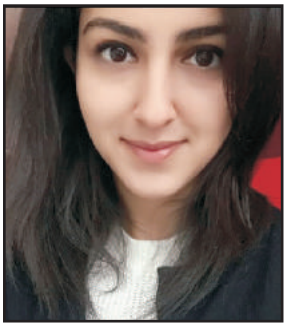

Introduction:

Diabetic retinopathy (DR) is a progressive microvascular complication of diabetes due to which irreversible retinal damage can occur. This is the leading cause of vision loss in working-age adults (20-65 years) and, therefore, professionally active people .[1,2]

Optical Coherence Tomography And Retinal Nerve Fibre Layer:

Spectral domain optical coherence tomography (SD-OCT) imaginghas proven to be an effective tool for detecting the earlier stages of the disease, tracking progression, and monitoring treatment response in case of diabetic retinopathy.[3] Extensive research has correlated OCT based retinal thickness with visual acuity in diabetic macular edema .[5,6]

Association of retinal nerve fibre layer (RNFL) thinning with severity of type 2 DR on SD-OCT has been shown.[7] Progression of DR and poor glycemic control is related to RNFL thinning .[8,9]

Various studies have shown a reduction in the inner retinal thickness in the macula in diabetics with mild DR, which may suggest initial ganglion cell loss in the pericentral areas and RNFL thinning .[13,14]

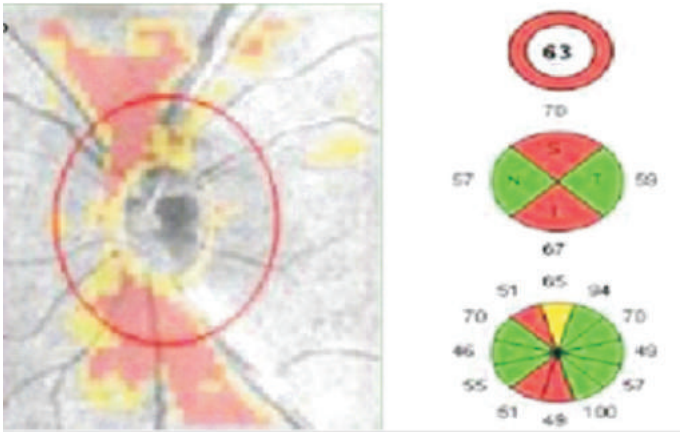

Figure 1: Retinal Nerve Fibre Layer (RNFL) thickness analysis using optic disc cube 200 × 200 feature depicting RNFL thinningin proliferative diabetic retinopathy

Rodrigues et al. [12] documented that neuroretinal changes occur before vascular changes ensue in diabetes mellitus. They noted a significant thinning of ganglion cell layer (GCL) and RFNL in patients with diabetes mellitus with no DR.

Pathophysiology Of Diabetic Retinopathyand Subsequent Rnfl Changes

Neurogenic Changes

Diabetic retinopathy, previously considered as a solely vascular disease, is now recognized as a neuro-vascular disease.Retinal neurodegeneration has been found to have a significant role in the pathogenesis of DR, including apoptosis of retinal neuronal cells and peripapillary retinal nerve fibre layer (RNFL) thinning .[16] Thus, we need to rule out the presence of glaucoma in such patients showing RNFL thinning.

The hypothesis given by Rodrigues et al. [12] showing that neuroretinal changes occur before vascular changes ensue in diabetes mellitus has been confirmed by electrophysiological and psychophysical studies .[17]

Vascular Changes

Basement membrane thickening, pericyte loss ,[19] oxidative and nitrosative stress ,[20] and decreased capillary perfusion lead to retinal capillary endothelium damage. This results in fluid leakage out of the capillaries resulting in DME, capillary closure and decreased capillary blood flow. These changes give rise to decreased blood supply to retina with resultant retinal ischemia and increased vascular endothelial growth factor (VEGF) release. [21,22] Administration of intra-vitreal anti-VEGF causes decrease in severity of DME.

Central retinal artery(CRA) supplies the inner 6 layers of retina. Resistive Index (RI), a parameter of vascular resistance, changes with the severity of DR. Increase in RI of CRA, related to the vascular endothelium damage, was found to correlate significantly with severity of retinopathy as well as decrease in RNFL thickness in our previous studies .[23]

Role Of Homocysteine

Homocysteine is a by-product of transmethylation reactions and is detoxified by methionine synthetase, which requires vitamin B12 and folate as coenzymes for proper function. Raised total plasma levels of homocysteine has been established to be an independent risk factor for retinal vascular occlusive disease.[24] Homocysteine, by inducing apoptosis in

retinal ganglion cells due to the expression of Bax, a proapoptotic protein, contributes to the development of diabetic retinopathy.[25] In our previous studies we have been able to demonstrate a correlation between increased serum levels of homocysteine and in vivo retinal nerve fibre layer thinning in the diabetic retina associated with an increased severity of retinopathy.[26] Therefore, strategies for controlling the level of homocysteine by supplementation with folic acid or vitamin B12 may be potential treatment approach to amend neurodegeneration.

Take Home Messages

1) Neurogenic changes precede vascular changes in diabetic retinopathy, therefore diabetics with normal fundus findings on examination should be followed up with OCT–RNFL at regular intervals.
2) Color doppler is an easy, inexpensive way to screen patients with DR as RI correlates with RNFL thinning.
3) Serum homocysteine should be done for all patients of diabetic retinopathy and any derangements should treated with folic acid and vitamin B12 supplementation in consultation with a physician.

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Intermittent Exotropia- Management In Current Perspective

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Management of intermittent exotropia is a great challenge for the strabismologist. Controversies do exist regarding its diagnosis and management. The most important issue about intermittent exotropia is variability of deviation which keeps the clinician puzzled. Hence various classifications are there to diagnose the magnitude and frequency of deviation, The most commonly used is the Newcastle control score. Others are Mohney and Holmes, Burian's and Krushner's classification. Management options fall into two categories.

1. Non Surgical Management
2. Surgical Management

1) Non Surgical Management:

Non surgical methods are effective more in younger children who are at risk of overcorrection and development of monofixation syndrome after surgery.

- Refractive Correction
- Observatio
- Patching
- Minus Lenses
- Orthoptic therapy
- Botulinum toxin

Refractive correction: Significant refractive error in the form of myopia, astigmatism and even hyperopia can impair sensory fusion and promote manifest deviation in intermittent exotropia. Full correction should be given in myopic patients. In hyperops little under correction will help these patients .Also special consideration should be given to the age of patient, extent of hypermetropia and AC/A ratio.

Observation:

Observation is considered suitable option in patients with absence of reduced visual acuity or amblyopia. Studies have shown stable deviation in majority of children with observation alone but also no clinically significant improvement.

Patching: Many studies are there but results are inconsistent about benefits. Although in general, results with patching were slightly better than with observation alone.

Minus Lenses:

Over minus lens therapy induces accommodative convergence and this can be used as temporary measure to promote fusion and delay surgical correction. But over minus therapy can cause asthenopia in older children. Over minus lens therapy can be considered as primary treatment especially in patients having high AC/A ratio and small angle consecutive exotropia after surgery.

Figure 1 : Left Exotropia

Orthoptic Therapy:

The convergence insufficiency treatment trial produced sound scientific data to support orthoptic therapy for the treatment of convergence insufficiency type of intermittent exotropia.This therapy is especially beneficial if the deviation is less than 25 prism.However duration, frequency and long term stability of these exercises is yet to be established.

Botulinum Toxin:

The botulinum toxin injection to lateral rectus muscle is another treatment option for fusional control and far and near deviation of patients with intermittent exotropia ,but the shortcomings of this therapy is lack of long term studies and precise dose for particular angle of deviation and the cost.

2) Surgical Management:

No consensus is there about criteria for taking up patients for surgery but surgery should be considered if –

a) There is increasing angle of intermittent exotropia.

b) Worsening control or frequency of deviation.

c) Inability to fuse and maintain stereo vision.

There is debate on the issue of preferred surgical procedure for treatment of intermittent exotropia. But following procedures are considered by different surgeons.

(i) Unilateral lateral rectus recession

(ii) Bilateral lateral rectus recession

(iii) Unilateral lateral rectus recession with medial rectus resection(R and R).

When we compare bilateral lateral rectus recession with unilateral lateral rectus recession and medial rectus resection (R and R), it is seen that short come outcomes tend to be better with (R and R) procedure but better long term outcomes are seen with bilateral lateral rectus surgery. Also when comparison of success rates between conventional and augmented surgery was done, statistically significant difference

was seen favouring augmented surgery. Studies have shown that rate of successful outcome is higher in surgical group than botulinum toxin alone however results were not statistically significant. Also when comparison was done for surgery alone and surgery with binocular vision training,later was found to be more effective.

Conclusion:

The management of intermittent exotropia continues to be controversial as the evidence of efficacy of various treatments remains unclear. Surgical treatment of childhood intermittent exotropia is associated with high recurrence rates and frequent overcorrection. The natural history of intermittent exotropia has not been well studied although many cases remain stable, some cases resolve without surgery. Further rigorous studies with intermittent exotropia are indicated and there is need for standardization for parameters for measurement, motor and sensory criteria for assessment of success and minimal long term follow up in these patients.

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Elderly patients have a lower risk of steroid-induced IOP elevation

Researchers retrospectively analyzed the correlation between age and the risk of steroid-induced ocular hypertension in adults with an intravitreal dexamethasone implant. Analysis of 570 eyes from 455 patients revealed that the incidence of IOP elevation decreased with advancing age, with patients younger than 51 years old having a significantly higher risk than older patients. The researchers conclude that steroid treatment may be safer in older patients and recommend caution when prescribing steroids to younger patients. *British Journal of Ophthalmology, September 2020*

Rarus Congenitus Anomalia- A Rare Congenital Anomaly of Optic Nerve Aplasia

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Abstract:

Aplasia of the optic nerve is an extraordinarily rare congenital anomaly that affects one or both optic nerves associated with the absence of the central retinal vessel and ganglion cells. We present a case of unilateral optic nerve aplasia in a 37 weeks old neonate . On examination , the child had microcornea and unilateral optic nerve aplasia.

Case report:

This is a case of a 37 weeks old neonate who was delivered by lower segment caesarian section at the gestational age of 33 weeks. The weight of the neonate at birth was 2.2 kg . After delivery the child was kept in NICU for 2 days where oxygen was given . Single surface phototherapy was done for 5 hours followed by phototherapy for 2 days at a local hospital . After the neonate had stabilised hewas sent to our hospital for screening for Retinopathy of prematurity.

On anterior segment examination of right eye, microcornea was found.

On fundus examination no clear disc was seen . Anomalous vessels were present at the posterior pole. There were extensive colobomatous areas all around with retinal dysplasia (As seen in figure 1)

On anterior segment examination of left eye the anterior segment was within normal limit and on fundus examination , retina was found to be mature . (As seen in figure 2)

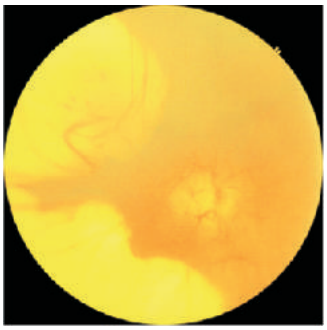


Figure 1: Image of the Right eye fundus showing no evidence of optic nerve head. Image taken on Nethra

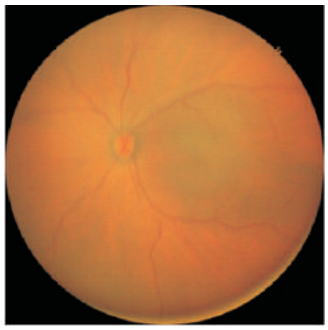
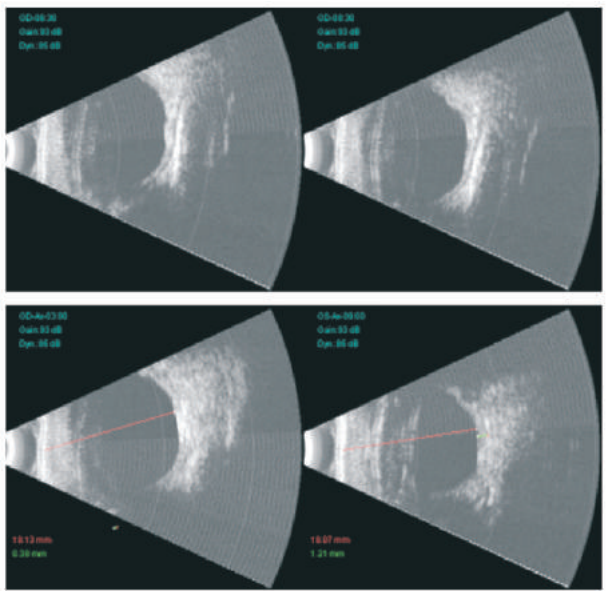


Figure 2: Left eye fundus showing mature retina . Images taken on Nethra forus camera

On B-Scan- There was no evidence of ONH shadow

Neonate's parents were advised to undergo a CT-scan for the neonate . When the parents reviewed with the report the



Comments: RE–Minimal Inferiror RC Coloboma involving disc & macula. ONH shadow not seen, ON absent, Vit cavity clear. No e/o RD or CD.
LE–Anatomically normal posterior segment.
AXL-18.07mm & ON normal. No e/o RD or CD.

next day it said–Increase in AP diameter of the right globe and thinning of posterior coat and aplastic right optic nerve noticed. Rest of the optic pathway was normal and left optic nerve was normal. Thus confirming the diagnosis of optic nerve aplasia in Right eye.

Discussion:

ONA is a rare developmental anomaly characterised by the absence of optic nerve and disc, ganglion cells and nerve fibre layeralong with retinal blood vessels.[1,2]

Earlier it was attributed as failure of the mesoderm to enter the foetal fissure and provide vascularisation of the retina and nerve tissue.[1]

Later reports suggested that ventral invagination of the optic vesicle caused nerve fibre misdirection and secondary atrophy.[3]

Yanoff and colleagues postulated a primary failure of ganglion cells to develop and send out axons as the cause of ON agenesis.[2]

Thus ONA can be due to defective formation of the embryonal fissure, failure of the mesenchymal anlage of the hyaloid system to enter the embryonal fissure or primary agenesis of the retinal ganglion cells.

Family history is not consistent with the mendelian inheritance and results of chromosomal examination in cases of ON aplasia are normal. Males and females are similarly affected.[5]

While unilateral ONA is rarely associated with brain or developmental anomalies , bilateral ONA is frequently associated with intracranial abnormalities. [5,7]

True ON aplasia is characterised clinically by blindness (no light perception), absent disc , absent central and branch retinal vessels and afferent pupillary defect.[6,7]

Histopathological examination to look for the absence of ganglion cells and nerve fibre layer along with the presence of vestigial dural sheath may help to differentiate true ON aplasia from severe ON hypoplasia.[7]

The commonly associated ocular anomalies include microphthalmos, microcornea , ptosis , squint, iris hypoplasia, irido-fundal coloboma and persistent hyperplastic primary vitreous.[7]

Conclusion:

Unilateral ON aplasia is a rare condition with poor visual prognosis and rarely associated with CNS anomalies. Clinical and radiological features can help differentiate it from other developmental anomalies of the eye ball.

Declaration of patient consent:

The authors certify that they have obtained all appropriate patient consent forms . In the form the patients has/have given his/her /their consent for his/her /their images and other clinical information to be reported in the journal. The patients understood that their names and initials will not be published and due efforts will be made to conceal their identity , but anonymity cannot be guaranteed.

Financial support and sponsorship:

Nil

Conflicts of interest

There are no conflicts of interest

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Steroid and Antibiotic Injection at the time of Cataract Surgery could prevent DME

This analysis evaluated the effect of intravitreal triamcinolone acetonide–moxifloxacin at the time of cataract surgery on diabetic macular edema (DME). Their retrospective chart review of 64 patients with preexisting diabetic retinopathy found that mean visual acuity at 4 to 12 weeks postoperatively ranged between 0.32 and 0.43 logMAR. Central macular thickness did not change significantly after surgery. They conclude that triamcinolone and moxifloxacin stabilize macular thickness after cataract surgery and can be considered for patients with DME. *Journal of Cataract & Refractive Surgery, September 2020*

A Typical Presentation of Orbital Pseudotumor Presenting As A Large Medial Canthal Sub Conjunctival Cyst in A Young Adult Male

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Abstract :

Background : Pseudotumor of orbit is an unusual clinical entity with incidence of about 4-6%.

Case Report : A 26-year-old man presenting with redness, cystic swelling and pain at the medial aspect of the right eye since 1 week but was not associated with proptosis and ptosis. Considering the age and clinical presentation of the patient, all differential diagnosis of conjunctival cystic and inflammatory lesions were considered. Relevant laboratory investigations were performed but were normal except eosinophilia and raised ESR. Contrast enhanced magnetic resonance imaging reports were suggestive of IOIS. The patient was managed conservatively with favourable outcome.

Conclusion : All conjunctival cystic lesions need not to be operated unless confirmed otherwise.

Keywords : Idiopathic orbital inflammatory syndrome(IOIS),orbital pseudotumor, eosinophilia, immune mediated, conjunctival cystic lesions, proptosis, case report.

Introduction:

Orbital pseudotumor also known as Idiopathic Orbital Inflammatory Syndrome (IOIS) is a idiopathic, benign, noninfective inflammatory condition of the orbit which was first described by Birch-Hirschfield in 1905,as 'idiopathic orbital inflammatory syndrome.[1-3]

It comprises of 4.1–6.3% of orbital disorders and typically occurs in the adult population. Orbital Magnetic Resonance Imaging (MRI) is the single most important diagnostic test, but serological studies and incisional biopsy can be necessary to exclude a systemic cause.[4]

The aim of this study was to describe the clinical presentation, radiological features and favourable outcomes with corticosteroids in the rare cases of IOIS.

Case Report:

A 26-year-old man presented on 05-09-2019 with the chief complaints of redness, swelling and pain at the medial canthus of right eye since1 week. The swelling was associated with lid edema and restriction of ocular movements superiorly and medially since 1week. There was no history of fluctuation of symptoms or diminution of vision. There was no history of fever, rash, joint pain, any other systemic symptoms, preceding infection or trauma to the eye. There was no history of intake of any medications .Also there was no family history of similar complaints.

His general examination was normal. On neurological examination, the cranial nerves were normal except extraocular movements. On ocular examination the extraocular movements were restricted superiorly and medially in the right eye. Visual acuity, pupillary reaction and fundoscopy were normal. There was no audible bruit on auscultation over the right eye. The intraocular tension in both eyes was normal. A possibility of inflammatory swelling was considered and patient was prescribed an antibiotic steroid combination eye drop along with systemic anti-inflammatory drugs and was asked to follow up after 3 days.

Due to certain personal reasons patient presented after 1 week with a localised cystic swelling near the medial canthus. The symptoms still persisted but the pain and redness was slightly reduced. Swelling was approx. 6mm X 7mm in size, well defined superior, inferior and lateral margins, cystic in constistency, non reducible, non mobile, lateral margin was 1mm away from the limbus but the medial margin was merged with the caruncle and was not clearly defined. The overlying conjunctiva was congested but was free however; cyst was adherent to the underlying tissues. (figure 1)

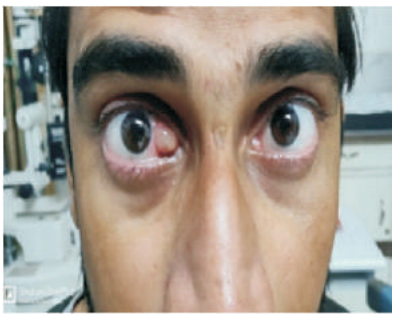

Figure 1 : Pre-treatment Photograph of the Patient Showing Right Eye Conjunctival Cystic Lesion in the Young Adult Male

All differential diagnosis of conjunctival cystic and inflammatory lesions were considered. From the battery of lab tests that were advised TLC was normal except with eosinophilia. The erythrocyte sedimentation rate was elevated. Liver, renal function, thyroid functions and stool examinations were normal.

A Computed tomography (CT) with intravenous contrast showed bulky medial rectus muscle with fluid filled hypodense cystic lesion near the medial rectus with focal bulge in the conjunctiva suggestive of pseudotumor of the right orbit (figure 2 & 3). Considering the radiological features and negative blood reports, the patient was diagnosed as Idiopathic orbital inflammatory syndrome.

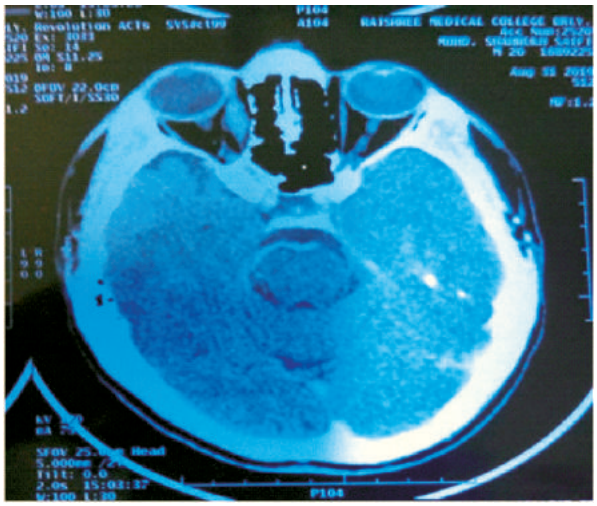

Figure 2: Pre –treatment CECT image of Brain with Orbit Showing Medial Rectus thickening in the Right Orbit.

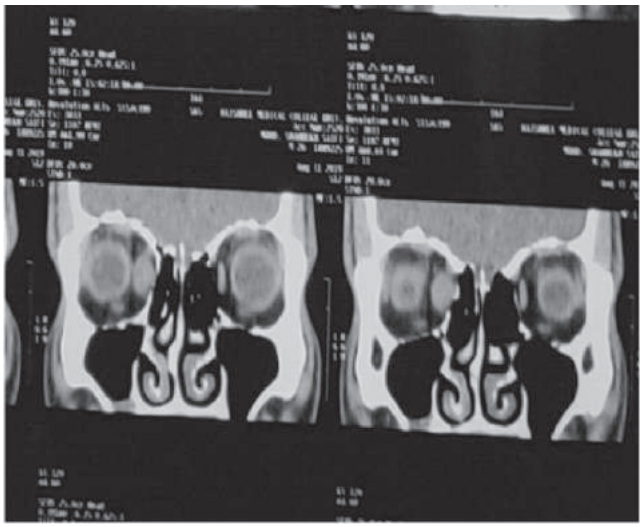

Figure 3: Pre-treatment CECT Orbit Showing Cystic Conjunctival Lesion the Medial Aspect of Right Eye.

He was started on high dose of oral prednisolone (1.5 mg/kg/day) for 15 days followed by tapering doses over 10–12 weeks. The patient started showing response after 48 h and, at the end of 2 months there was improvement in eye symptoms. There was progressive thinning of the cyst wall and conjunctival epithelium with spontaneous rupture and expulsion of the cyst through the conjunctiva(figure 4). The patient is on a maintenance dose of steroids and is kept under observation with monthly follow-up to rule out local recurrence or disease progression(figure 5).

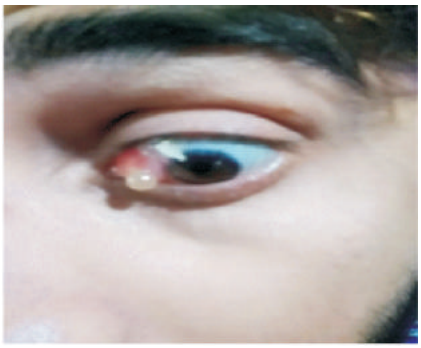

Figure 4: Spontaneous Rupture and Expulsion of the Cyst through the Conjunctival Layer.

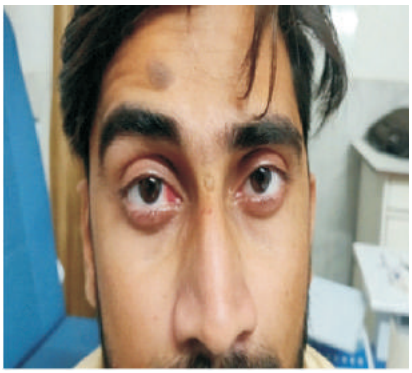

Figure 5: 3weeks Post Treatment Image of the Patient Showing Slight Redness of the Overlying Conjunctiva with Remenant Inflammation.

Discussion :

IOIS is the third most common orbital inflammatory disease next to thyroid eye disease and orbital lymphoproliferative disease usually seen in adults but may be seen in children. Unilateral presentation is more typical but bilateral presentations are not uncommon.[5]

Pain is the most common symptom in adult IOIS and occurs 58-69% of the time followed by diplopia(31–38%).[6,7]

Periorbital edema/swelling is the most common sign and occurs 75–79.2% of the time followed by proptosis (32–62.5%), EOM restriction (54.2%) red eye (48%), chemosis (29%), decreased vision (20.8%), and ptosis (16.7%)[8-9] Therefore, physical examination of patients with suspected IOIS involves lid assessment (retraction/lid lag/lagophthalmos), orbital assessment (proptosis), extraocular muscles (restriction),

globe (injection/chemosis), and optic nerve function (visual acuity/color plates/relative afferent pupillary defect).

The etiology and pathogenesis of IOIS is currently not known but however infectious and immune-mediate etiologies have been implicated.

Observation for IOIS for mild cases of inflammation may be acceptable but if there is no clinical resolution or worsening of symptoms then additional therapy is indicated.

❖ **The details of the case are taken with due consent of the patient.**

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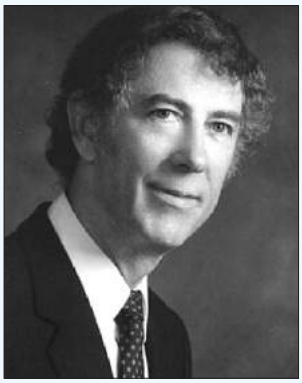
LEGEND IN OPHTHALMOLOGY

Sir Charles William Simcoe



The Simcoe Cannula was developed about 40 years ago by C. William Simcoe MD, an ophthalmologist in Oklahoma, USA. Bill Simcoe was born in Stillwater on June 5, 1931 and passed away in his Tulsa home on October 22, 2017.

Dr. Simcoe also developed many innovations such as Simcoe irrigation and aspiration cannula &C-loop haptics. While examining and reshaping a paper clip, he had an idea of how to invent a much safer intraocular lens design the Simcoe open C loop which has become the industry standard in modern cataract surgery. He refused to patent any of his inventions and are widely used now in cataract surgery

A native of Stillwater, Charles William Simcoe was a Korean War and Marine Corps veteran. He was a graduate of the University of Oklahoma medical school.Through Project Orbis, a nonprofit dedicated to preventing blindness, Simcoe travelled the globe, teaching doctors how to perform safer, less costly cataract surgeries.

A Randomized Controlled Clinical Trial to Compare Conventional Drug Instillation to A Device Dropper method in Medical treatment of Glaucoma

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Abstract :

Purpose : To compare and analyze the performance of a device dropper over conventional drop instillation method on ease of administration, compliance, patient satisfaction & intraocular pressure control in persons with glaucoma on ocular hypotensive médications.

Methods : We enrolled 72 individuals with primary open angle glaucoma or ocular hypertension, on treatment with fixed combination (α agonist+β blocker) drugs for at least 6 months .These were randomized into two groups (36 in each arm). Group 1 administered the drug with a device dropper (DD) and Group 2 used conventional drop instillation(CDI) method. Recruited individuals were interviewed for subjective difficulties using a formatted questionnaire at first month follow up and intraocular pressure (IOP) change from baseline was evaluated.

Results : Baseline demographic & ocular characteristics were similar in both groups. 57.1% in the conventional instillation and none in the device dropper had reported difficulty in using the eye drops on follow up visit. Device dropper group had significantly less spillage and contamination of eye surface or dropper tips , required minimal assistance, accurately targeted on first drop placement directly into the eye compared to conventional drop instillation group(p-value<0.001). Mean intraocular pressure was comparable between the two groups.

Conclusion : Device dropper instillation method was observed to be easier to administer, more accurate in targeting the conjunctival cul-de-sac, reduced wastage with lesser contamination compared to the conventional drop instillation technique. Device droppers may be expected to have better compliance and effectiveness in medical management of glaucoma.

Key-words : glaucoma , device dropper , conventional instillation, compliance , adherence

Key Message : The device dropper was more user friendly, technically easier to instill drops with better accuracy ,less spillage and contamination compared with the conventional method of drug instillation ,and thus likely to improve compliance in the management of glaucoma.

Introduction:

In India 11.2 million people aged 40 years and older are estimated to have glaucoma.[1] Elevated intraocular pressure (IOP) is a major risk factor in progression of glaucoma and lowering of intraocular pressure is associated with delay in progression of disease.[2,3] Medical treatment is the initial treatment modality in management of glaucoma and strict adherence and compliance to recommended therapy is the cornerstone of successful glaucoma therapy. Suboptimal adherence to glaucoma therapy significantly contributes to progressive glaucoma.[4]

Compliance to any medication refers to the degree or extent of conformity to the recommendations of day to day treatment by the provider with respect to timing, dosage, and frequency. Factors leading to noncompliance have been described in many studies like social/environmental factors (lack of support, major life events, and travel), regimen factors (complexity, costs, and change in medication), individual patient factors (knowledge, memory, motivation), and medical provider factors (dissatisfaction, communication).[5]

In a study in South India, 42% of patients reported one or more problems in using their glaucoma medications, and around 6% reported less than 100% adherence or compliance to their medications .[6] A patient's inability to successfully instill an eye drop can have multiple consequences like inadequate IOP control that may have a major impact on vision. [4] Improper drug instillation techniques may lead to drug spillage ,increased drug reactions, dropper tip contamination and significantly enhances cost of therapy.[7] A device that could simplify drug instillation and address these difficulties can

improve adherence to topical medical therapy while eliminating drug wastage, spillage and contamination of dropper tips.[8,9]

Many studies[7,8,10,11] previously have attempted to analyze the performance of the various commercially available device droppers and have found them to have better efficacy & patient satisfaction. However these were performed on a small sample, and the devices were not widely used due to high cost, poor accessibility and not being suitable to fit to all eye drop bottles.

We conducted a randomized control study to compare the efficacy, ease of administration, patient compliance and level of satisfaction of a low cost device dropper assisted instillation as compared to conventional drop instillation method in medical management of glaucoma.

Material and Methods :

Our study was a prospective, randomized controlled trial conducted between April 2019–September 2019. A total of 72 eligible participants of glaucoma or ocular hypertension with 144 eyes were included to assess the efficacy of device droppers with 95 % power and 5 % level of significance.[10] Enrollment of eligible persons was done after obtaining consent for participation in the study and to use the information for publication in scientific literature. Patients were randomized into two groups by a computer generated randomisation method. The study was approved by the Ethics committee and the Institutional Review Board for conduct of human ocular research (IEC201900314) and adhered to the tenets of the Declaration of Helsinki.

Glaucoma was defined as presence of glaucomatous optic nerve head (ONH) changes with or without high intraocular pressure (IOP) and corresponding visual field defects. We graded the disease severity based on the visual fields using Hodapp Parish Anderson criteria and enrolled only those subjects who presented with moderate glaucoma.[12] Ocular hypertension was defined as IOP>21mmHg and corneal thickness <550 microns without evidence of optic nerve damage and visual field defects. We included subjects with Primary open angle glaucoma (POAG) and /or ocular hypertension, aged above 40 years, with baseline IOP not higher than 25 mmHg and those self–administering the fixed combination [β blocker+ α agonist] of medications for 6 months or longer .We excluded patients with best corrected visual acuity (BCVA) less than 6/60 in both eyes, severely constricted visual fields (Mean Deviation greater than -12 dB) ,12persons older than 70, those who were physically weak and infirm, and those unable to use eye drops on their own, those unable to report for follow up and patients presenting with tremors and arthritis.

Detailed ophthalmic examination was done which included BCVA & IOP, slit lamp biomicroscopy, gonioscopy, fundus and visual field for all the patients. Visual field defects were defined by the presence of localized Bjerrum scotoma, nasal step ,arcuate scotomas and biarcuate scotomas . All the consecutive subjects with defined inclusion criteria were enrolled and recruited by the principal investigator and were randomized into two groups (36 in each arm) based on a computer–generated number Group 1– device dropper group (DD) and Group 2– conventional drop instillation group(CDI). The investigators and paramedical staffs performing ocular examination and distributing questionnaire to the patients were masked to the study groups. Primary outcome was measured as IOP control at follow up visit, Secondary outcomes was comparison of ease of administration using a validated questionnaire10 between the two groups.

In the device dropper group, a short video clip demonstrating how to use the device was shared with every patient. The device was manufactured by Aurolab , Madurai, Tamilnadu, India for the purpose of study and provided free of cost to all the patients. The dropper device was fitted with a lubricating eye drop and live demonstration of its use was given by a trained paramedical staff to the patients randomized to the Dropper Device Group1 . Patients randomized to Group2 (conventional drop instillation) were advised to continue using the eye drops as per their routine administration. The paramedical staff assigned for counselling patients provided instructions to reassure the correct technique of eye drop instillation using audio–visual aids. Counseling included instructions on the method of instillation, restricting instillation to a single drop, avoiding tip contamination and strict adherence to the medical treatment regimen advised by the examining ophthalmologist.

All patients were advised to review after 4 weeks and a complete ophthalmologic evaluation including measurement of IOP, visual acuity, slit lamp examination and posterior segment evaluation was completed by ophthalmologists masked to details of the Groups assigned to the patients. IOP was measured by Goldman Applanation tonometry by a single observer and the median of three readings was considered for analysis. A validated questionnaire 10was administered to all the patients by paramedical staff seeking details such as difficulties encountered on using the eye drops.

In order to determine the correct instillation technique and to ensure compliance, the patients were asked to instill eye drops in the presence of an observer at the initial visit (Figure 1) . The observer assessed the performance of device dropper over CDI by marking the experiences of the patient with a yes or no response in the given questionnaire . The questions addressed the ease of administration, spillage, single drop into the eye , better aim , bottle tip contact to eye with responses as always, often, sometimes , rarely or never.[10]

Statistical analysis- Descriptive variables are given with Frequency (Percentage) or Mean (Standard deviation). The data were analyzed with frequency of distribution and descriptive statistics. Snellen's equivalent visual acuity was converted to the logarithm of the minimum angle of resolution (logMAR) units for the statistical analysis. Mean ± SD, Median and inter-quartile range (IQR) were obtained for continuous variables and data were expressed as Numbers or as Percentage for Categorical variables Chi-square test was used to compare the categorical variables of demographic characteristics and Fisher's exact test was used to find out the association of ease of administration with either technique of instillation. Paired t–test or Wilcoxon sign rank test was used to find out the significant difference between the baseline and the follow-up visits,. Student's t-test was used to find out the significant difference between study group and the control group. The intergroup differences for continuous variables were tested with independent t-test. P-value less than 0.05 were considered statistically significant. All statistical analysis was performed using STATA software version 14.0 (Texas, USA).

Results :

The baseline demographic factors between the two groups were similar with no statistically significant difference (Table1)

Table1: Demographic and Diagnostic Characteristics of the Study Participants

	Device dropper (n=36)	**Conventional drop instillation** (n=36)	**P-value** [b]
Age (y), Mean ±SD	61.6 ±10.2	62.3 ±9.4	0.763 [a]
Male gender, n (%)	18(50.0)	21(58.3)	0.478
Type of glaucoma* Primary open angle Ocular hypertension	62(86.1) 10(13.9)	66(91.7) 6(8.3)	0.289
logMAR VA*, Median(IQR)	0.18(0 to 0.30)	0(0 to 0.18)	0.075 [c]
RNFLD*, n (%)	39(54.2)	47(65.3)	0.174
Cup disc ratio*, Mean ±SD	0.671 ±0.09	0.679 ±0.10	0.605 [a]
Visual field defects*, n (%)	30(41.7)	34(47.2)	0.502
Lens status*, n (%) Clear Cataractous Pseudophakic	21(29.2) 35(48.6) 16(22.2)	15(20.8) 32(44.4) 25(34.7)	0.211

**variables were presented in eye-wise (n=72 eyes), IQR – inter-quartile range*

VA- Visual acuity, RNFLD-retina nerve fiber layer defect

a independent t-test, b Chi-square test, c Wilcoxon rank sum test

The Mean age of the device dropper group was 61.6 ±10.2 and that of conventional instillation group was 62.3 ±9.4 years. There were equal number of males and females in Device dropper (DD) group and a slightly higher male preponderance of 21 males (58.3%), 15 females (41.7%) seen in the conventional drop instillation (CDI) group. In the device dropper group, a diagnosis of POAG was present in 86.1 % and OHTN in 13.9% . In the CDI group 91.7% had POAG while 8.3% had OHTN. Median (interquartile range) best corrected visual acuity measured by log MAR was 0.18 (0 to 0.30) in the DD group and 0 (0 to 0.18) in the CDI group, with no statistically significant difference in between the two groups (p–value=0.07) at baseline.

70 /72 patients were eligible for total analysis-35 in each group with onepatient (2.8%) lost to follow up from each group. Baseline Mean ±SD IOP was 16.6 ±3.2 mmHg in the device dropper group and 16.4 ±3.8 in the CDI group with no difference between the two groups (p-value=0.758) (Table 2).

Table2: Comparison of IOP between the Device Dropper and Conventional Drop Instillation Groups

	Device dropper	**Conventional drop instillation**	**P-value** [a]
Baseline Mean ±SD (95% CI)	16.6 ±3.2 (15.9 to 17.3)	16.4 ±3.8 (15.5 to 17.3)	0.758
Follow up visit Mean ±SD (95% CI)	16.5 ±3.0 (15.7 to 17.2)	16.4 ±3.0 (15.6 to 17.1)	0.860
P-value [d]	0.528	0.894	–

[a] independent t-test, [d] Paired t-test

At 1 month follow up , the mean IOP was 16.5 ±3.0 in the DD group and 16.4 ±3.0 in the CDI group with no difference from baseline in both the groups and also no statistically significant difference between the two groups (p-value=0.860).

In the device dropper group, 97.1 % of patients had no difficulty using the eye drops compared to 42.9% in the CDI group (p–value<0.001) and none of the patients in the DD group needed assistance to instill eye drops on any of the days during the study period as compared to 54.3% of patients in the second group (p-value <0.001) (Table 3). All patients in the DD group never reported to have touched the eye with the bottle tip,

compared to 2.9% of patients in the CDI group (p–value<0.001). However in the CDI group there were 57.1% who reported of the bottle tip sometimes touching the eye, 5.7% often reported tip touching the eye , 34.3% reported of the bottle tip rarely touching the eye (Table 3)

Table3: Comparison of Ease of Administration between Device Dropper and Conventional Drop Instillation groups

	Device dropper (n=35)	Conventional drop instillation (n=35)	P-value[e]
Had difficulty using eye drops			
Yes	1(2.9)	20(57.1)	<0.001
No	34(97.1)	15(42.9)	
Needed help to instill eye drops in any of the day			
Yes	–	19(54.3)	<0.001
No	35(100.0)	16(45.7)	
Touched eye with bottle tip			
Often	–	2(5.7)	<0.001
Sometimes	–	20(57.1)	
Rarely	–	12(34.3)	
Never	35(100.0)	1(2.9)	
Spilled drops outside eye			0.001
Often	–	5(14.3)	
Sometimes	6(17.1)	16(45.7)	
Rarely	25(71.4)	13(37.1)	
Never	4(11.4)	1(2.9)	
Applied a single drop			0.012
Always	4(11.4)	1(2.9)	
Often	26(74.3)	18(51.4)	
Sometimes	5(14.3)	15(42.9)	
Rarely	–	1(2.9)	
Placed drop directly into eye			
Always	11(31.4)	1(2.9)	<0.001
Often	23(65.7)	23(65.7)	
Sometimes	1(2.9)	9(25.7)	
Rarely	–	2(5.7)	

[e] *Fisher's exact test*

71.4% of patients in the DD group and 37.1% in the CDI group, rarely reported of drug spillage outside the eye. In the CDI group there was a greater spillage compared to the DD group (p–value=0.001) with 45.7% patients sometimes reporting of spillage and 14.3% often reported of spillage of eye drops outside the eye (Table 3). In the DD group 74.3% of the patients often applied a single drop into the eye compared to 51.4% of patients in the CDI group (p–value= 0.012). Also in the DD group 31.4% of patients could always place the eye drops directly into the eye compared to only 2.9 % in the CDI group (p–value<0.001).

Discussion :

The current study evaluated the comparative effectiveness and ease of administration of ocular hypotensive medications in a cohort of individuals with POAG or Ocular hypertension using a low cost device dropper or the conventional drug instillation method. Our study results report the superior performance of device droppers over CDI with 97% reporting no difficulty and none requiring assistance in instilling the drug accurately into the eye.

Nordmann et al 10 study had reported that the Xal–Ease device dropper performed better than the dropper bottle in their cohort, requiring no help in drop instillation ,and also reduced the risk of the bottle tip touching the eye . Similarly, the device dropper used in our study had performed well with no patient needing assistance to instill drops nor touching the eye with the bottle tip.

Interestingly, the subjects in the DD group had a better target on the eye, with less spillage and contamination compared to CDI group .The device dropper had facilitated easier view of the tip of the bottle that helped in targeting the eye drop directly into the eye avoiding contact with the ocular surface and eyelashes. All patients in the DD group never reported touching the eye with the tip of the bottle, compared to 2.9% in the CDI group. 5.7 % of patients in the CDI group often, 34.3 % rarely and 57.1 % reported sometimes of the bottle tip touching the eye respectively. Similar observations were reported by Davies et al, [7] where the tip was contaminated in 42% –53% with conventional bottle, while none had shown contamination of the bottle tip when using the upright eye drop bottle (UEB).

On analyzing the efficacy of the device dropper over CDI , in terms of IOP control, it was to have no change in mean IOPat the follow up visit in both the groups .We believe a better technique to deliver the drop may have an indirect impact on better compliance . Virani et al,[13] reported better control of IOP by 10–13 % and lesser consumption of eye drop bottle by 14% in assisted instillation compared to the self instillation. We had recruited and randomized persons already on medical treatment, who had required no change in therapy to reduce

IOP at the time of inclusion in the study. This may partly account for insignificant differences in mean IOP at month 1 follow up between the two groups. A randomized, cross over study of newly diagnosed, treatment naïve patients, with a longer observation on device dropper or conventional technique of drug instillation is likely to provide more reliable answers to issues of compliance as well as any differences in treatment efficacy between the two groups

Brown et al, [14] in their study reported most patients to be unaware of the faulty techniques of drug instillation that may affect the IOP leading to an unintentional part of poor compliance. Use of an instillation device may help address some, if not all, difficulties for glaucoma patients who have to continue taking the medications for life time.

In our study ,we found better patient satisfaction in individuals using device droppers in terms of ease of use, better accuracy, less wastage and reduced contamination. In the DD group none reported of spillage compared to 14 .1 % often reporting of spillage in CDI. Likewise in a study by Gupta et al,[15] 31.43% had a spillage of the eye drops on the eyelids or cheek and 75.7% touched the eye with tip of the bottle with only 8.57% correctly instilling the eye drops. In the current study the device dropper group had always targeted the eye in 31.4% & 11.4% had always instilled a single drop in the cul de sac compared to 2.9% in the CDI group. Another study [16] had observed that of the 204 visually impaired patients, 71% could apply their drops, but only 29% managed without touching the ocular surface and 1.4 drops were needed to apply the equivalent of one drop successfully. Poor instillation techniques with medications not getting into the eyes have been observed to be a major cause of progressive glaucoma.[16, 17]

Assisted instillation of eye drop may be required by glaucoma patients depending on one's age, visual acuity, and general health, cognition ability and comprehension of individual and perhaps prevailing socio-cultural practices in community. Kass et al,[18] in an interview based study found that only 20.6 % of patients relied on others for eye drop instillation, while a majority of patients self-administered their medications. Several difficulties have been noted with self administration like falsely targeting the eye drop, difficulties in squeezing the bottle, forgetting to instill drop in time, extra-drops instillation, and difficulty in puncturing the bottle entry. [6,14,15,18,19]

Drug delivering aids are helpful in facilitating self instillation, however one should understand the limitations like learning curve,[20] physical force,[21] dispensing, cost, and availability. Several glaucoma medications are commercially available with device droppers that are suited to fit only that particular eye drop and cannot be interchanged with other eye drops. Additionally its high cost makes it unaffordable to all patients.

It is to be noticed that unlike the XAL-Ease,[10] which was designed only for the application of the fixed combination of latanoprost and its combination with timolol, our device dropper can be fitted with almost all eye drop containers coming in various shapes .

The major strength of our study was that in addition to assessing the self reported outcomes of the performance of the device droppers, we also studied the ease of administration as graded by an observer who was masked to the study groups. Secondly the study was a randomized controlled trial, with the ophthalmic personnel performing the study procedures blinded to the study groups. All patients enrolled had previous experience with self administration of eye drops thereby eliminating the learning effects . Lastly the study had recruited individuals using only a particular fixed combination of glaucoma medications to compare the efficacy in both the groups.

Our study had a few limitations like the small sample size, short follow up and also the results of the study are largely based on self reported responses which may not actually reflect practical difficulties in ensuring compliance in glaucoma patients requiring indefinite therapy. Secondly a crossover study where a single cohort of patients report sequentially on the use of both techniques could have provided a better comparison and understanding about the benefits of the device dropper being studied. Moreover compliance was measured by self-reporting responses from patients , rather than weighing the bottles used and counting the drops remaining in it, which could also result in potential bias in interpreting levels of compliance to medical therapy. In conclusion, the device dropper had similar IOP reduction as the CDI, but it was more user friendly, technically easier to instill drops with better accuracy, less spillage and contamination compared with the conventional method of drug instillation, and thus likely to improve compliance.

Additionally, the low cost, easy accessibility and universal compatibility to most commercially available eye drop containers, makes the device dropper a promising option to improve compliance in the management of chronic glaucoma .Future research focusing on randomized , controlled and cross over studies of newly diagnosed persons with glaucoma are required to evaluate long term efficacy and compliance of device droppers as compared to conventional drug instillation techniques.

Legend to figure –

Figure 1 (a,b) showing device dropper mentioned in our study , (c) showing the patient using device dropper to instill drop inside eye.

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JOURNAL UPDATE

Pseudostrabismus is a relatively frequent diagnosis in the first year of life

A new retrospective study reports the birth prevalence of pseudostrabismus during a single decade. During the first year of life, 1 in 113 children in Olmsted, Minnesota, were diagnosed with pseudostrabismus. Strabismus was subsequently diagnosed in 4.9% of pseudostrabismus infants—a rate that is lower than what has been previously reported but similar to prior observations in the same pediatric population. These findings suggest that the apparent elevated strabismus risk among patients with pseudostrabismus may not be causal, but instead, due to confounding factors.

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Endophthalmitis in a Vitrectomised Eye - An Unexpected Visitor!

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Abstract:

Purpose: This case report aims to highlight the rare incidence of endophthalmitis after pars plana vitrectomy and to elucidate the causative factors, implicated microorganisms, clinical features, prophylaxis, and treatment of this rare entity.

Methods: A 67-year-old male presented with complaints of a black spot in front of his right eye for 4 months. BCVA was CF@3m in RE and 6/9 in LE. On examination, RE had IMSC with a large macular hole, while LE was pseudophakic with an old macular tributary occlusion. The patient underwent Cataract surgery with 25G PPV + ILM Peeling + C3F8 in RE. 15 days later the patient developed endophthalmitis in the operated eye. The patient underwent a vitreous lavage with intra-vitreal antibiotic injections. One week later, the patient developed Retinal Detachment in the same eye.

Results: The patient was operated for macular hole and later on treated for endophthalmitis and RD. His final visual acuity was CF@2m.

Conclusion: Endophthalmitis following Pars Plana Vitrectomy has limited reports in the literature and is relatively uncommon. This case report highlights the factors which could lead to such incidences and discusses how to treat and prevent its occurrence.

Keywords: Endophthalmitis, Pars Plana Vitrectomy, Macular Hole

A 67-year-old male presented to our opd with complaints of a black spot in front of his right eye for the past 4 months.

Vision in the right eye was FC@3m and 6/9 in the left eye. With pinhole, vision in the left eye improved to 6/6 while there was no improvement in the right eye. The patient was a known hypertensive, controlled on medication.

On examination, the right eye was found to have a posterior subcapsular and cortical cataract, while the left eye had a PCIOL in the bag.

Fundus examination revealed a large macular hole in the right eye and the left eye had an old macular tributary occlusion with non centre involving cystoid macular edema(Figure.1,2 & 3).

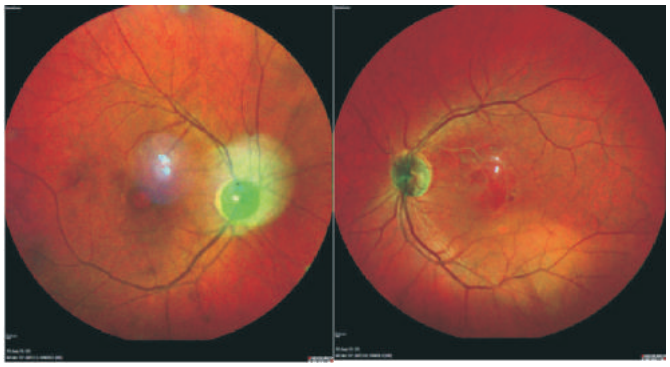

Figure 1: Fundus picture showing full thickness macular hole in the right eye and supero-temporal sclerosed vessel, suggestive of old macular tributary occlusion, with macular edema in the left eye.

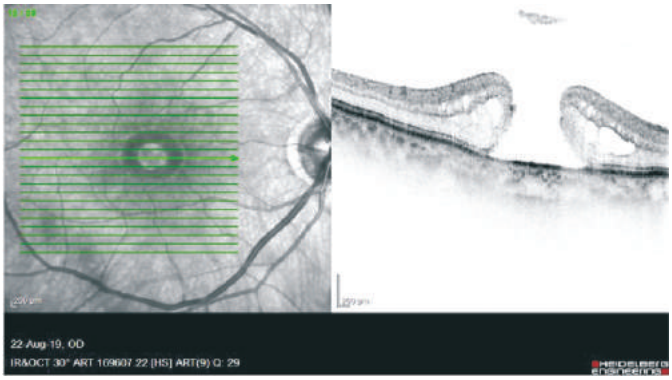

Figure 2: OCT of the right eye showing a large full thickness macular hole.

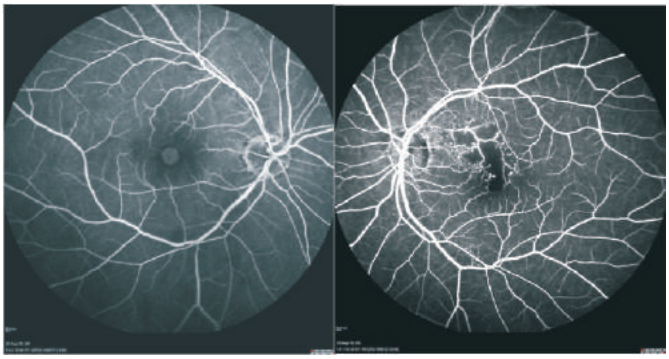

Figure 3: FFA of the right eye showing hyperfluorescence due to window defect owing to the macular hole and the left eye showing staining of the wall of the macular tributary vessel and capillary non perfusion area within the macula.

The patient underwent cataract surgery with monofocal IOL with 25G Vitrectomy + ILM Peeling + C3F8 Gas under local anaesthesia.

On post operative day 1, the right eye had mild corneal stromal keratopathy, PCIOL in the bag, and healthy looking retina with an 80% Gas Fill.

1 week later, the patient's vision in the right eye was FCCF. The gas bubble was at the level of superior vascular arcade (Figure4).

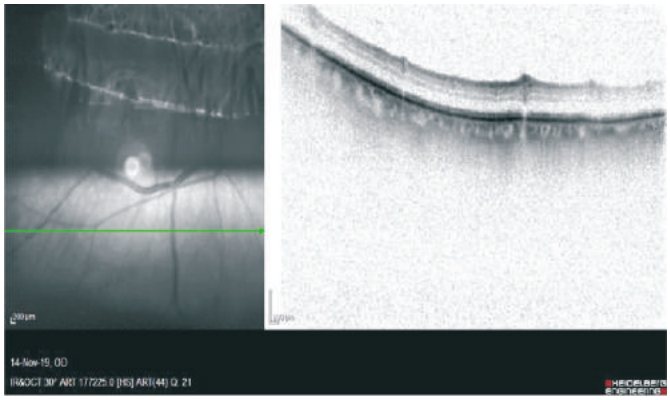

Figure 4 : Right eye OCT one week after surgery.

15 days after the surgery, the patient came with complaints of swelling, pain, and watering in the right eye for 1 day. The vision had dropped to HM in the right eye. The right eye had AC CELLS 1+ / Flare 1+ along with vitreous haze and severe exudation in the vitreous cavity. The patient was diagnosed with endophthalmitis. The patient underwent a Vitreous Lavage + intravitreal injection(Vancomycin(1mg in 0.1ml)+Ceftazidime(2.25mg in 0.1ml)+Dexamethasone(0.4mg in 0.1 ml)) under local anaesthesia. The patient was also started on Tab. Ciprofloxacin 750 mg BD, fortified Vancomycin and Ceftazidime eye drops, on hourly basis, and eye drop Prednisolone Acetate qid.

Culture reports suggested Coagulase Negative Staphylococcus Aureus. Anterior Chamber cells and flare and vitreous exudation didn't improve 2 days later and he was given a repeat dose of intravitreal (Vancomycin(1mg in 0.1ml)+Ceftazidime (2.25mg in 0.1ml)+Dexamethasone(0.4mg in 0.1 ml).

3 days later, Anterior Chamber reaction and exudation had reduced and fundus glow had returned, with a hazy view of the disc. 5 days later, the vision had improved to 2/60. Fundus view was better and peripheral exudation in the vitreous cavity was noted (Figure 5).

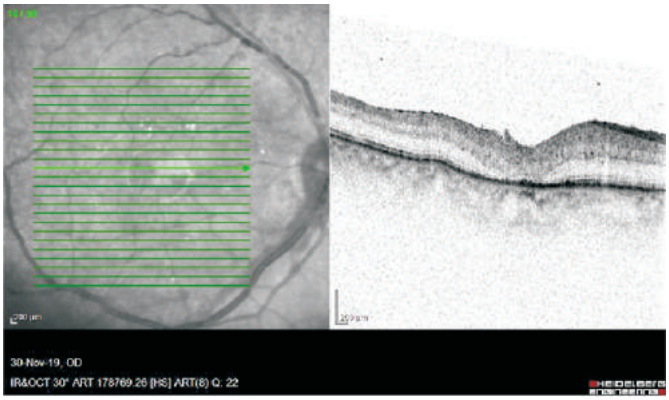

Figure 5 : Right eye OCT one week after surgery.

3 days later the patient came with diminution of vision in the same eye and he was noted to have a retinal detachment in the right eye. The patient underwent a repeat vitrectomy + endolaser with silicon oil injection in the right eye.

On Post-Op Day 7, his vision was CF@2m and retina was well attached. The patient was continued on topical steroid, antibiotic, and IOP lowering drugs.

The patient was examined 2 months later with a vision of CF@2m in the right eye, with retina well attached all around(Figure 6).

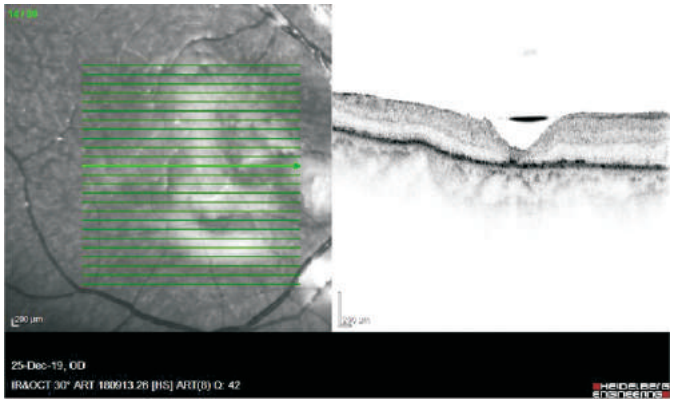

Figure 5 : RE OCT after RD Surgery with Silicon Oil in Situ.

Discussion :

Endophthalmitis in most of the cases is seen after cataract surgery or after intravitreal injections. The incidence of endophthalmitis, as reported in the literature, is 0.07%-0.4% after cataract surgery, and that after intravitreal injection, ranges from 0.04%-0.07%. Endophthalmitis is also common after trauma and after filtration surgeries for glaucoma.

Endophthalmitis after pars plana vitrectomy (PPV) is a rare entity as vitreous is like a nutrient-rich growth medium for microorganisms, and sans the vitreous after PPV, chances of

developing endophthalmitis are very bleak.

Being a rare entity, the reporting of such cases in the literature is quite scarce.[1-5]

The factors which are purportedly responsible for causing endophthalmitis post pars plana vitrectomy are as follows[6,7] :

1. Post-surgery leaking wound

Leaking sclerotomy sites after PPV may allow the microorganisms in the conjunctival cul-de-sac to gain access inside the vitreous cavity causing endophthalmitis. The incidence of endophthalmitis increases dramatically, if there is a tag of vitreous exuding from the site of sclerotomy, especially in a wound that has been left unsutured. Microorganisms use this vitreous strand as a scaffold to enter inside the vitreous cavity. This is known as the vitreous wick phenomenon.

2. Intraocular tamponading agents

Air, silicon oil, and expansile gases like C3F8, SF6 do not support the growth of microorganisms. They also seal the sites of sclerotomies well owing to the differential surface tension of these agents.[8] This provides good wound integrity.

The balanced salt solution, on the other hand, does not seal the site of sclerotomy as well as the above-mentioned agents, and therefore its use may facilitate the entry of microorganisms inside the vitreous cavity.

3. Associated pharmacotherapy

The use of subconjunctival antibiotics after PPV has shown to keep the incidence of endophthalmitis after PPV under check. Some centres do not follow this practice and it may be responsible for endophthalmitis after PPV.

Use of intravitreal anti-vegf injections, triamcinolone acetonide, dexamethasone implant concurrently with PPV may also be responsible for causing endophthalmitis following PPV.

4. Surgeon's learning curve

Increased operating time is considered to be one of the causative factors of endophthalmitis post PPV. Therefore, cases being operated by young surgeons might be at a slightly higher risk of developing endophthalmitis after the surgery. Poorly constructed wounds might also be responsible for leaking wounds post operatively, thereby inviting infections.

5. Diabetes mellitus

Patients with uncontrolled diabetes mellitus and high blood sugar levels are naturally predisposed to develop infections in the post-operative phase.

Diabetics are also likely to have a concurrent cataract, which would increase the operative time. There might also be the presence of complex tractional retinal detachment, which would again increase the operating time and would also require complex handling, both of which could lead to increased chances of developing endophthalmitis after the surgery.

Microbiological Spectrum

A wide variety of microorganisms have been held responsible for causing endophthalmitis post vitrectomy. These

include coagulase-negative staphylococci, Pseudomonas, Propionibacterium, enterococci, and Bacillus species.[9] Coagulase-negative staphylococci is the most common organism causing endophthalmitis after PPV.

Clinical Features

Endophthalmitis following PPV, closely resembles endophthalmitis due to any other cause, in signs and symptoms.[10] Patients generally present with acutely painful, red-eye associated with/without watering and mucopurulent discharge. The presence of lid edema strongly raises the suspicion of endophthalmitis. These symptoms are accompanied with blurring/diminution of vision. Patients typically have hypopyon and dense vitritis, with exudation in the vitreous cavity.

Although in some cases, the features may not be very marked, or there may be a delayed presentation, due to the absence of vitreous, which acts as a growth medium for microorganisms.

Treatment

Clinicians need to carry a high level of suspicion when a patient presents with symptoms of diminution of vision, pain, redness after surgery. It is always advisable to err towards the diagnosis of endophthalmitis when in doubt. Endophthalmitis should be treated as an ocular emergency.

Intravitreal antibiotic injections need to be administered as soon as possible once the diagnosis is made. Antibiotics most commonly used are Vancomycin(1mg in 0.1ml) and Ceftazidime(2.25mg in 0.1ml). Other broad-spectrum antibiotics(Cefazolin, Amikacin, Moxifloxacin, Imipenem, Piperacillin/Tazobactam) may also be used.

Intravitreal Dexamethasone(0.4mg in 0.1ml) is also given concurrently to counter the inflammation inside the eye.

If based on clinical examination, fungal etiology is suspected, then intravitreal Voriconazole950-100ug in 0.1ml)/ Amphotericin-B(5ug in 0.1ml) is injected and the steroid is contraindicated.

Before injecting, a sample from the vitreous cavity should be taken and sent for culture and sensitivity. If media is clear and visibility is good, vitrectomy may be done to clear the bacterial/fungal load as much as possible.

If there is gas/silicon oil in the vitreous cavity, then the sample may be taken from the anterior chamber.

Fortified topical antibiotics and oral antibiotics are included in

the post-injection regime. Topical steroids may be included if fungal etiology has been ruled out and the cornea is healthy.

The patient needs to be called for frequent follow-up visits (preferably every 3 days) and intravitreal injections need to be repeated as per the need. Antibiotics may be altered as per culture and sensitivity reports.

Prevention

Preoperative asepsis is a must. 10% povidone-iodine should be used to clean the lids and lashes prior to every surgery.[11] A few drops of 5% povidone-iodine solution should be instilled in the conjunctival cul-de-sac and left for a few minutes. This povidone-iodine should be thoroughly washed and then the surgery should be commenced.

This practice is known to reduce ocular flora considerably and has shown to drastically reduce the chances of developing endophthalmitis after surgery.

Lid speculum and adhesive surgical drape should be used to keep the eyelashes away from the field of surgery.

Patients who have any signs of ocular/periocular infection (such as stye, blepharitis, dacryocystitis, etc) should be treated for the infective etiology first and the elective surgery should be taken up only after the infection has completely subsided.

Some surgeons prefer to mix antibiotics in the saline infusion fluid. Although this practice is controversial and not universally followed.

While making sclerotomy, it is advised to displace the conjunctiva with a swab before making an entry with the trocar. This ensures that the conjunctival and scleral entry wounds are not in the same line, which thereby decreases the chances of microorganisms gaining an entry inside the vitreous cavity.

The entry of the trocar should be in a beveled manner and not perpendicular to the sclera. This makes the wound self-sealing and reduces the chances of a leaking wound post-surgery.

After the surgery, the proper closure of the wounds needs to be ensured and the wounds may be sutured if at all there is a doubt of leaking sclerotomy.

Visual outcomes

Visual gain after the treatment of endophthalmitis post-PPV is quite varied. In most of the cases, the gain of vision post-PPV endophthalmitis is quite poor which may also be attributed to the primary retinal pathology.[12,13] As per several study reports, the visual outcomes after post-PPV endophthalmitis are poor as compared to endophthalmitis after cataract surgery.

Conclusion

Endophthalmitis after PPV is a rare entity but it may have grave consequences. It usually carries a very poor prognosis despite aggressive treatment and best efforts from the treating physician. Prevention is the best cure for this entity and every measure needs to be taken to ensure that chances of infection post PPV are minimal.

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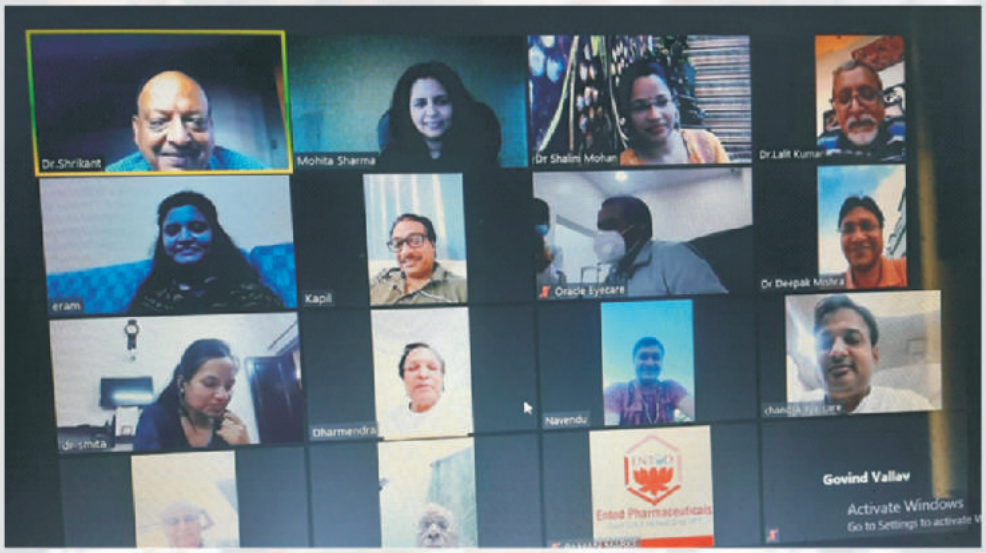

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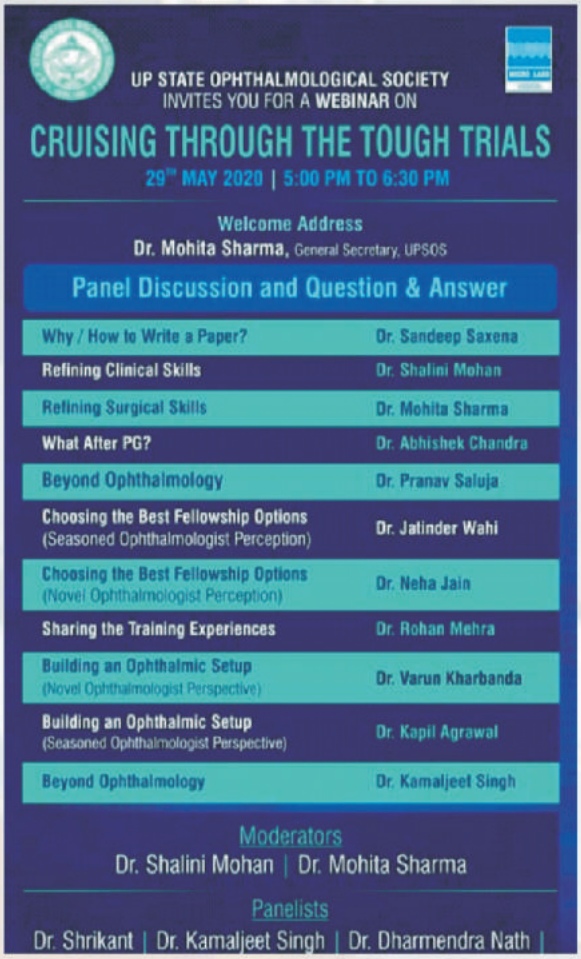

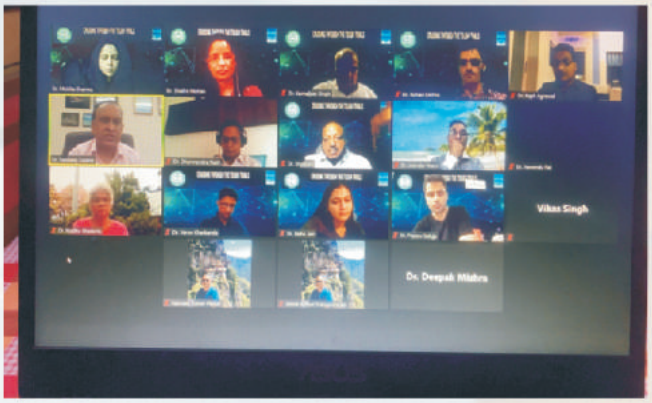

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