Our Patient Desires no Less Than 20/20: with any New Lenses or Surgeries, is it Achievable? (Newer Lenses and Refractive Eye Surgeries)

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Introduction

Cataract and refractive errors are the common causes of preventable blindness in both developed and developing countries. Globally, uncorrected refractive error remains the main cause of visual impairment. Refractive error is commonly corrected with help of spectacle, contact lenses and refractive surgery. From 1990 to 2010 the number of blind and visually impaired people due to cataract has decreased.[1] However, the total number of cataract surgeries has increased considerably in all the regions of the world, especially in Asia, with improvement of surgical techniques and in turn lower rate of complications.[2,3] Current treatment options for cataract is surgical removal of the crystalline lens, and replacement with an intraocular lens (IOL). Majority of patients improve their visual acuity through this procedure. According the current records of NPCB for the year 2017-2018, 150% cataract surgeries were done. And 24% free spectacles were given to school children. With the advent of the newer techniques and increased standard of living, patients with cataract nowadays have a higher demand on postoperative visual performance.

The "ideal" intraocular lens (IOL) should restore the patients' vision without complications or visual compromises at all distances.[4] Emmetropia can be achieved with the use of different IOLs, in almost all cases and refractive surgeries.[4,5,6] It includes monofocal, multifocal and accommodative IOLs meant to provide clear vision at near and distant focal points without additional spectacle correction and toric IOLs for astigmatism correction.[3] Refractive surgeries include refractive corneal surgery (LASIK, LASEK, PRK, EPI-LASEK). The purpose of this review is to give an overview of various surgical technologies and modalities to achieve vision 20/20.

Current IOL Technology

The modern era of cataract surgery started with the introduction of phacoemulsification surgery in 1967 by Charles Kelman.[7] Initially, monofocal lenses were implanted. Premium IOL implies aspheric IOL with different optical

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characteristics (multifocal IOLs, toric IOLs, toric multifocal IOLs, and accommodative IOLs). Different new materials are now being used for premium IOLs, including hydrophobic acrylic, hydrophilic acrylic, silicone, and PMMA biomaterials. The biomaterial used for premium IOL should ensure excellent long-term uveal biocompatibility, based on the inflammatory foreign-body reaction of the eye against the implant, and capsular biocompatibility, determined by the relationship of the IOL with residual lens epithelial cells within the capsular bag.8 Different IOL materials show different adhesive properties, where hydrophobic acrylic materials present highest level of adhesiveness.9 After IOL implantation the IOL fuses with the anterior and posterior capsule. It prevents its decentration and rotation.

Type Of Intraocular Lens

Cataract surgery is a refractive procedure in true sense. The goal of modern cataract surgery is not removal of opaque lens from the visual axis and replacing it with an artificial lens, but to provide 6/6 vision. There are various types of IOL's available are as follows - [15]

Monofocal: The most common type of lens used in cataract surgery is a monofocal IOL set to focus for up-close, medium range or distance vision. Most people have them set for clear distance vision. Conventional monofocal lenses are spherical, meaning they are designed to provide clear vision at a single focal point (usually far away for good driving vision, for example). With conventional IOLs, typically eyeglasses or contact lenses are also needed in order to use a computer, read or perform other close-up tasks within arm's length.

Multifocal: IOLs that provide both distance and near focus at the same time are called multifocal IOLs. The lens has different zones set at different powers. It is designed so that the brain learns to select the right focus automatically. Multifocal IOLs contain added magnification in different parts of the lens to help treat presbyopia, decreasing the need for reading glasses or computer glasses after cataract surgery. Multifocal IOLs tend to provide better near vision than accommodating IOLs, but they also are more likely to cause glare or mildly blurred distance vision. Multifocal lenses are of two types, diffractive and refractive lenses. Diffractive lenses are usually bifocal lenses wherein bifocality is grinded on the posterior surface of lens. Tecnis & ReSTOR are examples of such lenses. Refractive lenses are usually multifocal lenses wherein multifocality is grinded on the anterior surface of lens. And they are pupil dependent. So, it is not recommended to those who drive at night. Array, ReZOOM, MF 4 are some of the examples. US-FDA-approved multifocal IOLs include Tecnis Multifocal IOL (Abbott Medical Optics) and AcrySof IQ ReSTOR (Alcon).

Accommodative: These lenses move or change shape inside your eye, allowing focussing at different distances. Accommodative IOLs expand the range of clear vision with both an aspheric design (as opposed to spherical design of monofocal IOLs) and also flexible "haptics" - the supporting legs that hold the IOL in place inside the eye. These flexible legs allow the accommodating IOL to move forward slightly when looking at near objects, which increases the focussing power of the eye enough to provide better near vision than a conventional monofocal lens. Accommodating IOLs may not provide the same level of magnification for near vision that a multifocal IOL does. FDA-approved accommodating IOLs include Crystalens AO and Trulign Toric IOL, both made by Bausch + Lomb.

Toric: A toric lens can correct astigmatism as well as nearsightedness or farsightedness. Astigmatism is a refractive error caused by an uneven curve in the cornea or lens. The toric lens is designed with different powers in different meridians of the lens. They also have alignment markings on the peripheral part of the lens that enable the surgeon to adjust the orientation of the IOL inside the eye for optimal correction. Prior to cataract surgery, the surgeon places temporary markings on the patient's cornea that identify the location of the most curved meridian of the front of the eye. When the toric IOL is implanted during the cataract procedure, the surgeon rotates the IOL so the markings on the IOL are aligned with the markings on the cornea to insure proper astigmatism correction. US-FDA-approved toric intraocular lenses available in the U.S. include: Tecnis Toric, AcrySof IQ Toric, Staar Toric IOL (Staar Surgical), and Trulign Toric (Bausch + Lomb). Other ways to reduce corneal astigmatism is by limbal relaxing incision and opposite clear corneal incision which are incision at steep meridian on cornea that heals with flattening reducing the toricity of cornea. So, patient can enjoy a good vision.

Aspheric: The shape of the natural lens inside the eye may vary in curvature from centre to periphery. In other words, the eye's natural lens is aspheric or not spherical. Aspheric IOLs are designed to more closely match the shape and optical quality of the eye's natural lens, and thereby can provide sharper vision, especially in low light conditions. US-FDA-approved IOLs include: Tecnis Aspheric (Abbott Medical Optics), AcrySof IQ (Alcon), SofPort AO (Bausch + Lomb), and Softec HD (Lenstec).

Extended Depth of Focus (EDOF): EDOF IOLs, also referred to as Extended Range of Vision (EROV) IOL, are proposed for the treatment of presbyopia. In contrast to multifocal IOLs used in treatment of presbyopia, EDOF lenses work by creating a single elongated focal point to enhance "range of vision" or "depth of focus". At this time there is one FDA-approved EDOF IOL, Tecnis Symfony Extended Range of Vision (Abbott Medical Optics). Tecnis Symfony IOL is also available in four toric models. The IC-8™ IOL (AcuFocu, Inc., Irvine, CA) and WIOL-CF (Medicem, Czech Republic) are not FDA-approved or available for sale in the United States.

Patient Selection Criteria for Multifocal Lenses

Before surgery, it is mandatory to have a discussion with the patient and patient's relative in order to determine his/her expectations and lifestyle related needs.[4] Patient selection and counselling are crucial events.[4,6,10] The ideal patient is motivated to achieve spectacle independence for distance and near vision, and has realistic expectations.[6] 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.[11] 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.[6] [3,4,10] Any pre-existing ocular co morbidity that could affect the vision are relative to absolute contraindications for 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.[4,12] Due to tear-film abnormality, patients with dry-eye syndrome and meibomian gland dysfunction are potentially extremely unsatisfied after cataract surgery, and hence these diseases should be treated aggressively before surgery. Ocular disorder with capsular instability is relative to absolute contraindication for cataract surgery. Macular disorder and optic nerve head disease have less contrast sensitivity post cataract surgery. Diabetic retinopathy and Age Related Macular Degeneration progresses post cataract surgery. Care should be taken while considering for IOL implantation in patients with glaucoma or any optic nerve damage. Only glaucoma suspects and ocular hypertensive patients with no disc or visual field damage who have been stable for a longer period of time should be candidates for multifocal IOLs.[13] Preoperative ocular coherence tomography and perimetry evaluation could rule out subtle or occult pathology while in cases of significant or progressive pathologies, multifocal IOLs are contraindicated.[4] Furthermore, in patients with posterior eye segment changes, the visualisation of macula and optic nerve will be impaired after both toric and multifocal IOL implantation, and this could result in various difficulties in later diagnostic as well as therapeutic procedures.[4] In order to provide some spectacle independence in these patients, monofocal monovision should be considered as a viable option.[14]

Refractive Surgery

Refractive surgery, a subfield of ophthalmology, is defined as the surgical correction of refractive errors of the human eye. Refractive errors are measured in diopters (D) and are Classified as axially symmetrical, astigmatic, or (most commonly) mixed. The axially symmetrical types of refractive error are nearsightedness (myopia) and farsightedness (hyperopia). Myopia is present when the eye is too long in relation to its refractive apparatus.

In the myopic eye, parallel incident light rays are focussed onto a point in front of the retina, and the image on the retina itself is blurred (figure 1, I). Hyperopia (or

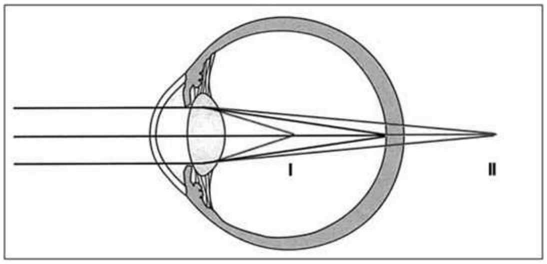

Figure:1 Image formation in myopia and hyperopia. In myopia, the image of a point at infinity is projected in front of the retina (I); in hyperopia, the image of a point at infinity is projected behind the retina (II).

hypermetropia) is the medical term for farsightedness. This type of refractive error arises when the eye is too short for its refractive apparatus. Myopia and hyperopia are often found in combination with astigmatism, though astigmatism can also occur alone. A further type of refractive error is the presbyopia that occurs in normal aging, which is caused by a gradual loss of flexibility of the lens rendering it unable to increase its refractive power for near vision, i.e., to accommodate. Along with refractive error higher order aberration also exists. Coma and spherical aberration are most common. Excimer laser techniques and incisional procedures are used in refractive corneal surgery; phakic intraocular lenses (PIOL) and refractive lens exchange (RLE) are used in lens surgery.[16]

Refractive Corneal Surgery

The surface treatment techniques include photorefractive keratectomy (PRK), laser-subepithelial keratomileusis (LASEK), and epi-LASIK. In these three types of procedure, corneal tissue is ablated with an excimer LASER just below the corneal epithelium, which is the outermost of the five layers of the cornea. Before ablation, the corneal epithelium is removed by a mechanical or chemical method or with a LASER (as in PRK), with an alcohol solution (as in LASEK), or else it is separated from the underlying tissue with a microkeratome (as in epi-LASIK). After ablation, the corneal epithelium is put back in place. The combination of a lamellating stromal corneal incision with excimer-laser ablation is known as laser in situ keratomileusis (LASIK). In this technique, a microkeratome or a femtosecond laser is used to cut a flap which is folded back to have access to stromal tissue (figure 2).

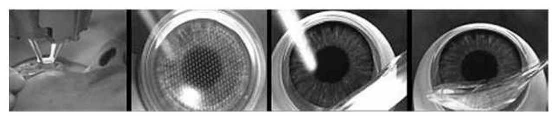

Figure 2: A LASIK procedure with a femtosecond laser and an excimer laser: a) The laser beams are focused, under computer guidance, onto a point lying at a precisely calculated depth (femtosecond laser). b) A flap is created by the concentration of many thousands of individual laser pulses in a single plane. c) The flap is lifted, and the refractive error is corrected with the argon fluoride excimer laser. d) Finally, the flap is repositioned.

The femtosecond LASER is the newest technology for creating a corneal flap. It is very safe: the risk of a cutting error, as may occur with a mechanical microkeratome, is extremely low.

Phakic IOL: Unlike the above described lenses, phakic lens are not associated with cataract surgery. They are permanently implanted into the eye to reduce a person's need for glasses or contact lenses, without removing the natural lens. They are placed just in front of or just behind the iris while preserving the natural crystalline lens. This is in contrast to intraocular lenses that are implanted into eyes after the eye's cloudy natural lens has been removed during cataract surgery. Phakic IOLs function very similarly to contact lenses. Phakic lenses are approved by the FDA for the correction of nearsightedness (myopia) only and include Visian Implantable Collamer Lens (Staar Surgical) and Verisyse (Abbott Medical Optics).

Clear Lens Extraction (CLE) also called refractive lens exchange (RLE) is the removal of a non-cloudy natural lens of the eye with the placement of corrective lenses. The clear lens extraction technique is very similar to cataract extraction. The eye's natural lens is removed and replaced with a prescription intraocular lens.

However, refractive surgical procedures are considered not medically necessary because the correction of refractive errors can be achieved with eyeglasses or contact lenses.

Indication for refractive surgeries

The Commission for Refractive Surgery (Kommission Refraktive Chirurgie, KRC), a joint committee of the German Ophthalmological Society (Deutsche Ophthalmologische Gesellschaft, DOG) and the Professional Association of Ophthalmologists in Germany (Berufsverband der Augenärzte Deutschlands, BVA) has issued generally applicable indication criteria for refractive surgical procedures with the aim of preventing severe complications.[17] The "range of applicability" (or "indicated range") is the range of pre-operatively measured parameters within which the technique in question is considered to be suitable and has only rare adverse effects.

All refractive surgical techniques are held to be contraindicated for patients under age 18, or when a refractive error (other than presbyopia) is currently progressing in severity. The excimer-laser techniques (LASEK, PRK, LASIK, epi-LASIK) are used for the correction of myopia up to -8 dpt (LASIK for myopia up to -10 dpt), hyperopia up to +4 dpt, and astigmatism up to 5 dpt. These techniques are contraindicated in the presence of a symptomatic cataract, glaucoma with marked visual field damage, or exudative macular degeneration. A preoperative corneal thickness of less than 500 microns is a further contraindication for the lamellar surgical procedures.

Take Home Message

Sight is what your eyes produce. Every human has a right to have good vision. To see, the world with clear, crisp vision, various modalities are available like spectacle, contact lenses, refractive surgeries and cataract surgery. General practitioners play a crucial role many times in counselling patients about their refractive errors and cataract. Vision 20/20 is achievable when the disease or condition is identified and corrected at right time on presentation to a doctor. Awareness to have a good vision is very important. It takes a team work by general practitioner and ophthalmologist to give a patient a good vision.

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Chronic obstructive pulmonary disease 1

What does endotyping mean for treatment in chronic obstructive pulmonary disease?

This Series paper discusses a possible new taxonomy of COPD, the role of endotypes and associated biomarkers and phenotypes, the gaps (and opportunities) in existing knowledge of COPD pathobiology, how systems biology and network medicine can improve understanding of the disease and help to identify relevant endotypes and their specific biomarkers, and how endotypes and their biomarkers can improve the precision, effectiveness, and safety of the treatment of patients with COPD.

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