Lens Aberration and Multifocal Iols Characteristic Appearance by Bio-Microscopy

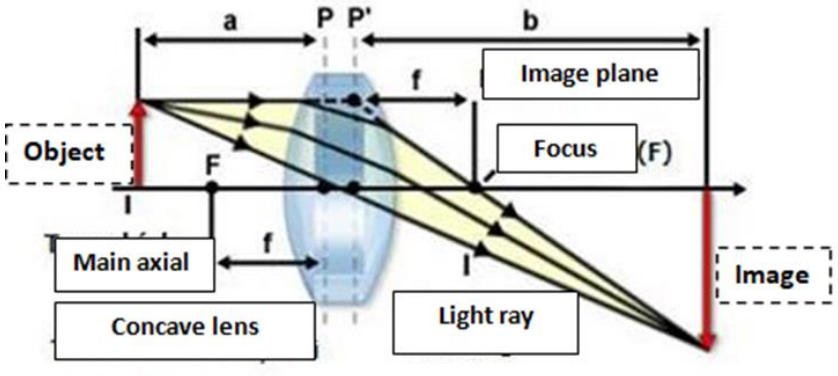
Author Details: Duong Dieu MD, PhD.
Faculty of Medicine Nguyen Tat Thanh University-300A Nguyen Tat Thanh Street-HCM City- Vietnam.
duongdieumd@gmail.com, duongdieumd@ntt.edu.vn.

Abstract
The IOL manufacturing process of different brands is not the same and it is recommended to use the same brand IOL for both eyes. Useful vision after cataract surgery and implantation of intraocular lens (IOL) depends on surgical techniques, measurement of refractive parameters as well as adaptation of the patient. (neural adaptation). Multifocal or progressive lenses, if used prior to cataract surgery, are relatively more adaptable. Results of visual acuity after IOL implantation surgery depends on surgical techniques, on setting the correct refraction first and then the quality of the IOL after, lastly on adaptation of the patient (neural adaptation). Identification of multifocal IOLs through bio microscopy is essential for both doctors and patients in using it. The objective of this paper is to note some characteristics of lens aberrations, and multifocal IOLs characteristic appearance by bio microscopy in order to choose, to confirm.
Key words: *lens aberrations, implantation of intraocular lens (IOL), multifocal IOLs, IOLs characteristic appearance.*

Introduction:

Results of visual acuity after cataract surgery and implantation of intraocular lens (IOL) depends on surgical techniques, measurement of refractive parameters as well as adaptation of the patient. (neural adaptation). The objective of this paper is to note some characteristics of lens aberrations, and multifocal IOLs characteristic appearance by bio microscopy in order to choose, to confirm for useful vision. In order to have useful vision, it is necessary to first know about lens aberration

1 Lens aberration: Optical phenomena are divided into 3 fields. Optics describing the wave behavior of light was discovered by Christian Huygen, then developed by Young and Maxwell. Photonics deals with the interaction between light and matter with the wave properties proposed by Newton and the particle nature fully explained by Planck. Geometric optics that conceives of light as rays and describes images through lenses and mirrors [1]. Gauss a German mathematician and scientist who hypothesized aberrations to determine optical properties of the object and the image is not near the axis through the lens [2]. There are many types of lenses, but they can be divided into two main types: convex lenses and concave lenses. A convex lens has a positive focal length, which means that the actual focal point magnifies the image of the object. The Intraocular lens IOL is this type. Objects and pictures are as follows (Figure 1):



F1. Object and image through lens

Emetropia has no refractive error, the image of the object lies directly on the retina. Myopia is a refractive error in which the image is located in front of the retina. Farsightedness (hyperopia) has images behind the retina. Astigmatism is caused by an irregular curvature of the cornea or lens, resulting in blurred images on the retina.

Anisotropia is the difference in refraction between two eyes. Refractive error leads to an uneven image of the eyes (aniseikonia). Aberration has the following manifestations: distortion, comet, spherical aberration, astigmatism, petzval field curvature, chromatic aberration) and defocus. Astigmatism aberration similar to coma; however, this phenomenon is not sensitive to aperture size and is highly dependent on the bevel of the light beam. This aberration is represented by the off-axis image of a point object appearing as a line segment or ellipse instead of as a single point. Depending on the angle of the off-axis light beam entering the lens, the segment image can be oriented in two different directions: longitude or latitude. The intensity ratio of the unit image will decrease, with clarity, detail, and contrast being lost as the distance to the center increases. For people with large refractive errors, glasses need to be adjusted so that the image size for the eyes is even compared to the standard lens. Formula for magnification adjustment glasses: D(diopter) =[1/(1-(t/n)P]x[1/(1-hF)] Where: t = center thickness (in metres); n = index of refraction; P = anterior baseline curve; h = peak distance PD (in metres); F = posterior peak distance. If the difference between 2 eyes is up to 3 diopters, glasses is needed. Also the difference of 3 diopter lenses will be clearly different - a lens will need to be at least 3mm thick and have a +7.5 spherical base curve. Consequences of peak distance (PD): With 12mm PD, each diopter has a corresponding magnification of 2%. The adaptability of the eye is from 2-4 diopters, respectively 4-8%. [3]

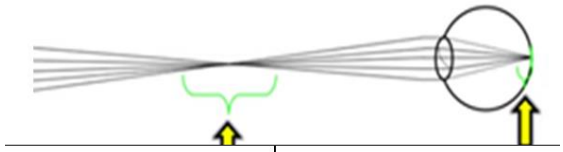
2. Identification of multifocal intraocular lens characteristics by bio-microscopy [1][4].

2.1 Implantation of IOL: An intraocular lens (or IOL) is an artificial lens that replaces the eye's natural lens that was removed during cataract surgery. The normal lens is transparent when light rays enter the eye, helping to see clearly. If the lens is cloudy, the vision will be blurred, or less colorful, especially when the eyes are bright. Blurred vision can be caused by many eye diseases so it needs to be check up by an eye doctor. Cataract patient with cloudy lens that has been removed and replaced it with an IOL to improve vision. IOLs come in different focusing powers, just like eyeglasses or contact lenses. Your ophthalmologist will measure your eye length and corneal curve to show the IOL power, the axe for each person's eyes.

2.2 What are IOLs made of?

Most IOLs are made of silicone, acrylic or other plastic components. Some are also coated with a special material to help protect the eyes from harmful ultraviolet (UV) rays from the sun.[5] Some current IOLs promote the advantage of extended depth of focus (EDOF).

Depth of focus is the image that is clear when light enters the central part of the IOL, and the image is blurred outside of this range. And depth of field is used for objects in one area to make the image clear and objects outside the depth of field will be blurred [1]. (Figure 2)



F2. Depth of focus and field

2.3 Types of IOLs:

Monofocus intraocular lens is the most common type of lens used in cataract surgery. It has a focus distance. It is set to focus for near, mid-range, or long-range vision. Most people place them for clear foresight. After placing the IOL, it is necessary to wear eyeglasses for reading or close work.

Multifocus intraocular lens (progressive aspheric intraocular lens) These IOLs provide both near, inermediate and far focus simultaneously. This IOL has different powers in different compatibility areas located in the IOLs. These lenses allow focusing at different distances.

Astigmatic intraocular lens (toric or spheric intraocular lens) For people with astigmatism, there is an IOL called a toric lens. An uneven curve of the cornea or cristalline lens caused a refractive error of astigmatism.

Toric lenses are designed to correct the astigmatism. The refractive error of astigmatism >0.75 diopter is usually indicated with toric lenses.[3]

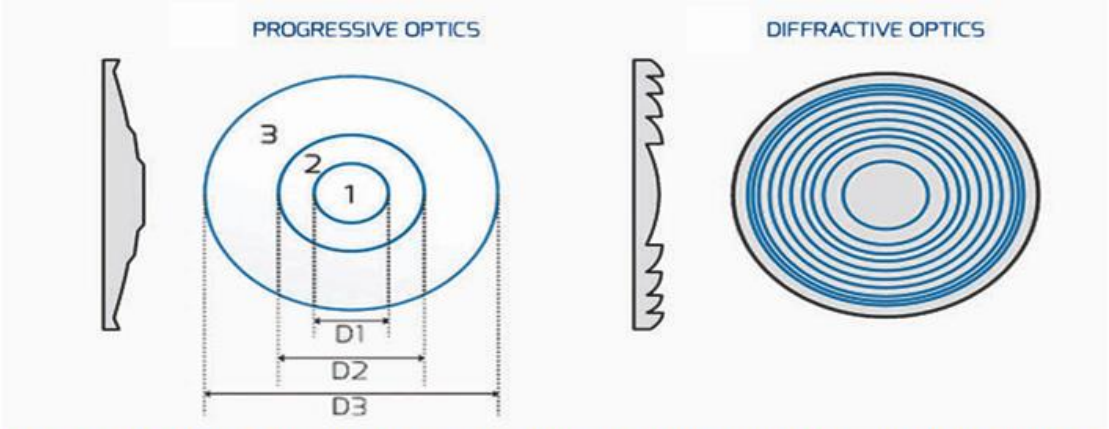
Using combined IOL according to patient requirements:

If the two eyes with different IOLs have different focal lengths, for example, one eye can see far and one eye to see near is called monovision, it will take time to adapt after placing the IOL. coordination adaptation from monovision to binovision [6]. Cataract surgery/multifocal IOL placement is relatively more adaptable if progressive lenses or lenses have been used in the past. In case of non-adaptation, the appropriate IOl must be taken out. IOL replacement rate is about 1% [7]. The time to decide on the second eye surgery is a matter of safety considerations. And it is necessary to refer to the national standard for cataract surgery [8]

2.4 Identification of multifocal IOLs by microscopy: it is very important for both doctors and patients to use it before and after surgery as shown in Table 1 and Figure 3 below [9,10,11,12].

Table 1: Characteristic appearance of multifocus IOL by biomicroscopy

N⁰	Name	Country	Characteristic- Appearance by biomicroscope	Optic design	Image
1	**Tecnis Symfony ZXR00**	Johnson& Johnson- USA	Color round rings	Diffraction EDOF	
2	**AT LARA 829 MP**	ZEISS_ Genmany	Color round rings	Diffraction EDOF	
3	**Lentis Mplus MF20**	Oculentis Genmany	Color round rings	Diffraction EDOF	
4	**MINI WELL READY**	SIFI S.p.A - Italia	No color ring, smooth face	Toric correction EDOF	



F3 Left= Mini Well Ready design: no color, smooth, D! positive & D2 negative spheric correction. D3 same monofocus. Right=diffraction with color rings by biomicroscopy

Conclusion:

The IOL manufacturing process of different brands is not the same and it is recommended to use the same brand IOL for both eyes. Multifocal or progressive lenses, if used prior to cataract surgery, are relatively more adaptable. Results of visual acuity after IOL implantation surgery depend on setting the correct refraction first and then the quality of the IOL after. Identification of multifocal IOLs through microscopy is essential for both doctors and patients in using it.

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Author Profile

Duong Dieu received the MD (1978) and PhD (2003). He was chief of the Ophthalmology Department for over 30 years with a clinician/surgeon. From 2010 to now he is vice dean of the Faculty of Medicine of Nguyen Tat Thanh University in HCM city- Vietnam.