· Opinion ·

Retinal detachment repair through multifocal intraocular lens-overcoming visualization challenge of the peripheral retina

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INTRODUCTION

Sir Nicholas Harold Lloyd Ridley has revolutionized the practice of ophthalmology by performing the first intraocular lens (IOL) implantation in 1949[1]. His scientific achievement was acknowledged thirty years later, which led to US Food and Drug Administration approval in 1981[2]. Although the basic principles of IOL implantation have not changed since, many efforts have been invested in perfecting IOL design during the past decades.

While the natural crystalline lens can dynamically accommodate and actively change its refractive power, the conventional IOL implants cannot, as their refractive power is fixed. Thus contemporary IOL research has been focusing on regaining accommodation after cataract surgery. Currently, accommodative and refractive/diffractive IOL designs are commercially available to offer possible independence from glasses[3].

In brief, accommodative IOLs have the capability of changing their physical properties and thus dynamically change their refractive power. Refractive and diffractive IOLs, which share similar features, have several different focal points. They simultaneously create several (2-3) images one on top of the other, for the brain to choose from: infinity, reading distance and optionally an intermediate distance[4]. Diffractive and refractive IOLs are known for inducing significant image distortion, glare, and loss of contrast sensitivity, especially in mesopic conditions, when the pupil is dilated. Nevertheless, and despite these adverse effects, their use and popularity have significantly increased in recent years[5].

Modern pars plana vitrectomy (PPV) has also been constantly evolving since first introduced by Machemer[6] in 1970. PPV allows delicate and controlled evacuation of the vitreous gel and further sophisticated manipulation of the retina. Being a delicate surgical procedure, PPV requires perfect visualization of the vitreous and retina up to the ora serrata and beyond. Modern PPV heavily relies on the patient's own optical system, including the IOL implant, for visualization. Thus, the diffractive/refractive type IOLs pose a significant new visualization challenge for retinal surgeons.

Few reports have been published to date confirming visualization difficulties during vitrectomy with multifocal IOLs, nevertheless no solutions have been offered so far. Yoshino *et al*[7] and Kawamura *et al*[8] reported visualization difficulty during vitrectomy for epiretinal membrane (ERM) peeling and for retinal detachment respectively, caused by diffractive IOLs. On the other hand, Marques *et al*[9] reported normal visualization during PPV with accommodative IOL. This paper is the first to demonstrate and suggest a few practical solutions to improve visualization during vitrectomy with multifocal IOLs.

SURGICAL TECHNIQUE

After informed consent was obtained, a 3-port vitrectomy surgery for rhegmatogenous retinal detachment repair was performed, using a wide field contact indirect lens. The 27-gauge valved trocars (Alcon Laboratories, Inc., Fort Worth, TX, USA) were inserted 3.5 mm posterior to the limbus inferotemporally (infusion line port), superonasally and superotemporally. During the first stages of the surgery, visualization of the posterior pole and periphery was only mildly compromised by the diffractive IOL. The Placido Disc pattern of the diffractive surface of the IOL slightly distorted the retinal image, but the retinal image was reasonable, especially when viewed through the central zone or in between the optical zones (Figure 1).

After vitrectomy the retina was inspected and the culprit break was marked. Nevertheless, after fluid-air exchange was performed, the funduscopic view became blurry to a degree where the marked retinal tear could not be seen (Figure 2). A 30-gauge needle was then used to coat both surfaces of the IOL with a thin layer of viscoelastic material (HEALON® OVD, Abbott Medical Optics, Santa Ana, CA, USA), injecting behind the IOL through pars plana and injecting anteriorly

Figure 1 Retinal view through a multifocal IOL under fluid, using a wide-field contact lens.

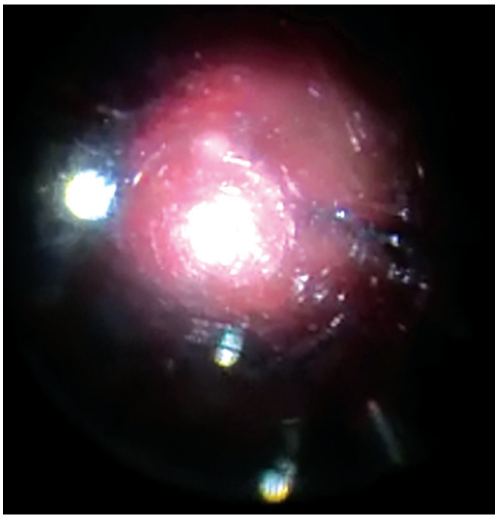

Figure 2 Initial retinal view through a multifocal IOL under air, using a wide-field contact lens.

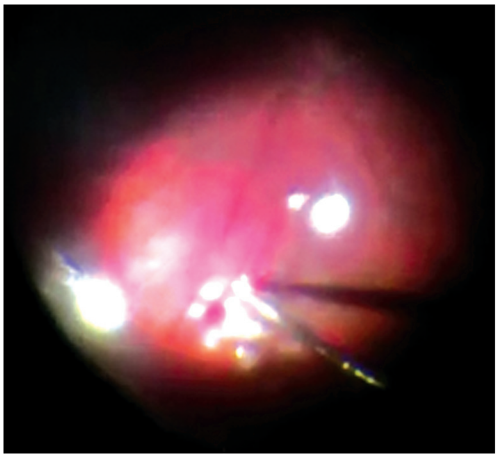

Figure 3 Improved retinal view through a multifocal IOL under air, using a wide-field contact lens, after coating the IOL anteriorly and the posterior capsule posteriorly with Healon, and slightly tilting the contact lens.

through the anterior chamber, and the hand-held indirect contact lens was slightly tilted. The surgeon's view was hence vastly improved, allowing for safely completing the surgery (Figure 3). The subretinal fluid was drained through the retinal break using a soft-tip Charles Flute, and the retina completely reattached. Air was then exchanged with 25% SF_6 (sulfur hexafluoride), the viscoelastic was removed from the anterior chamber using balanced salt solution irrigation, and finally the trocars were removed.

DISCUSSION

Modern vitrectomy surgery requires excellent visualization of the vitreous and retina, and relies upon the patient's own optical system. Multifocal IOLs are optically designed to trade image quality with glasses independence. Their optical design reduces image quality and contrast sensitivity, and causes glare, all of which worsen as the pupil dilates. Surgeon's fundus view is closely correlated with patient's view, and therefore also becomes compromised in eyes with implanted multifocal IOLs, more so as the pupil is pharmacologically dilated[10].

Visualization during a standard PPV under air is more challenging compared to PPV under water, because the refractive index difference between the IOL and gas is higher relative to the refractive index difference between the IOL and liquid. Under these conditions slight surface irregularities induce a greater optical distortion of the image. Therefore, the poorest surgeon's view is expected during PPV under air with a multifocal lens and a dilated pupil.

The physical structure of the multifocal IOLs dictates that the visualization artifacts change in quality and severity depending on the target's location and light's path to the surgeon's viewing system. Thus, areas of interest can rapidly seem to disappear and reappear in a different place or become abruptly optically distorted as the light crosses different IOL optical zones. In that aspect, macular surgery is different from retinal detachment repair surgery, since in the former the surgeon can experience a more stable image and less distortion as long as the light is tunneled through the central optical zone of the IOL. In contrast, during retinal detachment surgery the entire optical system is in a brisk constant change, which requires much more effort and skills to maintain optimal visualization.

To overcome these visualization challenges, fluid-air exchange should be deferred until view-sensitive surgical stages have been completed. By tilting the optical system, the image reflected from the interface surfaces may be steered away from the surgeon's viewing system. Shielded (beveled) illumination may be used to block the light from directly scattering and reflecting into the viewing system. Wide-field indirect viewing systems use condensing lenses and the image obtained is less affected by media irregularities. By coating the IOL with a thin layer of viscoelastic material, the refractive/diffractive effect of the multifocal IOL is attenuated, as well as other surface irregularities such as IOL scratches and posterior capsule irregularities. According to Snell's law of refraction, when light passes through refractive elements, the degree of ray diversion is proportional to their refractive indices difference. Thus, by coating the IOL with viscoelasticity, the surface irregularities of the IOL (including the refractive/diffractive elements) have less optical influence, and thus the fundus image improves. This same principle is naturally prevalent in the eye where the corneal epithelium is coated with a thin mucin layer. While most viscoelastic compounds may achieve this goal, the use of a dispersive agent is preferred since these typically produce a smooth and even coating. This technique is also useful to avoid fogging and condensations on the IOL surface when operating under air[11-12].

This paper discusses a few principles on ways to improve visualization through multifocal IOLs during vitrectomy surgery. We routinely employ the discussed techniques in our vitrectomy cases, such as the use of indirect contact visualization system that is slightly tilted, and coating of the IOL with viscoelasticity when multifocal IOLs and poor fundus view are present.

The above described techniques should usually be sufficient to enable conventional PPV. Nevertheless, in extreme cases, and when other media problems co-exist, endoscopic vitrectomy, IOL removal, open-air vitrectomy or keratoprosthesis-assisted vitrectomy may be indicated. As multifocal IOL implants become general practice during cataract extraction, further research is required to find solutions for improving image quality and visualization during vitrectomy.

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