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REVIEW

The posterior chamber phakic refractive lens (PRL): a review

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Abstract

Implantation of phakic intraocular lenses (pIOLs) is a reversible refractive procedure, preserving the patient's accommodative function with minimal induction of higher order aberrations compared with corneal photoablative procedures. Despite this, as an intraocular procedure, it has potential risks such as cataracts, chronic uveitis, pupil ovalization, corneal endothelial cell loss, pigmentary dispersion syndrome, pupillary block glaucoma, astigmatism, or endophthalmitis. Currently, only two models of posterior chamber pIOLs are commercially available, the implantable collammer lens (STAAR Surgical Co.) and the phakic refractive lens (PRL; Zeiss Meditec). The number of published reports on the latter is very low, and some concerns still remain about its long-term safety. The present article reviews the published literature on the outcomes after PRL implantation in order to provide a general overview and evaluate its real potential as a surgical refractive option.
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Introduction

Corneal ablation surgical procedures such as photorefractive keratectomy or laser *in situ* keratomileusis are usually the preferred options by refractive surgeons for correcting refractive defects. However, the range of safe dioptric correction for these procedures has been progressively narrowed as a consequence of the mid and long-term complications observed, particularly in cases of high refractive error, such as keratectasia,[1] corneal haze,[2] regression,[3] dry eye,[4] or poor postoperative visual quality.[5,6] It has been shown that photoablative refractive surgery in high ametropia can lead to a significant increase in ocular aberrations[5] and decrease in visual performance.[6] Furthermore, corneal photoablation has a decreased predictability for the correction of high refractive error because of the unknown and unpredictable effects on corneal biomechanics.[7]

Intraocular refractive procedures have become a safe, efficient and predictable alternative for treating high ametropias when the use of corneal photoablative procedures is not possible or high risk. Advances in intraocular lens (IOL) designs, surgical tools, and procedures, as well as viscoelastic substances, have allowed the development of intraocular refractive surgery.[8] The implantation of phakic intraocular lenses (pIOLs) is a reversible refractive procedure that preserves the accommodative function with minimal induction of higher order aberrations compared with corneal photoablative procedures.[9] Despite this, as an intraocular procedure, it has potential-associated complications such as cataract, chronic uveitis, pupil ovalization, corneal endothelial cell loss, pigmentary dispersion syndrome, pupillary block glaucoma, astigmatism, or endophthalmitis.[10]

pIOLs may be divided into anterior chamber and posterior chamber lenses, with anterior chamber lenses being further divided into angle supported and iris fixated.

Angle-supported pIOLs were first implanted in 1986. These lenses have shown good refractive results in the long term, but significant rates of complications such as corneal endothelial cell loss, chronic uveitis, or pupil ovalization have been observed with some models, particularly with the initial designs.[11,12]

Several iris-fixated pIOLs have been developed, although the most widely implanted

is the Artisan lens (Ophtec BV, Groningen, The Netherlands), giving good long-term results with low complication rates.[13] FDA approval (2004) has been only obtained for the Verisyse iris-fixated pIOL (Abbot Medical Optics, Inc., Santa Ana, CA, USA), which is a model that holds several similarities with the Artisan.

Posterior chamber pIOLs have improved considerably since their introduction by Fyodorov in 1986.[14] Only two models of posterior chamber pIOLs are available: the implantable contact lens (ICL; STAAR Surgical Co., Monrovia, CA, USA) and the phakic refractive lens (PRL; Zeiss Meditec, Jena, Germany; not commercially available since early 2012; Table 1).

The ICL is the most widely implanted posterior chamber pIOL, with the Visian ICL 4 model having obtained FDA approval for the correction of high ametropia in 2005.[15] It is a rectangular single-block IOL made of a hydroxyethyl methacrylate copolymer combined with a hydrophilic collagen (<0.1%) material of a 1.45 refractive index. This pIOL is available in several diameters (11 to 13 mm), with a variable optical zone depending on the optical power (4.65 to 5.5 mm for negative lenses and 5.5 mm for positive lenses). It was designed as a sulcus-supported lens, and for this reason sulcus-to-sulcus distance is crucial for an appropriate selection of the lens diameter.[16] There are a number of studies evaluating the outcomes obtained with the different models of ICL, and therefore there is a complete characterization of the refractive outcomes and complications resulting from the implantation of this pIOL.[17–24]

The current review will focus on the other available posterior chamber pIOL, the PRL, which has been very recently removed from the market. This pIOL was initially developed in 1987, now in its third generation, and was conceived to be implanted in the posterior chamber through an autosealing corneal incision. In theory, the third-generation model of PRL was designed to float freely within the aqueous humour contained in the posterior chamber, not exerting pressure on the cilliary structures nor contacting with the anterior surface of the crystalline lens. It has been demonstrated that the lens moves forward during accommodation, allowing a normal aqueous humour flow inside the posterior chamber.[25] However, the actual behaviour of the PRL is not completely known nor understood. In addition, some concerns still remain with regards to the use of this pIOL because of a number of reported complications.[26] The aim of the current article is to review the published literature reporting on the outcomes after PRL implantation in order to provide a general overview and evaluate its real potential as a surgical refractive option.

Technical features of the review

One independent reviewer (RJPC) completed a systematic search in PubMed database without data restrictions for articles related to the PRL. A combination of text words and medical subject headings of the National Library of Medicine was used in the literature search from January 1997 to April 2011 using the following key words: phakic refractive lens, PRL, posterior chamber phakic intraocular lens, and Medennium. All articles found were carefully reviewed to select those that reported outcomes in cases implanted with the PRL or details of the surgical technique for implantation. A total of 22 articles meeting the search criteria were found:[25–46] 15 case series, 6 case reports, and 1 surgical technique article. Three systematic reviews about pIOLs including information about the PRL were also considered as relevant for the present review article.

Table 1 Comparison between ICL and PRL parameters

	ICL-V4	*PRL*
Total length (myopia)	11.5 to 13 mm	10.8 to 11.3 mm
Total length (hyperopia)	11 to 12.5 mm	10.6 mm
Lens power (myopia)	−3 to −23	−3 to −20
Lens power (hyperopia)	+3 to +21	+3 to +15
Optical zone (myopia)	4.65 to 5.5 mm	4.5 to 5 mm
Optical zone (hyperopia)	5.5 mm	4.5 mm
Material	Collagen copolymer	Purified silicone
Refraction index	1.45	1.46
Central vaulting	Higher	Lower
Peripheral vaulting	Lower	Higher
Method of injection	Injector	Folding forceps
Minimum required ACD	2.8 mm (measured from endothelium)	3 mm
Astigmatism correction	+1 to +6 D	No
Incision size	3 mm	2.75 mm
Teorethical haptic position	Ciliary sulcus	Zonula

PRL description

The PRL is a pIOL indicated for the correction of moderate-to-high myopia as well as some degrees of hyperopia (Figure 1). It is a monofocal spherical lens with two different geometries: biconcave for myopia correction and concave–convex for hyperopia correction. It has a single-block design and it is made of a new generation of ultra-thin hydrophobic silicone material with a refractive index of 1.46 and specific gravity of 0.99. As a consequence of these specific features, the material is ultra-thin, elastic, and hydrophobic. The latest generation of this pIOL includes a small proportion (0.2%) of porcine collagen aiming to achieve a greater hydrophilicity and permeability to gas and nutrients. The collagen increases biocompatibility, facilitating the deposition of a monolayer of fibronectin on the pIOL surface, thus making the implant invisible to the immune system.[20] In addition, the thin and flexible haptics allow adaptation to the intraocular anatomy and dynamics.

The lens is available in refractive powers ranging between -3 and -20 D in 0.50 D steps for the correction of myopia and powers between $+3$ and $+15$ D in 0.50 D steps for the correction of hyperopia. The optical zone diameter varies from 4.5 to 5 mm depending on the refractive power of the lens. There are two models for negative lenses: PRL 100, with a total diameter of 10.8 mm and PRL 101 with a total diameter of 11.3 mm. The model for hyperopia, PRL 200, has a total diameter of 10.6 mm.

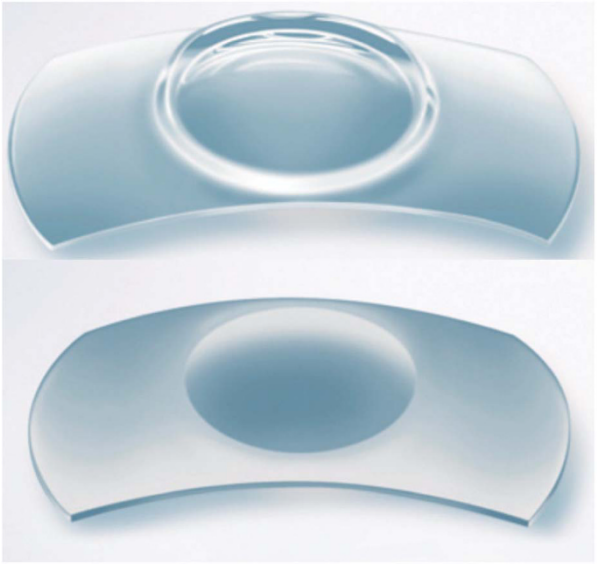

Figure 1 Image of the PRL models for myopia (upper) and hyperopia (lower).

Preoperative assessment and patient selection for PRL implantation

As for any candidate for pIOL implantation, a complete ophthalmological examination must be carried out before the surgery including a comprehensive clinical history, uncorrected and best-corrected visual acuity (preferably using optotypes in logMAR scale under photopic conditions, 85 cd/m^2), objective, subjective and cycloplegic refraction, anterior segment biomicroscopy, tonometry, scotopic pupillometry (preferably using infrared-based devices), corneal topography, biometric analysis (axial length, white-to-white (WTW) distance, and anterior chamber depth), corneal endothelial analysis by means of a specular microscopy (cell density and hexagonality), binocularity evaluation, and fundus evaluation under complete pharmacological mydriasis allowing a complete observation of the peripheral retina. The surgeon must properly inform the patient about the surgical procedure and its risks. The use of spherical hydrophilic contact lenses must be discontinued during a period of at least 1-week before this preoperative examination, whereas a longer period is required for toric hydrophilic and rigid gas permeable contact lenses.[47] It is appropriate to confirm and record the refractive error stability during at least 1 year before the intervention.

The main indication for PRL implantation includes prior contraindication of corneal refractive surgery for myopic or hyperopic refractive error correction (post-surgical central keratometry below 36vD, residual stromal bed of $<250\,\mu$m or residual central corneal thickness below 400 μm after the programmed laser ablation).

The factors that contraindicate this type of implant for refractive error correction include: age under 18 years old (except in certain cases of anisometropic amblyopia with intolerance to contact lenses and non-compliance with other less invasive treatment options),[27] previous intraocular surgery, anterior chamber depth (corneal endothelium-anterior surface of the crystalline lens) <3 mm, glaucoma, history of uveitis, lenticular opacity, non-treated peripheral retinal lesions, scotopic pupillary diameter of >7 mm, neuro-ophthalmological disease, pregnancy or breastfeeding, and unrealistic expectations.[42,48] In addition, any condition associated to a potential zonular weakening should be also considered as a contraindication for the implantation of PRL, such as history of ocular trauma with secondary zonular damage, Marfańs syndrome diagnosis, or other systemic illnesses characterized by fragility of the cilliary processes.[37] A preoperative evaluation of the zonule by means of ultrasound technology is recommended in order to confirm structural integrity.[49]

Selecting PRL size and power

A complete characterization of the anterior segment is crucial in candidates for PRL implantation. This characterization should not only include biomicroscopy and biometric analysis (anterior chamber depth), but also the analysis of the integrity and dynamics of some intraocular structures that may interact with the pIOL. Currently available technology such as high-frequency ultrasonography, anterior segment optical coherence tomography (OCT) or Scheimpflug rotating cameras, allow compiling valuable information for an appropriate selection of PRL size, considering its location, and potential complications.[16] The manufacturer still recommends a selection of the PRL size based on the external horizontal WTW distance, or corneal diameter in spite of the poor correlation of this diameter with intraocular dimensions.[16,50] The manufacturer criteria recommendation for size selection are as follows: the PRL 100 model for myopic eyes with WTW $\leq$ 11.00 mm, PRL 101 model for myopic eyes with WTW $>$ 11.0 mm, and PRL 200 for hyperopic eyes. Indeed, a study carried out using ultrasonography in eyes implanted with PRL demonstrated a significant variability in the location of the pIOL, with the existence of contact areas between the haptics of the myopic PRL and the zonule in 50% of cases analysed.[41] The power calculation is carried out by the manufacturer according to the spherical equivalent (SE) obtained preoperatively, considering a distance between the trial frame and the eye of 12 mm. The exact algorithm used for this specific calculation is not provided by the manufacturer, but it could possibly be quite similar to that used for power calculations of other types of pIOLs (Van der Heijde formula).[20]

Refractive outcomes

Several authors reported their outcomes in myopic and hyperopic patients after PRL implantation (Table 2). All of them conclude that the implantation of this pIOL is an efficient and predictable method for the correction of myopia and hyperopia in the short- and mid-term follow-up, but they all also agree in the need of controlling its long-term behaviour.[26,29–32,38,42]

Hoyos *et al*[42] published the results of a series of 31 eyes, 17 myopes (mean SE: -18.46 D) and 14 hyperopes (mean SE: $+7.77$ D), having completed a follow-up period of at least 12 months after implantation. Within the myopic group, mean SE was -0.22 ± 0.87 D and 82% of eyes presented a SE within ± 1 D. In the hyperopic group, mean SE was -0.38 ± 0.82 D and 79% of eyes had a SE within ± 1 D. Pallikaris *et al*[38] published the results of a series of 34 myopic eyes of 17 patients (mean SE: -14.70 ± 2.65 D) with a mean follow-up of 17.17 ± 3.76 months after PRL implantation. Mean postoperative SE was 0.61 ± 0.89 D, with 79% of eyes having a SE within ± 1 D from targeted refraction. Mean uncorrected distance visual acuity improved from counting fingers (CD) preoperatively to 0.62 ± 0.28 postoperatively and corrected distance visual acuity improved from 0.70 ± 0.24 preoperatively to 0.85 ± 0.24 (decimal) at the end of the postoperative follow-up. Koivula and Kugelberg[25] reported the visual and refractive outcomes of a series of 20 eyes implanted with PRL, 14 myopes (SE: -9.19 D) and 6 hyperopes (SE: $+6.13$ D). After surgery, mean SE in the myopic group was -0.31 ± 0.51 D and -0.60 ± 0.63 D in the hyperopic group. Safety index, understood as the ratio between preoperative best-corrected VA and postoperative best-corrected VA, was 1.12. Efficacy index, as the ratio between postoperative best-corrected VA and preoperative uncorrected VA, was 0.87 in the overall sample. The same authors presented the results for a longer follow-up (2 years) of this same group of patients, obtaining an improvement in both indexes. Specifically, the safety index changed to 1.2 and the efficacy index improved to 0.91.[30] On a separate study by Koivula and Zetterström[45]

Table 2 Refractive outcomes after the implantation of phakic refractive lens reported by different authors

Authors	*n (eyes)*	*Mean preop SE (D)*	*Follow-up (months)*	*Mean postop SE (D)*	*% Eyes within ±1 D*	*Efficacy index*	*Safety index*
Hoyos *et al*[42]	17	-18.46	12	-0.22 ± 0.87	82		
Hoyos *et al*[42]	14	$+7.77$	12	-0.38 ± 0.82	79		
Pallikaris *et al*[38]	34	-14.70 ± 2.65	17.17 ± 3.76	0.61 ± 0.89	79		
Koivula *et al*[30,33]	14	-9.19	12	-0.31 ± 0.51			
Koivula *et al*[30,33]	6	$+6.13$	12	-0.60 ± 0.63			
Koivula and Zetterström[45]	40	$+5.90 \pm 2.51$	12	-0.46 ± 0.48	100	0.70	0.89
Jongsareejit[32]	50	-12.54 ± 4.22 (sph) -1.38 ± 1.24 (cyl)	12	-0.23 ± 0.38			
Donoso *et al*[26]	53	-17.27 ± 4.58	8.0 ± 9.4	-0.23 ± 1.05	71.2	1.0	1.40
Verde *et al*[31]	91	-11.9 ± 5.0	12		80	0.98	1.22
Gil Cazorla *et al*[29]	16	$+5.65 \pm 1.41$	12	0.07 ± 0.43	100	0.9	0.8
Portaliu *et al*[46]	34	-14.08 ± 4.00	72	-0.45 ± 0.62	91.2		
Pérez-Cambrodí *et al*[51]	35	-10.25 ± 3.19	57.34 ± 9.24	-0.11 ± 0.36	97.14	1.16	1.26

on 40 hyperopic eyes (SE: +5.91 D), they reported safety and efficacy indexes of 0.89 and 0.70 at 1-year postoperatively, without eyes gaining 2 or more best-corrected VA lines and 2 (5%) that lost 2 lines.

Other reported series of eyes implanted with PRL are those from Jongsareejit,[32] Donoso and Castillo,[26] Verde *et al*,[31] and Gil-Cazorla *et al*.[29] Jongsareejit[32] reported the outcomes of a series of 50 eyes of 31 myopic patients (mean sphere: −12.54 ± 4.22 D; mean cylinder: −1.38 ± 1.24 D), finding a mean SE of −0.23 ± 0.38 D 1 year after surgery. Donoso and Castillo[26] analysed the outcomes after PRL implantation in 53 eyes of 39 patients with a mean preoperative SE of −17.27 ± 4.58 D and an average follow-up of 8.0 ± 9.4 months. They found a mean postoperative SE of −0.23 ± 1.05 D, a total of 71.2% of eyes with a SE within ±1 D, and efficacy and safety indices of 1.0 and 1.40, respectively. To date, Verde *et al*[31] have presented the largest series of eyes implanted with PRL, a total of 91 eyes of 51 myopic eyes with mean SE of −11.9 ± 5.0 D. One year after surgery, 80% of eyes had a SE within ±1 D, and the efficacy and safety indices were 0.98 and 1.22, respectively. Gil-Cazorla *et al*[29] published the outcomes of a series of 16 hyperopic eyes of 9 patients with a mean SE of +5.65 ± 1.41 D. In this series, the mean SE at 1 year after PRL implantation was 0.07 ± 0.43 D, with safety and efficacy indices of 0.9 and 0.8, respectively. All eyes included in such study presented a SE within the range of ±1 D.

Most of the studies available analyse outcomes 1 year after implantation or less. A recent report by the authors displays the visual and refractive outcomes of a series of 35 myopic eyes (mean SE: −10.25 D) of patients implanted with PRL without other complementary surgical procedure 57.34 ± 9.24 months after surgery.[51] Safety and efficacy indices were reported as 1.16 and 1.26, respectively, with 97.14% of patients having the postoperative SE within ±1 D. These results agree with those recently reported by Portaliou *et al*[46] on 143 myopic eyes; 34 of those eyes were followed-up to 6 years, and 67% were within 0.50 D and 91.2% within 1.00 D of target refraction.

Visual and optical quality results

Only one published report analysed the ocular higher order wavefront aberrations pattern in myopic eyes implanted with the PRL.[38] In this study, a Hartmann–Shack wavefront sensor was used to measure the type and magnitude of ocular higher order aberrations for 3 and 5 mm pupils in 15 eyes before and after implantation. An overall increase, although not statistically significant, of third- and fourth-order aberrations was found. This was accompanied by slight but statistically significant reduction of the modulation transfer function (MTF). Particularly, the ocular MTF decreased by a factor of 1.3 for the 20 cycles/degree frequency after PRL implantation.

With regards to visual performance, Yu *et al*[28] carried out a comparative study to evaluate the effect on contrast sensitivity of three different types of pIOL: angle-supported pIOL (Phakic 6-H), iris-fixated pIOL (Verisyse), and the PRL. Within the PRL group, these authors found that contrast sensitivity increased significantly postoperatively for 6, 12, and 18 cycles/degree under both photopic and mesopic conditions. When they compared the outcomes among the different pIOL types, angle-supported and iris-fixated pIOLs seemed to provide better postoperative contrast sensitivity compared with the PRL. This potential limitation in contrast sensitivity with the PRL might be related to the aberrometric profile induced by the pIOL, particularly for large pupil apertures. This approach deserves further investigation in future studies.

Dynamics and intraocular interaction of the PRL

As with any type of pIOL, an adequate behaviour of the PRL in the anterior segment is determinant to avoid potential complications. Koivula *et al*[33] measured the distance between the posterior surface of the PRL and the anterior surface of the crystalline lens using Scheimpflug imaging. They confirmed a significant reduction during the first year postoperatively, with stabilization and no significant changes afterward.

Studies about the intraocular dynamics of the PRL have been also carried out using OCT (Figure 2), allowing a greater penetration through highly dispersive tissues such as the limbus and the sclera, thus making a proper visualization of angular structures possible.[52] The movement of the PRL during the accommodation process has been observed and characterized using this technology.[25] Particularly, a significant anterior displacement of the three PRL models (100, 101, and 200) with accommodation has been reported, although the PRL 100 model was the only one found to preserve the distance with the anterior crystalline lens surface. This decrease in distance between the PRL and crystalline lens with accommodation for the 101 and 200 models has been hypothesized to be related to their larger weight and length.[25] The PRL design has been also found to favour some lens rotation. Koivula *et al*[30] reported a rotation of $>10^{\circ}$ in the vast majority of cases during the first postoperative year, decreasing afterward. Stabilization of the PRL in the posterior chamber seems to occur therefore 1 year after surgery. The maintenance of an acceptable vault and rotation during the follow-up are signs of good prognosis.

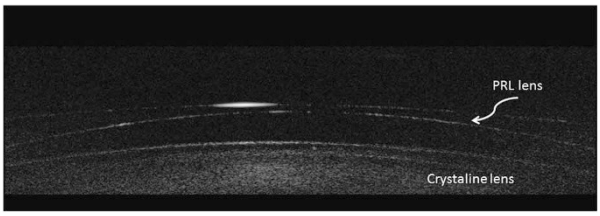

Figure 2 Tomogram obtained with a spectral domain optical coherence tomography system (3D OCT-1000, Topcon, Tokyo, Japan) showing the relative position of the anterior surface of the crystalline lens and the posterior surface of the PRL (vault).

Very high-frequency ultrasonography is the most useful technology for evaluating the position of the lens respect to the zonule. In theory, this pIOL should rest on the zonule without inducing any damage. However, Pitault *et al*[34] found in their series that this ideal positioning only occurred in 57% of the eyes examined. It might be hypothesized that smaller implants would be more easily positioned at the zonule level and larger implants at the ciliary sulcus level. However, it has been found that both PRL positions may coexist for the same implant in the same eye.[40,41] Stabilization of the PRL over the zonule promotes lens rotation whereas its position in the ciliary sulcus leads to an increase in the anterior convexity of the pIOL, thus reducing anterior chamber depth and narrowing the iridocorneal angle.

Other morphological and physiological alterations after PRL implantation have been also studied and reported. The postsurgical flare reaching its peak on the day following the surgical procedure disappears completely by 3 months after surgery without any subsequent inflammatory reaction.[25] The intraocular pressure increases significantly in the immediate postoperative period as a result of several factors such as the retention of viscoelastic material or the effect of the postsurgical corticoid therapy.[32] The endothelial cell density suffers a mild but significant reduction in the initial postoperative period as a result of the surgical manipulation. Verde *et al*[31] reported no statistically significant changes after the third postoperative month, while Koivula and Zetterström[45] reported an increase between 3-month and 1-year postoperatively by 1.1%, although not statistically significant, with an overall decrease in cell density compared with baseline of 3.8% at 1-year postoperatively. Jongsareejit[32] reported a loss of 5.4% after a 6-month follow-up.

Complications

One of the most relevant concerns about the implantation of any type of posterior chamber pIOL is the development of secondary cataract. This may occur as consequence of contact between the anterior surface of the crystalline lens and the posterior surface of the PRL or because of an alteration in the dynamics of the aqueous humour outflow between both structures, resulting in inflammation and cataract.

Lower incidence of secondary cataract after PRL implantation has been reported in the peer-reviewed literature in comparison with that reported for the other posterior chamber pIOL model, the ICL.[14,15,17,19,20,33,35,38] A possible factor accounting for this might be the protective effect of the rotating design of the pIOL, avoiding the continuous contact between the pIOL and any particular area of the anterior surface of the crystalline lens. Stabilization of the PRL on the cilliary sulcus should be avoided to protect the crystalline lens from the inflammatory aggression induced when interaction with this structure occurs.[53] Another potential complication of lens location on the cilliary sulcus is pigmentary dispersion[43] that may cause pigmentary glaucoma.[32] Biomicroscopic detection of transillumination areas in the iris may indicate the presence of mechanical contact between the anterior surface of the PRL and the iris.[33]

It should be considered that stabilization of the PRL over the zonule also has potential risks. The continuous contact of the haptics of the PRL with the zonule may cause their progressive weakening. It should be noted that the structure of the zonule is particularly fragile in patients with high degrees of myopia as a consequence of the zonular fibres tension after the elongation of the ocular globe, which occurs without a proportional change in the dimensions of the crystalline lens. This may cause zonular dehiscence[25,26] and spontaneous dislocation of the PRL toward the vitreous cavity.[36,37] As with other types of pIOL, other potential complications have been also described, such as secondary uveitis, retinal detachment,[26] or choroidal neovascularization.[39]

Conclusions and future perspectives

The majority of studies on the correction of high refractive spherical errors with PRL implantation conclude that this implant is efficient and predictable in the short and long term. Its floating design attempts to avoid the presence of continuous contact between the posterior surface of the PRL and the anterior surface of the crystalline lens, thus reducing the risk of cataract in comparison with other posterior chamber pIOL models. However, the contact between the haptics of the PRL and a structurally fragile zonule may result in important complications such as zonular dehiscence and dislocation of the pIOL toward the vitreous chamber, extremely rare with the other posterior chamber pIOL models. More information about the zonule

configuration is needed in order to improve the design of this pIOL. In addition, zonule evaluation by means of ultrasonography or any other coming technology that allows the visualization of the zonular structure should be considered as a crucial preoperative test before considering the implantation of a PRL.

Lens size should be selected according to a more detailed characterization of the anterior segment and not based on the measurement of corneal diameter. Anterior segment OCT and high-resolution Scheimpflug photography-based techniques are non-invasive technologies that allow the clinician to accurately measure the distance between the posterior surface of the PRL and the anterior surface of the crystalline lens, as well as the level of pIOL rotation. These imaging techniques should be used as an additional tool for monitoring the postoperative evolution of the implant and its potential risk of inducing damage to the anterior segment structures.

Another limitation of PRL implants is the size of the optical zone, which is very limited and favours night vision disturbance symptoms such as glare and halos. Furthermore, pIOL size selection is limited with only two available options for myopic eyes and a unique option for hyperopia. Besides, the lack of designs for astigmatism correction implies the need for complementary corneal refractive procedures for correcting residual astigmatic errors.

In summary, further research is needed with regards to PRL implantation outcomes. Short- and long-term visual outcomes reported make the technique promising despite the lower number of patients implanted worldwide compared with other lens designs. Optical quality, visual performance, and quality of life measures are some of the desirable approaches for future research on PRL, if they become available again.

Conflict of interest

The authors declare no conflict of interest.

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