Bilensectomy: An updated review

Veronica Vargas[1,2], Jorge L. Alio[1,2,3,4]

Access this article online

Quick Response Code:

Website: www.saudijophthalmol.org

DOI: 10.4103/sjopt.sjopt_197_21

Abstract:

Phakic intraocular lenses (pIOLs) have been widely implanted and are a great option for the correction of high refractive errors. There are three types of pIOLs: angle-supported, iris-fixated, and posterior chamber pIOLs. Regardless of the pIOL type, all of them will be explanted at some point, mainly due to cataract development. Therefore, it is important to know the visual and refractive outcomes of bilensectomy (pIOL explantation following cataract surgery and intraocular lens implantation). The aim of this article is to review the visual outcomes and complications of bilensectomy.

Keywords:

Bilensectomy, cataract surgery, phakic intraocular lenses

Introduction

Uncorrected refractive error remains one of the main causes of severe vision impairment worldwide and represents an important economic burden.[1,2] There are several nonsurgical (spectacles and contact lenses) and surgical procedures (corneal refractive surgery, phakic intraocular lenses [pIOLs], and refractive lens exchange) for the correction of refractive errors. Refractive surgery has a significant impact on quality of life,[3] and pIOLs play an important role in patients with high refractive errors which are usually not good candidates for corneal refractive surgery. Despite the many advantages of pIOLs (correction of high refractive errors, good visual quality, and simple surgical implantation technique), all of them will be explanted at some point. The main causes for pIOL explantation have been described by Alió *et al.*,[4] being cataract development the most common cause in all types of pIOLs. Iris fixated pIOLs are the only AC pIOLs that remain in the market with two different models available: the Artisan or Verisyse (nonfoldable IOL) and the Artiflex or Veriflex (foldable IOL) (Ophtec, The Netherlands).[5]

In this review, we will discuss the outcomes following bilensectomy of each type of pIOL that has been published in the literature [Table 1].

Phakic Intraocular Lenses: Background

Phakic IOLs can be divided into three categories: (1) anterior chamber (AC) angle-supported (AS) pIOLs, (2) AC iris-fixated (IF) pIOLs, and (3) posterior chamber (PC) pIOLs.

AC pIOLs were introduced since the 1950s; despite having promising visual results, sight-threatening complications such as corneal decompensation and uveitis gave them a bad reputation and they were withdrawn from the market.[16] In the 1980s, Baikoff and Momose improved the AS pIOL design, and since then, several models were developed aiming to reduce the complication rates without having any success despite having good visual outcomes.[17] The long-term complications resulted in the withdrawal of all AS pIOLs from the market.[18] Iris-fixated pIOLs remain in the market with two different models available: the Artisan or Verisyse (nonfoldable IOL) and the Artiflex or Veriflex (foldable IOL) (Ophtec, The Netherlands).

PC pIOLs were introduced in the 1990s.[16] The first PC pIOL models presented with complications such as pigment dispersion, pupillary block glaucoma, anterior subcapsular cataracts, and dislocation into the vitreous.[19] However, their design has been improving through the years, and two PC pIOL models are available: the Implantable Collamer Lens (ICL) V4c and V5 (STAAR Surgical Co., Monrovia, California, USA) and the Implantable Phakic Contact Lens (IPCL, Care Group Sight Solutions, India).

Departments of [1]Cornea, Cataract and Refractive Surgery and [2]Research and Development, VISSUM, [3]Universidad Miguel Hernández, School of Medicine, Universidad Miguel Hernández, [4]IBERIA Eye Bank, Oftalred, Universidad Miguel Hernández, Alicante, Spain

Address for correspondence:
Prof. Jorge L. Alio, Calle Cabañal, 1-Edificio Vissum 03016, Alicante, Spain.
E-mail: jlalio@vissum.com

Submitted: 17-Aug-2021
Revised: 12-Nov-2021
Accepted: 18-Nov-2021
Published: 29-Aug-2022

How to cite this article: Vargas V, Alio JL. Bilensectomy: An updated review. Saudi J Ophthalmol 2022;36:129-32.

Angle-Supported Phakic Intraocular Lens Bilensectomy

Causes

The main causes of bilensectomy are cataract development, endothelial cell density (ECD) loss, and pupil ovalization.[6]

Usually, cataract development in these patients is secondary to high myopia (which is a risk factor for the development of posterior subcapsular and nuclear cataracts) and aging.[20,21]

The reasons for ECD loss are related to the pIOL design and a shallow AC depth.[6]

Pupil ovalization is secondary to haptic compression of the iris root vessels which may lead to ischemic iridopathy and inflammation[21] [Figure 1].

Visual and refractive outcomes

A study by Liu *et al*.[7] reported a significant improvement in corrected distance visual acuity (CDVA) from 0.66 ± 0.31 to 0.47 ± 0.46 logarithm of the minimum angle of resolution (logMAR) after phakic 6H (Ophthalmic Innovations International, Ontario, CA, USA) bilensectomy. They used the SRK/T and Holladay 1 formulas for IOL calculation; 81.3% of the eyes were within ± 1.0 diopter (D) of the intended correction (emmetropia to low myopia).

Alió *et al*.[6] also reported a statistically significant ($P = 0.006$) improvement in CDVA from 0.30 ± 0.15 to 0.56 ± 0.19 (decimal) and in spherical equivalent (SE) (from −3.58 ± 4.13 D to −0.80 ± 1.22 D) after bilensectomy secondary to cataract. CDVA changed from 0.55 ± 0.13 to 0.57 ± 0.15 after bilensectomy secondary to pupil ovalization, and it remained almost the same in those patients that underwent bilensectomy due to ECD loss (from 0.58 ± 0.25 before surgery to 0.59 ± 0.11 after surgery).

Steinwender *et al*.[8] reported their outcomes using femtosecond laser-assisted cataract surgery. The mean preoperative CDVA improved significantly from 0.40 ± 0.23 logMAR to 0.22 ± 0.11 logMAR postoperatively ($P = 0.027$). The mean manifest refractive SE (MRSE) was −0.11 ± 0.49 D and MRSE was within ± 0.75 D of target refraction in all eyes.

Table 1: Published studies of bilensectomy, type of phakic intraocular lenses explanted, number of eyes included in each study, and mean time between phakic intraocular lens implantation and bilensectomy

Author	pIOL model	Number of eyes	Time (mean ± SD)
Alió *et al*.[6]	ZB5M, ZSAL-4, Phakic 6 (AS)	64	10.04±3.66
Liu *et al*.[7]	Phakic 6H (AS)	16	6.6±1.2
Steinwender *et al*.[8]	AS and IF	10	11.9±4.0
Vargas *et al*.[9]	Artisan (IF)	43	12.2±5.5
Duignan *et al*.[10]	Artisan/Artiflex (IF)	17	7.8±2.6
de Vries *et al*.[11]	Artisan (IF)	36	5.0±3.4
Vargas *et al*.[12]	ICL, IPCL, PRL (PC)	87	7.1±5.1
Kamiya *et al*.[13]	ICL (PC)	10	3.6±1.9
Meier *et al*.[14]	ICL (PC)	38	8.0±4.2
Morales *et al*.[15]	ICL (PC)	14	ND

Time: Time in years between phakic IOL implantation and bilensectomy. SD: Standard deviation, IOL: Intraocular lenses, pIOL: Phakic IOL, AS: Angle-supported. IF: Iris-fixated. PC: Posterior chamber, IPCL: Implantable phakic contact lens, ICL: Implantable collamer lens, PRL: Phakic refractive lens, ND: No data

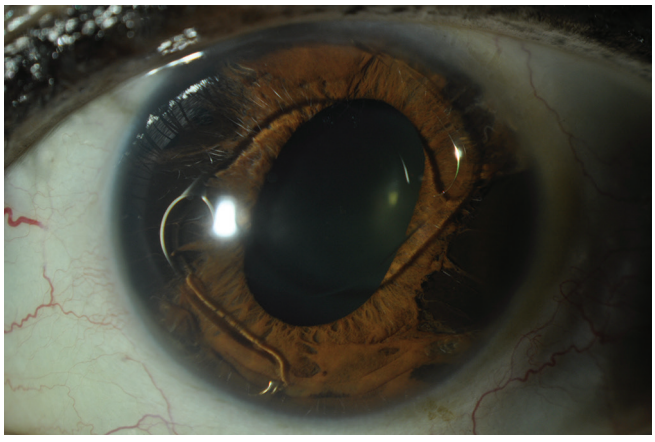

Figure 1: Pupil ovalization in a patient implanted with an angle-supported anterior chamber phakic intraocular lenses

Complications

The explantation of AS pIOLs is difficult due to the presence of angle adhesions of the haptic of the pIOL that can lead to intraoperative AC bleeding and an increased postoperative inflammatory reaction.[6,7]

Sight-threatening complications such as endophthalmitis, rhegmatogenous retinal detachment, and corneal decompensation have also been reported.[7]

Iris-Fixated Phakic Intraocular Lens Bilensectomy

Causes

The main causes for IF pIOL bilensectomy are cataract development and ECD loss.

No direct relationship between IF pIOL and cataract development has been clearly shown,[22,23] therefore, its development seems to be related to high myopia and aging.

Regarding ECD loss, many causes have been described: shallow AD depth, direct contact between the pIOL and the endothelium during implantation, a near distance between the central or peripheral pIOL edge to the endothelium, altered aqueous flow, and chronic subclinical inflammation.[19,24]

Visual and refractive outcomes

Our group[9] reported the outcomes of 43 eyes following Artisan (Ophtec, The Netherlands) pIOL bilensectomy. The mean uncorrected visual acuity (UCVA) and CDVA improved from 0.85 ± 0.49 to 0.45 ± 0.28 and from 0.45 ± 0.42 to 0.23 ± 0.22 logMAR ($P = 0.00$), respectively, after bilensectomy. Seventy-two percent of the patients achieved a CDVA of 20/40 or better, and 53.4% of the eyes were within ± 1.0 D of the target correction.

Duignan *et al*.[10] evaluated the visual outcomes of 17 eyes that underwent bilensectomy secondary to cataract development. The mean CDVA improved from 0.5 ± 0.3 to 0.2 ± 0.1 logMAR after surgery. Thirty-five percent of the eyes were within 0.5 D of target refraction, and 82% within 1.0 D of target refraction.

de Vries *et al*.[11] in their series of 36 eyes reported that the mean CDVA improved from 0.45 ± 0.38 to 0.17 ± 0.18 logMAR; eighty-three percent of the eyes had a CDVA of 20/40 or better after surgery. Seventy-two percent of the eyes were within ± 1.0 D and 86.1% within ± 2.0 D of target refraction using the SRK/T formula.

Complications

Intraoperative complications are rare, but postoperative complications may occur. These include hyphema, wound leakage, postoperative ocular hypertension, and retinal detachment.[9]

Posterior Chamber Phakic Intraocular Lens Bilensectomy

Causes

The main cause for PC pIOL bilensectomy is cataract development [Figure 2]. Unlike AC pIOLs, cataract development in eyes implanted with a PC pIOL has been directly correlated to the pIOL due to its proximity to the crystalline lens. Early cataract formation is secondary to surgical trauma, while late-onset cataract is related to contact between the pIOL and the crystalline lens[25] and aging. Other causes for cataract development are insufficient aqueous humor circulation, lens trauma from preoperative Nd: YAG laser peripheral iridotomy, and inflammation.[18,26,27]

Visual and refractive outcomes

Kamiya *et al*.[13] reported their outcomes in 10 eyes after ICL (versions V2 and V4) (STAAR Surgical Co., Monrovia, California, USA) bilensectomy. Both UCVA and CDVA improved significantly ($P = 0.09$ and $P = 0.008$, respectively) after surgery. Ninety percent of the eyes were within 1.0 D of the targeted correction and 80% within 0.5 D.

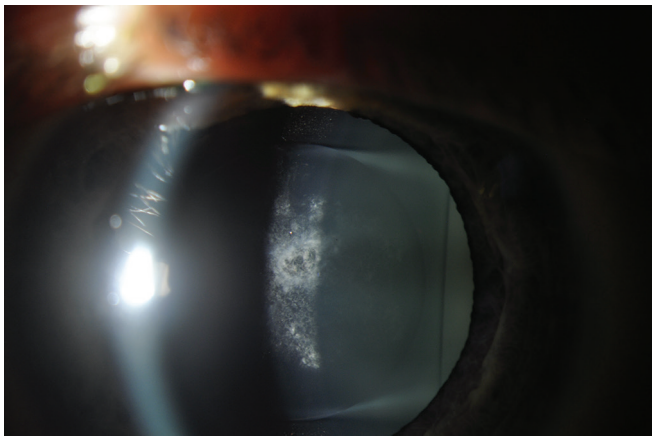

Figure 2: Anterior subcapsular cataract on a patient with a posterior chamber phakic intraocular lens

Meier *et al*.[14] in their series of 38 eyes reported an improvement in CDVA from 0.30 (0.22–0.40) to 0.03 (0.00–0.10) logMAR after ICL (versions V2, V3, and V4) bilensectomy. Thirty-seven eyes gained a mean of 2 lines in visual acuity. Fifty-seven percent of the eyes were within ± 0.50 D of the target refraction and 82% within ± 1.00 D.

Morales *et al*.[15] reported an improvement in mean UCVA from 0.83 ± 0.34–0.40 ± 0.27 logMAR after ICL (versions V2, V3, and V4) bilensectomy. No loss of CDVA was recorded. 71.4% of the eyes were within ± 1.0D of the target refraction.

Our group[12] reported the largest series with 87 eyes. Bilensectomy was performed in 72 eyes with an ICL, 7 with an IPCL (Care Group Sight Solutions, India) and 8 with a phakic refractive lens (Zeiss, Meditec, Jena, Germany). UCVA and CDVA had a statistically significant improvement ($P = 0.00$) after surgery. Eighty-six percent of the eyes had a CDVA of 20/40 or better, and 68% had a UCVA of 20/40 or better.

Complications

Complications such as myopic choroidal neovascularization and retinal detachment have been reported and are specific complications of highly myopic eyes.[20,14,12]

Conclusion

Cataract development is the main cause of bilensectomy regardless of the pIOL model. The time between pIOL implantation and bilensectomy is much longer in eyes implanted with an AC pIOL due to the greater distance between the pIOL and the crystalline lens. However, patients implanted with a pIOL usually have high myopia, which is a risk factor for cataract development.[20]

Sight-threatening complications like low ECD count occur more commonly in patients with an AC pIOL. Therefore, a close follow-up and a continuous monitoring of ECD are recommended in these patients. Although there are no guidelines on when to explant a pIOL due to ECD loss, some authors suggest that if the ECD decreases below 1500 cells/mm^2, the pIOL should be explanted.[28]

Other postoperative complications such as retinal detachment and choroidal neovascularization are most likely related to the high myopia usually presented in patients implanted with a pIOL. The incidence of retinal detachment after cataract surgery in the general population is 0.93%; this rate increases to 2.2% in highly myopic eyes.[20]

According to the published studies, bilensectomy is a safe procedure that significantly improves CDVA [Table 2]. However, more studies with a larger number of eyes and a longer follow-up time are needed.

Financial support and sponsorship

This study has been financed in part by the Network for Cooperative Research in Health "OFTARED," Nodo Dioptrio Ocular, Biobanco Iberia (Reference: RD16/0008/0012), funded by Instituto de Salud Carlos III, and co-founded by

Table 2: Corrected distance visual acuity before and after bilensectomy

Author	pIOL model	Bilensectomy results			
		CDVA (logMAR)		SE (D) (mean±SD)	Percentage of eyes within±1.00 D of TR
		Before surgery	After surgery		
Alió *et al*.[6]	ZB5M, ZSAL-4, Phakic 6 (AS)	0.30±0.15	0.56±0.18**	−0.80±1.22	ND
Liu *et al*.[7]	Phakic 6H (AS)	0.66±0.31	0.47±0.46	−1.61±0.95	81.3
Steinwender *et al*.[8]	AS and IF	0.40±0.23	0.22±0.11	−0.11±0.49	ND
Vargas *et al*.[9]	Artisan (IF)	0.45±0.42	0.23±0.22	−0.78±1.70	53.4
Duignan *et al*.[10]	Artisan/Artiflex (IF)	0.5±0.3	0.22±0.10	−0.43±0.78	82
de Vries *et al*.[11]	Artisan (IF)	0.45±0.38	0.17±0.18	−0.28±1.11	72
Vargas *et al*.[12]	ICL, IPCL, PRL (PC)	0.43±0.44	0.15±0.19	0.20±1.2	ND
Kamiya *et al*.[13]	ICL (PC)	0.19±0.30	−0.06±0.07	−2.07±1.56	90
Meier *et al*.[14]	ICL (PC)	0.30 (0.22–0.40)	0.03 (0.00–0.10)*	−1.18±1.73	82
Morales *et al*.[15]	ICL (PC)	ND	0.27±0.21	0.30±1.07	71.4

Spherical equivalent and percentage of eyes within 1 D of target refraction after bilensectomy . **Visual acuity in decimals, *Median and IQR. pIOL: Phakic intraocular lens, CDVA: Corrected distance visual acuity, SE: Spherical equivalent, D: Diopter, SD: Standard deviation, AS: Angle-supported, IF: Iris-fixated, PC: Posterior chamber, ND: No data, TR: Target refraction, IQR: Interquartile range, IPCL: Implantable phakic contact lens, ICL: Implantable collamer lens, PRL: Phakic refractive lens

the European Regional Development Fund (ERDF), Project "A way to make Europe."

Conflicts of interest

There are no conflicts of interest.

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