



# OPEN Indications and outcomes of intraocular lens exchange at a tertiary ophthalmic center in Northern China from 2016 to 2024

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To report the indications and outcomes of intraocular lens (IOL) exchange at a tertiary referral center in northern China over a period of 8 years. Setting: Ophthalmology departments of Hebei Eye Hospital, Hebei, China. Design: Retrospective cross-sectional study. In this retrospective study, the medical records of 233 patients with a history of IOL exchange were reviewed between 2016 and 2024. These cases were reviewed to determine surgical indications, the type of intraocular lens removed, the type of intraocular lens implanted, the time between operations, surgical complications, and visual outcomes. All postoperative data were analyzed at least six months after follow-up. The mean age of our participants was  $50.05 \pm 21.76$  years (range 5–82 years), with a male percentage of 65.67%. The mean time between primary surgery and IOL exchange was  $6.64 \pm 6.16$  years (range 0.01–30 year). The main indications of IOL exchange were IOL dislocation (63.37%) and IOL opacification (21.81%). The most common ophthalmic comorbidity was high myopia. Procedures for secondary IOL implantation were scleral fixated IOL with sutures (34.16%), IOL in ciliary sulcus (26.75%), in-the-bag IOL (26.31%) and Iris fixation IOL (7.82%). The mean postoperative corrected distance visual acuity (CDVA) was significantly higher compared to the mean preoperative CDVA ( $p = 0.00$ ). The mean preoperative and postoperative IOP were  $16.23 \pm 4.92$  and  $14.84 \pm 3.05$  mmHg, respectively ( $p = 0.00$ ). No serious complications were observed. IOL dislocation is the most common indication of intraocular lens implantation, followed by IOL opacification. Simultaneous scleral-sutured fixation after IOL replacement is the most common procedure in secondary IOL implantation.

**Keywords** Indications, Intraocular Lens exchange, IOL dislocation

Cataract surgery is the most common performed surgery worldwide<sup>1</sup>; however, a second operation may be necessary for some patients to remove or exchange the IOL<sup>2</sup>.

With the development of cataract surgery and IOL materials and the emergence of better IOL calculation formulas, visual outcomes after cataract surgery have become very predictable<sup>3</sup>. But as the number of cataract surgeries has increased significantly, the number of IOL replacements has increased.

Most studies have shown the common surgical indications for intraocular lens replacement were IOL dislocation, IOL opacification or corneal decompensation<sup>2,4–6</sup> and the most frequent indications of IOL exchange of anterior and posterior chamber IOLs were corneal decompensation and IOL dislocation, respectively<sup>2,5,7</sup>.

Hydrophilic acrylic IOLs have been marketed for more than 20 years and this type of intraocular lenses are inexpensive and widely used in developing countries, including China. Since IOL opacification mainly occur in hydrophilic acrylic IOLs<sup>8</sup>, IOL opacification has gradually become one of the important indicators of IOL replacement<sup>9,10</sup>.

With the wide application of refractive lenses (Phakic IOLs, multifocal IOLs and toric IOLs) in developed countries and regions, the request for IOL exchange owing to IOL intolerance and residual refractive errors was on the rise<sup>2,4,11,12</sup>.

This study analyzed and classified the indications, clinical outcomes and complications of IOL replacement in a tertiary eye hospital in North China. To our knowledge, this was the largest and longest series of IOL replacement studies reported to date from a single institution in China.

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Patients and methods

This is a retrospective study involving 233 consecutive patients who underwent IOL exchange surgery between 2016 and 2024 at a tertiary public eye hospital in northern China. Surgeries were performed by the experienced surgeons.

Data collection

The data were collected from the medical records including age, sex, systemic diseases, ocular comorbidity, history of ocular surgery, interval between primary and secondary IOL implantation, preoperative and postoperative intraocular pressure (IOP) and corrected distance visual acuity (CDVA), reasons for IOL implantation, types and positions of lens for primary and secondary IOL implantation, and postoperative complications. Postoperative data were recorded for at least three months after the secondary surgery.

Statistical analysis

Continuous variables were summarized using mean ± standard deviation for normally distributed variables and median (interquartile range) for non-normally distributed variables. Categorical variables were reported using frequency (percentages). The visual acuity was converted to the logarithm of the minimum resolution Angle (logMAR) for statistical analysis. Comparisons were analyzed using 2-sample t tests or nonparametric tests for continuous variables. P-value < 0.05 was considered statistically significant. All statistical analyses were performed using IBM SPSS Statistics (Version 25, IBM Corp., USA) and R Version 3.6.0. Graphs were generated with GraphPad Prism 9.

Ethics approval

The study adhered to the Declaration of Helsinki and was approved by the Ethical Committee of Hebei Eye Hospital in June 2024. The ethics committee waived patient consent, owing to the retrospective nature of this study. The study was carried out in accordance with the Chinese national legislation and the principles of the Declaration of Helsinki.

Ethics approval rephrased statement

The expression of the content of ethical approval is supplemented. The study was approved by the Ethical Committee of Hebei Eye Hospital in June 2024. As this study was retrospective and the data came from Hebei Eye Hospital, the Ethics Committee waived patient consent.

Result

Data from 243eyes of 233 patients were included in the analysis (Table 1). The mean age of patients was 50.05 ± 21.76 years (5 to 82 years). Mean follow-up was 32.61 ± 18.08 months (4 to 63 months). In total, 136 right eyes (55.97%) and 107 left eyes (44.03%) were included.

Characteristic	Value
Eyes/patients (n)	243/233
Age (y)	
Mean ± SD	50.05 ± 21.76
Range	5 to 82
Sex, n (%)	
Male	153(65.67%)
Female	80(34.33%)
Eyes n (%)	
Right	136(55.97%)
Left	107(44.03)
Bilateral IOL exchange, n (%)	10(4.12%)
Type of original IOL, n (%)	
AC IOL	11(4.53%)
PC IOL	232(95.47%)
Follow-up (m)	
Mean ± SD	32 ± 15.66
Range	4 to 63
Interval between PS and exchange (y)	
Mean ± SD	6.64 ± 6.16
Range	0.01 to 30

**Table 1.** Demographic characteristics of the study population. Data are presented as numbers and percentages, means and standard deviations (SD). y = years; n = number; PS = primary surgery. AC = anterior chamber; IOL = intraocular lens; PC = posterior chamber; .

Table 2 shows the incidence of systemic and ocular comorbidities in enrolled patients. High myopia and hypertension were the most common ocular and systemic comorbidities respectively.

The indications for IOL replacement are shown in Fig. 1, and representative examples of cases included in the study are shown in Fig. 2. IOL dislocation was the most common cause, accounting for 154 cases (63.37%) (Fig. 1).

Mean time from original surgery to IOL exchange was  $6.64 \pm 6.16$  years (Table 1). The mean time between initial and secondary surgeries was shortest in the refractive surprise in setting of refractive surgery group ( $0.04 \pm 0.02$  years) and longest in the corneal decompensation group ( $9.75 \pm 8.66$  years). Due to factors such as IOL opacification, residual refractive error, refractive surprise, Phakic IOL intolerance, and capsular contraction, the average IOL replacement time was less than 4 years. In contrast, the average time for the groups with corneal decompensation and IOL dislocation exceeded 7 years after the primary surgery (Table 3).

The time of intraocular lens removal was represented by the Kaplan-Meier curve and compared using the log-rank test. The last five groups with the fewest cases were grouped into the “others” group. As shown in Fig. 3, the median survival time of intraocular lens replacement was higher in the lens dislocation group and the corneal decompensation group, while the median survival time of intraocular lens replacement was relatively lower in other groups ( $p < 0.05$ ).

During the secondary implantation surgery, there were 83 eyes (34.16%) with Scleral fixation with sutures, 65 eyes (26.75%) with ciliary sulcus implantation, 64 eyes (26.34%) with in-the-bag implantation, and 19 eyes (7.82%) with iris fixation. Twenty (7.94%) patients remained aphakic. Among the patients with ciliary sulcus implantation, there were 3 eyes underwent posterior chamber phakic intraocular lens implantation surgery. Except for four iris fixation IOLs located in the posterior chamber, the rest were located in the anterior chamber. (Table 4)

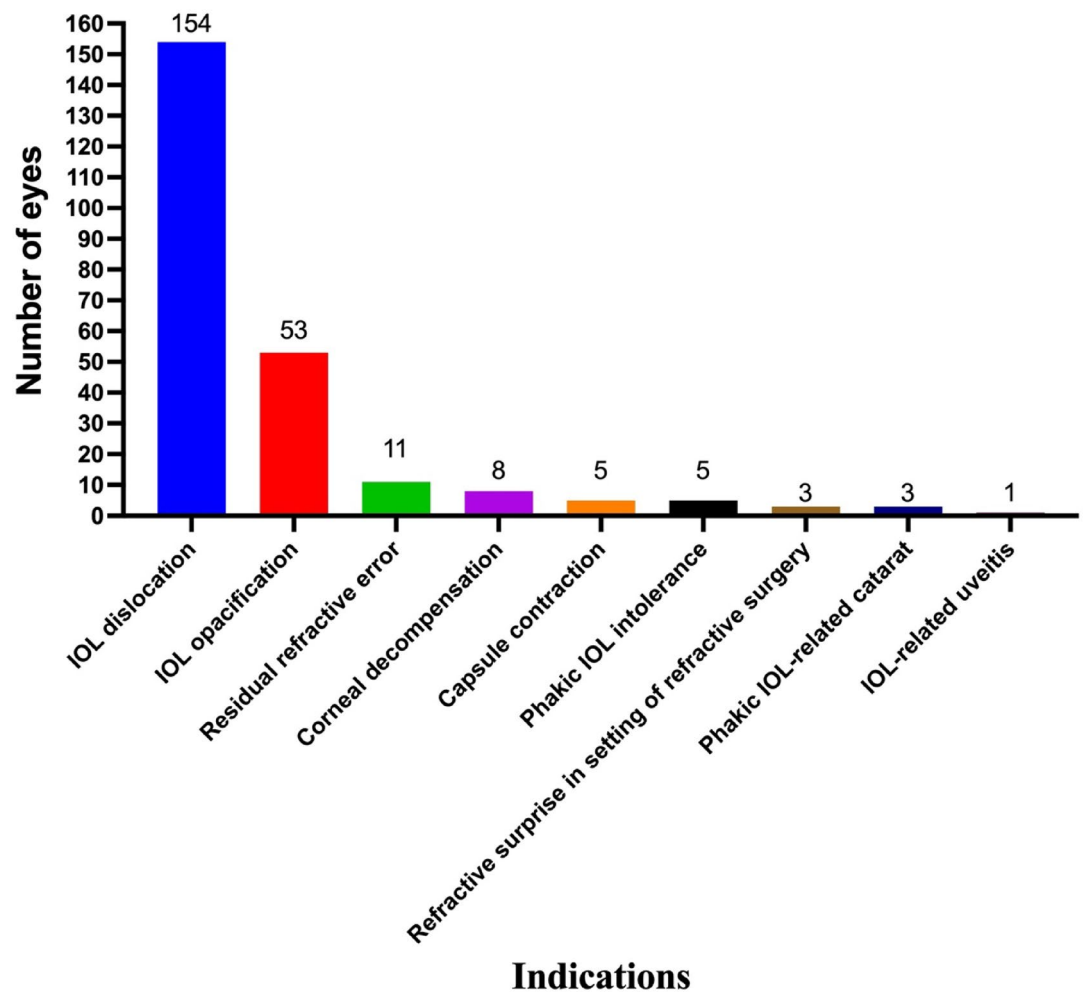
The full list of intraoperative coincident surgeries and postoperative complications shown in Table 5. Corneal edema occurred in 7 eyes (2.88%) in the early postoperative period, and gradually subsided after the application of mild steroid eye drops in all cases. Increased IOP was present in 8 eyes (3.29%). However, the IOP of all cases was reduced to normal levels through topical antiglaucoma eye drops. Other complications included cystoid Macular Edema in 1 case (0.41%) and choroidal detachment in 3 cases (1.23%). No serious complications were observed.

Compared with preoperative mean IOP( $16.23 \pm 4.92$  mmHg), postoperative mean IO( $14.84 \pm 3.05$  mmHg) was significantly decreased ( $p < 0.05$ ). Subgroup analysis showed that mean postoperative IOP in the posterior chamber (PC) IOL group and the anterior chamber (AC) IOL implantation group were significantly lower than preoperative IOP ( $p = 0.00$ ;  $p = 0.03$ , respectively). (Table 6)

Overall, postoperative CDVA was significantly higher compared to preoperative CDVA ( $P = 0.00$ ). Subgroup analysis was performed according to surgical indication classification. The CDVA significantly improved in cases of IOL dislocation ( $P = 0.00$ ), IOL opacification ( $P = 0.00$ ), Capsule contraction ( $P = 0.00$ ), Residual refractive error ( $P = 0.03$ ) and Phakic IOL-related cataract ( $P = 0.00$ ). In the corneal decompensation group, there was no statistical significance between preoperative and postoperative CDVA due to keratopathy( $p = 0.20$ ). The other subgroups did not meet the level of significance due to the small sample size or the presence of Phakic groups. (Table 7)

Comorbidity	N (%)
Ophthalmic	
High axial Myopia	30(12.34%)
Posterior capsular opacification	19(7.82%)
Glaucoma	15(6.17%)
Retinal disease	12(4.94%)
Glaucoma surgery	7(2.88%)
Nystagmus	5(2.06%)
Vitreoretinal surgery	4(1.65%)
Amblyopia	3(1.23%)
Uveitis	2(0.80%)
Congenital microphthalmos	1(0.41%)
Pseudoexfoliation syndrome	1(0.41%)
Systemic	
HTN	34(13.99%)
DM	23(9.47%)
IHD	1(0.41%)
Cerebral Infarction	1(0.41%)

**Table 2.** Patient comorbidities. Data are presented as numbers and percentages, means and standard deviations (SD). y = years; n = number; PS = primary surgery; Pseudoexfoliation syndrome = PEX. HTN: Hypertension; DM: Diabetes Mellitus; IHD: Ischemic Heart Disease.



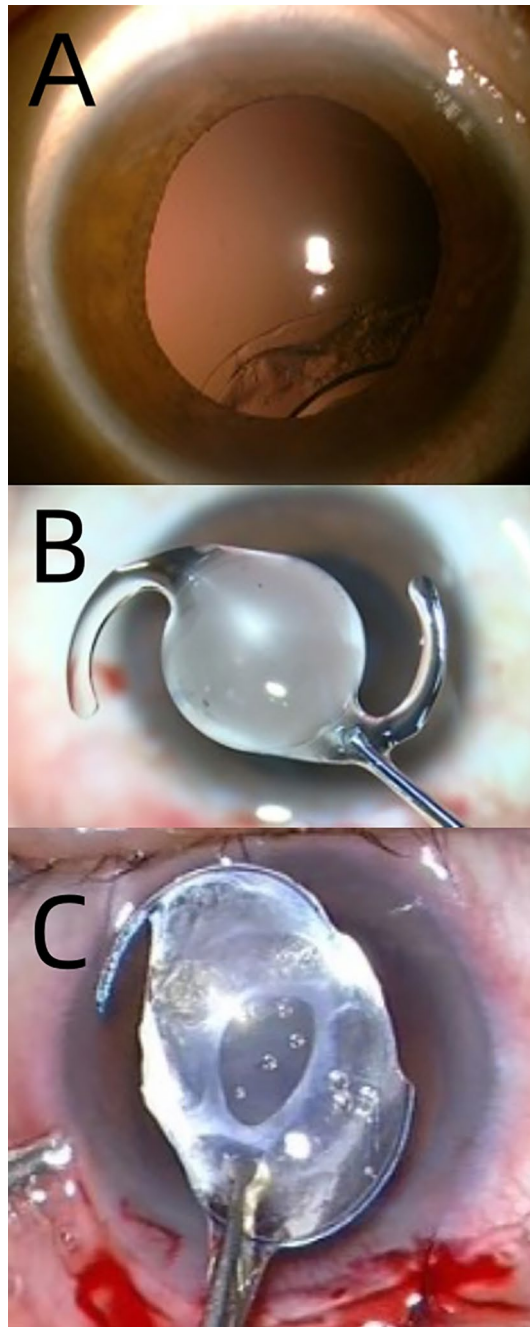
**Fig. 1.** The Indications of IOL exchange.

## Discussion

At present, most of the studies on IOL replacement are in European and American countries. Similar studies in Asian countries and regions, including China, are relatively few. To the best of our knowledge, our study is the largest single-center study on IOL exchange in China<sup>13–15</sup>.

As with much of the previous research, IOL displacement remains a main indication for IOL exchange<sup>2,5</sup>. Various factors including intraoperative complications, ocular factors such as pseudoexfoliation syndrome, retinitis pigmentosa, high axial myopia, previous vitrectomy or trauma can lead to IOL displacement<sup>16</sup>. Pseudoexfoliation syndrome was the main cause of lens dislocation in many European and American studies<sup>5,11,17,18</sup>. The proportion of exfoliation syndrome in IOL displacement in our study was very low (0.40%) which was similar to the results of other domestic studies in China<sup>2,13–15</sup> and high axial myopia (13.31%) was the top ocular comorbidities of IOL dislocation in our study. IOL dislocation is a severe complication after cataract surgery and the prevention of lens dislocation is one of the hot topics in the world. Capsular tension ring (CTR) implantation can maintain the shape of the capsular pocket, reduce the contraction of the capsule, stabilize the tilt of the IOL, and reduce the risk of IOL dislocation in the long term<sup>19</sup>. Effective anterior capsule polishing effectively reduced capsule contraction, thereby reducing the incidence of lens tilt and dislocation<sup>20–22</sup>. Posterior capsulotomy within 1 year after surgery can reduce the risk of IOL dislocation<sup>23</sup>.

IOL opacification remains a significant problem in modern IOLs. To our knowledge, IOL opacification was the most common indication for IOL replacement in only a few studies<sup>7,8,24</sup>. It was also the second most common surgical indication in the study. The IOLs used in these studies were hydrophilic acrylic crystals, and later some manufacturers have also acknowledged problems with their products and have issued recalls<sup>8,25</sup>. Since the introduction of hydrophilic acrylic IOLs in the 1990 s, they have been welcomed around the world, especially in developing countries, because of their low price and good flexibility and biocompatibility<sup>26</sup>. At present, most studies show that IOL opacification was caused by calcification. Due to the increased opacity, IOL replacement is a must and can significantly improve the patient's quality of vision<sup>27</sup>. In our study, because the bags in this part of patients were in good condition, the replacement intraocular lens could be placed in the bag, thus significantly improving the visual quality. At the same time, some scholars covered the surface of hydrophilic IOLs with hydrophobic coatings to reduce the incidence of calcification. Due to the complex causes



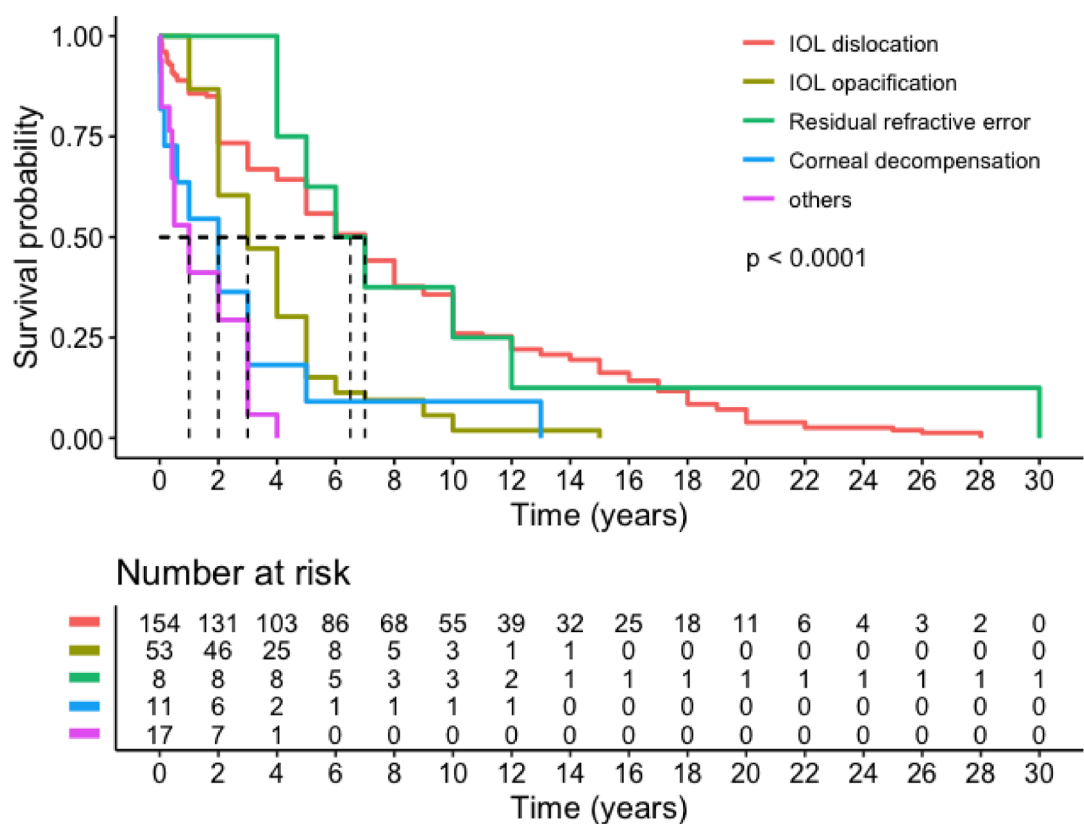
**Fig. 2.** The photographs showed the common indicators of IOL replacement. (A) IOL dislocation. (B) IOL Opacification. (C) Capsule contraction.

of calcification, including the influence of its own material and the IOLs surrounding microenvironment, the final result was not ideal, and the surface hydrophobic coating cannot prevent the crystal from calcifying<sup>28</sup>.

Residual refractive error after cataract surgery was the third leading reason for intraocular lens replacement. High myopia and history of corneal refractive surgery are important factors that cause residual refractive errors after surgery. In this study, among the 11 cases of postoperative residual refractive errors, 5 cases were associated with high myopia before surgery, and 1 case had a history of corneal refractive surgery. With the prevalence of posterior chamber intraocular lens refractive surgery in young patients with high myopia, postoperative intolerance and postoperative refractive abnormalities are gradually increasing. The main causes of patient intolerance to posterior chamber phakic IOLs were disabling glare and halos, and visual distortion. Cases of cataracts due to posterior chamber intraocular lenses have also been frequently reported, and secondary cataracts occurred in three eyes in this study. The most common type of phakic IOL-associated cataract is anterior subcapsular cataract<sup>29,30</sup>. The arch height is considered to be one of the most important factors increase

Indications	PC IOL	AC IOL	Time
	n (% of Total)	n (% of Total)	(Mean $\pm$ SD, year)
IOL dislocation	151(62.14%)	3(1.23%)	7.97 $\pm$ 6.63
IOL opacification	53(21.81%)	0	3.85 $\pm$ 2.75
Residual refractive error	11(4.53%)	0	2.71 $\pm$ 3.75
Corneal decompensation	0	8(3.29%)	9.75 $\pm$ 8.66
Capsule contraction	5(2.06%)	0	2.20 $\pm$ 0.84
Phakic IOL intolerance	5(2.06%)	0	0.43 $\pm$ 0.07
Refractive surprise in setting of refractive surgery	3(1.23%)	0	0.04 $\pm$ 0.02
Phakic IOL-related cataract	3(1.23%)	0	3.33 $\pm$ 0.58
IOL-related uveitis	1(0.41%)	0	1

**Table 3.** Indications and interval of IOL exchange for study participants.



**Fig. 3.** The survival analysis curve by Indications.

the risk of phakic IOL-related cataract development<sup>31</sup>. Other factors include phakic IOL contact with the lens and abnormal intraocular fluid circulation on the lens surface after surgery<sup>32</sup>.

In this study, corneal decompensation was also an important indicator of for IOL removal. Anterior chamber intraocular lens extraction was mainly performed in the corneal decompensation group (Table 3), which was also similar to foreign studies<sup>7,8,24</sup>. In studies from European and American countries, the proportion of corneal transplantation due to corneal decompensation is high, which is similar to the proportion of anterior chamber intraocular lens replacement<sup>16</sup> but the proportion of patients undergoing simultaneous corneal transplantation in this study is low. Only one patient underwent keratoplasty at the same time, and the rest of the patients simply underwent intraocular lens extraction due to lack of corneal donor materials or financial problems. These patients will be aphakia. At the same time, most of the postoperative correction of far vision did not improve significantly.

In our study, the most common secondary IOL implantation was transscleral suture fixation (33.33%), followed by intraciliary sulcus implantation (25.79%) and intracapsular implantation (25.40%). In the IOL dislocation group, the most common secondary IOL implantation was transscleral suture fixation. Due to the good function of the lens pocket in the IOL opacification group, in-the-bag implantation accounted for the



	IOL dislocation	IOL opacification	Residual refractive error	Corneal decompensation	Capsule contraction	Phakic IOL intolerance	Refractive surprise in setting of refractive surgery	Phakic IOL-related cataract	IOL-related uveitis	Total n (%)
PC	139(57.20%)	53(21.81%)	11(4.53%)	1(0.41%)	5(2.06%)	0	3(1.23%)	3(1.23%)	1(0.41%)	216(88.89%)
In the bag	1(0.41%)	48(19.75%)	9(3.70%)	0	3(1.23%)	0	0	3(1.23%)	0	64(26.34%)
In the ciliary sulcus (Three-piece)	54(22.22%)	4(1.65%)	2(0.82%)	0	1(0.41%)	0	0	0	1(0.41%)	62(25.51%)
Scleral fixation with sutures	80(32.92%)	1(0.41%)	0	1(0.41%)	1(0.41%)	0	0	0	0	83(34.16%)
Iris fixation	4(1.65%)	0	0	0	0	0	0	0	0	4(1.65%)
In the ciliary sulcus (Phakic)	0	0	0	0	0	0	3(1.23%)	0	0	3(1.23%)
AC	15(6.17%)	0	0	0	0	0	0	0	0	15(5.95%)
Iris fixation	15(6.17%)	0	0	0	0	0	0	0	0	15(5.95%)
Aphakia	0	0	0	7(2.88%)	0	5(2.06%)	0	0	0	12(4.94%)

**Table 4.** Position of secondary implanted IOL.

Factors	N (%)
Postoperative complications	
Corneal edema	7 (2.88%)
High IOP	8 (3.29%)
Cystoid macular edema	1(0.41%)
Choroidal detachment	3(1.23%)
Intraoperative coincident surgeries	
Anterior vitrectomy	125(51.44%)
Posterior continuous curvilinear capsulorhexis	21(8.64%)
Peripheral iridotomy	42(17.28%)

**Table 5.** Postoperative complications and intraoperative coincident surgeries of IOL exchange.

Explanted IOL	IOP (mm Hg) Mean $\pm$ SD		P value
	Preoperative	Postoperative	
AC	16.18 $\pm$ 6.46	13.18 $\pm$ 3.12	0.03
PC	16.23 $\pm$ 4.86	14.92 $\pm$ 3.03	0.00
Total	16.23 $\pm$ 4.92	14.84 $\pm$ 3.05	0.00

**Table 6.** Pre- and postoperative IOP. IOP = Intraocular pressure.

Indications	LogMAR CDVA		P value
	Preoperative	Postoperative	
IOL dislocation	0.93 $\pm$ 0.54	0.52 $\pm$ 0.47	< 0.01
IOL Opacification	1.07 $\pm$ 0.60	0.40 $\pm$ 0.29	< 0.01
Corneal Decompensation	1.49 $\pm$ 0.60	1.73 $\pm$ 0.11	0.20
Residual refractive error	0.10(0.10,0.30)	0.10(0.05,0.10)	0.03
Refractive surprise in setting of refractive surgery	-0.08(-0.13,0.01)	-0.08(-0.13,0.07)	0.32
Capsule contraction	0.83 $\pm$ 0.25	0.17 $\pm$ 0.12	< 0.01
Phakic IOL intolerance	0.00(0.08,0.11)	0.00(0.08,0.00)	0.41
Phakic IOL-related cataract	1.64 $\pm$ 0.10	-0.05 $\pm$ 0.05	< 0.01
IOL-related uveitis	0.22	0.22	-
Total	0.92 $\pm$ 0.59	0.49 $\pm$ 0.48	< 0.01

**Table 7.** Pre- and postoperative LogMAR CDVA based on surgical indications.

highest proportion in the IOL opacification group. In our study, the first choice for secondary IOL implantation was in the bag. In the case of damage to the capsular bag, IOL placement in the ciliary sulcus was the second option, in agreement with previous studies<sup>5,11,12,14</sup>. In addition, in the absence of lens capsule support, transscleral intraocular lens suture fixation was preferred, which was similar to a domestic study in China<sup>13</sup>. However, iris-fixed IOL was the first choice for patients without capsular support in European countries<sup>2,5,16</sup>. In the United States, ophthalmologists prefer to use angle-supported ACIOLs as the treatment for patients without capsular support<sup>4,33</sup>.

There are some limitations to the study. This study was designed retrospectively and involved only a single center. Another limitation of this study is that some patients were excluded due to the lack of important indicators, thereby causing bias. Due to the retrospective nature, there are no standardized surgical procedures or postoperative management protocols. A small proportion of our patients are left with aphakia. Most of these patients are patients with corneal decompensation without capsule support. They are not eligible for keratoplasty, so we decided to keep them aphakia.

In summary, this study was from a tertiary ophthalmic center in China, and IOL dislocation was the most common indication for intraocular lens implantation, followed by IOL opacification. At the same time, transscleral intraocular lens fixation after IOL replacement is the most common procedure in secondary IOL implantation. After IOL implantation, the mean postoperative CDVA improved significantly and mean IOP decreased significantly.

### Data availability

The raw data supporting the conclusion of this article will be made available by all the authors (1305118865@163.com or ykylcj@126.com), without undue reservation.

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## Author contributions

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Z.W., B.Z., Z. C. and C. L. The first draft of the manuscript was written by Z.W., and all authors commented on the previous versions of the manuscript. All authors read and approved the final manuscript.

## Declarations

### Competing interests

The authors declare no competing interests.

## Additional information

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