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Adjustable flanged technique for secondary implantation of four-point scleral-fixated posterior chamber intraocular lenses using two parallel 6–0 polyglactin sutures

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Abstract

Objective To assess the efficacy and safety of using the adjustable flanged technique for secondary implantation of four-point scleral-fixated posterior chamber intraocular lenses with two parallel 6–0 polyglactin sutures.

Methods Two parallel 6–0 polyglactin sutures were passed separately through the two haptics on the horizontal line of the 4-haptic IOL. The four externalized sutures were then trimmed and cauterized to form flanges. The best corrected visual acuity, intraocular pressure, and complications in all patients were observed and recorded.

Results The flanged technique using two parallel 6–0 polyglactin sutures was applied to 14 aphakic eyes. The average preoperative best corrected visual acuity was 1.00 ± 0.88 LogMAR (Snellen 20/200), which improved to 0.42 ± 0.38 LogMAR (Snellen 20/48) at the final follow-up ($P = 0.004$). None of the patients experienced vitreous hemorrhage, low intraocular pressure, or issues with exposed or broken sutures.

Conclusion The simplicity of the technique, along with its ability to accommodate adjustments post-implantation, allows for optimal positioning and reduces risks like IOL tilt or dislocation. Overall, this is a promising approach to secondary IOL implantation, with potential benefits for both patient outcomes and surgical efficiency.

Keywords Secondary implantation, Intraocular lenses, Flanged technique, Four-point scleral-fixated

Introduction

With the growing number of aphakic patients lacking sufficient capsular support or experiencing lens luxation, the use of scleral-fixated posterior chamber intraocular lenses (IOLs) has become increasingly prevalent in clinical practice. Scleral fixation is favored for its benefits, including stable IOL positioning, minimal complications such as iris capture, and overall good prognosis [1–8]. The Akreos-Adapt AO IOL (Bausch & Lomb), known for its foldable, hydrophilic, aspherical design and four-haptic configuration, is particularly suited for small incision surgery and four-point scleral fixation [8]. Previous literature has described various fixation techniques for

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the Akreos-Adapt IOLs, such as employing two sets of sutures to create rings on each side or using a closed continuous-loop suture for scleral four-point fixation. However, these methods may lead to excessive tensile deformation of the IOL [1, 6, 8–10].

The flange technology produced by Yamane et al. prevents the development of conjunctival peritomies and scleral flaps, addressing complications associated with suturing and facilitating quicker postoperative recovery for patients [11]. This adjustable flange method allows for the tightening of suture tension and IOL positioning. Even after the sutures are secured, the IOL can still be adjusted horizontally to ensure optimal centering of the optical [11–13].

Additionally, the choice of sutures significantly impacts the success rate of the surgery. Previous reports indicate that complications such as suture biodegradation, breakage, suture exposure, and other issues related to sutures can occur postoperatively, particularly with polypropylene 10−0 sutures [1, 10]. Therefore, this study utilized 6–0 polyglactin sutures, which offer greater durability and resistance to degradation, making them more suitable for long-term stability.

We present a modified technique for four-point fixation of the Akreos-Adapt AO IOL using two parallel 6–0 polyglactin sutures with a flanged technique. This method has proven to be reliable and reproducible, enhancing both anatomic and visual outcomes while reducing complications.

Materials and methods

Approval for this retrospective, noncomparative, interventional case series was obtained from The Medical Ethics Committee of Zhejiang Provincial People's Hospital. Inclusion criteria included patients with aphakic eyes lacking sufficient capsular support. Exclusion criteria included patients with additional eye conditions requiring treatment, such as retinal detachment or macular hole. The study complied with the principles of the Declaration of Helsinki.

Between September 2022 and June 2023, patients underwent the 6–0 polyglactin flanged technique for secondary implantation of four-point fixation of the Akreos-Adapt AO IOL in Zhejiang Provincial People's Hospital were enrolled. Prior to study commencement, all participants provided written informed consent regarding the potential benefits and risks of the procedure. Comprehensive ophthalmic examinations were conducted before and after surgery, gathering data on age, gender, best corrected visual acuity (BCVA), and intraocular pressure (IOP). Surgical complications were also documented. Each patient was followed up for at least three months postoperatively, with BCVA and IOP recorded. The postoperative IOL position was assessed using slit-lamp examination, swept-source anterior segment optical coherence tomography (AS-OCT) (VG2001, SVision), and ultrasound biomicroscopy. All decimal BCVA measurements were converted to LogMAR BCVA.

Surgical technique

All surgeries were performed by a single surgeon (Y.Q.C.) under retrobulbar anesthesia, with an anterior chamber maintainer inserted to regulate IOP.

First, the corneal periphery along a horizontal meridian centered over the visual axis was marked. Four scleral sites, each 2.0 mm from the limbus and 3.0 mm above or below the horizontal corneal mark, were separately marked at the 2 o'clock, 4 o'clock, 8 o'clock, and 10 o'clock positions. A 2 mm main incision was made at the 11 o'clock position on the corneal margin. A 4-haptic posterior chamber IOL (Akreos Adapt, Bausch & Lomb, Inc.) was then inserted into the anterior chamber and fully expanded on the iris surface, with the four haptics aligned with the four scleral sites.

The diameter of the 6–0 polyglactin suture matched the inner diameter of a 30-gauge needle, allowing it to be threaded through the needle. A 30-gauge needle carrying the 6–0 polyglactin suture was used for a paracentesis at the 2 o'clock scleral site. The needle was inserted into the posterior chamber, advanced behind the iris toward the haptic at the 2 o'clock position, passed through two haptics on the same horizontal line in front of the IOL surface, and exited at the corneal margin at the 10 o'clock position. The suture outside the limbus at the 10 o'clock position was then pulled inwards using forceps and brought out through the main incision. The 30-gauge needle was reintroduced into the posterior chamber at the 10 o'clock position, and after threading the suture into the needle, it was retracted along the original path and tightened. The other pair of sutures was secured in the same manner. Finally, the externalized sutures were trimmed and cauterized to create flanges. The IOL position was then adjusted to center the optical zone within the pupil (Figs. 1 and 2).

However, for patients with aniridia or iridocoloboma, some surgical procedures differed from those previously described. A 30-gauge needle carrying a 6–0 polyglactin suture was inserted into the posterior chamber from the scleral site at the 2 o'clock position, and the suture was pulled out through the main incision. The 6–0 polyglactin suture was then threaded through the two haptics of the IOL along the same horizontal line, and the IOL was inserted into the anterior chamber using a syringe. The 30-gauge needle was reintroduced into the posterior chamber at the 10 o'clock position, and after threading the suture into the needle, it was retracted along the original path and tightened. The subsequent surgical steps were the same as those previously described.

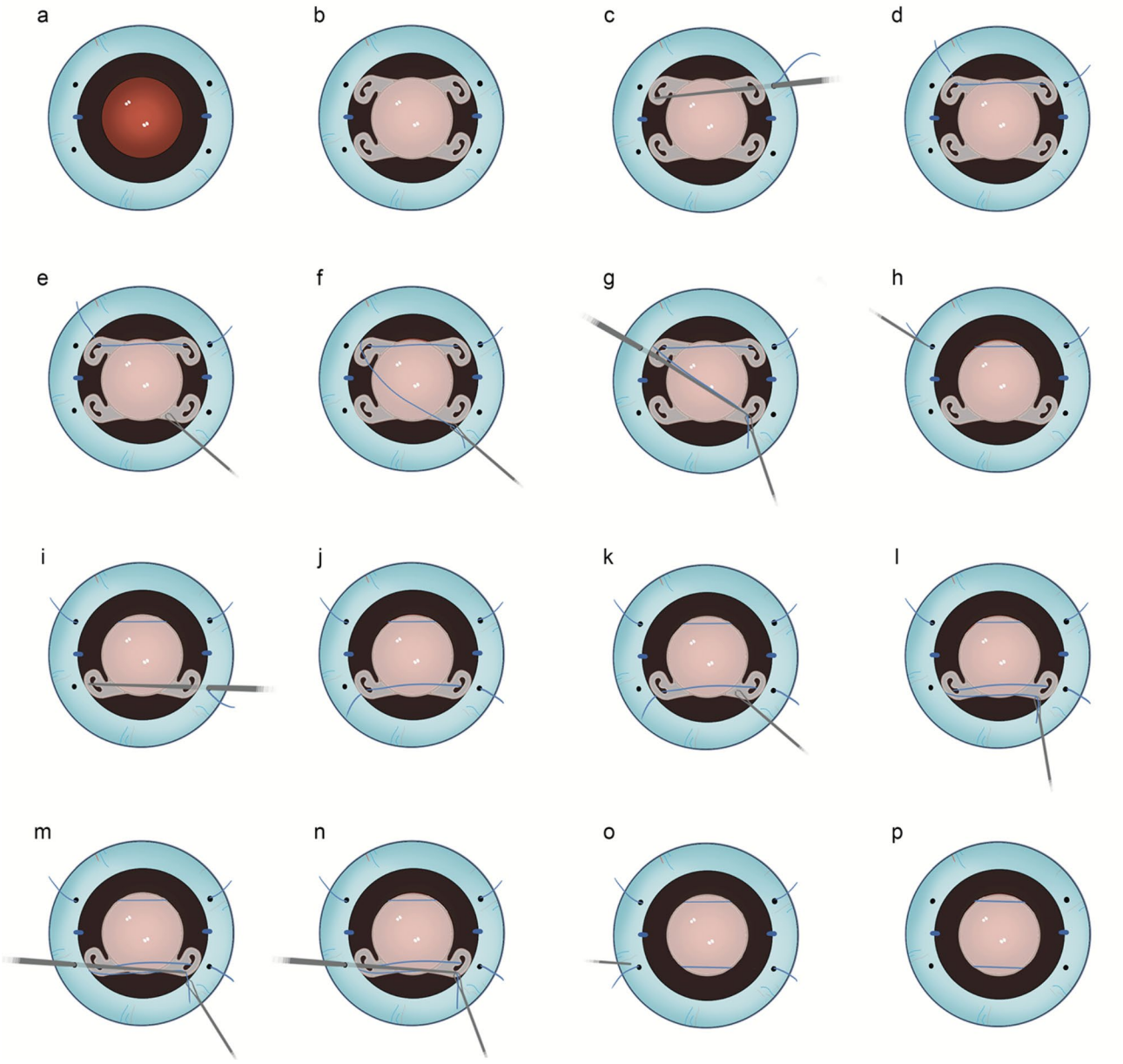

Fig. 1 Steps of the surgical process: **a**) Four scleral sites, 2.0 mm from the limbus and 3.0 mm above or below the horizontal corneal mark, were marked at the 2, 4, 8, and 10 o'clock positions; **b**) A 2 mm main incision made at the 11 o'clock position on the corneal margin, and the insertion of a 4-haptic posterior chamber intraocular lens (Akreos Adapt, Bausch & Lomb, Inc.) into the anterior chamber with expansion on the iris surface; **c**-**d**) A 30-gauge needle with a 6–0 polyglactin suture was used for a paracentesis at the 2 o'clock scleral site, passed through the posterior chamber and two haptics ahead of the intraocular lens surface, and exited at the 10 o'clock corneal margin; **e**-**f**) The suture was pulled into the 10 o'clock position using forceps and out through the main incision; **g**-**h**) The 30-gauge needle was reintroduced into the posterior chamber at the 10 o'clock position, the suture inserted, and then retracted and tightened; **i**-**n**) The other pair of sutures was secured in the same way; **o**-**p**) The externalized sutures were cut and cauterized to create flanges, and the intraocular lens was adjusted to center the optical zone

Statistical analysis

A paired-samples t-test was used to compare preoperative and postoperative LogMAR BCVA. Statistical analysis was conducted using SPSS 22.0 (SPSS for Windows). A P value less than 0.05 was considered statistically significant.

Results

The adjustable flanged technique for secondary implantation of four-point scleral-fixated posterior chamber IOLs using two parallel 6–0 polyglactin sutures was applied to 14 eyes of 14 patients with aphakia (10 males and 4 females). The mean age of the group was 53.4±16.0 years, with a range of 17–72 years. All patients had previously

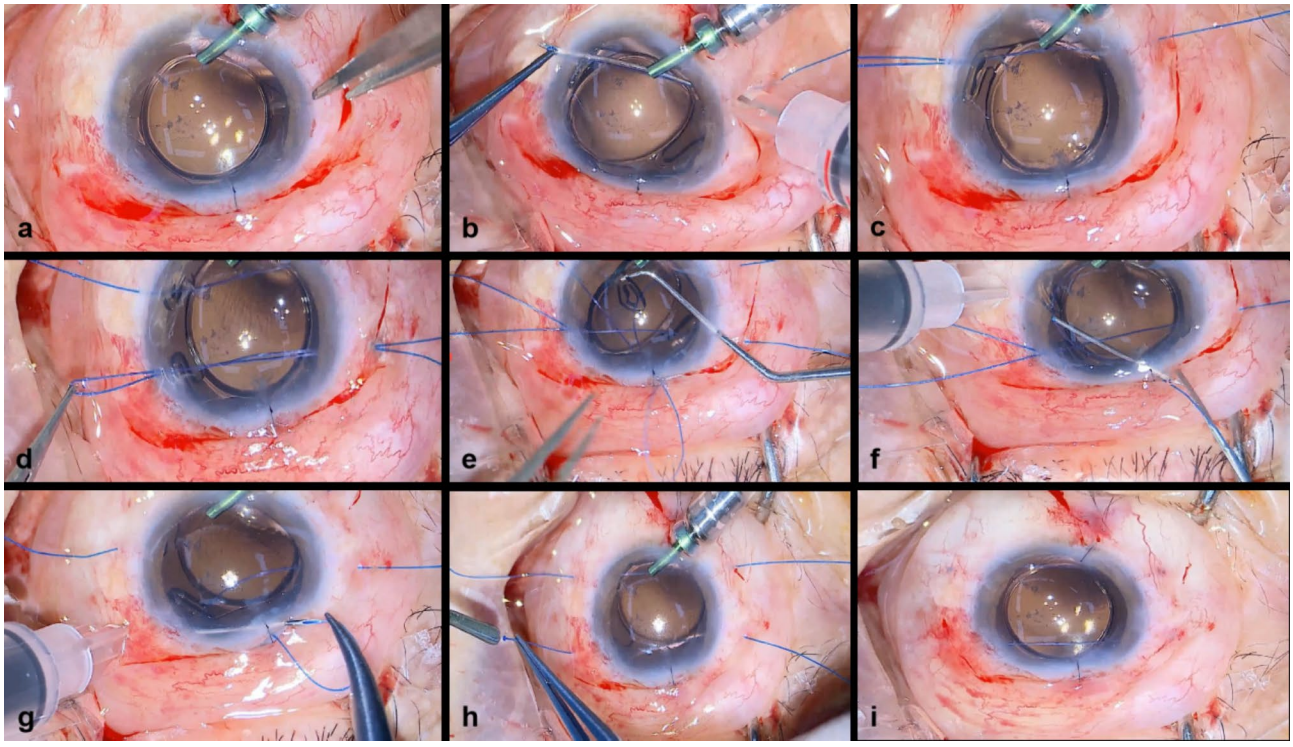

Fig. 2 Steps of the surgical process: **a**) A 2 mm main incision made at the 11 o'clock position on the corneal margin, and the insertion of a 4-haptic posterior chamber intraocular lens (Akreos Adapt, Bausch & Lomb, Inc.) into the anterior chamber with expansion on the iris surface; **b**-**g**) A 30-gauge needle with a 6–0 polyglactin suture was used for a paracentesis at the 2 o'clock scleral site, passed through the posterior chamber and two haptics ahead of the intraocular lens surface, and exited at the 10 o'clock corneal margin; The suture was pulled into the 10 o'clock position using forceps and out through the main incision; The 30-gauge needle was reintroduced into the posterior chamber at the 10 o'clock position, the suture inserted, and then retracted and tightened; The other pair of sutures was secured in the same way; **h**-**i**) The externalized sutures were cut and cauterized to create flanges, and the intraocular lens was adjusted to center the optical zone

Table 1 The baseline characteristics and postoperative outcomes in all cases

Case	Age	Eye	Preoperative BCVA (logMAR)	Postoperative BCVA (logMAR)
1	49	OD	0.00	0.00
2	54	OD	0.40	0.15
3	53	OD	1.85	0.92
4	25	OS	0.10	0.10
5	66	OS	1.30	0.60
6	52	OD	1.10	1.10
7	69	OS	2.30	0.22
8	61	OD	0.82	0.40
9	17	OS	0.30	0.00
10	46	OS	2.60	1.00
11	70	OS	0.00	0.00
12	56	OD	1.10	0.52
13	57	OD	0.30	0.30
14	72	OS	1.85	0.52

LogMAR=logarithm of the minimum angle of resolution; F=female; M=male; BCVA=best-corrected visual acuity

undergone phase 1 surgery without IOL implantation, including procedures for aphakia following pars plana vitrectomy with retinal detachment repair (n=4), intraocular foreign body (n=8), and endophthalmitis (n=2). Preoperative IOP for all patients was within the normal range (Table 1).

Postoperative visual acuity showed significant improvement in all patients after three months at the final follow-up. The mean preoperative corrected distance visual acuity was 1.00±0.88 LogMAR (Snellen 20/200), which improved to 0.42±0.38 LogMAR (Snellen 20/48) at the final follow-up (P=0.004).

No intraoperative complications were observed in any of the cases. Along with the improvement in visual acuity, follow-up examinations (ranging from 3 to 12 months) revealed no subluxation, tilt, or dislocation of the IOLs, as assessed by slit-lamp examination, swept-source anterior segment optic coherence tomography, and ultrasound biomicroscopy. Additionally, no vitreous hemorrhage, hypotony, suture exposure, or breakage were noted in any of the patients (Fig. 3).

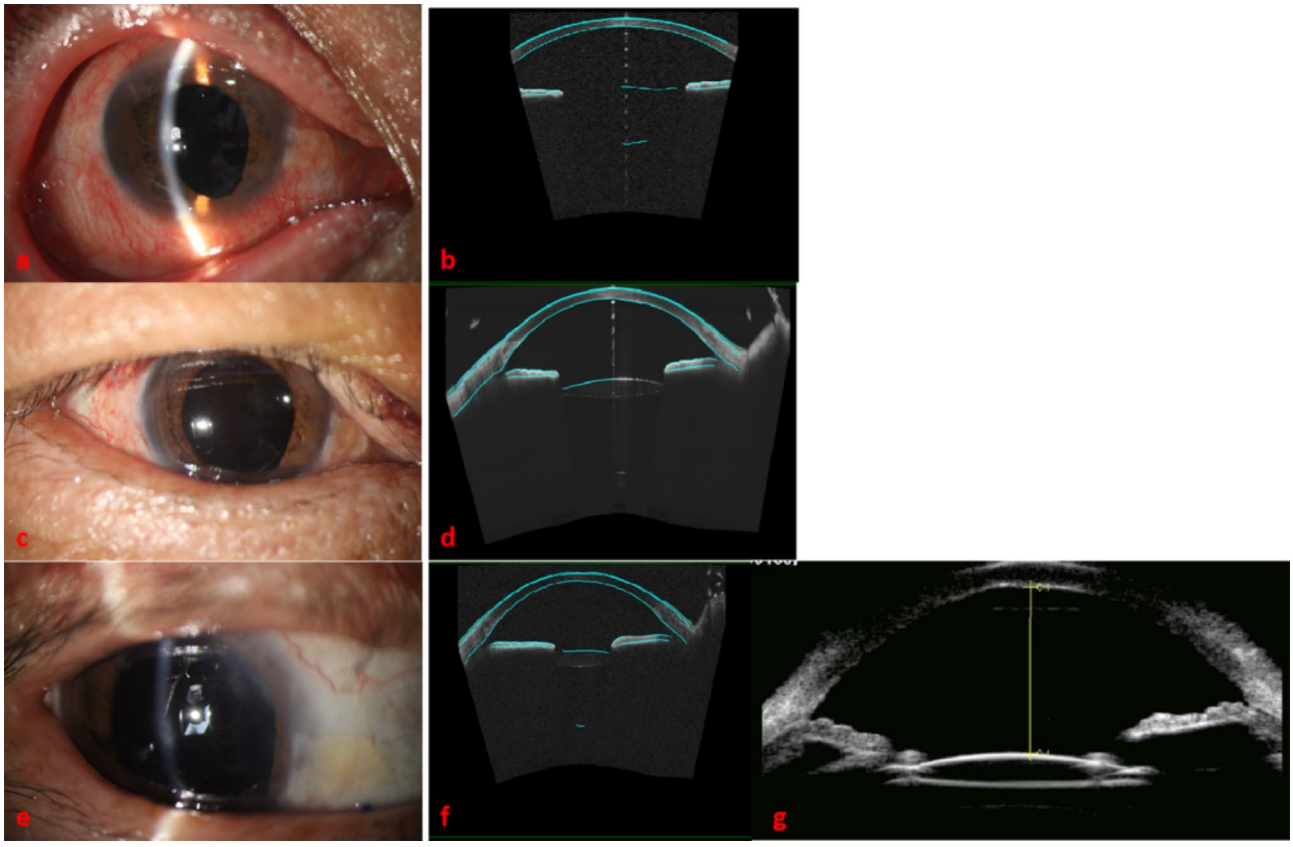

Fig. 3 Representative case. A 54-year-old man underwent phase 1 surgery implantation for endophthalmitis. The preoperative BCVA before secondary implantation of IOL was 0.4. **a-b**) The preoperative anterior segment photograph and AS-OCT showed the absense of lens and capsule. **c-d)** Postoperatively at 1 week, the BCVA was 0.7. The anterior segment photograph and AS-OCT showed a good position of IOL. **e-g**) Postoperatively at 3 months, the anterior segment photograph, AS-OCT and UBM showed a good position of IOL, whitout IOL tilt or dislocation. The BCVA was 0.8

Discussion

Since the introduction of scleral fixation for intraocular IOL implantation in 1986 [14], researchers have continuously refined surgical techniques over the decades. Improvements have included considerations on whether and how to create a scleral flap, the choice and design of IOLs, suture materials and models, and fixation methods. These advancements have progressively reduced complication rates, including issues such as IOL subluxation and tilt, retinal detachment, hemorrhage, macular cystoid edema, ocular hypertension, and suture erosion or breakage [1, 10, 13, 15]. Building on the techniques of various scholars and incorporating clinical experience, this study introduces an innovative method for scleral fixation IOL implantation: the four-point fixation of the Akreos-Adapt AO IOL using two parallel 6–0 polyglactin sutures and a flanged technique.

This procedure offers several advantages. Firstly, the Akreos-Adapt AO IOL, selected for all patients in this study, is foldable, hydrophilic, aspherical, and equipped with four haptics [8]. This allows for a small corneal incision to insert the IOL and facilitates four-point fixation. Although hydrophilic acrylic IOLs has the possibility of their opacification in contact with air or gas in very specific surgical procedures such as DMEK, DSEAK and posterior vitrectomy via pars plana where they leave gas, postoperative inflammation and the risk of IOL tilt or dislocation can also be significantly reduced, and better prognosis visual acuity can be achieved. Furthermore, the use of four-haptics IOLs substantially decreases the likelihood of iris capture complications, particularly in cases of floppy iris, such as Marfan's syndrome. Iris capture can result in secondary issues like glaucoma and iritis, which can severely impact the patient's vision [2–5, 8].

Secondly, the use of 6–0 polyglactin sutures, known for their superior toughness and resistance to degradation, enhances long-term stability for scleral fixation of the IOL. This significantly reduces the risk of suture breakage, a major complication. Moreover, 6–0 polyglactin sutures are well-suited for this procedure because their diameter matches the inner diameter of a 30-gauge needle. The flange created by the 6–0 polyglactin suture is larger than the scleral puncture made by the 30-gauge needle, which facilitates suture traction and simplifies the surgical process.

Thirdly, this study utilized flange technology for scleral fixation of IOLs, as opposed to other suture fixation techniques such as intrascleral fixation, glued IOLs, or iris-sutured IOLs. This technique, initially described by Yamane et al. and later modified by Canabrava et al., [11–13] involves using 6–0 polyglactin sutures with flanges at four scleral sites to secure the IOLs. This method simplifies the procedure, as the suture can be guided into the eye with a 30-gauge needle without the need for tying or embedding, thereby reducing the complexity of scleral fixation surgery and minimizing suture-related complications. Additionally, it avoids the production of conjunctival peritomies and scleral flaps. The four-point scleral fixation enhances IOL stability and reduces the risk of tilt or dislocation. However, in specific cases such as pediatric patients with Marfan syndrome and elastic sclera, the flange structure alone may not be sufficient for stabilization. In these cases, flattened flange structures, which provide increased stability and prevent conjunctival exposure, have been suggested as a safer option [16].

A fourth key advantage of this technology is the ability to independently adjust the length of the two parallel 6–0 polyglactin sutures, a feature not available with other suture fixation methods. The adjustable flange technique enables precise tightening of the sutures to achieve optimal tension and IOL positioning, even after the sutures are fixed, to ensure the IOL optical zone is perfectly centered.

Fifth, this study utilized sutures configured in two horizontal parallel lines, allowing the IOL to be suspended on these sutures. This approach helps prevent excessive tensile deformation of the IOL, which could occur with circular or semi-circular fixation methods used on both sides of the Akreos-Adapt AO IOL.

In this study, all patients showed significant improvement in postoperative visual acuity at the final follow-up, which was more than three months later. There were no intraoperative complications observed during the follow-up period. Thus, this technology proved to be an effective and safe method for managing aphakia. Although we have not observed any IOL movement or iritis in this study, the possibility of these events occurring in a longer period should not be excluded.

Nonetheless, certain limitations of this study have been noted. The sample size of 14 patients was small, and the study focused on a limited number of indicators, and some were not quantified. Further, the follow-up period was short. Long term follow-up studies with a large sample size can be conducted in the future, which can provide more robust data on the long-term efficacy and safety of the technique.

Conclusion

The simplicity of the technique, along with its ability to accommodate adjustments post-implantation, allows for optimal positioning and reduces risks like IOL tilt or dislocation. Overall, this is a promising approach to secondary IOL implantation, with potential benefits for both patient outcomes and surgical efficiency.

Abbreviations

IOL	Intraocular lenses
BCVA	Best Corrected Visual Acuity
IOP	Intraocular pressure
AS	OCT-Anterior segment optic coherence tomography

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Not applicable.

Author contributions

HC: idea generation, critical revision of the manuscript. HC, JLJ, CXW and JFY: data collection, writing of the manuscript. YQC, JBM, GLY and LJS: critical revision of the manuscript, supervision, administrative support. All the authors were involved in the critical revision of the manuscript, supervision of the manuscript and final approval of the submission.

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Data availability

The datasets for the analysis of the current study are readily available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study followed the tenets of the Declaration of Helsinki and was approved by the Ethics Committee of the Zhejiang Provincial People's Hospital Institutional Review Board, and written informed consent was obtained from all patients.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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