Comparison of retropupillary fixated iris claw lens versus sclera fixated lens for correction of pediatric aphakia secondary to ectopia lentis

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Abstract:
AIM: To evaluate the postoperative visual acuity and complications in eyes with ectopia lentis in children who underwent lens removal and then implantation of retropupillary fixated iris claw lens versus scleral fixated intraocular lens (SFIOL) implantation.

MATERIALS AND METHODS: A retrospective analysis of pediatric cases who presented with lens subluxation secondary to ectopia lentis and who underwent lens extraction (57 eyes of 38 patients) with either retropupillary iris fixated intraocular lens (IOL) implantation (Group A – 36 eyes of 20 patients) and SFIOL implantation (Group B – 21 eyes of 18 patients) was done over a period of 5 years from March 2010 to February 2015. The main outcome measures were preoperative and postoperative best-corrected visual acuity (BCVA) and secondary postoperative complications.

RESULTS: The study patients were divided into two groups: Group A patients were implanted with retropupillary iris claw lens whereas Group B patients were implanted with SFIOL. The mean age of presentation was 12 years, the mean follow-up period was of 24 months (range 14–36 months), and the median follow-up period was 26 months in both the groups. An improvement in the mean BCVA (LogMAR) was seen in both the groups. In Group A, the mean BCVA improved from 1.5 ± 0.2 preoperatively to 0.3 ± 0.2 postoperatively, whereas in Group B, the mean BCVA improved from 1.5 ± 0.3 preoperatively to 0.3 ± 0.2 postoperatively (P < 0.001). None of the eyes in either of the groups had any serious complications such as glaucoma, uveitis, cystoid macular edema, or endophthalmitis.

CONCLUSION: Retropupillary iris fixation and scleral fixation of IOL are both safe and viable options for the correction of ectopia lentis in pediatric age group.

Keywords: Aphakia, ectopia lentis, iris claw lens, Marfan syndrome, scleral fixated intraocular lens, scleral fixated lens

Introduction
Ectopia lentis in children commonly occurs as an idiopathic or hereditary condition.[1] Rarely, it can be due to trauma and the more common nontraumatic conditions are Marfan syndrome, homocystinuria, Weill–Marchesani syndrome, spherophakia, and other metabolic syndromes.[1,2] Ectopia lentis in children is associated with very weak zonules and marked subluxation [Figure 1], which produces varying degree of refractive errors having both regular and irregular astigmatism and higher order aberrations.[1] Refractive correction with spectacles and contact lens is much easier in...
total dislocation of crystalline lens as the central visual axis is aphakic. However, partial subluxation necessitates a surgical removal in view of the high astigmatism, lens edge-induced aberrations, and lens edge-induced myopia.[1,2]

Pediatric cataract surgeries are challenging for an ophthalmologist with respect to timing of surgery and also due to the anatomical considerations. The surgeon must accommodate for the alteration in axial length of the eye which will alter the refractive status of the eye and thus poses a challenge with respect to intraocular lens (IOL) power calculation.[1] The timing of surgery is important in pediatric patients, as any unnecessary delay may lead to the development of amblyopia and the loss of binocularity.

Aphakia in pediatric patients can be corrected either by spectacles, contact lenses, or secondary IOL implantation.[1,2] Retropupillary fixated iris claw lenses and scleral fixated IOL (SFIOL) are preferred in children as the long-term effects of anterior-chamber IOL (ACIOL) on the endothelium are poor.[9]

We aimed to study the safety and efficacy of both these lenses in correcting pediatric aphakia. We selected retropupillary fixation of both the iris claw lens and the scleral fixated lens to keep the IOL in the posterior chamber, a very safe place, which gives maximum protection to the corneal endothelium.[1,3] The possible dreaded complications with these lenses include decentration, IOL tilting, iris chafing, de-enclavation, suture breakage, secondary glaucoma, endophthalmitis, and endothelial decompensation.[4,5] We carried out this study to understand the long-term efficacy and safety of the posterior iris claw lens and scleral fixated lenses to establish them as a viable option for the management of ectopia lentis.

**Materials and Methods**

It is a retrospective analysis of patients with idiopathic, congenital, and traumatic subluxated lens with more than 180° of zonular dialysis over a period of 5 years from March 2010 to February 2015 after approval from the ethics committee of the institute. This study protocol followed the tenets of the Declaration of Helsinki, and all privacy requirements were met. All surgeries were performed by a single surgeon. A detailed medical history was recorded from the patient’s parents, and examination was done by a pediatrician to rule out other systemic congenital anomalies in cases having features of Marfan syndrome and microspherophakia.

A preoperative clinical examination which included visual acuity testing using Snellen chart, refraction (dry and cycloplegic), slit lamp biomicroscopic examination, fundus examination, and postpupillary dilatation was done. B-scan ultrasonography was done when the fundus details were not clearly visible. Automated keratoreflectometer (Zeiss IOL Master, Carl Zeiss Meditec) was used to obtain the keratometry values, axial length, and IOL power. The final IOL power selected for the implantation was calculated as given in Table 1. Children in the age group of 6–15 years having lens subluxation of 180° or more were selected for surgery if they presented with any one of the following: monocular diplopia, distance best-corrected visual acuity (BCVA) worse than 20/200, variable refraction or variable BCVA measurements caused by progressive subluxation of the lens, and bisection of the pupil by the lens edge and failure of conservative management in view of noncompliance with glasses. Patients with <6 years of age, distance BCVA of better than 20/125, unfit for general anesthesia, and various corneal or retinal pathologies that would affect the final visual outcome were excluded from the study. Informed consent for surgery and physician fitness for general anesthesia was obtained for all patients.

**Surgical technique**

All surgeries in both the groups were performed by a single surgeon. In patients with structural problems of the iris, such as iris coloboma, aniridia, and traumatic iridodialysis or sphincter tears, scleral fixated lens was preferred.

In Group A, the excel optics iris claw IOL was implanted (Chennai Model No: PIC 5590, SIC4280P). This is a modified version of Dr. Worst and Dr. Daljit Singh model. The overall length of the IOL is 8/9 mm so that the pupillary dilatation was good enough for the posterior-segment evaluation in the postoperative period. The optic is biconvex and 4.5/5.5 mm in size. The A-constant for this lens was 117. The guidelines that were followed for the correction of IOL power in the age group of less
than 8 years are mentioned in Table 1. Above 8 years of age, the IOL power was calculated as is done for adults. Preoperative pupillary dilatation was performed with tropicamide 1% and phenylephrine 5% (Sunways). The surgery was performed through a superior 5.5 mm limbal three-plane incision. Sodium hyaluronate 1.4% was used as an ocular viscoelastic device (OVD). Two paracentesis incisions (1.2 mm) were made on either side at 3’o clock and 9’o clock position using a microvitreoretinal (MVR) blade. A small capsulorhexis was carried out using pediatric capsulorhexis forceps and 26-gauge capsulotomy needle. Soft cortical matter was aspirated using Simcoe cannula with low infusion. The anterior chamber was filled with OVD, and the capsular bag was pulled out and removed with a fine nontoothed forceps after the removal of surrounding vitreous. Intracameral pilocarpine or acetylcholine (Miochol 0.01% preservative free, Appasamy ocular devices) was injected to constrict the pupil to a diameter of at least 5 mm. A small peripheral iridectomy was performed with a vitrector followed by anterior vitrectomy (Accurus Visu 150). Iris claw IOL was introduced into the anterior chamber. OVD was injected at each stage to deepen the anterior chamber and maintain space. Holding the optic with a lens forceps on the one haptic side was tilted down and pushed under the iris with gentle manipulation. Simultaneously, a fine 30-gauge rod was passed through the paracentesis on the same side. Once the haptic was behind the iris, the haptic of IOL was tilted up to produce an indent on the iris. The iris was enclaved into the haptic claw with the gentle push of the rod. Then, with similar maneuver, the haptic enclavation on the other side was performed. If vitreous disturbance occurred during any stage of surgery, automated vitrectomy was performed. The wound was closed with 10-0 nylon–interrupted sutures in all cases [Figure 2].

In Group B, preoperative pupillary dilatation was done with tropicamide 1% and phenylephrine 5% (Sunways). Small limbal peritomies were done overlying the region marked for scleral dissection. Three-port sclerostomies were made, each 1.5 mm in size using an MVR blade, 2.5 mm from the limbus in the aphakic region and 3 mm from the limbus in the phakic area. A pars plana lensectomy along with a pars plana vitrectomy (Accurus Visu 150) was done following which a superior 12’o clock scleral incision was made. A corneoscleral tunnel was fashioned out of the incision. A 10’o polypropylene suture (Ethicon) was inserted 1.5 mm away from the limbus in the 3’o clock–9’o clock axis so that its position is behind the iris. The needle was inserted till its beveled tip is visualized in the pupillary zone. Then, a 27-gauge needle was inserted in the same axis but opposite to the site of entry of the SFIOL suture till its tip is visualized in the pupillary zone. The SFIOL needle was then docked into the lumen of the 27-gauge needle and brought out using the Rail-Road technique so that the length of the SFIOL suture transverses the eyeball. The suture was then brought out from the superior tunnel using a forceps and was cut at the center. Each of the cut ends was tied to the eyelets of the SFIOL. The lens was then inserted vertically into the eye via the superior tunnel, and then, it was gradually rotated in the eye by applying traction and counter-traction using the pull of the sutures at 3’o clock and 9’o clock externally. The lens was kept straight and any tilting, if present, was corrected at that time. The lens was finally positioned in the sulcus. Finally, the suture ends were tied to the sclera and the knots were buried [Figure 3]. The IOL implanted was an Aurolab SC6530 (Aurolab, India) single-piece PMMA lens with eyelets. Sclerostomies and conjunctiva were sutured using 6 o vicryl sutures.

### Postoperative care

The eyes in both the groups were patched after surgery, and postoperatively, topical prednisolone acetate 1% eye drops and ofloxacin 0.3% eye drops were prescribed 4–6 times a daily with a tapering schedule over 2 months. Topical ketorolac eye drops were prescribed twice daily for 3 months. The patients were followed up on the 1st day, 15th day, 2nd month, and every 3 months and thereafter for 1 year. At each follow-up, detailed slit lamp biomicroscopic examination to check for IOL position [Figure 4], intraocular pressure by noncontact tonometer, Snellen visual acuity, and best spectacle corrected visual acuity were recorded.

Statistical analysis was performed using Statistical analysis was performed using SPSS software (IBM Corp.
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Results

The present study was performed over a 5-year period from March 2010 to February 2015. A total of 57 eyes of 38 patients with ectopia lentis were enrolled. These patients were divided into two groups. Group A consisted of 36 eyes of 20 patients which underwent implantation of iris claw lens. However, in Group B, 21 eyes of 18 patients were included that underwent implantation of scleral fixated lens [Chart 1]. The mean age of the patients in both the groups was 12 years (range: 6–15 years) and the age distribution in both groups is demonstrated in Figure 5. In both the groups, the males outnumbered females by a ratio of 3:2 [Figure 6]; thus, both the groups were grossly age and gender matched. Unilateral involvement was seen in four patients in Group A and in 15 patients in Group B. The average duration of follow-up period for both the groups was 24 months (range: 14–36 months).

The various causes of ectopia lentis in our study population included Marfan syndrome, microspherophakia, trauma, and idiopathic. Systemic disorders such as Marfan syndrome and microspherophakia were found to co-exist in 30 eyes in Group A and 16 eyes in Group B [Table 2].

An improvement was defined as a minimum of two lines increment in the visual acuity on the Snellen chart. Improvement was noted in 35 eyes in Group A (97.2%), whereas in Group B, 19 out of 21 eyes showed improvement (90.4%). The mean preoperative BCVA (LogMAR) was 1.5 ± 0.2 in Group A and was 1.5 ± 0.3 in Group B. There was a statistically significant improvement in BCVA [Figures 7 and 8] and other visual parameters such as spherical and cylindrical error and spherical equivalent postoperatively at final visit in both the groups (P < 0.001) [Table 3].

Complications [Figure 9] such as partial decentration of the lens were observed in two eyes in Group A; however, the edge of the lens optic did not intersect the visual axis, and no intervention was performed in these cases as the patients were asymptomatic. One eye in Group A had a disenclavation of the lens after blunt trauma to the eye with hand; this was later corrected by surgical re-enclavation. Pupil ovalization was noted in four eyes (11.1%) and was the most common complication encountered in Group A; however, none of these eyes require any further intervention.

In Group B, one eye was observed to have lens decentration in the immediate postoperative period, leading to blurred vision; this was corrected surgically. Retinal detachment was observed in one eye in Group A (2.7%) and in two eyes in Group B (9.5%). This was attributed to the presence of high myopia within these patients. An attempt was made to correct this surgically by pars plana vitrectomy along with silicon oil injection. One case in Group B had a pupillary block with raised IOP on day 15 follow-up visit, probably due to blockage of the surgical peripheral iridectomy by vitreous; this was managed successfully by Nd-YAG laser peripheral iridectomy. None of the patients in either group had other known complications such as cystoid macular edema, uveitis, glaucoma, and endophthalmitis.
The surgical correction of aphakia in children without posterior capsular support is a cumbersome task. Conservative management of ectopia lentis, especially in cases with advanced zonular damage, using spectacles or contact lenses is associated with improper correction of refractive condition, which may lead to significant visual disability and the development of amblyopia. Devices such as Cionni rings and capsular tension rings with extra hooks have been used to stabilize the capsular bag in the subluxated lenses; however, following this, a significant number of cases develop IOL decentration and posterior capsule opacification. Often, the IOL dislocates in the postoperative period requiring secondary suturing to the sclera or iris. There is much debate and discussion on the best method for secondary IOL implantation that offers the lowest complication rate and the best possible visual rehabilitation over several years. In the post-ACIOL era, the IOL design and surgical technique have undergone many modifications and improvements to minimize the surgical time, complications, and the rehabilitation time and to maximize the optical quality and patient comfort. Iris fixated lenses and scleral fixed IOL are both good options as they are the most physiological ways to correct aphakia with respect to the positioning of the lens in the eye. They offer the advantages of true posterior-chamber implantation, which results in a deeper anterior chamber and greater distance from the corneal endothelium and has a lower intraoperative and postoperative risk profile than anterior fixation.

Most of the problems and complications with iris fixated IOL were solved with improved design, manufacturing, and surgical techniques. The most common complication reported in our series was mild ovalization of the pupil in four eyes (11.1%) and decentration of IOL in two eyes (5.5%). Gonnermann et al. reported pupil ovalization in 13.9% of cases. Pupil ovalization may be due to fixation of the haptic very tightly or asymmetrically. de Silva et al. reported the most common complication to be wound leak and dislocation of iris claw lens, having an incidence of 6% each. Our series had no wound leak in either group and one eye (2.7%) had disenclavation in Group A which was attributed to trauma. Nearly, 70% of our patients achieved a final visual acuity of 20/40, which is comparable to 60% reported by de Silva et al. in their

Discussion

Figure 5: Age distribution in Groups A and B

Figure 6: Gender distribution in Groups A and B

Figure 7: Box plot comparing preoperative and postoperative best-corrected visual acuity in Group A – iris claw intraocular lens

Figure 8: Box plot comparing preoperative and postoperative best-corrected visual acuity in Group B – scleral fixated intraocular lens
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The mean postoperative spherical equivalent at the last follow-up was −1.30 ± 1.00 D, which was comparable to that reported by Gonnermann et al.\[14\]

The problems associated with iris claw lens such as the patients experiencing glare and presence of iris atrophy in the area of lens enclavation over a period of time were not observed in our study.

The concept of transscleral fixation of IOL, later known as SFIOL, was first given by Malbran et al.\[16\] Our study and also many other studies\[17‑20\] show encouraging results with the implantation of SFIOL. The known complications with SFIOL procedure including suture erosion and breakage, leading to IOL subluxation or dislocation, rhegmatogenous retinal detachment, endophthalmitis, pupillary block, and formation of conjunctival granuloma have been mentioned in various studies.\[19‑22\] Kumar et al.\[17\] have shown that transscleral fixed IOL is well tolerated in the pediatric age group. Similar results are observed in our study. Hoffman et al.\[18\] described a different technique of scleral fixed IOL. They used a four-point fixation technique and observed lesser chances of IOL tilting and late-onset IOL subluxation. Long-term studies were conducted by Asadi and Kheirkhah,\[19\] who reported a late IOL dislocation due to polypropylene suture breakage in 24% of eyes after 7–10 years. Another long-term study by Vote et al.\[20\] has shown the mean time of suture breakage to be 4 years. Recent studies by Price et al.\[21\] and Buckley\[22\] have recommended the use of a thicker suture material-like Mersilene or 9-0 polypropylene to avoid late suture breakage. We did not observe corneal decompensation in any of our patients in both the groups until the last follow-up visit.

The drawbacks of our study are that the corneal endothelial cell counts were not performed sequentially before and after surgery. Further, it had a short follow-up period; thus, we have not observed many long-term complications such as iris atrophy, leading to IOL subluxation in Group A and suture-related issues in group B.

In our study, the visual outcome after implantation of both retropupillary fixated iris claw lens and transscleral fixed IOL in children without posterior capsular support shows encouraging and comparable results. Both these lenses offer a safe and viable alternative in these complex situations where the surgeon cannot salvage the bag for IOL implantation and an alternative is required. The complication rates with either lens appear to be similar in our study; however, a long follow-up is required to observe suture-related complications such known to be associated with SFIOL.

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**Figure 9:** Complications in Groups A and B

**Table 2:** Causes of ectopia lentis in the study group

| Indications       | GROUP A-Iris claw IOL (No. of eyes) | GROUP B-SFIOL (No. of eyes) |
|-------------------|------------------------------------|-----------------------------|
| Marfan’s syndrome | 16                                 | 10                          |
| Microspherophakia | 14                                 | 6                           |
| Trauma            | 4                                  | 5                           |
| Idiopathic        | 2                                  | 0                           |

**Table 3:** Analysis of best-corrected visual acuity, pre- and post-operative refraction in Groups A and B

|                      | Group A-Iris Claw IOL (36 eyes) Mean±SD | Group B-SFIOL (21 eyes) Mean±SD |
|----------------------|----------------------------------------|---------------------------------|
|                      | Pre-op       | Post-op        | P   | Pre-op       | Post-op        | P   |
| BCVA (LogMAR)        | 1.5±0.2     | 0.3±0.2        | <0.0001 | 1.5±0.3     | 0.3±0.2        | <0.0001 |
| SPH (D)              | -7.5±1.6    | -1.1±0.5       | <0.0001 | -8.2±1.5    | -1.4±0.8       | <0.0001 |
| CYL (D)              | -4.8±2.7    | -0.8±0.3       | <0.0001 | -5.0±2.0    | -0.6±0.4       | <0.0001 |
| SE                   | -9.5±2.01   | -1.3±1.0       | <0.0001 | -10.6±1.8   | -1.6±1.2       | <0.0001 |

BCVA-Best corrected visual acuity, SPH-spherical error, CYL-cylindrical error, SE-Spherical equivalent, SD- standard deviation.

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Conclusion

Iris fixation and scleral fixation of IOL are both safe and viable options for the correction of ectopia lentis in the pediatric age group.

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Conflicts of interest

There are no conflicts of interest.

References

1. Simon MA, Origlieri CA, Dinallo AM, Forbes BJ, Wagner RS, Guo S. New management strategies for ectopia lentis. J Pediatr Strabismus 2015;52:269‑81.
2. Nelson LB, Maumenee IH. Ectopia lentis. Surv Ophthalmol 1982;27:143‑60.
3. Odenthal MT, Sminia ML, Prick LJ, Gortzak‑Moorstein N, Völker‑Dieben HJ. Long‑term follow‑up of the corneal endothelium after artisan lens implantation for unilateral traumatic and unilateral congenital cataract in children: Two case series. Cornea 2006;25:1173‑7.
4. Dick HB, Augustin AJ. Lens implant selection with absence of capsular support. Curr Opin Ophthalmol 2001;12:47‑57.
5. Assia EI, Nemet A, Sachs D. Bilateral spontaneous subluxation of scleral‑fixed intraocular lenses. J Cataract Refract Surg 2002;28:2214‑6.
6. Price MO, Price FW Jr., Werner L, Berlie C, Mamalis N. Late dislocation of scleral‑sutured posterior chamber intraocular lenses. J Cataract Refract Surg 2005;31:1320‑6.
7. Jacobi PC, Dietlein TS, Jacobi FK. Scleral fixation of secondary foldable multifocal intraocular lens implants in children and young adults. Ophthalmology 2002;109:2315‑24.
8. Singh D. Intraocular lenses in children. Indian J Ophthalmol 1984;32:499‑500.
9. Lifshitz T, Levy J, Klemperer I. Artisan aphakic intraocular lens in children with subluxated crystalline lenses. J Cataract Refract Surg 2004;30:1977‑81.
10. van der Pol BA, Worst JG. Iris‑claw intraocular lenses in children. Doc Ophthalmol 1996;92:29‑35.
11. Rijnneveld WJ, Beekhuis WH, Hassman EF, Dellaert MM, Geerards AJ. Iris claw lens: Anterior and posterior iris surface fixation in the absence of capsular support during penetrating keratoplasty. J Refract Corneal Surg 1994;10:14‑9.
12. Güell JL, Velasco F, Malecaze F, Vázquez M, Gris O, Manero F. Secondary artisan‑Verysiseaphakic lens implantation. J Cataract Refract Surg 2005;31:2266‑71.
13. Mohr A, Hengerer F, Eckardt C. Retropupillary fixation of the iris claw lens in aphakia. 1 year outcome of a new implantation techniques. Ophthalmologe 2002;99:580‑3.
14. Gonnermann J, Klamm MD, Maier AK, Rjasanow J, Joussen AM, Bertelmann E, et al. Visual outcome and complications after posterior iris‑claw aphakic intraocular lens implantation. J Cataract Refract Surg 2012;38:2139‑43.
15. de Silva SR, Arun K, Anandan M, Glover N, Patel CK, Rosen P. Iris‑claw intraocular lenses to correct aphakia in the absence of capsule support. J Cataract Refract Surg 2011;37:1667‑72.
16. Malbran ES, Malbran E Jr., Negri I. Lens guide suture for transport and fixation in secondary IOL implantation after intracapsular extraction. Int Ophthalmol 1986;9:151‑60.
17. Kumar M, Arora R, Sanga L, Sota LD. Scleral‑fixed intraocular lens implantation in unilateral aphakic children. Ophthalmology 1999;106:2184‑9.
18. Hoffman RS, Fine IH, Packer M, Rozenberg I. Scleral fixation using suture retrieval through a scleral tunnel. J Cataract Refract Surg 2006;32:1259‑63.
19. Asadi R, Kheirkhah A. Long‑term results of scleral fixation of posterior chamber intraocular lenses in children. Ophthalmology 2008;115:67‑72.
20. Vote BJ, Tranos P, Bunce C, Charteris DG, da Cruz L. Long‑term outcome of combined pars plana vitrectomy and scleral fixed sutured posterior chamber intraocular lens implantation. Am J Ophthalmol 2006;141:308‑12.
21. Price MO, Price FW Jr., Werner L, Berlie C, Mamalis N. Late dislocation of scleral‑sutured posterior chamber intraocular lenses. J Cataract Refract Surg 2005;31:1320‑6.
22. Buckley EG. Hanging by a thread: The long‑term efficacy and safety of transscleral sutured intraocular lenses in children (an American Ophthalmological Society thesis). Trans Am Ophthalmol Soc 2007;105:294‑311.