Double rectangular suture sulcus reconstruction in the management of aphakia with absent capsular support

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Aim

This study aimed to describe a new method of sulcus fixation of intraocular lenses (IOLs) with total or partial loss of capsular support.

Materials and methods

This was a prospective nonrandomized comparative clinical trial, where two groups were managed for IOL scleral fixation in the absence of capsular support. Group A included 12 cases with classic ab externo two-point sclera fixation and group B included 16 cases with the double rectangular suture sulcus reconstruction (DRSSR). The etiology of aphakia in group A included congenital cataract managed by lensectomy (three cases), trauma (six cases), and complicated phacoemulsification (three cases). In group B, aphakia was because of congenital cataract in two cases, trauma in five cases, hypermature cataract in three cases, and complicated phacoemulsification in two cases. A unique subset of group B included four eyes with posterior chamber IOL subluxation or dislocation managed by DRSSR. The main outcome measures included final best-corrected visual acuity (BCVA), lens stability, and complications.

Results

All 28 eyes had stable or improved BCVA and the mean postoperative BCVA had improved significantly from 6/30 to 6/7.5 (P = 0.004). There were no statistical differences between groups A and B in postoperative BCVA (P = 0.403), complications (P = 0.25), and astigmatism (P = 0.113). Group 2 B cases with subluxated and posterior dislocated IOLs were managed by DRSSR, with no need for exteriorizing the IOL, with excellent centration.

Conclusion

The DRSSR seems to be a safe method of providing an adequate bed for IOL stabilization in the absence of capsular support. This method is particularly useful in dislocated or subluxated IOLs that need repositioning under a closed globe with minimal manipulations.

Keywords:
aphakia, DRSSR, PCIOL

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Introduction

Properly positioned posterior chamber IOL (PCIOL) offers many advantages over an anterior chamber IOL (ACIOL). The potential advantages of PCIOLs over ACIOLs include a reduction in the number of optical aberrations (e.g. magnification, aniseikonia, lens edge glare, flutter), a decreased incidence of secondary glaucoma, and free movement of the pupil to control the amount of light entering the eye [1]. The risk for corneal decompensation, secondary glaucoma, and cystoid macular edema may be less with PCIOLs than with ACIOLs. In the absence of capsular support, many techniques have been described to secure the haptics to the region of the sulcus [1]. Since 1999, the general consensus has been to implant a large-diameter optic (6.5 or 7.0 mm) IOL in the ciliary sulcus through an ab externo (outside-in) approach with the advantage of passing the suture through the scleral wall while the eye is still firm, producing better visual acuity results and fewer complications [2]. All described techniques focus on IOL haptics fixation to the scleral wall at two or more points [3]. These techniques are not without complications, including IOL tilt, misalignment, myopic shift, IOL suture rupture, and dislocation [4]. In this study, we prospectively compare classic ab-externo two-point IOL fixation with a new technique of IOL scleral fixation based on fashioning trans-sclerally — at 1 mm from the limbus, a double rectangular suture sulcus reconstruction (DRSSR) to support the IOL optic, thus providing a cushion to the IOL being positioned in the sulcus. This technique is modified from a previously described technique by Ayoub [5].

Materials and methods

All patients were evaluated for preoperative status including visual acuity, refractive error (eyes with hypermature cataract were not included), K readings, pre-existing ocular conditions, previous surgeries, iris status, and capsule status. Ultrasound biomicroscopy (UBM) was performed whenever possible for sulcus

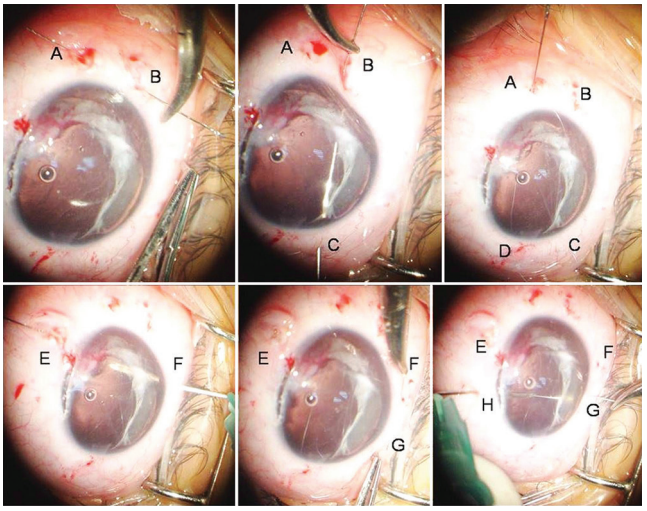
evaluation and follow-up. Patients were chosen to undergo classic ab-externo two-point sulcus fixation [6] or the DRSSR technique according to etiology. Patients presenting with subluxated or dislocated PCIOLs were preferentially managed by the DRSSR technique.

Surgeries were performed in the Kasr Al Ainy operating theater, Cairo University hospital, Cairo, and eye world hospital, Giza, Egypt. Informed consent was obtained from all participants. The study was reviewed and approved by an ethics committee. Institutional review board approval was available. Postoperative measurements included visual acuity, refractive error, complications, and the need for further surgery. Data collected included demographic data, ocular history, preoperative and final best-corrected visual acuity (BCVA), preoperative and postoperative intraocular pressure, and postoperative complications such as hyphema, vitreous hemorrhage, glaucoma escalation, IOL tilt or dislocation, and retinal detachment. The principal outcome indicator was the final BCVA. This indicator was reported as the percentage of eyes achieving a visual acuity of at least 6/12 and the percentage of eyes with a visual acuity of less than or equal to 6/60. Intraocular lens position was assessed by slit-lamp examination with a dilated pupil and by UBM whenever feasible. Preoperative and postoperative refraction was possible for patients where trauma or cataract did not obstruct or prevent measuring with refractometer. Glaucoma escalation was defined as new-onset glaucoma or the need for more aggressive control of pre-existing glaucoma with one or more additional medications or surgical intervention.

Follow-up for all patients extended to 13 months postoperatively.

Patients were divided into two groups to undergo classic ab externo two-point scleral fixation as described by Lewis [6] or the DRSSR technique. In the DRSSR technique, two localized radial conjunctival periotomies were created 4 mm apart in each quadrant of the eye, astriding the limbus. For the right eye, we usually start with the nasal and temporal horizontal meridia (Fig. 1). The needle of a 10–0 polypropylene (Prolene) suture with straight 16.0 mm STC-6 needles (Ethicon Inc., Ethicon, CA, USA) is introduced trans-sclerally in partial-thickness sclera from point A (Fig. 1) superonasally to exit inferonasally at point B, which is situated 4 mm inferior to A, from the formerly fashioned inferonasal conjunctival periotomy. The needle is then reintroduced from point B 1.0 mm posterior to the limbus to the pupillary plane and then pulled out of the eye by being engaged into the barrel of a 27-G needle introduced from the opposite inferotemporal sclera 1 mm posterior to the limbus to

Figure 1



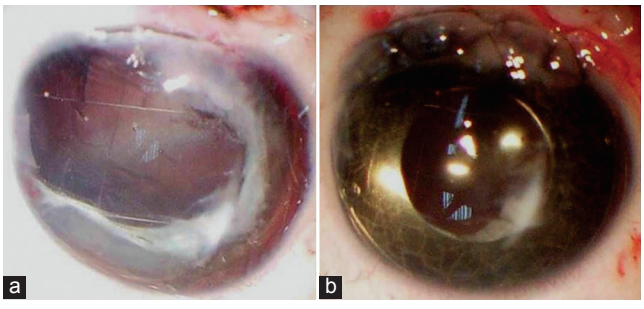
Detailed surgical technique; method of double scleral mesh scleral fixation OD: a needle is passed trans-sclerally from superonasal sclera at (A) 1 mm away from limbus to exit 4 mm inferonasally at (B). From (B), the needle is passed into the bevel of a 27 G syringe to exit at (C) 1 mm from the limbus. The needle is then passed trans-sclerally from (C) to exit at 4 mm superotemporally at (D). Similarly, the needle is passed from (E) to (F), passed trans-sclerally to exit at (G) 4 mm from (F) then at (H) 1 mm from the limbus, and then trans-sclerally to (E). At points (A) and (E), the knots are buried into the sclera.

exit through the opposite conjunctival periotomy at point C (Fig. 1). The needle is grasped with a needle holder and reintroduced from the same point for a distance of 4 mm in partial-thickness sclera superiorly to exit 1 mm posterior to the superotemporal limbus in the superior quadrant of the eye at point D. The second needle is reintroduced from the same point of sclera entry superotemporally in a similar manner 1 mm posterior to the limbus from superotemporal quadrant to the superonasal quadrant across the pupillary area to exit at the same point A of previous suture introduction superotemporally 1 mm posterior to the limbus, where a triple throw knot is fashioned and secured with a stay suture. At this same point of exit, a radial sclera tunnel was fashioned previously to bury the knot once secured. The same procedure is repeated between the superior and inferior vertical meridia of the eyeball. We start at a superonasal entry point E (Fig. 1), 1 mm posterior to the limbus, through the pupillary plane, where the needle exits 1 mm behind the inferonasal limbus at point F, then passed through partial-thickness sclera to the inferotemporal limbus at point G 4 mm distant from F. The second needle is passed from the inferotemporal point G and reintroduced through the pupillary plane to the opposite superotemporal quadrant at point H 1 mm behind the limbus. From point H, the needle is passed trans-sclerally to point E, which is 4 mm distant from H. A knot is fashioned and buried in partial-thickness scleral groove as mentioned previously. The suturing technique can be fashioned

at the surgeon's convenience and dexterity similarly in opposite quadrants, and the points of entry can be changed following the same sequence. The final result of the suturing technique is the creation of a 4 mm square prolene meshwork behind the pupillary plane (Fig. 2a), providing adequate IOL-optic support, in addition to the peripheral support for the haptics. Foldable three-piece IOLs (Tecnis ZA9003; ABBOTT, Illinois, USA) with 6 mm optic diameter and 13 mm overall diameter were used in seven eyes.

Two cases with traumatic aniridia needed aniridia lens implantation (Morcher® GmbH company, Morcher 67; Stuttgart, Germany). In the seven cases with insertion of 6.5 mm optic PMMA IOL (Biovision, Nagarabhavi, Bangalore, India), the wound was fashioned at posterior limbus ½ mm larger than the diameter of the lens optic, the IOL was positioned on the DRSSR and tethered between the two rectangles, and the wound was closed with interrupted sutures. In cases where the IOL was dislocated, and after fashioning the DRSSR, anterior vitrectomy was performed and the IOL was grasped with a forceps and simply inserted onto the mesh. Permanent tightening of the knots was performed after reforming the globe. The conjunctival localized periotomies were left to heal spontaneously. A subconjunctival injection of short-acting or long-acting steroids with atropine was administered. The eye was patched for 24 h. Postoperatively, all patients received steroid–antibiotic drops every 4 h for 2 weeks; this was tapered over the next 6–8 weeks. Cycloplegic eyedrops once or twice daily were used for 2 weeks to decrease the inflammatory response in the early postoperative period. A systemic steroid (1 mg/kg body weight) was administered to children with signs of severe uveitis. A comprehensive examination similar to the preoperative assessment was performed during the following visits. Four to 6 weeks after surgery, retinoscopy was performed and the patients were fitted with spectacles. Visual acuity was tested using the Snellen optotype method.

Figure 2



Final appearance (intraoperative). (a) Fashioning of scleral mesh resulting in a bed for IOL optic support. (b) Iris-tinted IOL is inserted and positioned in place through a posterior limbal incision.IOL optic is resting on a 4 mm square designed prolene mesh.

This consecutive series comprised eyes with aphakia that were determined clinically to have inadequate capsule support for a capsule-supported secondary IOL. Cases of torn scleral sutures with subluxated or posterior dislocated IOLs were also included.

Qualitative variables of the two study groups were described frequencies and percentages and quantitative variables were described as mean SD. Comparison of the preoperative characteristics of patients in the two armed was carried out using the χ^2-test for qualitative variables and the Mann–Whitney *U*-test for quantitative variables such as BCVA and astigmatism. *P* values to estimate differences in any variable between the two study groups were presented with a cut-off point for significance of less than 0.05. In addition, the paired Student *t*-test was used to estimate differences in quantitative variables before and after surgery for the study groups as a whole. The study group was divided into subgroups on the basis of preoperative and postoperative BCVA to compare this variable between the two study groups for patients who had BCVA less than or equal to 6/60 and those who had BCVA at least 6/12. χ^2 was used to compare groups A and B on the basis of the above-mentioned cut-off points.

Results

Twenty-eight eyes of 28 patients were operated from November 2008 to April 2012. Patients were classified into two groups as follows: group A: classic ab externo approach as described by Lewis [6]. This group comprised 12 eyes of 12 patients. Group B comprised 16 eyes of 16 patients undergoing DRSSR.

Both surgical techniques yielded the same results for the two study arms. There were no statistical differences between groups A and B in sex ($P = 0.40$), age ($P = 0.13$), preoperative BCVA ($P = 0.924$), postoperative BCVA ($P = 0.403$), postoperative complications ($P = 0.25$), astigmatism ($P = 0.113$), and follow-up period ($P = 0.25$).

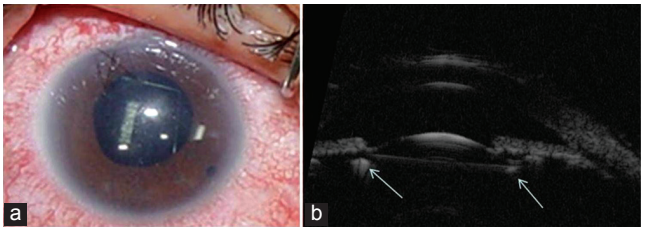
At the most recent follow-up visit, all 28 eyes had stable or improved BCVA and the mean postoperative BCVA had improved significantly from 6/30 to 6/7.5 ($P = 0.004$, Student's paired *t*-test, on the basis of log values). Patients were divided on the basis of spectacle BCVA (contact lens BCVA in aphakic eyes) into subgroups. Among the study groups (28 cases), 17 (60.7%) patients had preoperative BCVA as less than or equal to 6/60, whereas two (7.1%) had preoperative BCVA more than or equal to 6/12, which was statistically insignificant ($P = 0.66$). However, only one (3.6%) patient had postoperative BCVA of 6/60 whereas 22 (78.6%) patients had postoperative BCVA

of at least 6/12. Again, no statistical significance could be found between the two study groups ($P = 0.48$).

Discussion

Since the description of the principle of IOL suturing to the sclera by Girard [7] and the refinement of the technique by Malbran *et al*. [8], sewing the haptics of a PCIOL into the sulcus has been the standard method for IOL sulcus fixation in the absence of capsular support in all age groups. All described techniques depend on two or more points of fixation of the haptics by 10/0 or 9/0 prolene sutures and placement of the IOL in the sulcus behind the iris [9]. Prolene sutures tied to the haptics are not without complications including mechanical iridocyclitis, slippage of the knot along the haptic resulting in IOL decentration or tilt, and suture erosion through the sclera and or conjunctiva [10]. Management of exposed knots includes fashioning of sclera flaps to cover the knots or burial of the knots into the sclera [6]. In group A of our study, the results showed improvement and or stabilization of BCVA in all cases. Stabilization of vision was related to the presence of preoperative corneal compromise (three eyes). IOLs used for scleral fixation had an optical zone range from 6.5 to 7 mm and an overall diameter range from 13 to 13.5 mm. Our postoperative visual results, astigmatism, and complications rate in this series were also similar to those reported in the literature [11]. In group B, we used a different approach on the basis of IOL optic support on a specially designed prolene mesh, rather than IOL haptics scleral fixation. This technique was found to provide adequate support for iris-tinted Morcher IOLs in two cases with traumatic aniridia, with an improvement in visual acuity (Fig. 2) and good IOL centration. A major advantage of our technique was performing the scleral mesh on a closed globe before fashioning the large corneoscleral wound to introduce the IOL. Anterior vitrectomy was then performed, and then the IOL was simply placed in position over the prefashioned scleral mesh. In our randomized trial, there were no statistical differences in the two groups in demographic criteria, etiology of aphakia, visual results, and rate of complications. We were concerned about transfixing the pars plicata 1 mm behind the limbus at eight points while passing the needle to create the double scleral mesh, increasing the risk of internal bleeding; however, this was not the case as a mild vitreous hemorrhage was found in three out of 12 cases in group A and three out of 16 cases in group B. A second concern was IOL tilt, which was found in one case in each group. In group A, IOL tilt developed in a complicated case of aphakia with corneal decompensation that was managed by a combined secondary two-point sulcus fixation of a PMMA IOL and penetrating keratoplasty (one case). In group B, the case was that of a congenital cataract previously managed by lensectomy, and presented for IOL implantation at the age of 25 years (one case) that was managed by the double sclera mesh technique. IOL tilt in this case was because of an intraoperative diagnosis of total posterior synechiae and Söemmering ring that mechanically mildly tilted the IOL despite dissection. One would presume from the design of the double sclera mesh, which results in the creation of a 4 mm square prolene centered on the pupil in addition to the peripheral support, that our method of sclera fixation would result in perfect centration of the IOL in the sulcus without any tilt. This was achieved in 15 of 16 cases and was noted clinically and on UBM in many instances (Fig. 3). However, mild IOL tilt in one case occurred because of narrow sulcus from the previous surgery and the dense posterior synechiae. From this experience, we agree with Kamal *et al*. [12] on the importance of UBM before planning IOL scleral fixation to assess the hidden area of the sulcus and avoid intraoperative surprises. A particular group in group B of our series included cases presenting with IOL decentration, haptic knot breakage, and IOL posterior subluxation in four cases managed by the same technique. Methods of repositioning dislocated or subluxated IOLs comprise extraction of the IOL through a large corneal incision with all associated hazards of prolonged surgery, ocular hypotony and vitreous prolapse, and a closed-eye technique requiring complex intraocular manipulations involving placing a loop rather than a knotted suture to anchor the dislocated haptic [13]. Alternatively, other techniques included externalization of the haptics through a clear corneal incision, suturing the knots, and then replacing the IOL into the sulcus [9]. These methods add to the time of surgery, create a corneal wound, conjunctival periotomy and a scleral flap, and include complex manipulations of the IOL at the level of the anterior vitreous, iris, and anterior chamber with potential

Figure 3



(a) Anterior segment photograph of a case showing double scleral meshwork-supported IOL in an aphakic eye without capsular support. Note minimally disturbed conjunctiva and sclera. (b) UBM showing a well-centered IOL on the scleral mesh. Arrows point to the positioning of the sutures.

complications [14]. In our technique, the double scleral mesh was designed under a closed and formed eyeball before fashioning any additional wound. This allowed accurate and easy placement of the sutures without inducing ocular hypotony. The dislocated IOL is then grabbed by a forceps and placed onto the designed mesh and the subluxated IOL was also replaced onto the mesh with minimal manipulations after releasing the IOL from the surrounding vitreous gel. Another advantage of our method is the nonviolation of the conjunctiva and the minimal postoperative scarring as the wounds placed at the limbus are radial conjunctival incisions that heal spontaneously without suturing (Fig. 3). No scleral flap was necessary and only two deep sclera pockets were designed to bury the two knots in each quadrant. The rate of complications in this group was also similar to that reported previously for ab externo sulcus fixation. There were no statistically significant differences in BCVA, astigmatic rate, and complications between the two groups. For properly positioning an IOL in the sulcus in the absence of capsular support, the IOL has to be well supported in the anteroposterior axis of the eyeball, preventing it from falling back into the vitreous by gravity or forward against the iris. Also, the IOL has to be well supported in the coronal plane of the eyeball into the sulcus, preventing it from tilt and inducing astigmatism, and iris chaffing. Two-point IOL-scleral fixation provides the anteroposterior support of the IOL by anchoring the haptics at points attachment to the sclera. Two-point sclera fixation techniques depend in IOL fixation in the coronal plane of the eyeball on the snug fit of a large C-loop IOL in the ciliary sulcus, providing stability and preventing tilt. However, in the absence of a perfect centration of the knots on the haptics, IOL tilt remains a problem. We believe that the DRSSR technique provides a new concept in IOL scleral fixation addressing these two issues simultaneously. By tethering the IOL optic in between the sutures of the sclera mesh, the IOL is held in its exact position with no forward or backward movement, and the extension of the two rectangular meshes to the sulcus provides adequate support of the IOL haptics in the sulcus, preventing possible IOL tilt. A similar technique has been described before by Gentile *et al*. [15], where double rectangular sutures were used as silicone oil retention sutures in aphakic eyes with iris loss, and also described by the study of De Grande *et al.* [16], in which previously placed silicone oil retention sutures were used to help support the implantation of a secondary artificial iris intraocular lens while it was being subjected to scleral fixation. Several recent reports have indicated that over time, the 10–0 polypropylene suture can degrade, resulting in spontaneous subluxation of the intraocular lens. The key point emphasized in these articles is that this occurs years after implantation, typically 4–5 years or later. The investigators raise concern that past reports, which have indicated good results in patients, both adults and children, who have undergone this procedure using 10-0 polypropylene suture, have not been followed long enough for this complication to occur. The issue of long-term viability of 10–0 polypropylene suture presents a particularly important concern for pediatric patients because life expectancy is measured in decades [17]. Stewart and Landers [18] recommended that 9–0 polypropylene suture be used as an alternative to 10–0 polypropylene because it has a 60% greater tensile strength, 50% greater diameter, and a 125% greater cross-sectional area. The 9–0 polypropylene is available on some of the needles that are being used currently for trans-scleral fixation (CIF-4; Ethicon Inc.), but not others (STC-6; Ethicon Inc.) [18]. Our study has strengths: it is a prospective comparative study including two matched groups with two different techniques performed by the same surgeon with a relatively long follow-up. Limitations might include a relatively small sample size in both groups (12 and 16 cases). However, this particular cohort of our study is not a common pathology to deal with. In conclusion, our technique of double rectangular scleral mesh fixation deserves attention and further evaluation in a larger cohort.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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