Scleral-fixated intraocular lens implantation with "irregular, knotless, zigzag-shaped scleral tunnel suture technique" combined with pars plana vitrectomy or anterior vitrectomy

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Abstract:

PURPOSE: This study aims to introduce a new suture method and report surgical outcomes of patients who underwent scleral-fixated intraocular lens (SF-IOL) implantation combined with either pars plana vitrectomy (PPV) or anterior vitrectomy (AV).

METHODS: Twenty-three eyes performed SF-IOL implantation combined with PPV (Group 1), and 34 eyes performed SF-IOL implantation combined with AV (Group 2) were included in the study prospectively. The SF-IOL, either polymethyl methacrylate or foldable IOL, was sutured into the sclera using PC-9 sutures in an irregular, knotless, and zigzag-shaped manner. The scleral tunnel was approximately 12-15 mm long, with at least four sharp edges. Suture tips were trimmed within the scleral tunnel. Postoperative outcomes and complications were evaluated.

RESULTS: Both groups showed no complications such as suture tip expulsion, suture reaction, IOL dislocation, or increased intraocular pressure during postoperative visits. Group 1 exhibited a statistically significant improvement in visual acuity compared to preoperative values (P = 0.036 for the 1st month, <0.001 for the 3rd month). Similarly, Group 2 demonstrated a statistically significant improvement in visual acuity compared to the preoperative period (P = 0.001 for the 1st month, <0.001 for the 3rd month).

CONCLUSION: The "irregular, knotless, and zigzag-shaped scleral tunnel suture technique" yielded favorable results in terms of IOL stability and visual acuity. This technique can be safely employed in patients undergoing SF-IOL implantation combined with PPV or AV.

Keywords:

Anterior vitrectomy, aphakia, pars plana vitrectomy, scleral-fixated intraocular lens implantation, *Z*-suture method

Introduction

An important step in cataract surgery is the implantation of an intraocular lens (IOL). In cases where there is insufficient support from the zonular or posterior capsular structure, the IOL cannot be implanted in the capsular bag or posterior chamber. In such cases, alternative methods such as anterior chamber IOL implantation, iris-fixated IOL, or scleral-fixated IOL (SF-IOL) implantation should be considered. Each of these methods has its own advantages and disadvantages, and the choice of technique may depend on the surgeon's expertise and comfort level with different surgical approaches. Capsular and zonular weakness can be caused by various factors, including trauma, previous complicated cataract surgery, degenerative processes, pseudoexfoliation, iatrogenic factors, and congenital conditions.[1-4]

In the SF-IOL implantation method, the IOL is secured onto the ciliary sulcus using transscleral sutures. This technique was initially developed in the early 1990s. To minimize the risk of suture erosion and endophthalmitis, it is advised that the sutures should not be left under the conjunctiva.

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There are additional perioperative risks associated with this procedure, including retinal detachment, suprachoroidal hemorrhage, and lens dislocation.[5,6]

In scleral fixation IOL implantation, the sutures are commonly secured under the scleral flap. However, a knotless scleral fixation technique called the *Z*-suture method has also been recommended in recent times.[7]

In this study, our objective was to assess the surgical outcomes of patients who underwent SF-IOL implantation using the "irregular, knotless, and zigzag-shaped tunnel suture technique." This technique differs from the conventional *Z*-suture method and was performed in combination with either pars plana vitrectomy (PPV) or anterior vitrectomy (AV).

Methods

Twenty-three eyes of 23 patients (Group 1; 5 females, 18 males) who underwent SF-IOL implantation surgery combined with PPV and 34 eyes of 34 patients (Group 2; 10 females, 24 males) who underwent SF-IOL implantation surgery combined with AV were included in the study prospectively. While two patients were phakic, one patient was pseudophakic, and 20 patients were aphakic in Group 1, 9 patients were phakic, 16 patients were pseudophakic, and nine patients were aphakic in Group 2.

All participants were informed, and consent forms were obtained before surgery-the study adhered to the tenets of the Declaration of Helsinki. The study was approved by the Inonu University Malatya clinical research ethics committee (Reference number: 2017/107).

The patient's best-corrected visual acuity (BCVA) and intraocular pressure values were recorded preoperatively. An anterior segment examination was performed, and a fundus examination was completed. The keratometric measurements of the patients and the IOL power calculations were calculated with Lenstar – LS 900 before the surgery.

BCVAs, anterior segment examinations, and IO*P* values of the patients were recorded on the postoperative 1st day, in the 1st week, and the 1st–3rd months. Perioperative complications such as intraocular or suprachoroidal hemorrhage and postoperative complications including lens dislocation or tilt, suture exposition, corneal edema, pupillary irregularity, cystoid macular edema, retinal detachment, and endophthalmitis were recorded.

Surgical technique

Combining scleral-fixated intraocular lens surgery with pars plana vitrectomy

After performing a standard 3-port 23-gauge transconjunctival PPV under retrobulbar or general anesthesia, a 360° scleral indentation was performed to assess the peripheral retina. This stage involved conducting PPV, pars plana lensectomy, or other vitreoretinal surgical procedures. At the end of the surgery, air tamponade was performed in all cases. In addition, laser endophotocoagulation was applied to the peripheral retina in all cases.

Subsequently, a sufficient conjunctival peritomy was performed at the 2 and 8 o'clock positions through a limbal incision, allowing visualization of the sclera. Infusion through the scleral port facilitated anterior chamber and globe stabilization. A clear corneal incision, approximately 5 mm in size, was made in the superior quadrant. Sodium hyaluronate 2.3% ocular viscoelastic device (Healon 5, sodium hyaluronate 2.3%) was injected into the anterior chamber.

Loops of 10/0 polypropylene sutures (PC-9, Alcon®) were passed through the holes in the IOL implant's haptics (AcrivaUD HAF, foldable scleral fixation IOL, VSY, Türkiye), and the sutures were secured to the haptics. The sutures were then brought out from the sclera approximately 1.5 mm from the limbus at the 2 and 8 o'clock positions (opposite 180°), passing through the back of the iris. The corneal incision was enlarged to 5.0 mm, and the IOL was inserted into the posterior chamber. Subsequently, the corneal incision was sutured with a 10/0 nylon suture, and the viscoelastic substance in the anterior chamber was removed.

Starting from the right side of the suture exit points from the sclera, each suture was stitched lamellarly and irregularly, with a length of 2–4 mm, at angles of 90° or less to each other, and with at least five bends (the technique was adapted for ease of suturing, without strict rules being followed) [Figure 1]. The normal tonus of the globe facilitated scleral lamellar suturing. The total length of the intrascleral sutures was adjusted to be at least 12-15 mm. The last intrascleral suture was slightly stretched, cut from its adjacent point on the sclera, and the suture tip was released into the scleral tunnel. The conjunctiva was closed using an 8/0 polyglactin suture, and a subconjunctival antibiotic/steroid injection was administered. The surgical technique is also shown in the schematic diagram in Figure 2.

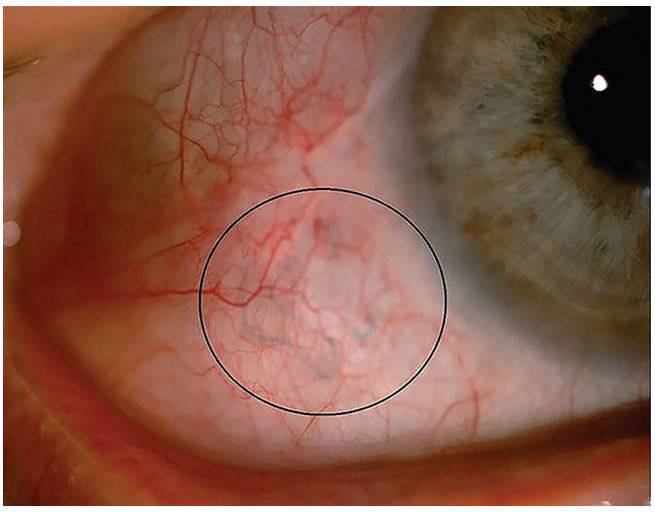

Figure 1: The postoperative appearance of irregular, knotless, andzigzag-shaped scleral tunnel suture technique in a patient (The suture is visible within the circle)

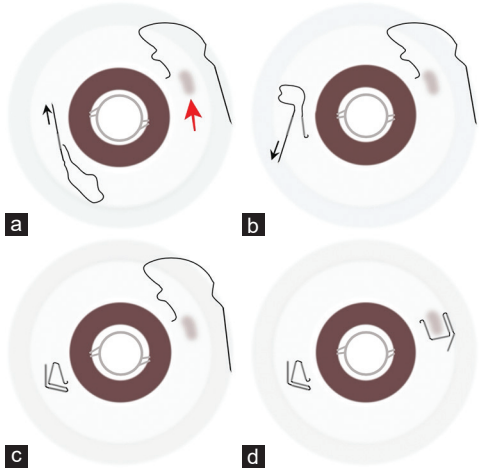

Figure 2: Schematic diagram for the steps (a-d) of irregular, knotless and zigzag-shaped scleral tunnel suture technique, black arrow: Suture needle passing direction, red arrow: Area of scleral thinning

(NOTE: Infusion was discontinued as needed during the surgical procedure).

Scleral-fixated intraocular lens surgery combined with anterior vitrectomy

In addition to the scleral fixation techniques described above, the following points were considered. An anterior chamber maintainer was attached to provide stabilization of the anterior chamber and globe tonus. A large AV was performed using a vitrectomy probe, ensuring a depth of at least 2 mm from the iris plane.

(NOTE: Laser photocoagulation was performed on the peripheral retina in all cases, 2 months after surgery).

Statistical analysis

SPSS for Windows Statistical Software (version 22.0; IBM Corp., Armonk, NY, USA) was utilized for the analysis. The results were reported as mean ± standard deviation or median (minimum–maximum). The Shapiro–Wilk test was employed to assess the normal distribution of continuous variables. The statistical significance of changes in visual acuity was determined using the Wilcoxon matched-pairs signed-rank test. $P < 0.05$ was considered statistically significant.

Results

In Group 1, the mean age was 61.83 ± 19.7 years, and in Group 2, it was 61.68 ± 23.9 years. The mean follow-up time was 8.17 ± 1.8 months in Group 1 and 10.24 ± 5.8 months in Group 2. Group 1 had 5 females and 18 males, whereas Group 2 had 10 females and 24 males. Group 1 had 19 primary and 4 secondary IOL implantations, whereas Group 2 had 27 primary and 7 secondary IOL implantations. In addition, 2 patients in Group 1 and 1 patient in Group 2 underwent combined pupilloplasty surgery. Demographic and clinical characteristics of the groups and follow-up period are shown in Table 1.

The median preoperative BCVA in Group 1 was 0.01 (0.01–0.7) as a decimal, and in Group 2, it was 0.05 (0.01–0.6). In the 1st month postoperatively, the BCVA was 0.05 (0.01–0.6) in Group 1 and 0.1 (0.01–0.7) in Group 2. In the 3rd month postoperatively, the BCVA was 0.05 (0.01–0.7) in Group 1 and 0.15 (0.01–1.00) in Group 2. There was a statistically significant increase in visual acuity compared to preoperative values in both Group 1 ($P = 0.036$ for the 1st month, <0.001 for the 3rd month) and Group 2 ($P = 0.001$ for the 1st month, <0.001 for the 3rd month) [Table 2].

There was only one perioperative complication, which was a vitreous hemorrhage in one patient from Group 1, and it resolved spontaneously in the 2nd month postoperatively. No other postoperative complications were observed, such as lens dislocation, suture exposure, corneal edema, cystoid macular edema, retinal detachment, or endophthalmitis. Two patients in Group 1 had anterior synechia, and one patient in both groups had pupillary irregularity as postoperative complications.

Discussion

Various methods can be used for IOL implantation with scleral fixation to the posterior chamber. One widely employed technique involves closing the flap and positioning the suture knot underneath it after creating a scleral flap. This approach effectively prevents complications associated with suture exposure, ensuring a successful procedure.[8] Compared to the transscleral sutured method, SF-IOL implantation using the *Z*-suture technique offers several advantages. One of the key benefits is the ease and speed with which the procedure can be performed.[9] *Z*-suture can be easily performed regardless of implant type, haptic shape, fixation type, and suture design.[10] Our technique is a modified version of the *Z*-suture method, designed to simplify the suturing process and make it easier to apply.

Previous studies have demonstrated that performing five zigzag passes with the *Z*-suture technique provides sufficient resistance against traction from the implant in *ex vivo* series. With each additional pass of the *Z*-suture, the resistance to traction force increases, ultimately exceeding the tensile force after five passes.[7,11] In our study, we achieved IOL stabilization with irregular, knotless, and zigzag-shaped suturing passed five times intrascleral, where each passage was approximately 12-15 mm long. We did not observe any IOL decentralization in the long-term follow-up. The main advantage of this method is the ease of suturing, which is slightly different from *Z* suturing. While intrascleral sutures were adjusted to parallel in the *Z*-suture technique, suturing was performed irregularly in all directions and formed at least five bends according to the ease of suturing completely in our technique. The goal is to make suturing easier for the surgeon during surgery. During long-term follow-up, we did not find any complications such as IOL decentralization in the surgeries that we combined with both AV and PPV.

In a study conducted by Choi *et al*., it was found that there was no significant difference in visual outcomes, refractive shifts, and complication rates between patients who underwent AV and

Table 1: Demographic and clinical characteristics of the groups

	Group 1 (*n*=23)	Group 2 (*n*=34)	*P*
Age (year±SD)	61.83±19.7	61.68±23.9	0.591
Gender (*n*)			
Female	5	10	0.558
Male	18	24	
Preoperative BCVA (decimal), median (minimum–maximum)	0.01 (0.01–0.7)	0.05 (0.01–0.6)	0.002
Postoperative BCVA (decimal) in the 3rd month, median (minimum–maximum)	0.05 (0.01–0.7)	0.15 (0.01–1.00)	0.053
Postoperative refraction (SE), median (minimum–maximum)	−0.50 (−4.0–+2)	0 (−3.50–+2.50)	0.664
Follow-up time (month±SD)	8.17±1.8	10.24±5.8	0.317

BCVA: Best-corrected visual acuity, SD: Standard deviation, SE: Spherical equivalent

Table 2: Pre- and postoperative best-corrected visual acuity of groups

	Group 1	Group 2
Preoperative BCVA (decimal), median (minimum–maximum)	0.01 (0.01–0.7)	0.05 (0.01–0.6)
Postoperative BCVA (decimal) in the 1st month, median (minimum–maximum)	0.05 (0.01–0.6)	0.1 (0.01–0.7)
Postoperative BCVA (decimal) in the 3rd month, median (minimum–maximum)	0.05 (0.01–0.7)	0.15 (0.01–1.00)
P	0.036 for the pre-1st month <0.001 for the pre-3rd month	0.001 for the pre-1st month <0.001 for the pre-3rd month

BCVA: Best-corrected visual acuity

those who underwent PPV in combination with scleral fixation IOL implantation.[12] The scleral fixation method utilized fixation sutures placed in a linear scleral incision (groove). Similarly, we performed SF-IOL implantation surgery combined with both AV and PPV. Although our method had slight differences, we observed generally low rates of perioperative and postoperative complications in our study.

SF-IOL implantation surgery, whether with or without a scleral flap, can be associated with certain complications. When combined with PPV, there may be an increased risk of vitreoretinal complications. Major complications that can occur include increased intraocular pressure, vitreous hemorrhage, retinal detachment, and lens dislocation. It is important to be aware of these potential complications when performing SF-IOL implantation surgeries and to take appropriate measures to minimize their occurrence.[13-15] However, in our study, we did not observe any vitreoretinal complications in either group, except for one patient who experienced a perioperative vitreous hemorrhage. We believe that the low incidence of vitreoretinal complications may be attributed to the perioperative peripheral laser photocoagulation performed in the PPV group and the postoperative laser photocoagulation in the AV group. The only observed postoperative complications were anterior synechiae in two patients in Group 1 and pupillary irregularity in one patient in both groups. We hypothesize that the anterior synechiae may have been caused by the air tamponade used in the PPV group. These anterior synechiae were successfully separated using a spatula during suture removal.

One of the key long-term complications in the transscleral IOL suturing method is suture exposure and the subsequent risk of late endophthalmitis.[16,17] To prevent this complication, it is commonly advised to position the suture knot beneath a scleral flap. However, a study by Solomon *et al*. revealed that even with the use of a scleral flap, 73% of patients experienced suture erosion during long-term follow-up. Hence, while this method may delay suture erosion, it does not entirely prevent it.[18] In our method, suture erosion was not observed in any cases.

The modified *Z* suture technique does not affect the other complications of scleral fixation surgery. Increased intraocular pressure has been reported as the most common postoperative complication in scleral fixation surgery.[19] In our surgeries, no intraocular pressure increase was observed in any patient during the postoperative period. Furthermore, complications such as hyphema and cystoid macular edema, which are commonly associated with scleral fixation surgery, have not been observed in our cases.

Conclusion

The irregular, knotless, zigzag-shaped tunnel suture Technique, we performed eliminates the need for a scleral flap, avoiding associated complications. It offers advantages over the scleral flap technique and conventional *Z* suturing in terms of ease of application and suturing for the surgeon. The technique can be combined with AV and PPV. However, further prospective studies with larger sample sizes are required to assess long-term results.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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