IJBCS
ISSN: 2147-1428

Original Article

International Journal of Basic and Clinical Studies (IJBCS)
2018; 7(2): 7-17 Bulut E at all.

Comparison of Transscleral Fixation of PMMA and Acrylic Foldable Intraocular Lenses*

Erkan Bulut[1] Semih Cilsim[2] Fevzi Akkan[2] Kadir Eltutar[3]

[1] M.D. Beylikduzu Government Hospital, Istanbul, Turkey
[2] M.D. World Eye Hospital, Istanbul, Turkey
[3] M.D. Assoc. Prof. Haseki Educational and Research Hospital, Istanbul, Turkey

Abstract

Purpose: To evaluate the clinical outcomes of transscleral fixation of PMMA and acrylic foldable intraocular lens implantation
Materials and Methods: This study included 49 eyes of 49 patient Acyrlic foldable IOL was implanted in 23 eyes, PMMA IOL in 26 eyes by sutured scleral fixation technique with ab interno double scleral flaps. The mean age was 63.4 years (range, 42-75 years). The mean follow up was 9.4 months (range 6-17 months).
Results: The mean preoperative best corrected visual acuity(BCVA) according to Snellen chart were 0.33±019 and 0.29±0.25 for foldable and PMMA groups respectively. The mean preoperative cylindrical equivalents was 2.38 ±1.3 D in foldable group and 2.37±1.3 D in PMMA group. The mean postoperative BCVA was same or improved in all patients. The mean postoperative cylindrical equivalents was 1.47±0.7 D in foldable group and 2.67±1.5 D in PMMA group. The change for cylindrical equivalents was statistically significant in foldable group ($p<0.05$). The most common postoperative complications were transient corneal edema (12%), transient ocular hypertony(12%) and anterior chamber reaction (8%). Postoperative complications were almost the same in both groups.
Conclusion: Secondary IOL implantation with scleral fixation is safe and effective procedure. Transscleral fixation using foldable IOL provides safe surgery for surgeon, less surgically induced astigmatism and rapid visual rehabilitation compared to PMMA IOL .

Key words: Scleral fixation, PMMA IOL, Acrylic foldable IOL, Postoperative complication

* **This article was produced from the thesis of ophthalmology specialist in medicine.**

Corresponding Author: Erkan Bulut, Beylikduzu Government Hospital, Istanbul, Turkey, Pinartepe Mahallesi, 34500 Buyukçekmece-Istanbul Turkey, E-mail: erkanbulut@outlook.com, Phone: +905057725402

IJBCS
ISSN: 2147-1428

Original Article

International Journal of Basic and Clinical Studies (IJBCS)
2018; 7(2): 7-17 Bulut E at all.

Introduction

Distortion in capsulozonular integrity is a challenging problem during and after a cataract surgery due to both implantation region of the intraocular lens (IOL) whether to the posterior or anterior chamber and also a decision to select the type of the IOL.

Leaving the patient aphakic with spectacle correction has become less popular due to poor visual outcomes from image distortion and prismatic effects. Aphakic contact lens correction is not always tolerated by patients. There are surgical options exist for optical rehabilitation in the presence of inadequate capsulozonular support. These are implanting IOL to anterior chamber (AC) with angle or iris supported and suturing a posterior chamber (PC) to the iris and fixating a PC IOL transsclerally.

The ideal position for a placement of secondary IOL is into the capsular bag because of its anatomic position. So most of the surgeon prefer transsclerally fixated PC IOL implantation in the absence or inadequate capsulozonular support. Transsclerally fixated IOL has same advantages in certain eyes: certain anatomic location, less endothelial decompensation, less chronic inflammation and less peripheral anterior synechia, decreased risk of glaucoma, narrow anterior chamber (AC) and cystoid macular edema (CME) (1,2). The sulcus fixation is the best method for IOL implantation among capsulozonular defected eyes with the proves of histologic studies of the anterior segment (3). IOL haptics are stabilized with the border of poorly vascularized area near the scleral surface by the scleral fixation (4). There are many different scleral fixation techniques suggested from the beginning of this surgery. These are including traditional scleral sutured and sutureless techniques. Also, different type of scleral fixation IOLs were produced by the manufacturers in time. Today surgeons are preferring not only rigid polymethylmethacrylate (PMMA) IOL but also foldable IOL for transscleral fixation cases. Foldable IOL implantation is need the small corneal incision which provides low astigmatism, less intraoperative complications and early recovery of visual acuity.

The purpose of this study is to evaluate the clinical outcomes of transscleral fixation of PMMA and acrylic foldable intraocular lens implantation.

Patients and Methods

We studied on 49 patients (49 eyes), examined in the Department of Ophthalmology, Istanbul Educational Hospital (İstanbul, Turkey). The patients were followed up mean 9.4 months (range 6-17 months). All of the patients had no zonulocapsular support. Thirty six of them phacoemulsification complications, 6 eyes had lens luxation, 3 eyes had complicated anterior chamber IOL, 2 eyes had IOL opacification and 2 eyes with folded IOL due to severe capsular contraction syndrome. The patients' demographic characteristics are summarized in Table 1.

IJBCS
ISSN: 2147-1428

Original Article

International Journal of Basic and Clinical Studies (IJBCS)
2018; 7(2): 7-17 Bulut E at all.

Table 1: Demographic characteristic

	Group 1	Group2
Number of eyes	26	23
Avarege age(years)	64.8	61.9
Age interval	42-75	18-75
Male /Female	16/10	13 / 10

These patients randomly divided into two groups. While the PMMA IOL implanted patients was considered as Group 1,the foldable acrylic IOL was as Group 2 (Figure 1and 2). Both IOLs had a hole with in the haptics for scleral fixation by a suture .

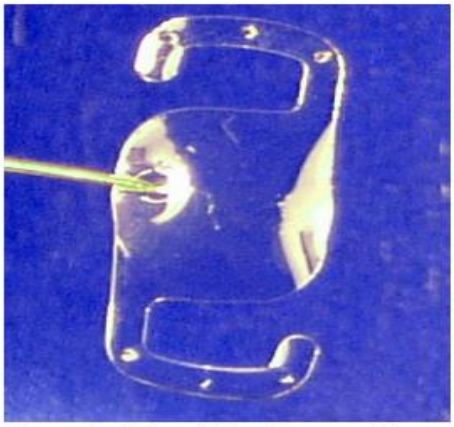

Figure1: Scleral fixation acrylic foldable IOL

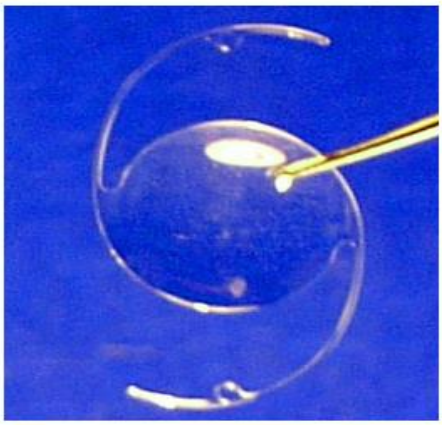

Figure 2: Scleral fixation PMMA IOL

Both group had identical pathologies. Preoperatively, all patients had a complete ophthalmic examination, including best corrected visual acuity (BCVA) according to snellen chart, slit-lamp evaluation of the anterior segment including angle structure by the goldmann three mirror lens, Goldmann applanation tonometry, fundus assessment after pharmacologic pupil dilation, and B-mode ultrasound. Biometry was done using contact A-scan ultrasound axial length measurements and by keratometry with kerato refractometer. The IOL power was calculated using the SRK II formula. All procedures were performed by the same surgeon by using ab interno technique. The procedures were performed under retrobulbar or

IJBCS
ISSN: 2147-1428

Original Article

International Journal of Basic and Clinical Studies (IJBCS)
2018; 7(2): 7-17 Bulut E at all.

subtenon anesthesia. Local anesthesia induced by lidocaine 2% solution. Both group was compared for preoperative and postoperative BCVA with intraoperative and postoperative complications as well as refractive changes.

Surgical Technique

. Preoperative preparation of the patients was by instillation of cyclopentolate 1% and phenylephrine hydrochloride 2,5% three times per ten minutes until 45 minutes to the surgery. All patients received the same systemic sedatives (oral diazepam 10 mg) 45 minutes before starting surgery.

1. Surgery started with corneal tunnel incision. Anterior vitrectomy was performed for the removal of capsular remnants in pupillary area and vitreous strands in both anterior chamber and incision site.
2. Anterior chamber was filled with ophthalmic viscosurgical device (OVD). The OVD protects the endothelium, pushes vitreous back and moves the iris forward, which expands the posterior chamber and avoids the need to use a needle pierce to the iris. It also enables the rigidity of the eyeball for the facilitation of insertion of the suture's needle.
3. Two conjunctival peritomies were created at 2 and 8 o'clock or at 4 and 10 o'clock.
4. Then sclera was cauterized for hemorrhage.
5. Two triangular shape scleral flaps were made posterior to limbus which was characterized as two thirds the thickness of the sclera and 3mm size equilateral triangle.
6. Corneal incision was extended to 7mm for PMMA IOL and 3.5mm for foldable IOL implantation.
7. IOL haptics were tied with 10-0 polypropylene suture (PC-9, Alcon Surgical, Fort Worth) loops.
8. The needle was inserted through the corneal incision and penetrates the ciliary sulcus from the inside to out. The needle exit point was 1 mm far from the limbus beneath the formerly prepared scleral flaps (Figure 3).
9. PMMA IOL was implanted through the 7mm corneal incision, foldable IOL was folded and implanted by using folding forceps through the 3.5 mm corneal incision to the posterior chamber (Figure 4).
10. The temporal and nasal sutures are tightened and adjusted to achieve optimum centration of the IOL before sutures tied permanently.
11. Both scleral flaps and conjunctiva were closed with 8/0 absorbable suture, then the cornea with 10/0 nylon suture.

IJBCS
ISSN: 2147-1428

Original Article

International Journal of Basic and Clinical Studies (IJBCS)
2018; 7(2): 7-17 Bulut E at all.

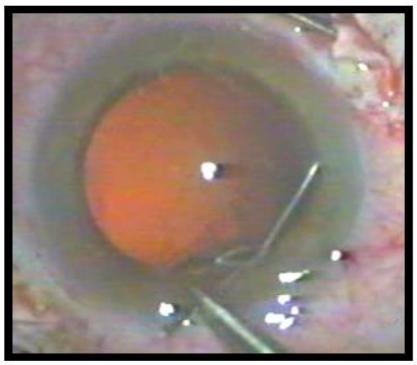

Figure 3: The needle was inserted through the corneal incision and penetrated the ciliary sulcus from the inside to out.

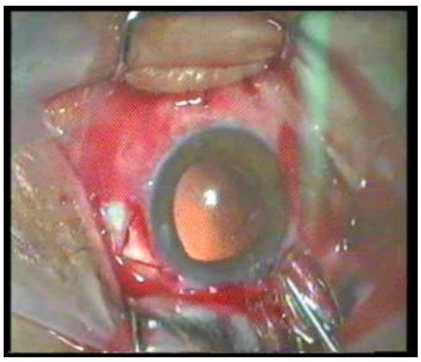

Figure 4: Acrylic foldable IOL implantation through the small corneal incision

Follow up and statistical analysis

Postoperatively, patients were examined at day 1, 1 week, 2 weeks, 1 month, and every 3 months . Mean follow up was 9.4 months (range, 6-17 months)

SPSS program was used for statistical analysis. The numeric variables were compared by the "Student's t test "

Results

We studied 49 eyes of 49 patients. The mean age of the patients was 63.4 years (range, 18-75 years). Male to female ratio was 1.45 (29/20).) (table1). The mean age of group 1 was 64.8 years (range, 42-75 years) and of group 2 was 61.9 years (range, 18-75 years). Foldable IOL was implanted in 23 eyes, PMMA IOL in 26 eyes by sutured scleral fixation technique with ab interno double scleral flaps. The mean follow up was 9.4 months (range 6-17 months). The mean IOL's diopter(D) was 21.5 D (range, 16 to 21.5 D) in group 1 while 20.1 D (range, 15.5 to 24 D) in group 2.

Preoperative mean BCVA according to Snellen chart was 0.29±0.25 in group 1 while 0.33±019 in group 2. Postoperative at sixth month BCVA was 0.56±0.24 in group 1 while 0.61±0.16 in group 2 (Figure 5) . Visual acuity increase in both group was statistically significant ($p<0.05$). In the postoperative sixth month examination, BCVA was achieved 0.5 or better in 19 eyes (73%) in group 1 and 18 eyes (78.3%) in group 2. When we compared the final BCVA between the groups, the difference was not statistically significant ($p>0.05$).

The mean spherical equivalent change between the preoperative and postoperative sixth months in both groups was similar (Figure 6). Myopic shift in both group was seen according to the mean spherical equivalent results at sixth month visit (-1,34 D versus -1,27D)

IJBCS
ISSN: 2147-1428

Original Article

International Journal of Basic and Clinical Studies (IJBCS)
2018; 7(2): 7-17 Bulut E at all.

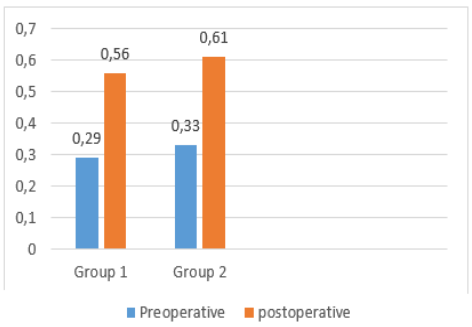

Figure 5: Average mean visual acuity in both groups preoperative and postoperative at sixth month

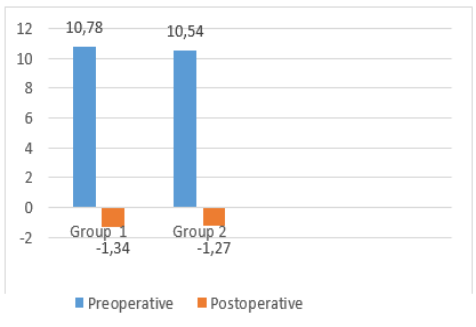

Figure 6 : Average mean spherical equivalent in both groups preoperative and postoperative at sixth months

In group 1, mean astigmatic change between preoperatvie and sixth month postoperative was 2.37 D (range, 1.0 to 6.0 D) to 2.67 D (range, 0.75 to 5.50 D) with a statistically insignificant p value of >0,05.

On the other hand, the change in group 2 was 2.38 D (range, 0.75 to 5.50 D) to 1.47 D (range, 0.75 to 3.0 D) with statistically significant ($p<0.05$) (Figure 7).

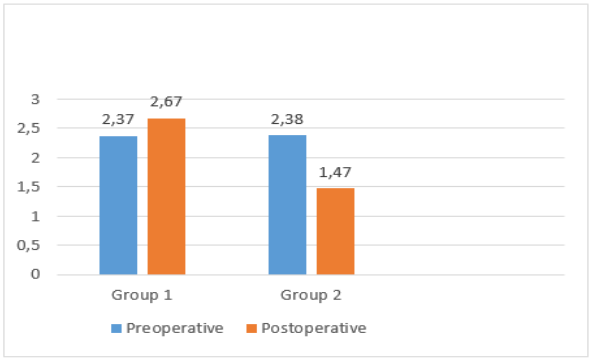

Figure 7 : Average mean astigmatism in both groups preoperative and postoperative at sixth months

Any intraoperative complication was not seen in both group. Postoperative complications were as follows (Table 2): transient corneal edema 4 patients in group 1 versus 2 patients in group 2 that was resolved with medical therapy in 2 weeks; hyphema in 1 patient in group 1 versus 1 patient in group 2 that was resolved conservative management; mild vitreous hemorrhage in group 1 and was resolved

IJBCS
ISSN: 2147-1428

Original Article

International Journal of Basic and Clinical Studies (IJBCS)
2018; 7(2): 7-17 Bulut E at all.

spontaneously in 1 month; transient ocular hypertony in 4 patients in group 1 versus 2 patients in group 2; transient ocular hypotony was seen in 2 patients in group 1 versus 1 patient in group 2; anterior chamber reaction in 3 patients in group 1 versus 1 patient in group 2 and treated with medical therapy ; cystoid macular edema in 2 patients in group 1 versus 1 patient in group and treated by sub-tenon's triamcinolone injection ; IOL tilt in 1 patient in group 1 versus 1 patient in group 2; IOL decentralization in 2 patient in group 1 versus 1 patient in group 2 that wasn't effect the vision in miotic pupil; polyprolene suture erosion was seen in 1 patient in each group that was treated by surgically with scleral patch.

There were no cases of choroidal and retinal detachment, iris capture and endophthalmitis.

Table 2: Postoperative complications

Complication	Group 1(n=26)	Group 2(n=23)	Total (n=49)
Transient corneal edema	4 (16%)	2 (9%)	6 (12%)
Hyphema	1 (4 %)	1 (4.5%)	2 (4 %)
Vitreous hemorrhage	1 (4 %)	-	1 (2 %)
Transient Ocular hypertony	4 (16%)	2 (9%)	6 (12%)
Transient Ocular hypotony	2 (8%)	1 (4.5%)	3 (6 %)
Anterior chamber reaction	3 (12%)	1 (4.5%)	4 (8%)
Cystoid macular edema	2 (8%)	1 (4.5%)	3 (6 %)
IOL tilt	1 (4 %)	1 (4.5%)	2 (4 %)
IOL decentralization	2 (8%)	1 (4.5%)	3 (6 %)
Suture erosion	1 (4 %)	1 (4.5%)	2 (4 %)

Discussion

Secondary IOL implantation is one of the surgical options to treat aphakia. IOL implantation in the bag or sulcus is ideal position if there is an intact capsular bag or adequate capsular support. In the absence of the capsulozonular support, IOL implantation is a challenging situation for the surgeons. IOL can be implanted into anterior chamber or posterior chamber. Today most of the surgeon do not prefer the IOL implantation to anterior chamber due to serious complications. Complications such as corneal edema, pupillary block glaucoma, cystoid macular edema (CME) and uveitis-glaucoma -hyphema (UGH syndrome) especially in patients with shallow anterior chambers, corneal guttata or diabetes (5,6). Posterior chamber IOL implantation with scleral fixation technique is another option for treating the aphakia in the absence capsulozonular support. There are many different techniques and modifications available for scleral fixation

IJBCS
ISSN: 2147-1428

Original Article

International Journal of Basic and Clinical Studies (IJBCS)
2018; 7(2): 7-17 Bulut E at all.

IOL including the traditional scleral sutured technique and the suturless technique (7)

Not only surgical technique but also IOL technologies are developing for scleral fixation. Rigid IOL most widely used for scleral fixation over the past 20 years. Although the rigid PMMA is the most widely used material for scleral fixation over the past 20 years, several disadvantages are the larger corneal-scleral incisions, anterior chamber collapsing due to the usage of higher calibrated surgical tools, higher risk of choroidal hemorrhage, and induced higher postoperative astigmatism. For these reasons foldable scleral fixated IOL that needs smaller corneal incision widely acceptance by the surgeons for the scleral fixation procedure in recent years. The small corneal incision has important advantages; low postoperative astigmatism, less intraoperative complication because of relatively closed system that prevents intraoperative hypotony and rapid visual rehabilitation.

In our clinic, 49 eyes of 49 patients were operated two types of IOL implantation with suturing transsclerally by ab interno technique using double scleral flaps to treat the aphakia. These IOLs were classified as a rigid PMMA and acrylic foldable according to the structural properties.

In the literature, postoperative BCVA increase considered as success for secondary IOL implantation. In our study we compared pre- and postoperative mean BCVA in both group. There was a statistically significant improvement in the mean postoperative BCVA. When we compared the mean postoperative BCVA between the groups, there wasn't any statistical significance. This result is very similar to that reported studies of Yosuke et al. (8) and Monteiro et al. (9).

For the last decades most of the surgeon prefers the small corneal incision for transscleral IOL fixation procedure because of less postoperative astigmatism and low intraoperative complication rates. Surgical induced astigmatism (SIA) was related to the length,
type, location of the incision (10). However, the most significant factor is the incision width (11). In our study, we compared the mean astigmatism between the preoperative and postoperative in both group. The mean astigmatism decreased in foldable IOL group and was in same range in PMMA IOL group. Pre- and postoperative mean astigmatic change at sixth month was statistically significant in foldable IOL group due to the small corneal incision for scleral fixation IOL implantation. Kaynak et al. (12), Monteiro et al. (9) and Taşkapili et al. (13)reported that they implanted foldable IOL through the small corneal incision for scleral fixation procedure. Our result was similar to the result of their studies

Retinal detachment wasn't observed in our study. Lee et all reported, retinal detachment was seen 4,9 % of the cases after transscleral IOL implantation (14). Also, Baykara et al. (15) reported 2% of the cases. On the other hand, Taşkapili et al. (13) reported there was no retinal detachment in their series. Before the IOL is sutured, sufficient and extensive anterior vitrectomy must be performed in all eyes, and residual lens capsule and anterior vitreous in the pupillary area must be removed. This will reduce the occurrence of retinal complications. Paolo et al. (16) advised that suturing the IOL after an effective anterior vitrectomy to prevent postoperative retinal complications.

IJBCS
ISSN: 2147-1428

Original Article

International Journal of Basic and Clinical Studies (IJBCS)
2018; 7(2): 7-17 Bulut E at all.

In our study, CME was seen in 3 (6%) cases. These cases were responded to treatment of subtenon triamcinolone injection. The contact between the uveal tissue and the haptics of the IOL plays an important role to developing CME . Kaynak et al. (12) reported that CME was developed in 2 cases and resolved by the medical treatment. Taşkapili et al. (13) reported that CME that resistant to treatment was seen 2 case in their studies.

In our study, transient corneal edema (6 cases), transient ocular hypertony (6 cases) and anterior chamber reaction (4 cases) were seen as the most common postoperative complications. All these complications were resolved completely with medical treatment.

Paolo et al. (16) suggested that hyphema and vitreous hemorrhage was seen in higher rates in rate for scleral fixation procedure. Blackmann et al. (17) reported that intraocular hemorrhage was the main complication of transscleral fixation surgery, and it was resolved spontaneously without any sequelae. Vitreous hemorrhage and hyphema were seen in 6 (2%) cases in a report by Baykara et al. (15). In our studies vitreous hemorrhage and hyphema were seen in 3(6%) cases. These complications resolved spontaneously without permanent sequelae. Our complications rates were higher than the other studies due to using ab interno technique. Because in scleral fixation with in ab interno technique surgeon's view is obscured when making needle passes transsclerally which increase the risk of collateral damage to the surrounding tissue that may cause hemorrhage. Today most of the ophthalmic surgeons prefer the ab externo technique instead of ab interno because of easy surgical manipulation and low complication rates (7).

Kaynak et al. (12), Monteiro et al. (9) and Andrew et al. (18) reported that there was no IOL tilt and decentralization. Baykara et al. (15) reported that IOL tilt was seen in 5 (1.7%) cases and 3 of them was needed surgical IOL repositioning. İn our studies IOL tilt was seen in 2 (4 %) cases and IOL was repositioned in 1 case due to visual disturbance. Causes of IOL tilt are; sutures not being 180 degrees apart, tightened unequally in both side and not checking the IOL position at the end of the surgery. In addition, if the needle exit point from the sclera is not equal at one or both sides can cause IOL tilt like our cases.

In the literature (12,15,19), IOL decentralization was seen at different rates as 0% to %16.7. In our series, IOL tilt was seen in 2 (6%) cases and there was no secondary surgery needed like Baykara et al. (15) studies because of the IOL edge wasn't seen in miotic pupil and absence of visual disturbance.

The most serious complications of the sutured scleral fixation is suture erosion that can cause endophthalmitis (20,21). One method of managing suture erosion involves burying the knots under triangular scleral flaps (22) in scleral grooves (23), or rotating the knots into the eye (25). Lubnewski et al. (2) reported that scleroconjunctival suture erosion was seen in half of the cases as the most common complication. Kaynak et al. (12) reported that suture erosion was seen 10 % cases although sutures were covered with scleral flap. Baykara et al. (15) reported that sutures were covered by scleral flap or patch, by this way any suture erosion wasn't seen in any cases. In our study, although the using scleral flap, the suture erosion was

IJBCS
ISSN: 2147-1428

Original Article

International Journal of Basic and Clinical Studies (IJBCS)
2018; 7(2): 7-17 Bulut E at all.

seen 2 (4%) cases and the patients were treated with scleral patch. In recent years, suturless transscleral fixation method is getting more popular due to both decreasing in surgery duration and complication rates related to the sutures and IOL. This technique firstly was described by Scharioth and Pavlidis in 2007 (26,27). After that Agarwall et al. described another sturless scleral fixation technique that using a quick-acting surgical fibrin sealant derived from human blood plasma (fibrin glue) to glued the IOL haptics into the sclera (28). Last few years new suturless scleral fixating technique that first described by Yamane (28) in 2016 is getting great popularity. Yamane (28) described new surgical approach to suturless scleral IOL fixation technique by the passes the need for significant conjunctival and scleral dissection, scleral flaps to fixating the IOL.

In conclusion, secondary IOL implantation with scleral fixation is safe and effective procedure. In transscleral fixation using foldable IOL provides safe surgery for surgeon, less surgically induced astigmatism and rapid visual rehabilitation compared to PMMA IOL .

References

1.Transsclerally sutured intraocular lenses in penetrating keratoplasty. Am J Ophthalmol. 1992 :15;113(6):619-25

2. Lubniewski AJ, Holland EJ, Van Meter WS, Gussler D, Parelman J, Smith ME. Histologic study of eyes with transsclerally sutured posterior chamber intraocular lenses. Am J Ophthalmol. 1990;15:110(3):237-43.

3.Smiddy WE, Sawusch MR, O'Brien TP, Scott DR, Huang SS. Implantation of scleral-fixated posterior chamber intraocular lenses. J Cataract Refract Surg. 1990 ;16(6):691-6

4. Oshika T, Tsuboi S, Yaguchi S, Yoshitomi F, Nagamoto T, Nagahara K, Emi K. Comparative study of intraocular lens implantation through 3.2- and 5.5-mm incisions. Ophthalmology. 1994;101(7):1183-9.

5. Por YM, Lavin MJ. Techniques of intraocular lens suspension in the absence of capsular/zonular support.Surv Ophthalmol. 2005;50(5):429-62.

6. Hirashima DE, Soriano ES, Meirelles RL, Alberti GN, Nosé W. Outcomes of iris-claw anterior chamber versus iris-fixated foldable intraocular lens in subluxated lens secondary to Marfan syndrome. Ophthalmology. 2010 ;117(8):1479-85.

7. Malav Joshi, Mark K. Walsh. Scleral-Fixated Intraocular Lenses: An Update on the Current Surgical Approaches Curr Surg Rep 2015; 3:11.

8.Oshima Y, Yu HG, Chung H, Wee WR, Le JH. Transscleral fixating of acyrilic intraocular lenses in the absence of capsular support through the 3,5 mm self-sealing incision. J cataract and refract Surg, 1998;24:1223-9

9. Monteiro M, Marinho A,Salgado- Borges J, Ribeiro L, Castro-Correia. Evaluation of a new scleral fixation foldable IOL in the absence of capsular support. J Fr. Opthalmology 2007;30 (8):791-797

10. Ermis SS, Inan UU, Ozturk F. Surgically induced astigmatism after superotemporal and superonasal clear corneal incisions in phacoemulsification. J Cataract Refract Surg. 2004;30(6):1316–1319

11. Kohnen T, Dick B, Jacobi KW. Comparison of the induced astigmatism after temporal clear corneal tunnel incisions

of different sizes. J Cataract Refract Surg. 1995;21(4):417–424.
12. Kaynak S, Ozbek Z, Pasa E, Oner FH, Cingil G: Transscleral fixation of foldable intraocular lenses. J Cataract Refract Surg. 2004 Apr; 30(4): 854-857
13. Transscleral fixation of a single-piece hydrophilic foldable acrylic intraocular lens. Taskapili M, M Gulkilik G, Engin G, Kocabora MS, Yilmazli C, Ozsutcu M, Kucuksahin H
Can J Ophthalmol 2007; 42:256–61
14.Lee JG, Lee JH, Chung H: Factors contributing to retinal detachment after transscleral fixation of posterior chamber intraocular lenses. J Cataract Refract Surg. 1998 May; 24(5): 697-702.
15. Baykara M, Ertürk H, Avcı R, Karataş A, Akova B: Skleral Fiksasyon Yöntemi ile Göz İçi Lens İmplantasyonu .Türk Oftalmoloji Gazatesi 2004; 34: 55-60
16. Lanzetta P, Bandello FM, Virgili G, Crovato S, Menchini U: Is scleral fixation a safe procedure for intraocular lens implantation? Doc Ophthalmol. 1999; 97(3-4): 317-24.
17. Bleckmann H, Kaczmarek U: Functional results of posterior chamber lens implantation with scleral fixation. J Cataract Refract Surg. 1994; 20(3): 321-6.
18. Wallmann AC, Monson BK, Adelberg DA Transscleral fixation of a foldable posterior chamber intraocular lens. J Cataract Refract Surg. 2015 Sep;41(9):1804-9.
19. Durak A, Oner HF, Kocak N, Kaynak S.: Tilt and decentration after primary and secondary transsclerally sutured posterior chamber intraocular lens implantation. J Cataract Refract Surg. 2001; 27(2): 227-32
20. Epstein E. Suture problems. J Cataract Refract Surg. 1989;15(1):116.
21. Schechter RJ. Suture-wick endophthalmitis with sutured posterior chamber intraocular lenses. J Cataract Refract Surg. 1990;16(6):755–6.
22. Ramocki JM, et al. Foldable posterior chamber intraocular lens implantation in the absence of capsular and zonular support. Am J Ophthalmol. 1999;127(2):213–6.
23. Bergren RL. Four-point fixation technique for sutured posterior chamber intraocular lenses. Arch Ophthalmol. 1994;112(11): 1485–7.
25. Lewis JS. Sulcus fixation without flaps. Ophthalmology. 1993;100(9):1346–50.
26. Gabor SG, Pavlidis MM. Sutureless intrascleral posterior chamber intraocular lens fixation. J Cataract Refract Surg.2007;33(11):1851–4. *This was the first paper describing the sutureless intrascleral technique along with a link to their surgical video.*
27. Scharioth GB, et al. Intermediate results of sutureless intrascleral posterior chamber intraocular lens fixation. J Cataract Refract Surg. 2010;36(2):254–9. *This was the first time a major review of the results and complications of the suture-less intrascleral IOL fixation technique was reported by Scharioth and colleagues, who were the pioneers of this technique. They reporte a very low rate of complications compared to scleral sutured IOL techniques. They only had 2 out of 63 cases of IOL decentration.*
28. Yamane S, "Transconjunctival Intrascleral IOL Fixation With Double-Needle Technique," film presented at the ASCRS Symposium on Cataract, IOL and Refractive Surgery, New Orleans, Louisiana, USA, May 2016.