Original Article

Comparison of two different intraocular lenses used in the modified Yamane technique

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Purpose: To compare AcrySof MA60AC (Alcon Laboratories, Fort Worth, TX, USA) and Sensar AR40e (Johnson and Johnson, Santa Ana, CA, USA) used in Yamane sutureless scleral fixation technique in terms of visual acuity, refractive stability, and complications. **Methods:** A retrospective, cross-sectional study was conducted in Istanbul Başakşehir Çam and Sakura City Hospital. Patients were divided into two groups: The first group consisted of patients with MA60AC lenses, while the second group consisted of patients with AR40e. Aphakic patients who underwent secondary intraocular lens (IOL) implantation and had postoperative minimum 3-month follow-up records were included. Visual acuity, refractive outcomes, perioperative and postoperative complications were recorded. **Results:** Forty-nine patients were included in the study. Twenty-two patients were in the first group and 27 patients were in the second group. Age, gender, and follow-up time were similar between groups (P = 0.546, 0.213, and 0.347, respectively). The median lenticular astigmatism value was 0.86 (0.08–2.11) D in group 1 and 0.99 (0.31–2.96) D in group 2 (P = 0.898). There was no significant difference between groups in terms of visual acuity, spherical, cylindrical, and spherical equivalent values (P = 0.752, 0.375, 0.073, and 0.949, respectively). In group 1, a haptic tip fracture and optic–haptic separation were observed perioperatively. Optic–haptic junction separation was observed in one patient in group 1 on postoperative day 1. In group 1, epiretinal membrane development was significantly higher (P = 0.019). **Conclusions:** Both AcrySof MA60AC and Sensar AR40e IOLs via the modified Yamane technique yielded favorable and predictable outcomes. Although statistically insignificant, haptic problems were more common in the first group.

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Cataract surgery is a common procedure globally, especially among the elderly population, with intraocular lens (IOL) implantation being a standard approach.[1] Advances in surgical techniques have enabled the use of small incisions, such as in phacoemulsification and IOL implantation (Phaco-IOL), which is considered the gold standard method.[2] In cases where capsular support is lacking, various methods have been developed for IOL implantation, including sutureless scleral fixation IOL (SSF-IOL) techniques.[3-7]

One such technique gaining popularity is the modified Yamane technique (SSF-IOL-MY), which is a variation of the original Yamane technique.[8] This technique involves scleral fixation of IOL using ab externo sclerotomies, simultaneous externalization of the lens haptics, and thermocauterization to secure the haptics intrasclerally. The SSF-IOL-MY technique has shown promise in terms of postoperative results and ease of application.[9]

Previous studies have demonstrated the impact of cataract surgery and IOL implantation on anterior segment parameters, such as increased anterior chamber depth (ACD) and widening of the iridocorneal angle, refractive outcomes, and along with a reduction in intraocular pressure (IOP).[10-12] However, limited information exists regarding the comparison of different IOL types used in the SSF-IOL-MY technique.

Therefore, this study aims to investigate the effects of two different IOLs, AcrySof MA60AC (Alcon Laboratories, Fort Worth, TX, USA) and Sensar AR40e (Johnson and Johnson, Santa Ana, CA, USA), used in the modified Yamane technique. The comparison will focus on postoperative visual acuity, refractive stability, the presence of IOL tilt, and complications associated with each type of IOL. Understanding the outcomes and potential differences between these lenses will contribute valuable insights to optimize the SSF-IOL-MY technique and improve patient outcomes in cataract surgery.

Methods

This is a retrospective, comparative study, which includes data analysis of two different three-piece IOLs in the modified Yamane intrascleral fixation surgery performed between

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January 2023 and March 2024 in Başakşehir Çam and Sakura City Hospital. Patients were divided into two groups according to the type of IOL used. The first group consisted of patients with AcrySof MA60AC (Alcon Laboratories) lenses, while the second group consisted of patients with Sensar AR40e (Johnson and Johnson). Aphakic patients who underwent secondary IOL implantation and had postoperative minimum 3-month follow-up records were included in the study. However, patients with a history of ocular inflammation, bleeding disorders, and eyes with white-to-white corneal diameter measurements >12.5 or <11 mm were excluded. This study adhered to the tenets of the Declaration of Helsinki, and approval was obtained from the Institutional Review Board of Başakşehir Çam and Sakura City Hospital. Informed consent to publish the findings and images was gathered from the patients.

All patients included in the study underwent a comprehensive ophthalmologic examination postoperatively. The evaluation included auto refractometer measurement, uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), slit-lamp biomicroscopy, IOP measurement with Goldmann applanation tonometry, and dilated fundus examination. Anterior and posterior segment examinations were performed using the Topcon DRI OCT Triton Swept Source-OCTA (Topcon Corporation) to assess potential conjunctival extrusion of the sutures or haptics and postoperative cystoid macular edema (CME). The power of IOLs to be implanted was calculated by aiming for emmetropia for one-piece and three-piece IOLs based on at least two reliable and consistent measurements of all patients using optical biometry (Tomey optical biometry OA-2000 Opt-Meas V.4E) and the Sanders, Retzlaff, and Kraff/Theoretical (SRK/T) formula.

Demographic characteristics, laterality, follow-up times, postoperative UDVA, CDVA, spherical and cylindrical refractive values, spherical equivalent (SEQ), manifest refraction, endothelial cell count, ACD, corneal astigmatism, and axial length (AL) values were recorded. ACD and keratometry values were measured by Sirius+ tomographer (CSO). Each intraoperative or postoperative complication was noted. Lenticular astigmatism was calculated with the "Intraocular Astigmatism Calculator version 1.1." Snellen-measured UDVA and CDVA values were converted to logarithm of the minimum angle of resolution for statistical analysis.

All surgeries were performed by the same surgeon under general anesthesia. The Yamane flanged haptic intrascleral fixation technique was performed as previously described. But the technique was slightly modified. A trocar was inserted through the sclera at the inferior nasal quadrant for pars plana infusion. The main incision was placed through the upper temporal quadrant (135°). With the help of the Mendez ring, the sclerotomy marks were made exactly 180° apart (45° and 225°). Sclerotomy sites were marked 2 mm behind the limbus with a 2-mm tunnel. The entire capsule was removed, so that no capsular fragments were left behind, and the surgical field was prepared with a wide anterior vitrectomy. Through a 2.8–3.0 mm main incision, the IOL was implanted into the anterior chamber. With the help of forceps, the leading haptic was inserted into a 26-gauge needle, which was placed transconjunctivally through the sclera at the pre-marked area. The trailing haptic was then inserted into the second needle. First, the trailing haptic was pulled out from the needle and held 1 mm back to form a flange. Then the leading haptic was pulled out and the flange was formed by holding it 1 mm back. The IOL was centralized, and the haptics were embedded in the sclera. The trocar was removed and sutured with 7.0 Vicryl. The main incision was sutured with 10.0 nylon suture and removed in the first month of the operation.

The IOL to be used was selected according to the biometric results and the availability of suitable IOL power. Alcon MA60AC is an acrylic hydrophobic anterior asymmetric biconvex IOL with an optical diameter of 6 mm and a total length of 13 mm. It has two haptics made of Polymethyl methacrylate (PMMA), the haptic angle is 10°, and the haptic configuration is C-haptic. The other three-piece IOL used is the Sensar AR40e acrylic hydrophobic biconvex IOL with an optical diameter of 6 mm and a total length of 13 mm. There are two haptics made of PMMA, the haptic angle is 5°, and the haptic configuration is modified C-haptic. The slope of the haptics of the two IOLs is different [Fig. 1]. Although both haptic materials are PMMA, the shape of the flange is also different.[13]

Statistical analysis of the data was conducted using Statistical Package for the Social Sciences (SPSS) for Windows, version 25.0 (SPSS Inc., Chicago, IL, USA). To assess the normality of the variables, histogram plots and the Shapiro–Wilk test were utilized. Descriptive data analyses were presented with median, minimum, and maximum values. For comparing 2 × 2 tables, Pearson's Chi-square and Fisher's exact tests were employed. The Mann–Whitney *U* test was used to compare nonparametric data in paired groups.

Results

The investigation encompassed a cohort of 49 patients. Twenty-two individuals were allocated to the first group, distinguished by the use of AcrySof MA60AC IOLs, while the second group comprised 27 patients who received Sensar AR40e IOLs.

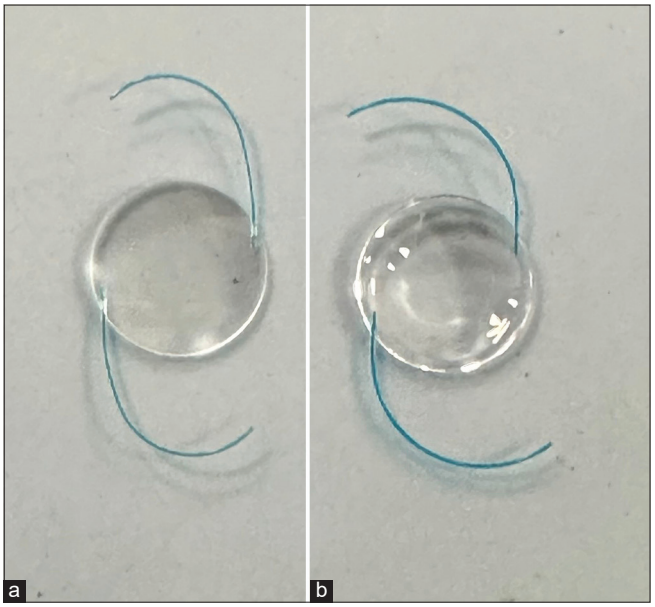

Figure 1: Demonstration of IOL and haptic designs: (a) MA60AC (C-haptic); (b) AR40e (modified C-haptic). IOL = intraocular lens

Regarding demographic characteristics, the median age within the first group was 73 years (18–83 years), whereas the median age in the second group was 74 years (10–81 years). Among the first group patients, 12 patients were male (54.5%) and 10 were female (45.4%), while in the second group, 13 patients were male (48.1%) and 14 were female (51.8%). Analysis revealed no statistically significant disparities in age or gender distribution between the two groups ($P = 0.546$ and $P = 0.213$, respectively).

The median duration of follow-up was similar in both groups, with a median of 8 months (3–16 months) in the first group compared to 6 months (3–12 months) in the second group, without a statistically significant difference ($P = 0.347$).

Comparison of postoperative visual outcomes, including uncorrected visual acuity (UCVA), best-corrected visual acuity (BCVA), spherical, cylindrical, SEQ values, and manifest refraction results are summarized in Table 1.

Postoperative ACD, keratometer readings, corneal astigmatism, lenticular astigmatism [Fig. 2], and AL median values are given in Table 2, which show no statistically significant disparity in any of them. Similarly, postoperative measurements of endothelial cell counts were not different between the two groups ($P = 0.204$).

Regarding perioperative and postoperative complications, a solitary case of haptic tip fracture was documented in group 1, along with an instance of optic–haptic junction separation.

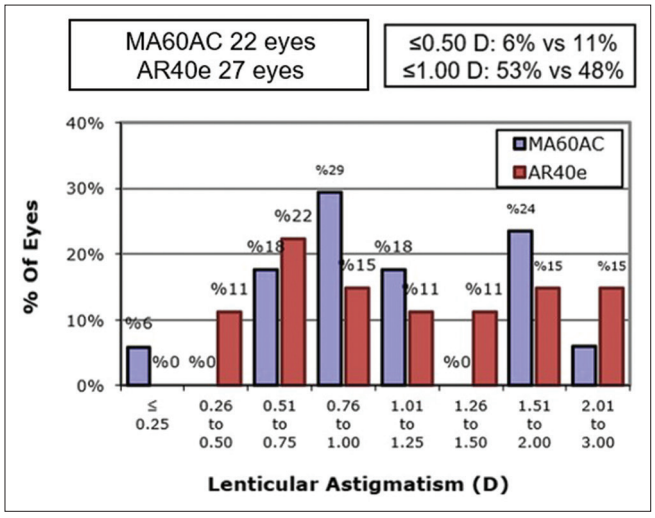

Figure 2: Distribution of lenticular astigmatism in both groups

Postoperatively, optic–haptic junction separation occurred in another patient from group 1. Incidences of CME were observed in two patients from group 1 and eight patients from group 2, with no statistically significant difference noted between the groups ($P = 0.071$). Noteworthy was the higher occurrence of epiretinal membrane formation in group 1 compared to group 2 ($P = 0.019$) [Table 3]. In addition, while endothelial cell counts exhibited no discernible intergroup variance, one case of bullous keratopathy was recorded in group 1. Incidence of glaucoma was reported in one patient from the first group, although no statistically significant difference in mean IOPs was noted between the groups ($P = 0.396$) [Table 1].

Discussion

This study sought to assess the postoperative outcomes of two distinct IOL designs employed in the modified Yamane technique. The findings indicated comparable visual outcomes, including UCVA and BCVA, as well as similar values for spherical, cylindrical, and SE refractions in both study groups. Furthermore, no significant variance in lenticular astigmatism was observed between patients in group 1 and group 2, with respective values of 0.86 and 0.99. These results suggest that employing the three-piece IOLs AcrySof MA60AC and Sensar AR40e in the modified Yamane technique constitutes a feasible therapeutic approach, demonstrating comparable efficacy between the two IOL designs.

Scleral IOL fixation has emerged as a significant procedure in contemporary ophthalmology practice. The prevalent factors contributing to the necessity for scleral IOL fixation include subluxated IOLs, pseudoexfoliation syndrome, and ocular trauma. While conventional methods such as iris fixation and IOL suturing have been established, a relatively recent technique has garnered attention. However, limited knowledge exists regarding the effective lens position, posing challenges to accurate IOL power calculation in such cases. The modified Yamane method presents an innovative approach enabling scleral lens fixation irrespective of ACD or iris condition. This technique involves the insertion of foldable lenses through a posterior limbal incision of approximately 2.0–2.8 mm, which is designed to minimize astigmatism. Postoperative outcomes have shown functional satisfaction. Nonetheless, the efficacy of this technique and the suitability of the chosen IOL in meeting patients' expectations regarding visual enhancement and refractive correction necessitate careful evaluation.[14,15] To our knowledge, there is only one report evaluating the visual acuity and complications of the Yamane technique with various IOL designs. Miura *et al*.[16] compared the NX-70 (Santen, Osaka, Japan) and PN6A (Kowa, Tokyo, Japan) IOLs in this study.

Table 1: Postoperative visual and refractive results of eyes

	Group 1 (*n*=22) median (min/max)	Group 2 (*n*=27) median (min/max)	*P*
UCVA (LogMAR)	0.22 (0.00/3.10)	0.22 (0.00/1.51)	0.813[a]
CDVA (LogMAR)	0.15 (0.00/3.10)	0.12 (0.00/1.51)	0.752[a]
Spherical value (D)	0.75 (-1.25/2.75)	0.50 (-2.25/4.00)	0.375[a]
Cylindrical value (D)	-1.5 (-0.50/-3.50)	-1.00 (0.00/–5.25)	0.073[a]
SEQ (D)	-0.12 (-1.75/2.00)	0.00 (-2.75/2.75)	0.949[a]
Manifest refraction (D)	0.00 (-1.75/1.12)	0.00 (-2.00/2.00)	0.656[a]

CDVA=corrected distance visual acuity, LogMAR=logarithm of the minimum angle of resolution, SEQ=spherical equivalent, UCVA=uncorrected visual acuity.
[a]Mann–Whitney *U*

Table 2: Postoperative keratometry readings and clinical characteristics of eyes

	Group 1 (*n*=22) median (min/max)	Group 2 (*n*=27) median (min/max)	*P*
ACD (mm)	4 (4/5)	4 (4/5)	0.132[a]
WTW (mm)	11.89 (11.31/12.26)	11.72 (11.19/12.13)	0.348[a]
K1 (D)	43.00 (40.50/45.00)	42.75 (38.25/46.62)	0.637[a]
K2 (D)	43.87 (41.50/46.00)	43.75 (39.50/47.25)	0.911[a]
Corneal astigmatism (D)	-1.00 (-3.00/-0.25)	-1.12 (−6.50/00)	0.423[a]
Lenticular astigmatism (D)	0.86 (0.08/2.11)	0.99 (0.31/2.96)	0.898[a]
IOP (mmHg)	15 (7/25)	12 (8/21)	0.396[a]
ECC (cells/mm^2)	1969 (1063/2914)	1494 (757/2789)	0.204[a]
AL (mm)	23.65 (22.75/24.25)	23.72 (22.81/24.42)	0.287[a]

ACD=anterior chamber depth, AL=axial length, ECC=endothelial cell count, IOP=intraocular pressure, WTW=white-to-white. [a]Mann–Whitney *U*

Table 3: Comparison of intraoperative and postoperative complications

	Group 1 (*n*=22)	Group 2 (*n*=27)	*P*
ERM	10	5	***P*=0.019[a]**
CME	2	8	*P*=0.071[a]
Bullous keratopathy	1	0	
Glaucoma	1	0	
Haptic related	2	0	

CME=cystoid macular edema, ERM=epiretinal membrane. [a]Pearson's Chi-square, Bold value= statistically significant data given in bold

These IOLs have 7- and 6-mm optics and 8.6- and 8.2-mm haptics, respectively, and both have polyvinylidene fluoride (PVDF) haptics, which are the favorite for this surgery. While there was no significant difference between these two IOLs in terms of visual acuity and complications, the overall length of PN6A IOLs was smaller than NX-70 IOLs, and PN6A IOLs were easy to maneuver in the anterior chamber due to their compactness. Therefore, the surgical time was significantly shorter. Remarkably, our analysis revealed no statistically significant disparity in visual acuity and refractive outcomes between the studied groups. At a minimum follow-up duration of 3 months postoperatively, the median ACD value remained consistent at 4 in both study groups. This uniformity could be attributed to the length of the inner IOL haptics embedded in the sclera. In addition, during sclerotomy, it is plausible that the puncture position of the 26-gauge needle may extend beyond 2 mm from the limbus.

In the discourse surrounding the surgical technique of scleral fixation for IOL implantation, a crucial consideration pertains to the characteristics of the IOL, specifically its haptic material and design. The AcrySof MA60AC and Sensar AR40e IOLs exhibit distinct geometric and material characteristics. AcrySof MA60AC features sharp edges both anteriorly and posteriorly, whereas Sensar AR40e displays a sharp posterior optical edge paired with a more rounded anterior optical edge.[17] Notably, among various hydrophobic acrylic IOLs, differences exist in their chemical properties owing to variations in acrylic materials. For instance, the optical material of the AcrySof IOL has been observed to have a propensity for absorbing dense adhesive proteins such as fibronectin and vitronectin.[18-20] Conversely, the optical surface of the Sensar IOL appears smoother compared to the AcrySof IOL due to differences in manufacturing processes; the Sensar IOL is produced using cryo-lathe cutting and tumble polish methods, whereas the AcrySof IOL is manufactured via a casting molding technique.[21] In addition, the acrylic polymer composition of the Sensar IOL bears closer resemblance to polymethyl methacrylate than that of the AcrySof IOL. This contention underscores the necessity of comprehending not only the material composition, but also the structural configuration of the haptic.[21] Recent investigations have brought to light substantial differentials in the efficacy of various haptic designs concerning intrascleral needle fixation.[22] For instance, IOLs featuring an L-shaped (modified C-haptic) haptic design, exemplified by the Sensar AR40e model, have garnered attention for their purported advantages over counterparts with a C-shaped design, typified by the MA60AC IOL.[22] In the study by Ma *et al*.,[13] IOLs containing different materials were compared and the best material was found to be PVDF, because this material resists breakage or deformation during surgery due to its flexibility. Many factors other than the loop material are involved in the shape recovery of IOL haptics. These include shape (design) and total haptic length, the angle between the haptic and optic, the type of connection between the haptic and optic (optic–haptic junction), and the shape and diameter of the cross section of the haptics.[23] So, when IOLs containing PMMA materials were compared within themselves, Tecnis ZA9003 (Johnson and Johnson), which has the same haptic structure as Sensar AR40e in terms of haptic–optic disinsertion force, dislocation force, and biomechanical stability, was found to be significantly better than MA60AC.[13] In addition, the state of the haptics after flanging was also evaluated and it was observed that MA60AC resembled a bulb while Tecnis ZA9003 resembled tapered cones.[13] In our study, all haptic problems occurred in the MA60AC group, such as haptic tip fracture and optic–haptic junction separation. Another interesting finding of this study was higher epiretinal membrane formation in MA60AC IOL group than Sensar AR40e IOL group, although there was no significant difference in terms of CME. This may be related to the higher level of cytokines released with the probable friction of the iris against the lens due to sharper haptic angulation in the MA60AC IOL or due to vitreous tractions during manipulations for haptic needle insertion.[24,25] Further studies designed with ultrasound biomicroscopy examinations will highlight the positions of the haptics and the iris plane. However, all these eyes were aphakic, but the complexity of the primary surgery (complicated cataract surgery or dislocated IOL extraction, etc.) is not known for any

of the groups; so, more sophisticated surgical manipulations might have facilitated epiretinal membrane formation and coincidentally, the ratio of primary surgery complexity may be higher in the MA60AC group. Further studies aiming to highlight the inflammatory effect of different haptic angulations are essential to make a precise comment.

The discernment of such nuances is paramount, as it informs clinicians about the feasibility and success rates of surgical manipulation, contingent upon the inherent properties of the haptic material. In our study, the AcrySof and Sensar IOLs emerged as the preferred choices for implementation in the modified Yamane technique. Hence, we conducted a comparative analysis between these two IOL options. Despite the distinct haptic angulation characteristics of the AcrySof MA60AC and Sensar AR40e IOLs, our study did not reveal a significant disparity in postoperative visual acuity or residual astigmatism.

The phenomenon of IOL tilt can contribute to the occurrence of higher-order aberrations as well as refractive errors, including both spherical and toric deviations.[26,27] In the context of the modified Yamane technique, wherein a three-piece IOL is fixated to the sclera, torque and stress exerted at the haptic–optic junction can induce IOL tilt. In addition, the process of passing the haptics through an intrascleral tunnel can further contribute to tilt. Despite efforts to standardize the placement of the 30-gauge needle externally at 180° intervals, variations in the length and angle of the tunnel within the eye may lead to asymmetry. Considering these factors, it is crucial to evaluate the distinctions among various IOL designs concerning tilt. In a recent study by Lin *et al*.,[28] which encompassed 39 patients undergoing the Yamane technique, the reported mean tilt was found to be 2.4°. Schranz *et al*.[29] reported a mean tilt angle of 7.67° in a study including 24 patients. While our study did not directly measure the tilt angle of various IOL designs utilized with the Yamane technique, the absence of a statistically significant variance in lenticular astigmatism implies that the IOL design may not substantially influence the tilt angle.

This study is subject to several limitations that warrant consideration. These include its retrospective design, the relatively small size of the patient cohort, the restricted duration of follow-up, and the inclusion of patients necessitating secondary IOL surgery for various reasons. In addition, preoperative corneal specular microscopy and postoperative IOL position by ultrasonic biomicroscopy were not evaluated. To comprehensively assess the enduring impact of employing the AcrySof MA60AC and Sensar AR40e designs in the modified Yamane technique, further research involving long-term studies with larger surgical populations is warranted.

Conclusion

Our findings demonstrate that the implantation of both AcrySof MA60AC and Sensar AR40e IOLs via the modified Yamane technique yields favorable and predictable outcomes. The modified Yamane surgery offers several IOL-assisted optical rehabilitation strategies, which can be tailored based on the surgeon's expertise. Based on our clinical results, it is evident that employing either of the two different IOLs yields comparable effects on refractive and visual outcomes. Thus, both approaches are deemed equally effective and safe for such cases.

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Ethical statement

Institutional Ethics Committee approval was obtained for this work (E-96317027-514.10-247172658). The dated on 28.06.2024.

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