

# Efficacy comparison of modified Yamane vs Z-suture techniques in aphakic eyes lacking adequate capsular support

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## 改良 Yamane 技术与 Z 缝合术式治疗无足够囊膜支撑的无晶状眼的疗效比较

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### 摘要

**目的:** 对比无足够囊膜支撑的无晶状体眼患者, 分别采用改良 Yamane 技术与 Z 缝合术式行巩膜固定人工晶状体 (IOL) 植入术后的视力预后、屈光可预测性及并发症发生率。

**方法:** 本回顾性研究纳入了 2017 至 2024 年间接受巩膜固定 IOL 植入术的无晶状体眼患者。将患者分为两组: 第 1 组接受改良 Yamane 术式, 第 2 组则采用 Z 缝合术式。评估指标包括最佳矫正视力 (BCVA, LogMAR)、等效球镜 (SE)、柱镜误差 (CE)、角膜散光 (CA)、平均绝对误差 (MAE) 及术后并发症。

**结果:** 本研究共纳入 101 例无晶状体眼患者, 平均年龄 72.6±10.7 岁。第 1 组纳入男 22 例, 女 19 例, 平均年龄 72.1±11.0 岁, 第 2 组纳入男 35 例, 女 25 例, 平均年龄 73.0±10.5 岁。术后 1 mo, 第一组 BCVA 显著优于第 2 组, 分别为 0.49±0.21, 0.66±0.17 LogMAR,  $P=0.02$ 。术后 6 mo, 两组 BCVA 差异无统计学意义, 分别为 0.38±0.19 与 0.41±0.20 LogMAR,  $P>0.05$ 。各随访时间点的组间 SE、CE

及 CA 均无统计学差异 (均  $P>0.05$ )。第 1 组术后 1 mo (0.72±0.80 vs 0.80±0.64 D) 和 6 mo (0.63±0.41 vs 0.72±0.33 D) 的 MAE 均略低于第 2 组, 但无统计学意义 ( $P>0.05$ )。两组总体并发症发生率相近; 但襟脱位在 Yamane 术式组发生率显著更高 ( $P=0.025$ )。

**结论:** 改良 Yamane 技术与 Z 缝合术式均为无足够囊膜支撑的无晶状体眼进行二期 IOL 植入术的安全有效选择。Yamane 术式在短期内表现出更快的视力恢复和略优的屈光可预测性, 而两种方法的长期结果相当。

**关键词:** 无晶状体眼; 巩膜固定人工晶状体; Yamane 技术; Z 缝合; 屈光可预测性; 平均绝对误差

### Abstract

• **AIM:** To compare the visual outcomes, refractive predictability, and complication rates associated with scleral-fixed intraocular lens (IOL) implantation using the modified Yamane and Z-suture techniques in aphakic patients lacking adequate capsular support.

• **METHODS:** This retrospective study included aphakic patients who underwent scleral-fixed IOL implantation between 2017 and 2024. Patients were divided into two groups: Group 1 received the modified Yamane technique, while Group 2 underwent fixation using the Z-suture technique. Best-corrected visual acuity (BCVA, LogMAR), spherical equivalent (SE), cylindrical error (CE), corneal astigmatism (CA), mean absolute error (MAE), and postoperative complications were assessed.

• **RESULTS:** Totally 101 aphakic patients (mean age 72.6±10.7 y) were included. Group 1 included 22 males and 19 females, with a mean age of 72.1±11.0 y. Group 2 included 35 males and 25 females, with a mean age of 73.0±10.5 y. At 1 mo postoperatively, the BCVA in Group 1 was significantly better than that in Group 2, 0.49±0.21 vs 0.66±0.17 LogMAR,  $P=0.02$ . By month 6, BCVA was comparable between groups (0.38±0.19 vs 0.41±0.20 LogMAR,  $P>0.05$ ). No statistically significant differences were observed in SE, CE, or CA at any time point (all  $P>0.05$ ). MAE was slightly lower in Group 1 at both 1 (0.72±0.80 vs 0.80±0.64 D) and 6 mo (0.63±0.41 vs 0.72±0.33 D), although these differences were not statistically significant ( $P>0.05$ ). Overall complication rates were similar; however, haptic dislocation was significantly more common in the Yamane group ( $P=0.025$ ).

• **CONCLUSION:** Both the modified Yamane and Z-suture techniques are safe and effective options for secondary

IOL implantation in aphakic eyes lacking adequate capsular support. The Yamane technique demonstrates faster visual recovery and slightly improved refractive predictability in the short term, while long-term outcomes are comparable between the two methods.

• **KEYWORDS:** aphakia; scleral-fixated intraocular lens; Yamane technique; Z-suture; refractive predictability; mean absolute error

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## INTRODUCTION

In aphakic eyes with insufficient capsular or zonular support, where in-the-bag intraocular lens (IOL) implantation is not possible, scleral fixation has become the most widely adopted method for secondary IOL placement. Alternative approaches include angle-supported anterior chamber IOLs and iris-claw IOLs, which may be considered in selected cases<sup>[1-3]</sup>. Furthermore, the literature describes a variety of scleral fixation techniques, ranging from conventional sutured to sutureless methods, as well as fibrin glue-assisted and flanged intrascleral fixation techniques<sup>[4-6]</sup>. These evolving surgical strategies highlight the ongoing search for an optimal balance between visual rehabilitation, refractive predictability, and long-term safety. Recent comparative analyses and systematic reviews have shown that the modified Yamane technique offers similar long-term best-corrected visual acuity (BCVA) and refractive outcomes compared to traditional sutured scleral fixation (SSF), with the added benefits of shorter operative times and faster early visual recovery, particularly in experienced hands<sup>[7]</sup>. In a recent study comparing the Yamane and Z-suture techniques, visual and refractive outcomes were found to be comparable, with mean absolute error (MAE) values also showing no significant difference between the two methods<sup>[8]</sup>. In our study, we compared the modified Yamane and Z-suture techniques in a single-center retrospective study, focusing on refractive outcomes and complication profiles.

## PARTICIPANTS AND METHODS

**Ethical Approval** This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethics approval was obtained from the Sakarya University Ethics Committee (Approval No. E-43012747-050.04-533610-564). Informed consent was waived because of the retrospective and anonymous nature of this study.

This retrospective study included patients who underwent scleral-fixated IOL implantation using either the modified Yamane technique or the Z-suture technique between 2017 and 2024 at Sakarya University. Patients with aphakia or inadequate capsular support who underwent secondary IOL implantation were included in the study. Exclusion criteria

comprised eyes with active or chronic ocular inflammation, uncontrolled glaucoma or a history of glaucoma surgery, advanced corneal opacity or corneal dystrophy, prior pars plana vitrectomy, and insufficient postoperative follow-up of less than 6 mo.

All surgical procedures were performed by experienced surgeons. In Group 1, scleral fixation was achieved using the modified Yamane intrascleral haptic fixation technique, whereas in Group 2, IOL fixation was performed using the conventional Z-suture method.

All patients underwent a comprehensive ophthalmologic examination preoperatively and at postoperative months 1 and 6. Evaluated parameters included BCVA (LogMAR), refractive outcomes including spherical equivalent (SE, diopters), cylindrical error (CE, diopters), corneal astigmatism (CA, diopters), and MAE (diopters) as an indicator of refractive predictability. Intraocular pressure (IOP, mmHg) measurements and detailed fundus examinations were also performed. Intraoperative and postoperative complications were systematically recorded.

## Surgical Techniques

**Modified Yamane technique** In Group 1, secondary IOL implantation was performed using the modified Yamane intrascleral haptic fixation technique. Prior anterior vitrectomy had been performed in all aphakic eyes included in this group. Following conjunctival displacement, a 30-gauge thin-walled needle was inserted transconjunctivally through the sclera at 2.0 mm posterior to the limbus, at two points approximately 180° apart. A three-piece foldable IOL was inserted into the anterior chamber. Each haptic was sequentially docked into the lumen of the 30-gauge needle and externalized through the scleral pathway. The externalized haptics were cauterized to create a flange and then tucked into the scleral tunnels, achieving sutureless fixation. The position and centration of the IOL were confirmed intraoperatively, and all incisions were self-sealing without the need for sutures.

**Z-suture technique** In Group 2, scleral fixation was performed using the conventional Z-suture method. Similar to Group 1, all aphakic eyes in this group had undergone prior anterior vitrectomy. After conjunctival peritomy, a 30-gauge thin-walled needle was inserted through the sclera 2.0 mm posterior to the limbus at positions 180° apart. Double-armed 10-0 polypropylene sutures introduced into the posterior chamber through the main corneal incision were externalized via the scleral entry points. Each haptic of the posterior chamber IOL was fixated by passing the sutures through the sclera in a Z-shaped pattern three times. The knots were trimmed and buried to minimize the risk of exposure or erosion, and the conjunctiva was closed with 8-0 vicryl sutures. The IOL's centration and stability were verified at the end of surgery.

**Statistical Analysis** Data were analyzed using SPSS v26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation. Comparisons between groups were performed using independent samples *t*-test or

Mann–Whitney *U* test, as appropriate. Categorical variables were analyzed using Fisher’s exact test. A *P*-value <0.05 was considered statistically significant.

**RESULTS**

A total of 101 patients (101 eyes) were included in this study. Group 1 (modified Yamane technique) consisted of 41 patients and Group 2 (Z-suture technique) of 60 patients. The mean age of the study population was 72.6±10.7 y, with 57 males (56.4%) and 44 females (43.6%). Baseline characteristics were comparable between the two groups (Table 1).

At postoperative month 1, mean BCVA was significantly better in the Yamane group (0.49±0.21 LogMAR) compared with the Z-suture group (0.66±0.17 LogMAR, *P* = 0.02). By month 6, BCVA improved in both groups and showed no significant difference (0.38±0.19 vs 0.41±0.20 LogMAR, *P*>0.05). Refractive outcomes demonstrated that SE, CE, and CA values were similar between the two groups at both 1 and 6 mo (all *P*>0.05). MAE was lower in the Yamane group at both 1 mo (0.72±0.80 D vs 0.80±0.64 D) and 6 mo (0.63±

0.41 D vs 0.72±0.33 D), although the differences did not reach statistical significance (*P*>0.05, Table 2).

Regarding complications, overall rates were comparable between groups. However, haptic dislocation was more frequent in the Group 1 (*P* = 0.025), while suture-related complications (such as erosion or knot exposure) occurred only in Group 2. Other postoperative events included transient IOP elevation, mild vitreous hemorrhage, and cystoid macular edema, all of which were managed successfully (Table 3).

**DISCUSSION**

In the present study, we compared the modified Yamane and Z-suture techniques for scleral-fixed IOL implantation in aphakic eyes lacking capsular support. Our results demonstrated that both techniques are safe and effective, with the Yamane technique providing faster early visual recovery and slightly lower MAE, whereas long-term visual and refractive outcomes were comparable between groups.

Long-term data from the literature further support the overall safety and effectiveness of scleral fixation techniques. Bausili Portabella *et al*<sup>[9]</sup> reported 10-year outcomes of sutured

**Table 1 Baseline characteristics of patients**

Parameters	Group 1 (n=41)	Group 2 (n=60)	<i>P</i>
Age ( $\bar{x}\pm s, y$ )	72.1±11.0	73.0±10.5	0.64
Sex (M/F)	22/19	35/25	0.72
Laterality (R/L)	20/21	32/28	0.81

**Table 2 Visual and refractive outcomes**

Parameters	Timepoint	Group 1 (n=41)	Group 2 (n=60)	<i>P</i>	$\bar{x}\pm s$
BCVA (LogMAR)	Preoperative	0.92±0.25	0.94±0.27	>0.05	
	1 mo	0.49±0.21	0.66±0.17	0.02 <sup>a</sup>	
	6 mo	0.38±0.19	0.41±0.20	>0.05	
SE (D)	Preoperative	-0.75±1.2	-0.70±1.3	>0.05	
	1 mo	-0.40±0.82	-0.45±0.95	>0.05	
	6 mo	-0.35±0.71	-0.40±0.86	>0.05	
CE (D)	Preoperative	1.25±0.9	1.20±1.0	>0.05	
	1 mo	1.05±0.71	1.00±0.81	>0.05	
	6 mo	1.00±0.65	0.95±0.7	>0.05	
CA (D)	Preoperative	1.10±0.62	1.05±0.73	>0.05	
	1 mo	0.76±0.64	0.81±0.65	>0.05	
	6 mo	0.72±0.5	0.77±0.44	>0.05	
MAE (D)	1 mo	0.72±0.8	0.80±0.64	>0.05	
	6 mo	0.63±0.41	0.72±0.33	>0.05	

<sup>a</sup>Statistically significant. BCVA: Best-corrected visual acuity; SE: Spherical equivalent; D: Diopters; CE: Cylindrical error; CA: Corneal astigmatism; MAE: Mean absolute error.

**Table 3 Postoperative complications**

Complication	Group 1 (n=41)	Group 2 (n=60)	<i>P</i>	<i>n</i> (%)
Cystoid macular edema	3 (7.3)	7 (11.7)	0.704	
Haptic dislocation	4 (9.8)	0	0.025 <sup>a</sup>	
Retinal detachment	2 (4.9)	0	0.162	
Bullous keratopathy	1 (2.4)	2 (3.3)	1.000	
Suture erosion	0	5 (8.3)	0.078	

<sup>a</sup>Statistically significant.

posterior chamber IOLs, showing stable visual acuity with a survival probability of 0.79 at 10 y, although suture breakage was more common in younger patients and in certain surgical settings. More recently, Qi and Lim<sup>[10]</sup> presented longitudinal outcomes of sutureless scleral-fixed IOLs, demonstrating significant and sustained improvements in BCVA up to three years postoperatively, with most complications occurring in the early postoperative period. Taken together, these findings suggest that both sutured and sutureless fixation techniques remain reliable options for secondary IOL implantation, with specific complication profiles that should guide surgical decision-making.

Several studies in the literature have compared the refractive outcomes of sutured and sutureless scleral-fixed IOL<sup>[11-14]</sup>. Our findings of slightly improved refractive predictability with the Yamane technique are consistent with recent meta-analytic evidence showing that sutureless scleral-fixed IOLs, particularly the Yamane approach, are associated with lower postoperative astigmatism and more stable refractive outcomes compared to sutured fixation<sup>[11]</sup>. This supports the notion that refractive predictability may be an important advantage of sutureless techniques. In line with this, Aydin *et al*<sup>[12]</sup> demonstrated that two different IOL types used in the modified Yamane technique achieved comparable refractive outcomes, confirming the overall reliability of this sutureless approach. Sindal *et al*<sup>[13]</sup> reported that long-term visual acuity was similar between sutured and sutureless fixation, but refractive outcomes were more stable in the sutureless group. Likewise, Jang *et al*<sup>[14]</sup> found that final BCVA did not differ significantly, but MAE was lower in eyes undergoing sutureless intrascleral fixation, suggesting better refractive predictability compared to conventional sutured fixation.

Taken together, these findings align with our results, supporting the view that sutureless fixation—particularly Yamane-based approaches—may offer advantages in terms of refractive stability and predictability, while maintaining comparable visual outcomes to sutured techniques. In addition to these reports, a recent study by Simsek *et al*<sup>[8]</sup> directly compared refractive outcomes of the Yamane and Z-suture techniques and, similar to our analysis, included MAE as a key parameter. They found that MAE values were comparable between the two groups, with a tendency toward better refractive predictability in the Yamane cohort. Our results parallel these findings, showing slightly lower MAE with the Yamane technique, although without statistical significance. MAE, as an objective measure of deviation from the intended refractive target, has become increasingly important in evaluating the quality of surgical outcomes, particularly in patients with high visual expectations. This concordance further supports the role of MAE as a useful metric for assessing refractive accuracy in scleral-fixed IOL surgery.

In our series, BCVA at 1 mo was significantly better in the Yamane group compared to the Z-suture group, whereas by 6 mo the visual outcomes were comparable. This finding highlights the faster visual rehabilitation associated with the

Yamane technique. Similar results have been reported in the literature; Zhang *et al*<sup>[7]</sup>, in a recent meta-analysis, showed that Yamane fixation yielded significantly improved 1-month BCVA compared to sutured fixation in single-surgeon series, although long-term BCVA did not differ between the two groups. Likewise, Byun *et al*<sup>[15]</sup> demonstrated that Yamane-based techniques provided faster early visual recovery, but the differences diminished by later follow-up, confirming that both methods ultimately achieve similar long-term visual outcomes.

In our study, overall complication rates were comparable between the two techniques; however, haptic dislocation occurred more frequently in the Yamane group, while suture-related problems were observed in the Z-suture group. Vitreous hemorrhage was also reported in both groups (4.9% in Yamane and 6.7% in Z-suture), with no statistically significant difference ( $P = 0.72$ ). Similar trends have been reported in the literature. Yalcinbayir *et al*<sup>[16]</sup> compared scleral suture fixation with the modified Yamane technique in eyes with posterior lens dislocation and found that both approaches achieved significant visual improvement, with suture-related late complications more common in the sutured group and early vitreous hemorrhage more frequent in the Yamane group. Erdogan *et al*<sup>[17]</sup> focusing on Marfan syndrome patients with ectopia lentis, reported that all three surgical approaches studied (scleral suturing, Yamane fixation, and iris-claw IOLs) were effective, but the type of complications differed across techniques: suture erosion in the sutured group, early hemorrhage or haptic-related issues in the Yamane group, and endothelial cell loss in iris-claw IOLs. Do *et al*<sup>[18]</sup> provided prospective evidence, showing that both sutured and flanged sutureless fixation improved vision similarly, but again with shorter operative times and different complication profiles—early hemorrhage in sutureless fixation and suture-related issues in the conventional group. Mizuno and Sugimoto<sup>[19]</sup> also reported similar patterns, with sutureless fixation offering shorter surgical times but more frequent early hemorrhage, while the sutured group was prone to late suture-related complications. Taken together, these results emphasize that while both techniques are effective and generally safe, the choice of method should consider the different complication profiles: Yamane may pose higher risks of early haptic-related issues, whereas Z-suture carries risks of late suture-related complications.

In this study, we demonstrated that both the modified Yamane and Z-suture techniques are safe and effective options for scleral-fixed IOL implantation in aphakic eyes lacking adequate capsular support. The Yamane technique offered faster visual recovery at 1 mo and demonstrated slightly lower MAE, suggesting a potential advantage in refractive predictability. However, complication profiles differed between the two techniques: haptic dislocation occurred more often with Yamane fixation, whereas suture-related problems were observed only in the Z-suture group. These findings highlight that while both methods are valid surgical options,

the choice of technique should be tailored to patient characteristics and surgeon expertise. Future prospective studies with larger cohorts and longer follow-up are warranted to better define the long-term refractive stability and complication risks associated with each approach.

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