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Comparative Analysis of Sutured and Sutureless 25G Pars Plana Vitrectomy: Impact on Surgically Induced Astigmatism and Hypotony

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ABSTRACT

Introduction: Vitreoretinal surgery has advanced with transconjunctival sutureless vitrectomy (TSV), using smaller incisions. However, TSV often causes hypotony due to sclerotomy leakage, leading to severe postoperative issues. This study compares outcomes between sutureless and sutured 25G pars plana vitrectomy (PPV) and highlights sutures' significance in TSV.

Methods: Fifty-four eyes underwent 25G PPV, divided into sutureless and sutured groups based on sclerotomy closure methods. Preoperative and postoperative evaluations at 1 week, 1 month, and 3 months included corrected distance visual acuity (CDVA), intraocular pressure (IOP), auto refractometer readings, and corneal topography. Special attention was given to postoperative hypotony, and surgically induced astigmatism (SIA) was assessed.

Results: The sutureless (mean age: 67.4±9.1 years, n=31) and sutured (mean age: 59.2±12.7 years, n=23) groups were analyzed. The sutureless group showed stable SIA at 1 and 3 months (1.39±1.1 vs. 1.30±0.9, p=0.695). The sutured group had higher SIA at 1 month (3.16±3.2 vs. 1.39±1.1, p=0.009), which decreased by 3 months (3.16±3.2 vs. 1.95±1.4, p=0.021). No significant intergroup differences were observed at the third month postoperatively. CDVA improved significantly in both groups (p<0.001), highlighting surgical efficacy. IOP was comparable to that of the sutureless group, but transient hypotony occurred in the sutureless group. IOP consistency favored the sutured group.

Conclusion: The study findings underscore the impact of suturing the sclerotomy ports on elevating SIA. However, it's crucial to note that SIA usually decreases by the third postoperative month, whereas hypotony-related complications can have enduring effects. Surgeons must carefully assess hypotony risks, particularly in children or in cases of high myopia, deciding on the necessity of sutures in microincisional PPV.

Keywords: 25-gauge pars plana vitrectomy, transconjunctival sutureless vitrectomy, surgically induced astigmatism, hypotony

Introduction

The conventional 20-gauge (G) pars plana vitrectomy (PPV) procedure results in a significant induction of surgically induced astigmatism (SIA) during the initial postoperative phase (1). This SIA originates from changes in corneal curvature due to suturing of sclerotomy ports (2). The corneal alterations subsequent to vitrectomy have the potential to adversely affect the visual outcomes of the surgical procedure. The advancement of transconjunctival sutureless vitrectomy (TSV), facilitated by smaller incision sclerotomies, represents progress in this field. TSV has gained popularity among vitreoretinal surgeons due to its minimally invasive nature, shorter surgical duration, and elimination of the need for conjunctival dissection and scleral suturing (3,4).

TSV has also demonstrated a decreased incidence of postoperative astigmatism. However, an increased susceptibility to hypotony and endophthalmitis has been observed due to inadequate closure of sclerotomies (5,6). Poorly sealed incisions may allow ocular surface fluid and bacteria to enter the vitreous cavity. Studies have shown a higher rate of bacterial contamination within the vitreous cavity following 25G TSV compared to 20G sutured vitrectomy (7). Moreover, reports indicate that the risk of developing endophthalmitis after 25G TSV, is approximately 28 times higher than after 20G sutured vitrectomy (8). A meta-analysis has also documented elevated occurrences of hypotony and choroidal detachment in TSV compared to 20G sutured vitrectomy (9).

Currently, TSV has become the most frequently favored approach in vitreoretinal surgery. This study aims to compare the clinical outcomes

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of sutured and sutureless 25G PPV, and to elucidate the role of sutures in microincisional sutureless vitrectomy.

Methods

This retrospective analysis included 54 eyes from 53 individuals who underwent 25G PPV at University of Health Sciences Türkiye, Göztepe Prof. Dr. Süleyman Yalçın City Hospital, Clinic of Ophthalmology. All pertinent ophthalmic data were extracted from the patient records. Exclusions from the study involved patients with corneal pathologies, prior ocular surgeries except for phacoemulsification, or traumas, combined phacoemulsification and PPV procedures, systemic autoimmune disorders, and those who did not comply with follow-up appointments for a minimum of three months post-surgery. The study was approved by the Clinical Research Ethics Committee of İstanbul Medeniyet University Göztepe Training and Research Hospital (approval no: 2022/0235, date: 13.04.2022).

The surgical approach entailed the standard 3-port 25G trocar cannula system (Alcon Laboratories, Fort Worth, Texas, USA) and was consistently performed by the same vitreoretinal surgeon, utilizing the Alcon Constellation vitrectomy system (Alcon Laboratories, Inc.). We created all sclerotomy incisions using a single-step, biplanar approach at a 30-degree oblique angle, 3.5-4 mm posterior to the limbus, depending on the phakic status, without displacing the conjunctiva. Based on the closure technique for the sclerotomy sites, patients were categorized into sutureless and sutured groups. The scleral massage method was employed for the sutureless group, while an absorbable 8/0 vicryl suture (PGA FSSB-Chirurgische Nadeln GmbH, Germany) was used for the sutured group. The sclerotomy incision site was grasped with a Colibri forceps and sutured parallel to the limbus, without conjunctival exploration. Sclerotomy closure was verified for leakage in both techniques, and the procedure was concluded only after confirming that the sclerotomies were properly closed.

Thorough ophthalmic evaluations were conducted for all patients preoperatively and at the end of the first week, first month, and third month postoperatively. These assessments encompassed auto refractometer readings (Topcon KR-1), corrected distance visual acuity (CDVA), intraocular pressure (IOP) measurements using pneumatic tonometry, slit-lamp biomicroscopy, dilated fundus examinations, and corneal topography. Patient demographics, including age, gender, etiology, and the presence of ocular and systemic diseases, were retrieved from medical records. Postoperative complications such as hypotony (IOP <8 mmHg), endophthalmitis, and vitreous hemorrhage were also documented.

Corneal topography was conducted both preoperatively and at 1 month and 3 months postoperatively using a video keratography system (Tomograph and Corneal Topographer, Sirius, Scandicci, Italy). Three consecutive topographic images were acquired per eye at each measurement point, with the best-aligned and fixed image selected for analysis. Data on anterior corneal astigmatism, mean keratometry (Km), flat (K1), and steep (K2) keratometry readings within the central 3 mm of the corneal front surface were recorded. SIA denotes the degree and axis of astigmatic change caused by the surgery. We preferred Alpins' method for the calculation of SIA using vector analysis (10). Vector analysis was performed by the automated software (11).

Statistical Analysis

Data analysis was performed using SPSS 17 software (SPSS for Windows, SPSS, Inc., Chicago, IL, USA). The normality of the data distribution was assessed via the Kolmogorov-Smirnov test and visualized through histograms and probability graphs. Descriptive statistics encompassed mean ± standard deviation for normally distributed data and median with interquartile range for non-normally distributed data. The Mann-Whitney U-test facilitated intergroup comparisons, while Wilcoxon tests (for non-normally distributed data) gauged differences between preoperative and postoperative measurements. The Friedman test was used for comparisons among three or more matched groups, and the chi-square test evaluated categorical data.

Results

The study comprised thirty-one patients in the sutureless group (19 male, 12 female, mean age: 67.4±9.1 years) and twenty-three patients in the sutured group (14 male, 9 female, mean age: 59.2±12.7 years). In the sutureless group, the most prevalent indication for surgery

Table 1. Demographic and clinical characteristics of the patients

	Sutureless group	Sutured group	p-value
Mean age (years ± SD)	67.4±9.1	59.2±12.7	0.040*
Sex (M/F)	19/12	14/9	0.975**
Eye laterality (R/L)	14/17	12/11	0.610**
Diabetes mellitus (n)	16	9	0.363**
Hypertension (n)	16	10	0.554**
Etiology			
Epiretinal membrane	7	3	
Vitreous hemorrhage	14	5	
Retinal detachment	4	10	
Macular hole	5	3	
Vitreomacular traction	1	1	
Dropped intraocular lens		1	
Surgical time (minutes ± SD)	47.3±18.6	75.1±36.9	0.004*
Tamponde usage			0.003**
Air	14	5	
Sulfur hexafluoride (SF6 20%)	7	3	
Octafluoropropane (C3F8 14%)	9	5	
Silicon oil	1	10	

*Mann-Whitney U-test, **Pearson chi-square test
SD: Standard deviation, M: Male, F: Famale, R: Right, L: Left

was diabetic vitreous hemorrhage, while in the sutured group, it was retinal detachment. Comprehensive details regarding the patients' demographic and clinical data can be found in Table 1.

Comparisons of K1, K2, and astigmatism values between preoperative and postoperative measurements at the first and third months revealed similarity in the sutureless group (p>0.05). In the sutured group, a noteworthy increase was observed in the mean K2 values (43.3±1.9 vs. 44.8±2.8, p=0.003) and corneal astigmatism (-1.2±0.8 vs. -2.6±2.9, p=0.012) at the 1-month mark compared to preoperative values. However, this disparity diminished and became statistically insignificant at the 3-month postoperative point (p=0.584, p=0.976, respectively) (Table 2). SIA was notably greater in the sutured group than the sutureless group at 1 month postoperatively (3.16±3.2 vs. 1.39±1.1, p=0.009). The SIA was reduced in the sutured group after 3 months (3.16±3.2 vs. 1.95±1.4, p=0.021), and no statistically significant distinction was observed between the groups at the third postoperative month (1.30±0.9 vs. 1.95±1.4, p=0.122, respectively) (Figure 1). Within the sutureless group, there was a slight indication of decreased SIA at 3 months postoperatively (1.39±1.1 vs. 1.30±0.9, p=0.695).

CDVA demonstrated a significant improvement in both groups over the follow-up periods. Preoperative and postoperative measurements taken at week 1, month 1, and month 3 mean logMAR CDVA measurements in the sutureless and sutured groups were 1.71±1.1 vs. 2.10±1.0, p=0.160; 1.62±1.2 vs. 1.83±1.0, p=0.178; 1.03±0.9 vs. 1.52±1.0, p=0.022; and 0.92±0.9 vs. 1.20±1.0, p=0.260, respectively. While IOP on postoperative day 1 was similar between the sutureless and sutured groups (18.9±6 vs. 17.8±4, p=0.617, respectively), the range of IOP distribution was wider in the sutureless group (Figure 2). Two patients in the sutureless group experienced hypotony (IOP <8 mmHg) on postoperative day 1, which resolved in subsequent follow-up visits. Preoperative and postoperative week 1, month 1, and month 3, IOP distribution in the sutureless and sutured groups was 19.2±7 vs. 17.3±6, p=0.280; 14.6±3 vs. 15.7±3, p=0.334; 16.7±5 vs. 16.3±4, p=0.867; and 17.4±6 vs. 15.8±4, p=0.356, respectively. The IOP trends across follow-up visits are illustrated in the graph in Supplementary Figure 1. Notably, severe complications such as suprachoroidal hemorrhage and endophthalmitis were absent in both groups. Postoperative vitreous hemorrhage occurred in one patient in the sutureless group and four patients in the sutured group. All instances of vitreous hemorrhage were attributed to recurrent hemorrhages stemming from diabetic retinopathy, and they resolved spontaneously without any intervention.

Discussion

Fuji et al. (12) introduced the concept of 25G vitrectomy as a TSV in 2002. Subsequently, in 2005, Eckardt (13) described 23G PPV. TSV emerged with advantages such as reduced surgical time, diminished suture-associated inflammation, and SIA, along with accelerated healing of sclerotomy

Table 2. Corneal topography changes during follow-up periods

	Parameters	Preoperative	1st month (30th day)	p value	3rd month (90th day)	p-value
Sutureless group	K 1, front (D)	43.1±2.2	42.9±2.2	0.434*	43.0±1.9	0.670*
	K 2, front (D)	43.8±2.2	43.8±2.2	0.882*	43.9±2.1	0.281*
	Astig, front (D)	-1.11±1.0	-0.61±1.1	0.244**	-1.02±0.7	0.471**
Sutured group	K 1, front (D)	42.4±1.9	42.2±1.8	0.390*	42.2±1.9	0.491*
	K 2, front (D)	43.3±1.9	44.8±2.8	**0.003***	43.5±1.9	0.584*
	Astig, front (D)	-1.2±0.8	-2.6±2.9	**0.012****	-1.4±1.1	0.976**

K1: Flat axis keratometry, K2: Steep axis keratometry, Astig: Astigmatism, D: Diopter, *Paired-sample t-test, ** Wilcoxon test; Each p value shows the statistical difference from the preoperative values

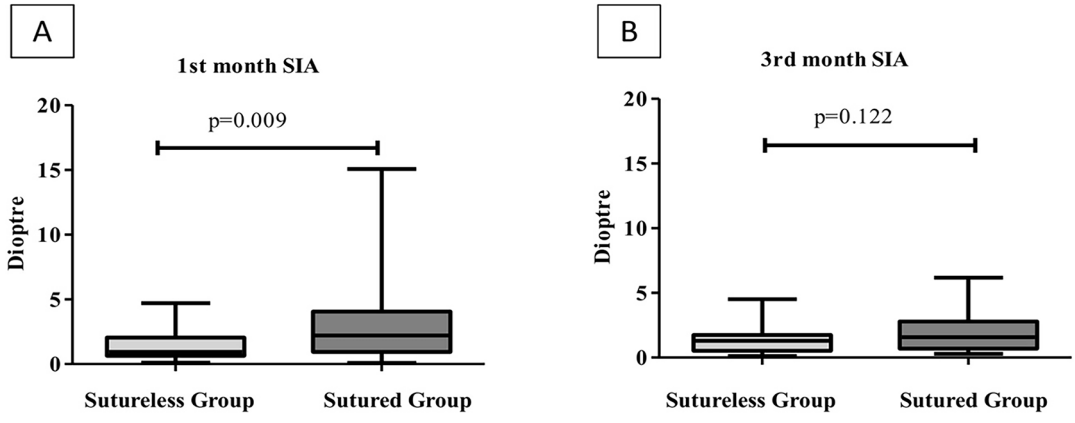

Figure 1. (A,B) Surgically induced astigmatism at the first and third months postoperatively in sutureless and sutured groups. Surgically induced astigmatism (SIA) exhibited a higher magnitude in the sutured group during the first month following the surgical procedure (**Figure 1A**). Subsequently, SIA reduced significantly, and by the third month postoperatively, no statistically significant disparity was observed between the sutureless and sutured groups (**Figure 1B**)

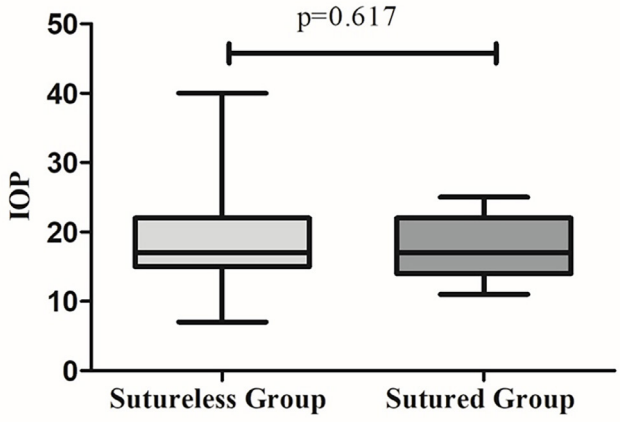

Figure 2. Intraocular pressure distribution on the first postoperative day in sutureless and sutured groups. No statistically significant discrepancy in intraocular pressure (IOP) was detected between the two groups on the first postoperative day. However, it is noteworthy that the sutureless group displayed a wider range of IOP variation on the first postoperative day, while IOP values in the sutured group demonstrated greater consistency

wounds (14). However, hypotony has emerged as a common complication following TSV, primarily due to leakage from the sclerotomy sites, which can lead to serious postoperative issues, including endophthalmitis and suprachoroidal hemorrhage (15). In 2010, a novel 27G microincisional sutureless vitrectomy system was introduced; however, its primary application was predominantly restricted to macular surgeries (16,17). The present study aimed to investigate the role of sutures in TSV and to perform a comparative analysis of clinical outcomes between sutured and sutureless 25G vitrectomy.

The study revealed that sutureless 25G PPV did not lead to a noteworthy alteration in corneal astigmatism during both the early and later postoperative periods. However, a notable increase in SIA was observed after sutured, 25G PPV. This aligns with previous reports, that indicated 25G TSV did not induce significant SIA, even in the early postoperative stage (18). A comparison between 23G and 25G TSV and conventional 20G PPV demonstrated that while 23G and 25G TSV had minimal impact on corneal topography, significant changes were noted following 20G vitrectomy. These changes returned to preoperative levels by the third month postoperatively (19). The origin of SIA in PPV has often been attributed to scleral cauterization and suturing of the sclerotomy sites (20). The findings of the current study corroborate these hypotheses. Similar to the conventional 20G PPV data, the application of scleral sutures, induced significant corneal astigmatism even in the context of 25G PPV with smaller incisions. Importantly, these corneal curvature changes resolved by the third postoperative month.

Hypotony, a notable concern post-TSV, is predominantly attributed to sclerotomy leakage (21). Hypotony, in turn, escalates the risk of endophthalmitis by facilitating the ingress of ocular surface microorganisms into the vitreous cavity (22). Additionally, hypotony can trigger maculopathy, choroidal detachment, and choroidal hemorrhage (22,23). Acar et al. (15) reported hypotony rates of 26.12%, 17.11%, and 8.10% at 2 hours, 1 day, and 1 week respectively, following 25G TSV. Schweitzer et al. (24) highlighted hypotony as the most frequent complication (21.1%) on the first postoperative day after 23G TSV, noting its resolution within subsequent days. Reported rates of postoperative hypotony range from 0% to 5.3% in 27G TSV cases in adults, and 0% to 40% in children after 25G TSV, according to the study by WenTao et al. (25) Additionally, they found a 10.5% incidence of hypotony in pediatric patients undergoing 27G TSV. Given the higher susceptibility of pediatric eyes to postoperative hypotony, routine suture placement may be considered to enhance wound closure and maintain stable IOP in these pediatric cases. In our study, two patients in the sutureless group experienced transient hypotony on the first postoperative day, with recovery within a week. Notably, no complications associated with hypotony were observed, and IOP values showed greater consistency in the sutured group.

The risk of endophthalmitis has been reported to be higher in TSV compared to sutured 20G PPV (26). Factors such as reduced infusion flow, retained peripheral vitreous, insufficient scleral wound closure, early postoperative hypotony, and wound distortion due to eye rubbing contribute to the elevated risk of endophthalmitis following TSV (27-29). In a substantial case series, Kunimoto and Kaiser (30) reported endophthalmitis incidence of 0.018% in 20G PPV and 0.23% in 25G TSV, indicating a 12-fold higher risk with TSV. However, Oshima et al. (31) found no significant disparity in endophthalmitis incidence between 23G and 25G TSV and 20G PPV, attributing this favorable trend to stringent antiseptic protocols and suturing of sclerotomies. Shimada et al. (32) similarly reported a comparable incidence of endophthalmitis (0.03%) for 25G TSV and 20G PPV, noting peripheral vitreous removal, suturing of sclerotomy sites in cases of inadequate closure, and conjunctival irrigation as contributing factors to their differing results.

Visual acuity gradually improved over follow-up in both groups. In the sutured group, SIA decreased by the third postoperative month, resulting in the highest CDVA at that point. Nonetheless, no statistically significant difference was observed between the groups by the third postoperative month.

Study Limitations

It's important to note that this study is the first to compare the clinical outcomes of sutured and sutureless 25G PPV. However, it does carry limitations such as its retrospective design, relatively small sample size, variations in the tamponade use between the groups, and relatively short follow-up duration. Additionally, due to the rarity of certain complications, particularly endophthalmitis and choroidal detachment, the study was limited in comparing these aspects between the groups.

Conclusion

The study highlights that sutureless 25G PPV is linked to minimal changes in corneal astigmatism during both the early and late postoperative phases, in contrast to sutured 25G PPV, which demonstrated a notable increase in SIA. The study reaffirms the significance of sutures in impacting PPV-induced astigmatism, outweighing the influence of incision size. It's crucial to note that the SIA induced by sutures in 25G PPV is transient and that the effects resolve by the third postoperative month, whereas complications related to hypotony may have more enduring effects. Hence, surgeons should carefully evaluate individual risks and make

informed decisions regarding suture placement, especially in high-risk cases such as pediatric patients or those with high myopia.

Ethics

Ethics Committee Approval: The study was approved by the Clinical Research Ethics Committee of İstanbul Medeniyet University Göztepe Training and Research Hospital (approval no: 2022/0235, date: 13.04.2022).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions: Surgical and Medical Practices - E.D., V.A.; Concept - E.D., V.A., H.O.; Design - E.D., V.A., H.O.; Data Collection or Processing - E.D., A.K., G.D.Ş.; Analysis or Interpretation – E.D., F.E.; Literature Search - A.K., G.D.Ş.; Writing – E.D., A.K., F.E.

Conflict of Interest: No conflict of interest was declared by the authors.

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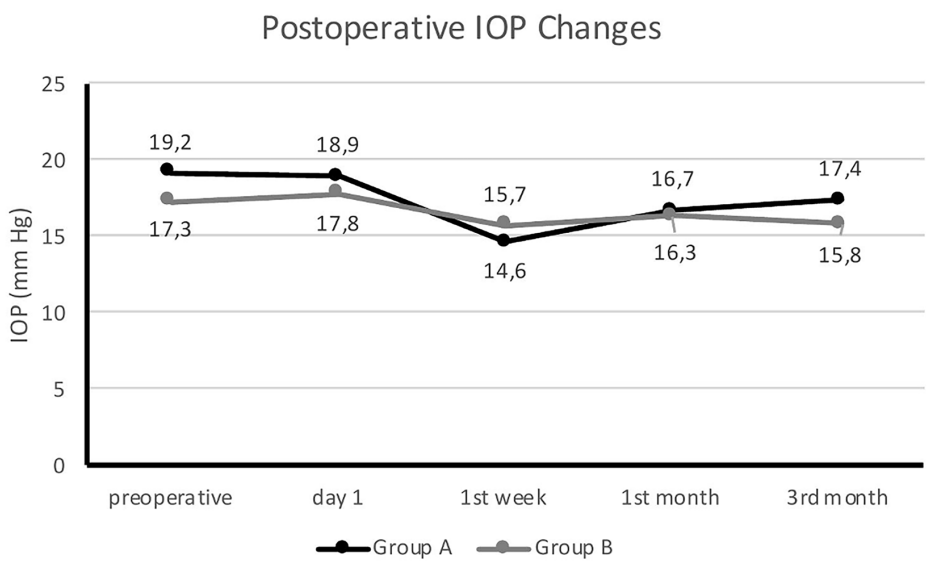

Supplementary Figure 1. Intraocular pressure (IOP) trends in the sutureless and sutured groups.
No statistically significant differences were observed between the groups at the follow-up visit ($p>0.05$)