Assessing tractional retinal detachment outcomes: A comparative analysis of 27-gauge and 25-gauge vitrectomy

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ABSTRACT

Purpose: To evaluate the surgical outcomes of 27-Gauge (G) and 25-G vitrectomy in patients with proliferative diabetic retinopathy (PDR) and tractional retinal detachment (TRD).

Materials and Methods: The study comprised a total of 41 patients. Preoperative data encompassed parameters such as the duration of diabetes mellitus (DM), HbA1c levels, gender, age, best corrected visual acuity (BCVA), central macular thickness (CMT), the severity of TRD. Post-surgical outcomes were regularly monitored for a minimum of 6 months.

Results: The mean age of patients in the 27-G and 25-G groups was 58.04±12.3 and 57.05±8.5 years, respectively. The mean duration of diabetes was 12.42±4.1 years, and the mean HbA1c level was 9.28±2.33 for all participants. The mean operation time was 93.65±20.8 minutes in the 27-G and 72.89±25.5 minutes in the 25-G group (p= 0.007). Significant changes were observed in both groups concerning BCVA and CMT; however, the degree of improvement was noted to be greater in the 25-G group compared to the 27-G group (p<0.05).

Conclusions: In both methods, significant changes were observed in anatomical and functional success. However, in the 25-G group, a notable difference was detected compared to the 27-G group in terms of BCVA improvement and reduction in CMT. It is evident that the utilization of 27-G unimanual PPV is considered a safe and effective approach in TRD surgery. Nevertheless, it is crucial to recognize that in specific cases, there may still be a requirement for the bimanual approach.

Keywords: Proliferative diabetic retinopathy, tractional retinal detachment, unimanual and bimanual ppv.

INTRODUCTION

The microincisional vitrectomy system (MIVS) was introduced two decades ago and has continuously evolved since its inception.[1-3] Initially, it was introduced as a 23-gauge (G) system, later incorporating 25-G and 27-G configurations into vitrectomy procedures.[4] The development of MIVS has brought about significant advantages, including self-sealing and sutureless wound healing, reduced conjunctival scarring and postoperative inflammation, along with improved visual outcomes and patient comfort.[5,6] The usage of 27-G pars plana vitrectomy (PPV), originally limited to simpler cases like epiretinal membrane (ERM), has now proliferated to encompass a wider spectrum of complex cases.[7-9]

Proliferative diabetic retinopathy (PDR) is a significant cause of vision loss, leading to complications such as vitreous hemorrhage (VH), tractional retinal detachment (TRD), and neovascular glaucoma. Despite the widespread use of panretinal photocoagulation and intravitreal injections of anti-vascular endothelial growth factor (VEGF), these conditions remain common in medical practice.[10] Hyperglycemia-induced changes in the vascular endothelium can result in increased vascular permeability, occlusion, and ischemia. VEGF molecules and other cytokines released by the ischemic retina play a crucial role in this process. The subsequent development of neovascular tissues and fibrotic membranes leads to gradual retinal surface shrinkage, potentially resulting in TRD. While various studies have addressed different approaches

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to TRD surgery, the instruments and tamponades used, and the effects of prior intravitreal anti-VEGF injections, there's a scarcity of sources comparing the effectiveness, safety, and postoperative differences between 25-G and 27-G vitrectomy in TRD.[11,12] Thus, our aim was to analyze the disparities between the 27-G and 25-G systems in TRD surgery secondary to PDR, encompassing intraoperative variations and postoperative findings.

MATERIALS AND METHODS

This study is a single-center, retrospective study conducted on eyes with TRD secondary to PDR that underwent PPV using 25-G or 27-G between May 2021 and June 2023 in the retina department of Basaksehir Cam and Sakura City Hospital. Ethics approval for this study was obtained from the Ethics Committee of Basaksehir Cam and Sakura City Hospital, Health Sciences University, Istanbul (approval code: E-96317027-514.10-232781491). The study was conducted following the principles of the Declaration of Helsinki. Informed consent was obtained from all participants.

Patients with a history of prior vitreoretinal surgical procedures, uveitis, known amblyopia, or a follow-up duration of less than six months after vitrectomy were excluded from the study. Preoperative data encompassed the duration of diabetes mellitus (DM), HbA1c levels, gender, age, lens status, macular involvement, the severity of TRD, and preoperative intravitreal anti-VEGF injections. At each visit, all patients underwent a comprehensive ophthalmological examination, including assessments of best-corrected visual acuity (BCVA) with a Snellen chart, biomicroscopic examination, intraocular pressure (IOP) measurement using Goldmann applanation tonometry (AT 900, Haag-Streit Diagnostics, Koeniz, Switzerland), detailed fundus examination, and optical coherence tomography (OCT) (Topcon Triton, Tokyo, Japan). These examinations were performed on the first day, at 2 weeks, and at 1, 3, and 6 months postoperatively.

Furthermore, intraoperative complications, such as iatrogenic retinal breaks, bleeding, suturing of the sclerotomy, and the utilization of instruments in the surgeries (e.g., micro-forceps, micro-scissors, chandelier lighting system), were meticulously recorded. The surgery time was defined as the duration between the insertion and removal of the trocars. Additionally, postoperative complications, including hypotony, glaucoma, vitreous hemorrhage, and choroidal detachment, were carefully noted.

The severity of TRD was graded following the criteria established in previous studies:[13]

Grade I: Multiple-point adhesion with or without one site plaque-like broad adhesion.

Grade II: More than one broad adhesion, however, fewer than three sites located posterior to the equator.

Grade III: More than three broad adhesion sites, located posterior to the equator or extending beyond the equator within one quadrant.

Grade IV: Broad adhesions extending beyond the equator for more than one quadrant.

Intravitreal bevacizumab (1.25 mg/0.05 ml) injections were administered to all patients three days before surgery. The surgeries were conducted by an experienced retinal surgeon (S. A. O.) under general anesthesia using the Constellation vitrectomy system (Alcon Laboratories, Fort Worth, Texas, USA) with the Eibos 2 noncontact wide-viewing system. All cases with 27-G PPV were initiated using the unimanual approach, while all cases with 25-G PPV were initiated using the bimanual approach. In instances where it was deemed necessary, a transition from the unimanual to the bimanual approach was performed. Cannulas were inserted into the inferotemporal, superotemporal, and superonasal quadrants. Core vitrectomy was performed in all cases, and triamcinolone-assisted posterior vitreous detachment was induced using the vitreous cutter's vacuum probe, followed by peripheral vitreous shaving. Fibrovascular membranes were segmented and dissected bimanually or unimanually. Internal limiting membrane (ILM) peeling was performed when necessary. Panretinal photocoagulation was applied, and silicone oil or perfluoropropane (C3F8) was used as endotamponade based on the number and location of retinal breaks and tractional fibrous membranes. Trocars were removed at the end of the surgery, and scleral wounds with leakage were closed using 8-0 vicryl sutures. Topical antibiotics (0.5% moxifloxacin), 1% prednisolone acetate, and a cycloplegic agent (0.5% tropicamide) were used for one month. Additionally, systemic steroids, antibiotics, or topical antiglaucomatous drops were initiated if necessary. Snellen BCVA values were converted to the logarithm of minimal angle of resolution (LogMAR) for statistical analysis. Counting fingers (CF), hand motion (HM), and light perception (LP) were assigned values of 2.0, 2.4, and 2.7 LogMAR, respectively.

Statistical analysis was performed using SPSS 22.0 software (IBM SPSS Statistics for Windows, Version

22.0. Armonk, NY: IBM Corp.). $p < 0.05$ was considered statistically significant. The Shapiro-Wilk test was used to assess data distribution. Descriptive statistics were presented as mean and standard deviation. Categorical variables were expressed as numbers and percentages. The Wilcoxon signed-rank test was used to compare two related samples. Group comparisons were conducted using the independent sample t-test or Mann-Whitney test, depending on the parametric or nonparametric distribution of the data, respectively. The chi-square and Fisher's exact tests were used to check nominal data. Pearson correlation analysis was employed for relational analyses.

RESULTS

Patient Characteristics

The study comprised a total of 41 eyes from 41 patients, with a mean follow-up period of 8.93 ± 2.03 months (ranging from 6 to 13 months). In the 27-G group, there were 23 patients, of whom 16 (69.6%) were male. Within the 25-G group, there were 18 patients, and 10 (55.6%) were female. Preoperatively, there were no significant differences between the 27-G and 25-G groups in terms of age, gender, duration of DM, HbA1c values, and the severity of TRD (Table 1). Additionally, there were no differences between the two groups concerning preoperative BCVA, IOP, CMT, the presence of cataract, or pseudophakia, and TRD grade.

Surgical Outcomes

The mean operation time was significantly shorter in the 25-G group compared to the 27-G group (72.89 ± 25.5 minutes vs. 93.65 ± 20.9 minutes, $p = 0.007$), as shown in Table 2. Additionally, there was a significantly lower rate of using micro-forceps, micro-scissors, and the chandelier lighting system in the 27-G group ($p < 0.001$, $p = 0.036$, and $p < 0.001$, respectively). In cases where 25-G PPV was performed, it was observed that surgeries involving the use of micro-scissors had a longer duration compared to those without (89.75 ± 23.1 vs. 59.4 ± 18.9 minutes, $p = 0.007$). In

Table 1: *Patient Demographics and Preoperative Data*

	27 Gauge (n=23) (%)	25 Gauge (n=18) (%)	Total (n=41) (%)	p
Age (year)	58.04± 12.3	57.05± 8.5	57.60± 10.7	0.70
Gender				
• Male	16 (69.6)	8 (44.4)	24 (58.5)	0.193
• Female	7 (30.4)	10 (55.6)	17 (41.5)	
Pre-op IOP (mm Hg)	15.3± 3.32	13.94± 3.48	14.7± 3.42	0.22
Pre-op BCVA in LogMAR				
• Mean ± SD	1.94± 0.53	2.15± 0.22	2.03± 0.43	0.37
• Range	1-2.7	2-2.7	1-2.7	
HbA1c				
• Mean ± SD	9.17±2.33	9.41±2.4	9.28±2.33	0.74
• Range	5.8-15.6	6.1-17.1	5.8-17.10	
Duration of DM (year)				
• Mean ± SD	13.26± 3.37	11.34± 2.25	12.42± 3.04	0.071
Pre-op CMT				
• Mean ± SD	508±323	521±141	547±258	0.813
Pre-operative Lens Status				
• Cataract	18 (78.3)	13 (72.2)	31 (75.6)	0.465
• IOL	5 (21.7)	5 (27.8)	10 (24.4)	
Severity of TRD				
• Grade 3	15 (65.2)	10 (55.6)	25 (61)	0.759
• Grade 4	8 (34.8)	8 (44.4)	16 (39)	

N: number, pre-op: preoperative, BCVA: best corrected visual acuity, IOP: intraocular pressure, LogMar: logarithm of the minimum angle of resolution, SD: standard deviation, Hba1c: hemoglobin A1c, DM: diabetes mellitus, CMT: central macular thickness, IOL: intraocular lens, TRD: tractional retinal detachment

Table 2: *Intraoperative Parameters*				
	27 Gauge (n=23) (%)	**25 Gauge (n=18) (%)**	**Total (n=41) (%)**	**p**
Operation time (minutes)				
• **Mean ± SD**	93.65 ± 20.9	72.89 ± 25.5	84.53± 25	0.007
Use of instruments				
• **Microforceps**	3 (13)	18 (100)	21 (51.2)	<0.001
• **Microscissors**	3 (13)	8 (44.4)	11 (26.8)	0.036
• **Chandelier**	4 (17.4)	18 (100)	22 (53.7)	<0.001
Endotamponade substance				
• **C3F8**	1 (4.3)	5 (27.8)	6 (14.6)	0.048
• **Silicone oil**	22 (95.7)	13 (72.2)	35 (85.4)	
Iatrogenic break	3 (13)	1 (5.6)	4 (9.8)	0.62
Wound suture number	12	25	37	<0.001
Combined Phaco-Ppv	17 (73.9)	13 (72.2)	30 (73.2)	1
N: number, SD: standard deviation, C3F8: perfluoropropane, Phaco: phacoemulsification, Ppv: pars plana vitrectomy				

the 27-G PPV group, surgeries where bimanual techniques were employed also had longer durations. In the 27-G PPV group, cases using the chandelier lighting system had an average operation time of 125.75 ± 13 minutes, compared to 86.9 ± 15.1 minutes in cases where it was not used (p = 0.001). Additionally, in the same group, a significant difference in surgery duration was found between cases using micro-forceps and micro-scissors and those that did not (131.67 ± 6.5 vs. 88 ± 15.4 minutes, p = 0.001).

In a total of 4 cases where PVR-C developed, with 3 of them belonging to the 27-G group, extensive retinectomy had to be performed. Peroperative drainage retinotomy was applied to one case from each group. In the case belonging to the 27-G group where retinotomy was performed, recurrence of retinal detachment was observed during follow-up. No difference was observed in the mean number of iatrogenic retinal breaks (p = 0.62). Furthermore, there was no significant distinction between the 27-G and 25-G groups in terms of the percentage of cases undergoing simultaneous cataract surgery (17 [73.9%] vs. 13 [72.2%], p = 1). In the 27-G group, 22 eyes (95.7%) required silicone oil, and 1 eye (4.3%) received C3F8 gas tamponade. In the 25-G group, 13 eyes (72.2%) needed silicone oil, while 5 eyes (27.8%) received C3F8. There was a significant difference in the type of endotamponade preference between the two groups (p = 0.048). At the end of the surgery, the 27-G group had a lower number of sutures for scleral wounds compared to the 25-G group (p = 0.001). Additionally, the time required for silicone oil removal was longer in the 27-G group than in the 25-G group (6.26 ± 2.09 months vs. 4.66 ± 1.41 months, respectively, p = 0.033). Importantly, during follow-up examinations, patients who underwent silicone oil removal did not exhibit any residual silicone oil in their eyes during their final visits.

Visual Outcomes

After surgery, the mean BCVA significantly improved in both groups (p = 0.035 for the 27-G group, p = 0.002 for the 25-G group, respectively). However, there was no significant difference in postoperative mean BCVA between the groups (p = 0.252). When assessing visual acuity improvements, significantly greater improvements were observed in the 25-G group (p = 0.039). Furthermore, there was a significant positive correlation between preoperative BCVA (p = 0.04, r = 0.320) and a negative correlation between the duration of silicone removal (p = 0.011, r = -0.476) and the duration of diabetes mellitus (DM) (p = 0.013, r = -0.387) with BCVA at the last postoperative visit. (Postoperative information is summarized in Table 3).

Anatomical Outcomes

Following the surgery, anatomical success was achieved in all eyes (100%) in both the 25-G and 27-G groups. However, it was observed that in one case from each group, recurrence of retinal detachment occurred after the first month. Both cases underwent re-PPV, and the retina was successfully reattached. Additionally, in the 25-G group, a significantly greater reduction in CMT was observed compared to the 27-G group (p = 0.02) (Table 3).

Table 3: *Postoperative Outcomes*				
	27 Gauge (n=23) (%)	**25 Gauge (n=18) (%)**	**Total (n=41) (%)**	**p**
Pre-op BCVA in LogMAR				
• Mean ± SD	1.94± 0.53	2.15± 0.22	2.03± 0.43	0.37
Post-op BCVA in LogMAR				
• Mean ± SD	1.36± 0.66 p: 0.035	1.14± 0.65 p: 0.002	1.27± 0.66	0.252
BCVA improving in LogMAR				
• Mean ± SD	-0.57	-1.005	-0.76	0.039
• Range	-1.7-0.7	-2-0	-2-0.7	
IOP				
• Ocular hypertension	0	1 (5.6)	1 (2.4)	0.439
• Ocular hypotony	0	2 (5.6)	1 (2.4)	0.187
Recurrent VH	1 (4.3)	0 (0)	1 (2.4)	0.561
Re-operation	0 (0)	0 (0)	0 (0)	
Post-operative CMT improvement				
• Mean ± SD	-100±361	-137±191	-117±197	0.02

N: number, pre-op: preoperative, BCVA: best corrected visual acuity, LogMar: logarithm of the minimum angle of resolution, SD: standard deviation, IOP: intraocular pressure, VH: vitreous hemorrhage, CMT: central macular thickness

Postoperative Complications

No cases of postoperative ocular hypotony or ocular hypertension were observed in the 27-G group. However, in the 25-G group, two patients experienced postoperative hypotony, and another patient had ocular hypertension (Table 3). In all cases, IOP elevations were successfully resolved with the use of anti-glaucomatous eye drops. Additionally, postoperative VH was detected in one patient in the 27-G group, but there were no indications for re-operation.

DISCUSSION

Initially, 27-G PPV was primarily employed for conditions such as ERM, idiopathic macular holes, and VH.[4] However, the scope of indications for 27-G vitrectomy has expanded to encompass more complex retinal disorders over the years, including RRD and PDR. Numerous studies have been conducted to compare the efficacy of these two systems in the management of these retinal conditions.[14-17] In our study, we aimed to evaluate and compare the surgical outcomes of 27-G and 25-G vitrectomy specifically in the context of PDR complicated by TRD.

In the current study, all retinas remained attached in both groups following the surgery, and this condition was consistently maintained throughout the follow-up, with only two exceptions. Consistent with prior research, our study demonstrated the absence of inferior anatomical outcomes in the 27-G group, confirming consistency with previous findings.[11,12,18] The average surgical duration was significantly longer in the 27-G group, in line with existing literature.[15,19] However, contrary to our findings, Chen et al. reported no significant difference in surgical duration.[12] Upon reviewing their study, it was observed that their patient sample included cases of TRD at all grades, whereas our study specifically focused on grade 3 and 4 cases. In cases where micro-scissors were used, it was found that the surgical duration was longer in both groups. Despite the lesser use of micro-instruments in the 27-G system, the longer surgical duration compared to the 25-G suggests that in grade 3-4 TRD cases, the bimanual approach might be superior to the unimanual approach. As diseases become more complicated, surgical durations tend to increase, and this effect might be particularly noticeable in the 27-G group. Sborgia et al. study revealed that there was no significant difference in vitreous removal time between the 25-G and 27-G groups for RRD. However, the total duration of surgery was longer in the 27-G group.[20] Additionally, these variances may be associated with the parameters considered during the calculation of surgical duration. Some studies assess only the duration of core vitrectomy and peripheral vitreous shaving, while others, including our study, evaluate the total duration of the surgery. Furthermore, variations in surgeons' experiences

with 27-G PPV could also contribute to these discrepancies. Moreover, considering that in 27-G vitrectomy, silicone oil is administered into the eye through a smaller diameter cannula, this may also be a factor affecting the duration of the surgery.

Removing existing fibrovascular membranes typically involves employing strategies such as segmentation, delamination, and bimanual techniques. Additionally, auxiliary tools like micro-forceps, micro-scissors, and chandelier lighting may be necessary. On the other hand, in 27-G, these membranes can be removed unimanually using the vitrector without the need for instruments such as micro-forceps. A small-caliber cutter can be placed in the space between the fibrovascular membrane and the retina, allowing the membrane to be divided into small pieces and then removed. As noted in previous studies, 27-G vitrectomy was used as a multifunctional tool and reduce the need for frequent instrument changes or different instruments in surgery.[16,17,21] However, it's important to note that the vitrector cannot entirely replace the role of micro forceps in tasks such as ERM and internal limiting membrane peeling. Moreover, in cases involving highly adherent fibrotic membranes, micro scissors and a chandelier lighting system still prove to be essential within the 27-G system. In addition, during membrane removal, iatrogenic retinal breaks were observed in three eyes of the 27-G group and one eye of the 25-G group. Postoperative VH was detected in only one eye. The low incidence of VH might be attributed to the preoperative intravitreal anti-VEGF injections administered to each patient, as mentioned in the literature.[21]

Previous studies have suggested a notably higher early visual gain in the 27-G PPV group compared to the 25-G group.[11,22] This outcome has been attributed to the 27-G method causing less inflammation, thus facilitating an early improvement in visual acuity. The reduced need for scleral sutures in the 27-G group can be particularly advantageous for promoting optimal wound healing in eyes with PDR. Since such eyes are prone to corneal epithelial defects either during or after surgery, maintaining a smooth ocular surface free from suture-related irritation can expedite ocular surface recovery. However, in our current study, we observed that both groups achieved a significant degree of visual and anatomical improvement, albeit with a higher change in visual acuity and CMT found in the 25-G group. Several factors, beyond surgical experience, may contribute to this outcome, including the inclusion of challenging TRD cases, especially those classified as grade 3 and 4, the duration of surgery, and the inflammatory reaction resulting from iatrogenic retinal breaks and retinectomies. The prolonged duration of silicone oil tamponade in the 27-G group, which may lead to silicone oil toxicity in the macula, could be considered as one of the contributing factors to these postoperative changes in both groups.

Compared to the 25-G system, the 27-G system, characterized by its smaller sphere of influence, facilitates membrane peeling without the frequent use of micro forceps. In theory, this reduced dependence on micro scissors and bimanual dissection techniques is anticipated to contribute to a reduced likelihood of iatrogenic enlargement of trocar entry sites. However, it's essential to acknowledge that factors such as the complexity of the surgical case, dissection and peeling of membranes extending from the posterior pole to the anterior retina, surgeon experience, and performing 360-degree panretinal photocoagulation can still occasionally lead to the expansion of the incision sites. This situation can potentially result in postoperative wound leakage, hypotony, VH, and even endophthalmitis. As demonstrated in various studies in the literature, our study observed a reduced need for suturing in the 27-G group.[7,14,21] Additionally, in some studies, it has been reported that hypotony is less frequently observed in the 27-G group compared to the 25-G.[19,23,24] In the current study, no eyes in the 27-G group experienced IOP fluctuation. However, hypotony was observed in two cases, while another case noted elevated IOP in the 25-G group. Differences in IOP between the groups were noticeable up to three months postoperatively, but no significant disparity was observed in the later period. Consistent with previous studies, no significant inter-group differences were detected during the six-month follow-up examinations. There were no cases of endophthalmitis in our cohort. It is possible to suggest that, in both surgical methods, the angle at which trocars were inserted into the sclera may impact this outcome.

The limitations of this study include its retrospective design and a limited patient sample size. The retrospective nature of the study restricted our ability to analyze specific surgical metrics, such as core vitrectomy and base vitrectomy times, due to inconsistent documentation in the patient records. However, the fact that all surgeries were performed by a single highly skilled surgeon eliminated variability associated with multiple surgeons. Furthermore, by deliberately including only grade 3 and 4 TRD, we ensured a more uniform cohort, allowing for a more detailed evaluation of outcomes in these complex cases.

CONCLUSION

In our study, we compared the anatomical and functional outcomes of 25-G and 27-G PPV performed on eyes with TRD but significantly greater improvements were observed in the 25-G group. It was demonstrated that 27-G vitrectomy took longer compared to 25-G; however, no significant intraoperative or postoperative complications were observed in either technique. It is considered that 27-G unimanual PPV can be utilized as a safe and effective method in TRD surgery. However, it should not be overlooked that there may still be a need for the bimanual approach in some cases.

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Conflicts of Interest

The authors declare that they have no conflict of interest.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent

The requirement for informed consent was waived by the local ethics committee.

Authors' role in this study was as follows:

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