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RETINAL DISORDERS

# Outcomes of 25-gauge vitrectomy for proliferative diabetic retinopathy

**Mahmoud Mohamed Farouk · Takeshi Naito · Khulood Mohammed Sayed · Toshihiko Nagasawa · Takashi Katome · Gamal Radwan · Ahmad Abdallah · Mohamed Elagouz**

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**Abstract**
*Background* To evaluate the efficacy and safety of 25-gauge transconjunctival sutureless vitrectomy (25-G TSV) in the management of vitreoretinal complications of proliferative diabetic retinopathy (PDR).
*Methods* A retrospective review of a noncomparative interventional case series including 200 eyes of 164 consecutive patients who underwent 25-G TSV for the management of PDR was performed. The main outcome measures were preoperative and postoperative visual acuity and intraocular pressure (IOP), the surgical success rate, and intraoperative and postoperative complications. All cases had a follow-up period of at least 6 months.
*Results* The mean logarithm of the minimum angle of resolution (LogMAR) visual acuity was significantly improved from 1.55 preoperatively to 0.72 at the final visit. No intraoperative complications related to the 25-G TSV procedure were recorded. Transient hypotony was recorded in 18 eyes (9%) on postoperative day 1 and 15 eyes (7.5%) on postoperative day 5. Two of these eyes (1%) had choroidal detachment on postoperative day 5. One case showed bacterial endophthalmitis after the second surgery. The single operation and final surgical success rates were 81.5% and 98% respectively.
*Conclusion* These outcomes of 25-G TSV showed its safety and efficacy in the management of PDR.

**Keywords** 25-gauge transconjunctival sutureless vitrectomy · Proliferative diabetic retinopathy

## Introduction

Small-incision surgical procedures have been developed in many disciplines, aiming to perform less traumatic operations that result in less patient discomfort and faster postoperative recovery. Fujii et al. [1, 2] described the use of a 25-gauge transconjunctival sutureless vitrectomy (25-G TSV) system, and found it applicable to a variety of vitreoretinal pathologies. Since that time, many investigators have reported successful results with 25-G TSV, its popularity has been rapidly increasing, and its indications continue to expand [2–7].

The sutureless nature of small-gauge vitrectomy leads to less traumatic surgical manipulation, less surgically induced astigmatism, and less postoperative patient discomfort, which facilitates early visual recovery [2–8]. However, this technique has been associated with a higher incidence of complications such as postoperative hypotony, choroidal detachment and endophthalmitis [9–13].

Initially, the use of 25-G TSV was limited to less complicated vitreoretinal procedures that did not require a

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M. M. Farouk · T. Naito (✉) · K. M. Sayed · T. Nagasawa · T. Katome
The Department of Ophthalmology and Visual Neuroscience, Institute of Health Biosciences,
The University of Tokushima Graduate School,
3-18-15 Kuramoto-cho,
Tokushima 770-8503, Japan
e-mail: naito@clin.med.tokushima-u.ac.jp

M. M. Farouk · K. M. Sayed · G. Radwan · A. Abdallah · M. Elagouz
The Department of Ophthalmology, Sohag Faculty of Medicine, Sohag University,
82524 Sohag, Egypt

more extensive vitrectomy, such as epiretinal membrane [14], macular hole [15], and uncomplicated vitreous hemorrhage [3, 4]. This was due to the flexibility of the instruments, making it unsuitable for complex procedures that required peripheral vitrectomy and more extensive manipulations during surgery. The instruments were also reported to bend or break during surgery [16, 17].

With the recent development of stiffer 25-G microsurgical instruments, such as forceps, scissors and directional endolaser probes, as well as the development of wide-angle illumination, more patients with complicated conditions, such as rhegmatogenous retinal detachment (RD), proliferative vitreoretinopathy, and diabetic tractional RD, are now being considered for 25-G TSV [18–24].

Vitreoretinal complications of proliferative diabetic retinopathy (PDR) are considered a challenge for 25-G TSV. Previous studies that reported the outcomes of 25-G TSV in these conditions included a limited number of cases [3, 18, 21–24]. The purpose of this study is to evaluate the efficacy and safety of 25-G TSV for the management of PDR.

## Materials and methods

### Patients

We retrospectively reviewed a consecutive series of 200 eyes of 164 patients who underwent 25-G TSV for the management of vitreoretinal complications of PDR at the Department of Ophthalmology, Tokushima University Hospital, from September 2006 to May 2009. The indications for vitrectomy included: (1) unresolved vitreous hemorrhage (VH) or severe premacular subhyaloid hemorrhage, (2) tractional RD affecting or threatening the macula, (3) tractional–rhegmatogenous RD, (4) progressive fibrovascular proliferations, and (5) neovascular glaucoma (NVG). The surgical indication was defined as the dominant cause of visual loss. Cases with previous vitrectomy or a follow-up period less than 6 months were not included in the study. All patients signed an informed consent form before intervention. Ethical committee approval to review patient data was obtained for this study.

### Methods

The medical records of patients were reviewed, and the following data were collected: patient age, gender, preoperative and postoperative Snellen visual acuity, intraocular pressure (IOP), and results of anterior segment and fundus examination as well as intraoperative and postoperative complications. Snellen visual acuities were converted into the logarithm of the minimum angle of resolution (LogMAR) score for data analysis. Hypotony was defined as an IOP of less than 8 mmHg [4, 11, 23], and an elevated IOP was defined as an IOP of more than 22 mmHg.

All operations were performed by one surgeon (T.N., T.N., T.K.) using the Naito 25-Gauge Cannula System (Duckworth & Kent Inc., Hertfordshire, UK), 25-G vitreous cutter (MidLabs, Inc.), the Millennium phacoemulsifier and vitrectomy system (Bausch and Lomb Japan Ltd, Tokyo, Japan) with Adaptable Enhancer (MidLabs, Inc.), and a Photon™ xenon light source (Synergetics, O'Fallon, MO, USA).

All patients underwent local monitored anesthesia care and received retrobulbar with subtenon anesthesia. Further topical anesthesia was administered during surgery as needed. The periocular skin was prepared with 5% povidone iodine solution. The conjunctival sac was irrigated by povidone–iodine solution, and then irrigated by balanced salt solution (BSS). The eye was prepared and draped in a standard fashion, and a lid speculum was placed. Insertion of the microcannula was performed before lens surgery in cases that underwent combined vitrectomy and phacoemulsification. The conjunctiva was displaced then fixed to the sclera with a fixation ring, and the incisions were made by inserting a 25-G microvitreoretinal (MVR) blade at a 30° to 40° angle through the conjunctiva, sclera and pars plana 3.5 mm from and parallel to the corneoscleral limbus to create an oblique scleral tunnel. The microcannulas, which are made of titanium and have a step to avoid slippage or loss, were then inserted through the conjunctival incision and into the scleral tunnel using a cannula inserter. Three microcannulas were inserted in the inferotemporal, superotemporal, and superonasal quadrants. The infusion catheter was connected to the inferotemporal cannula (which was the first to be inserted) and turned off until the beginning of the vitrectomy procedure.

Scleral tunnel lens surgery with intraocular lens implantation was then performed using a standard phacoemulsification technique in all cases with a visually significant cataract that precluded adequate visualization, and in all cases aged over 50 to avoid cataract progression.

Fundus visualization during vitrectomy was achieved using a hand-held, contact, self-irrigating viewing system (Ocular Hexagonal Vitrectomy Lenses, Ocular Instruments, Bellevue, WA, USA). A cut rate of 2,000 cuts/min and a vacuum level of 550 mmHg were used during vitrectomy. By 25-G TSV, all vitreous was removed, starting with core vitrectomy and then separation and removal of the posterior hyaloid (if not already separated). Intravitreal injection of suspension triamcinolone acetonide (Kenacort-A; Bristol Myers Co, Ltd, Tokyo, Japan) was applied for better visualization and complete removal of the posterior cortical vitreous. Dissection and removal of proliferative fibrovascular and epiretinal membranes were performed efficiently using the 25-G forceps, scissors and cutter. A bimanual technique with a chandelier lighting system was used in cases with tight membranes and epicenters. Transvitreal diathermy was used to coagulate bleeding vessels.

Peripheral shaving of the vitreous base was then performed with indentation. The peripheral retina was checked at the same time for breaks or fibrovascular tissue. A directional endolaser was used with indentation for panretinal photocoagulation (PRP) and photocoagulation around retinal breaks.

Fluid–air exchange with or without perfluoropropane gas or silicone oil injection were done according to the case specifics. In cases with silicone oil infusion, one sclerotomy site was converted to a 20-gauge diameter, and the silicone oil was injected through it with a 20-gauge cannula.

At the end of surgery, the microcannulas were simply removed from the scleral tunnels and the conjunctiva was pushed laterally using a cotton-wool applicator to separate its incision from the scleral incision. The infusion cannula was the last to be removed to maintain stability of the globe. Suturing of the sclerotomy sites was not performed except in cases with silicone oil infusion. The entry sites were checked for leakage or localized bleb formation by balanced salt solution (BSS), air, gas or silicone oil. A mixture of antibiotic (gentamicin, 40 mg/1 ml) and corticosteroid (dexamethasone, 1.65 mg/0.5 ml) was injected into the subconjunctival space. Topical antibiotic ointment was administered, and the eye was patched and shielded. Intraoperative complications and the methods of their management were recorded.

Patients were evaluated 1 day, 5 days, 1 month, 3 months and 6 months after surgery. At each follow-up, the following data were recorded: best-corrected visual acuity, IOP and findings of slit-lamp biomicroscopy of the anterior and posterior segments. Surgical success was defined as complete removal of vitreous opacities and preretinal proliferative membranes affecting or threatening the macula, with reattachment of the retina and preservation of vision of at least light perception.

### Statistical analysis

All analyses were performed using SPSS for Windows version 9.0 (SPSS, Inc., Chicago, IL, USA). Data were expressed as mean ± standard deviation (SD). A paired Student's *t*-test was used to make statistical comparisons between preoperative and postoperative LogMAR visual acuity and IOP. A proportion test was used to compare preoperative and postoperative proportions. A $P$-value$<0.05$ was considered as significant.

## Results

### Baseline and demographic data

Two hundred eyes of 164 patients (105 male and 95 female) with vitreoretinal complications of PDR underwent 25-G TSV. The mean age was 56.9±11.4 years (range 25–89 years). Table 1 summarizes demographic and base-line preoperative data of all patients. Some cases were found to have more than one type of pathology (e.g., tractional RD with vitreous hemorrhage). In these cases, the dominant cause of visual loss was considered as the surgical indication.

### Surgical data

Vitrectomy was combined with phacoemulsification in 156 eyes (78%). During the vitrectomy procedure, fibrovascular membrane dissection was performed in 92 eyes (46%). These included eyes with tractional RD affecting or threatening the macula, tractional–rhegmatogenous RD or progressive fibro-vascular proliferations, which were 59 eyes (29.5%), as well as some cases of vitreous hemorrhage with fibrovascular membranes, which were 33 eyes (16.5%). Iatrogenic retinal break during dissection was recorded in 29 eyes (14.5%) (representing 31.5% of eyes receiving membrane dissection). Endodiathermy was used for the control of bleeding during dissection in 14 eyes (7%). Directional endolaser with indentation was used for supplementary or primary PRP in all cases, with a mean

**Table 1** Demographic and base line preoperative data of all patients. SD, standard deviation; PEA, phacoemulsification; IOL, intraocular lens; ECCE, extracapsular cataract extraction; PRP, panretinal photocoagulation; RD, retinal detachment

| | | |
|---|---|---|
| Operated eye, number (%) | Right eye | 109 (54.5) |
| | Left eye | 91 (45.5) |
| Age (year), mean ± SD (Range) | | 56.9±11.4 (25–89) |
| Sex, number (%) | Male | 105 (52.5) |
| | Female | 95 (47.5) |
| Previous cataract surgery, number (%) | PEA with IOL | 24 (12 %) |
| | ECCE with IOL | 1 (0.5) |
| | ECCE without IOL | 1 (0.5) |
| | None | 174 (87) |
| Previous PRP, number (%) | Yes | 157 (78.5) |
| | No | 43 (21.5) |
| Lens status, number (%) | Cataract | 111 (55.5) |
| | Clear | 63 (31.5) |
| | Pseudophakia | 25 (12.5) |
| | Aphakia | 1 (0.5) |
| Surgical indication, number (%) | Vitreous hemorrhage | 124 (62) |
| | Preretinal hemorrhage | 6 (3) |
| | Tractional RD | 33 (16.5) |
| | Tractional rhegmatogenous RD | 6 (3) |
| | Progressive fibrovascular proliferation | 20 (10) |
| | Neovascular glaucoma | 11 (5.5) |

number of photocoagulation spots of 1,002±678.3. Retinotomy was performed to flatten the detached retina in two eyes (1%) and subretinal strand removal through artificial break was performed in another two eyes (1%).

Fluid–air exchange was not routinely performed at the end of every case. Intraocular tamponade was air in 66 eyes (33%), perfluoropropane gas in 44 eyes (22%) and silicone oil in 11 eyes (5.5%). The latter was injected by a 20-gauge needle through one enlarged sclerotomy that required suturing.

No intraoperative complications related to the 25-G TSV procedure were recorded. Conversion to 20-gauge vitrectomy was not needed in any case, and there was no detected leakage from the sclerotomy site requiring suture placement at the end of surgery (except for silicone oil-filled eyes). There was no recorded slippage of the microcannulas or deformity of instruments or cutter.

## Visual acuity outcomes

The mean overall LogMAR visual acuity was significantly improved from 1.55±0.98 preoperatively, to 0.72±0.83 at the final visit, 6 months postoperatively ($P<0.001$). There was also a significant improvement of visual acuity at 1 month and 3 months postoperatively. These results are summarized in Table 2. Sub-analysis of the mean LogMAR visual acuity of tractional/tractional–rhegmatogenous RD cases (39 eyes) showed statistically significant improvement from 1.54±1.08 preoperatively, to 0.99±0.82 at 3 months and 1.04±0.88 at 6 months postoperatively ($P=0.002$ and 0.005 respectively). However, there was insignificant improvement at 1 month postoperatively ($P=0.294$).

## Intraocular pressure outcomes

The mean overall preoperative IOP was 15.14±4.78 mmHg. The decrease in intraocular pressure was statistically significant on postoperative day 5 ($P<0.001$), but it was not significantly lower on postoperative day 1 ($P=0.08$). There was also no significant change in IOP at 1 month, 3 months and 6 months postoperatively, as shown in Table 3.

## Postoperative complications

Transient hypotony was reported in 18 eyes (9%) on postoperative day 1 and 15 eyes (7.5%) on postoperative day 5. Hypotony was associated with choroidal detachment in two of these eyes on postoperative day 5, which was spontaneously resolved in both cases within one week. One of these two cases showed persistent hypotony for 1 month, but IOP was normalized thereafter. All hypotony cases improved spontaneously and none of them required suture placement or additional volume infusion. We did not find a significant difference in the incidence of hypotony between fluid-filled and air/gas/silicone-filled eyes. Some cases with an elevated IOP more than 22 mmHg were recorded at all follow-up visits, but it was statistically significant only on postoperative day 1 (Table 3) and it was managed by topical and systemic hypotensive agents. Only three of these eyes (9.7%) were suffering from NVG, preoperatively.

Postoperative complications are summarized in Table 4. Early complications that can be attributed to the sutureless technique itself were choroidal detachment, bleb formation, subconjunctival gas, and subconjunctival silicone oil. Other early postoperative complications were persistent vitreous hemorrhage, hyphema, and anterior chamber fibrinous reaction.

None of the cases had bacterial endophthalmitis after the first vitrectomy, but one case showed bacterial endophthalmitis after the second vitrectomy, which was performed 3 months after the first vitrectomy for management of recurrent vitreous hemorrhage. Manifestations of endophthalmitis appeared on the fifth postoperative day in the form of hypopyon, anterior chamber fibrinous reaction and vitritis. Immediate management was by intravitreal antibiotics injection (vancomycin and ceftazidime) and obtaining vitreous and aqueous tap for bacterial culture. Results were positive for methicillin-resistant staphylococcus aureus (MRSA), which was sensitive to vancomycin. The same organism was isolated from conjunctival swab of the same eye. Endophthalmitis was managed successfully by intravitreal injection of antibiotics (2 times) without additional vitrectomy. Visual acuity improved from hand motion at presentation to 0.7 LogMAR visual acuity.

Late postoperative complications were RD, recurrent vitreous hemorrhage, anterior segment neovascularizations,

**Table 2** Preoperative and postoperative visual acuity results. LogMAR, logarithm of the minimum angle of resolution; SD, standard deviation

| | LogMAR mean ± SD (range) | *P*-value | Number of eyes (%) | | |
|---|---|---|---|---|---|
| | | | Improved | No change | Worsened |
| Preoperative | 1.55±0.98 (3 to 0) | | | | |
| Postoperative (1 m) | 0.88±0.91 (3 to −0.18) | <0.001 | 139 (69.5) | 19 (9.5) | 42 (21) |
| Postoperative (3 m) | 0.74±0.86 (3 to −0.18) | <0.001 | 149 (74.5) | 22 (11) | 29 (14.5) |
| Postoperative (6 m) | 0.72±0.83 (3 to −0.18) | <0.001 | 149 (74.5) | 23 (11.5) | 28 (14) |

**Table 3** Preoperative and postoperative IOP results. IOP, intraocular pressure; SD, standard deviation

| | IOP (mmHg) | | Hypotony[a] | | Elevated IOP[b] | |
|---|---|---|---|---|---|---|
| | Mean ± SD | *P*-value | Number (%) | *P*-value | Number (%) | *P*-value |
| Preoperative | 15.14±4.78 | | 2 (1) | | 10 (5) | |
| Postoperative | | | | | | |
| 1 day | 16.16±7.03 | 0.08 | 18 (9) | <0.001 | 31 (15.5) | <0.001 |
| 5 days | 13.42±5.88 | <0.001 | 15 (7.5) | <0.001 | 12 (6) | 0.33 |
| 1 month | 15.70±6.25 | 0.27 | 1 (0.5) | 0.28 | 14 (7) | 0.20 |
| 3 month | 15.90±5.94 | 0.11 | 0 | 0.07 | 13 (6.5) | 0.26 |
| 6 month | 16.08±5.96 | 0.09 | 0 | 0.07 | 13 (6.5) | 0.26 |

[a] Hypotony was defined as IOP< 8 mmHg

[b] Elevated IOP was defined as IOP> 22 mmHg

fibrovascular proliferations and epiretinal membrane formation (Table 4).

## Surgical success

Overall surgical success was achieved in 163 eyes (81.5%) after one vitrectomy operation, 24 eyes (12%) after two vitrectomy operations, four eyes (2%) after three vitrectomy operations, and five eyes (2.5%) after more than three vitrectomy operations. Four eyes (2%) had lost light perception as a result of refractory NVG due to postoperative development of angle neovascularizations. Neovascular glaucoma developed in these cases, despite complete intraoperative PRP and repeated vitrectomy surgeries as indicated. The final surgical success rate was 98% and the total number of 25-G TSV surgeries performed for the 200 eyes was 238 operations. The surgical success rates according to the indication for surgery are summarized in Table 5. Among the 11 cases with NVG, two eyes required trabeculectomy and three eyes still had a high IOP.

**Table 4** Early and late postoperative complications. Data are presented as number (%) of cases

| Early postoperative complications | 1day | 5 days | |
|---|---|---|---|
| Choroidal detachment | 0 | 2 (1) | |
| Bleb formation | 2 (1) | 3 (1.5) | |
| Subconjunctival gas | 2 (1) | 1 (0.5) | |
| Subconjunctival oil | 1 (0.5) | 0 | |
| Endophthalmitis | 1 (0.5)[a] | 0 | |
| Anterior segment fibrin | 9 (4.5) | 6 (3) | |
| Non-infectious endophthalmitis | 0 | 1 (0.5) | |
| Hyphema | 6 (3) | 1 (0.5) | |
| Vitreous hemorrhage | 30 (15) | 33 (16.5) | |
| Late postoperative complications | 1 month | 3 months | 6 months |
| Retinal detachment | 9 (4.5) | 10 (5) | 9 (4.5) |
| Recurrent vitreous hemorrhage | 22 (11) | 8 (4) | 7 (3.5) |
| Neovascularizations (angle and/or iris) | 0 | 10 (5) | 7 (3.5) |
| Fibrovascular proliferation | 0 | 2 (1) | 1 (0.5) |
| Epiretinal membrane | 0 | 2 (1) | 5 (2.5) |

[a] The case of endophthalmitis was reported on postoperative day 1 after the 2nd vitrectomy, which was performed 3 months after the 1st vitrectomy

## Discussion

This study reports the results of a retrospective analysis of the use of 25-G TSV in the management of vitreoretinal complications of PDR. To date, there is little information about the use of 25-G TSV in the management of vitreoretinal complications of PDR, and the number of cases is still limited [3, 18, 21–24]. In a study by Shimada et al. [25], PDR had not been considered a good indication for 25-G TSV. However, improvement in instrumentation, as well as the experience of surgeons, facilitated the expansion of the indications for 25-G TSV to involve such complex vitreoretinal procedures [18, 21, 24, 25].

Currently, most microsurgical instruments, such as scissors, forceps, straight and directional endolaser probes, and brighter illuminators using a xenon light source, are available as 25-gauge instruments. In our study, it was possible to achieve all surgical goals using 25-G instruments, including difficult ones such as complete removal of fibrovascular tissue and densely organized blood clots, peripheral shaving of the vitreous and laser photocoagulation of the peripheral retina. In previous reports [4, 9, 23], these difficult steps were considered to be a barrier against the use of 25-G TSV in complex surgeries. We have used the 25-G vitreous cutter (MidLabs, Inc.) for fibrovascular membrane removal in most cases, as this type of cutter has high performance in terms of cutting rate (2,500 cycle/minute), flow rate (7.3 ml/minute) and duty cycle (39%) [24]. 25-G scissors and forceps with or without a bimanual technique and chandelier lighting system were used in a small number of cases with tight membranes and epicenters.

In a study by Lakhenpal et al. [3], sclerotomy site enlargement and suture placement at the end of surgery were needed to facilitate passage of instruments for

**Table 5** The surgical success rates according to the indication for surgery. Data are presented as number (%) of cases in each group

| Anatomical Success | VH | tRD | trRD | PFVP | PRH | NVG |
|---|---|---|---|---|---|---|
| After one vitrectomy | 107(86.3) | 22(66.7) | 5(83) | 16(80) | 3(50) | 11(100) |
| After two vitrectomies | 12(9.7) | 5(15.2) | 1(17) | 2(10) | 2(33.3) | 0 |
| After three vitrectomies | 1(0.8) | 1(3) | 0 | 2(10) | 1(16.7) | 0 |
| After more than three vitrectomies | 1(0.8) | 4(12.1) | 0 | 0 | 0 | 0 |
| Lost eyes (no LP) | 3(2.4) | 1(3) | 0 | 0 | 0 | 0 |

VH, vitreous hemorrhage; tRD, tractional retinal detachment; trRD, tractional rhegmatogenous retinal detachment; PFVP, progressive fibrovascular proliferations; PRH, preretinal hemorrhage; NVG, neovascular glaucoma; LP, light perception

membrane dissection. Such a step was not needed in our operations, due to the availability of 25-G instruments. However, in a few cases (5.5%) that needed silicone oil infusion, we enlarged one sclerotomy site at the end of surgery to allow silicone oil injection using a 20-G cannula, which was followed by suture placement to prevent leakage. This drawback can be avoided by the use of a special 25-G cannula for silicone oil injection, as reported by Altan et al. [18] or even by the use of a 24-G angiocatheter with a rigid 25-G stylet needle as reported by Riemann et al. [19].

We encountered iatrogenic retinal tears in 31.5% of cases that needed membrane dissection. This incidence compares favorably with the results reported by Altan et al. [18], in which iatrogenic retinal breaks were reported in 28.5% of cases with diabetic tractional retinal detachment treated by 25-G TSV. This complication cannot be solely attributed to 25-G instruments, as most of these cases had preoperative advanced pathology. On the other hand, none of these cases suffered from RD postoperatively, because all iatrogenic breaks were properly treated intraoperatively by endolaser photocoagulation and proper tamponade.

Previously, some problems were associated with the use of a polyamide microcannula, such as deformities during insertion and slippage during instrument withdrawal [9]. In our series, we used Naito 25-Gauge cannulas, which are made of titanium and have a step to avoid slippage or loss [22]. With this unique design, these complications were not reported in any operation.

The sutureless nature and the possibility of wound leakage after 25-G TSV increases the risk of postoperative hypotony, choroidal detachment and endophthalmitis. Transient hypotony during the first postoperative week was one of the most commonly reported complications of 25-G TSV in previous studies [4, 9, 11, 23, 26, 27], with the incidence ranging from 1.8% [27] to 16% [9]. Some of these studies reported that the incidence after 25-G TSV was higher than after 20-G vitrectomy [11, 26]. Peripheral vitrectomy in eyes with PDR was considered by Shimada et al. [25] as a factor increasing the risk of postoperative hypotony (11%), and for this reason they considered PDR to be an unsuitable indication for 25-G TSV. In our study, we reported an incidence of 9% and 7.5% of hypotony on postoperative days 1 and 5 respectively, which is not markedly different from the results reported by Shimada et al. [25]. However, we do not consider this complication to be significant enough to exclude PDR as an indication for 25-G TSV. It was transient, improved spontaneously without interventions and did not lead to a vision-threatening complication, as only two eyes (1%) suffered from transient choroidal detachment. Shimada et al. [25] found that hypotony is more common in eyes without fluid–air/gas exchange, and this was not the case in our study, as we did not find a relation between the occurrence of postoperative hypotony and fluid–air exchange. Altan et al. [18] reported a higher incidence of hypotony (21%) 2 hours after 25-G TSV for diabetic tractional RD, and he defined hypotony as IOP of 5 mmHg or less. In our study, we considered hypotony as IOP less than 8 mmHg, which is higher than their limit; however, we reported a lower incidence on postoperative day 1. This difference can be explained by the earlier time of IOP measurement (2 hours postoperatively) in the Altan et al. study. This demonstration points to the importance of early evaluation of IOP after 25-G TSV. Yang et al. [21] reported transient hypotony on postoperative day 1 in one eye (2.2%) of 45 eyes that underwent 25-G TSV for vitreoretinal complications of DM. He used non-beveled scleral entry in all cases, and air tamponade in only eight eyes (17.8%). He reported a lower incidence of transient hypotony than in our study, where we used an oblique cannula insertion technique, which has been reported to decrease the incidence of early postoperative hypotony [27]. This variation between studies in the incidence of transient hypotony after 25-G TSV for PDR points to the presence of some factors other than the technique of cannula insertion and the type of intraocular tamponade. These factors may be related to the surgery itself, such as the extent of peripheral vitrectomy, the degree of manipulation and exchange of instruments through the microcannula, which may cause deformation of the scleral tunnel.

In our study, the number of cases with elevated IOP was statistically significant on postoperative day 1 only. This

explains why the mean IOP on this day was not statistically significantly different from the preoperative IOP, despite the presence of a significant number of cases with hypotony. This was not the case on postoperative day 5, where the percentage of cases with elevated IOP was insignificant. Early detection and management of an elevated IOP is very important in diabetic patients, as they are susceptible to vision loss due to impaired perfusion of the optic disc and retina. We managed all cases with an elevated IOP with topical and systemic medications, starting from postoperative day 1.

In a few cases in our series, we found subconjunctival bleb (1.5%) and gas (1%). In one case, we found subconjunctival silicone oil droplet on day 1, which disappeared spontaneously on day 5. According to a study by Cunha et al. [28], silicone oil may be detected in the conjunctiva or subconjunctival space by histopathologic examination, even if biomicroscopic examination seems to be normal. This may explain silicone oil droplet disappearance on day 5 in our case. These wound sealing related complications have also been reported in other studies [3, 18, 19, 22]. None of our cases showed continuous egress of fluid, gas or oil. Therefore, postoperative suture placement was not needed in our series.

The most devastating complication related to the sutureless nature of 25-G vitrectomy is bacterial endophthalmitis. Three comparative studies [10, 29, 30] reported a statistically significant 12-fold [10] to 28-fold [30] higher incidence of endophthalmitis in 25-G TSV than in 20-G vitrectomy. They consider the higher rate of early postoperative hypotony, the sutureless nature of the wound, the presence of residual vitreous, and the less vigorous flow through the 25-G infusion as factors contributing to this higher incidence of endophthalmitis with 25-G TSV. In our study, one eye suffered from bacterial endophthalmitis after the second vitrectomy surgery, which was performed 3 months after the first one, for management of recurrent VH. Considering the operative and medical reports of this case, the recommended approaches to decrease the incidence of endophthalmitis [10] were carried out, such as irrigation of the conjunctival sac with povidone iodine solution before surgery, conjunctival displacement with beveled cannula insertion, complete removal of the vitreous, inspection of the wound at the end of surgery to detect leakage and vitreous incarceration, ensuring that the conjunctiva was covering the sclerotomy site, and injection of subconjunctival antibiotics at the end of surgery. Intraocular tamponade with air was done at the conclusion of surgery. Kunimoto and Kaiser [10] considered that an air- and gas-filled vitreous cavity provides superior wound integrity compared to a fluid-filled eye, as all endophthalmitis cases in their study were fluid-filled. Moreover, in the postoperative period of our endophthalmitis case, IOP was 15 mmHg on postoperative day 1, and the photograph of the sclerotomy sites showed that they were well-covered by the conjunctiva. Therefore, we could not detect a link between the sutureless technique and the occurrence of endophthalmitis in our case. Scott et al. [30] reported that endophthalmitis after 25-G TSV was usually due to coagulase-negative staphylococci; however, the isolated causative organism in our case was MRSA.

Shimada et al. [31] reported that there was no significant difference between endophthalmitis rates after 25-G or 20-G vitrectomy. Their recommendations for the prevention of endophthalmitis were the same as used in our protocols. On the other hand, Scott et al. [30] considered diabetic patients as having a relative immune compromise putting them at greater risk of endophthalmitis, especially with the use of multiple intraocular instruments in such complex surgery. Therefore, diabetes mellitus may be a contributing factor in our endophthalmitis case. We still, however, are not sure whether the 25-G TSV played a role in this complication.

Not all postoperative complications in our series were attributed to the 25-G sutureless technique itself, but were more related to the progression of the disease process. These include progression of fibrovascular proliferation, recurrent vitreous hemorrhage, retinal detachment, and anterior segment neovascularizations.

The limitations of our study include retrospective analysis and lack of comparison with a control group to compare the results with 20-gauge and 23-gauge vitrectomy. A well-controlled prospective case series could provide a more definitive conclusion.

In conclusion, our study demonstrates that 25-G TSV is an effective and safe procedure for the management of vitreoretinal complications of PDR. This is due to improvement in techniques, instrumentation and surgeon experience, which allows this minimally invasive sutureless technique to be applicable for complex vitreoretinal surgeries and to not be limited to simple procedures as thought previously. Some complications related to the sutureless nature of 25-G TSV have been reported, but we believe that they do not prevent its use in PDR, and with further improvements in techniques and instruments, they can be avoided.

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