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Original Article

Comparison of the 20-Gauge Conventional Vitrectomy Technique with the 23-Gauge Releasable Suture Vitrectomy Technique

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Purpose: To compare the efficacy of the transconjunctival releasable suture technique for pars plana vitrectomy using 23-gauge (23G) instruments versus the conventional 20-gauge (20G) technique.

Methods: A retrospective and interventional case series was consecutively performed for 199 eyes of the 192 patients that were a part of this study. Clinical data were reviewed retrospectively regarding the operation time, preoperative and postoperative intraocular pressure, visual acuity and astigmatism for 54 consecutive patients who received a 23G releasable suture vitrectomy and for 98 consecutive patients who received a 20G conventional vitrectomy during the period between April 2007 and September 2010.

Results: Mean operation time based on the operation record was 88.5 ± 20.1 minutes in the 23G releasable suture vitrectomy group and 102.1 ± 23.1 minutes in the 20G conventional vitrectomy group, respectively (p = 0.01). The last best-corrected visual acuity (BCVA) was significantly better than the preoperative BCVA in both patient groups (p = 0.01, p = 0.01). The 23G releasable suture group showed less surgically induced astigmatism than the 20G conventional vitrectomy group. Vitreous bleeding was observed to be in 6 eyes (5.9%) in the 23G group, and in 8 eyes (8.2%) in the 20G group. In addition, ocular hypertension was noted to be in 3 eyes (3.0%) in the 23G group, and 6 eyes (6.1%) in the 20G group. No serious complications such as postoperative hypotony or endophthalmitis were observed in either group.

Conclusions: The 23G releasable suture technique is as effective as the 20G conventional technique and offers several advantages.

Key Words: Vitrectomy, Vitreoretinal surgery

The 23-gauge (23G) transconjunctival sutureless vitrectomy (TSV) technique was introduced as a less invasive method than the conventional 20-gauge (20G) vitrectomy [1]. Although the 23G TSV offers several advantages such as less surgical trauma, less inflammation and faster early recovery, it has the disadvantage of association with hypotony [2,3].

In the present study, we investigated the efficacy of using the releasable suture technique for the prevention of incompetent wound closure in 23G TSV. We compared the clinical outcomes of this releasable suture 23G vitrectomy with the conventional 20G vitrectomy.

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Materials and Methods

This study is a retrospective, consecutive and interventional case series. The medical records of 199 eyes were included in this study, 192 patients had undergone vitrectomy by either the 23G releasable suture vitrectomy method or 20G conventional vitrectomy method. Fifty-four consecutive cases (53 patients) who received a 23G releasable suture vitrectomy during the period between November 2008 and September 2010 were included in the 23G releasable suture vitrectomy group; and 98 consecutive cases (96 patients) who received a 20G conventional vitrectomy during the period between April 2007 and December 2008 were included in the 20G conventional vitrectomy group. These patients were followed for at least 6 months after

the operation. The potential benefits and possible risks of the technique were explained to the patients, and informed consent was obtained in accordance with the Helsinki Declaration. Approval for this study was obtained from the appropriate institutional review board.

Exclusion criteria

Patients were excluded from the study if they had any past history of an ocular surgery. The patients who needed the combined buckling procedure were also excluded from the study. Fifty-four cases underwent a releasable suture and 45 cases did not in the 23G releasable suture vitrectomy group. Cases that had not received this technique were not used to compare visual acuity, intraocular pressure, surgically induced astigmatism, postoperative pain score, and anterior chamber depth and chamber volume.

The conventional 20-gauge vitrectomy technique

All eyes underwent combined phacoemulsification by temporal clear corneal microincision (2.2 mm). In the conventional vitrectomy group, the standard technique that was used involved conjunctival peritomy, a 20G straight scleral incision, and closure of both the sclera and conjunctiva with 7.0 vicryl at the end of the surgery.

The 23-gauge releasable suture vitrectomy technique

A 0.72 mm-wide 23G stiletto blade (45° angle; BD Medical-Ophthalmic Systems, Franklin Lakes, NJ, USA) was inserted at a 5° to 15° angle through the conjunctiva, sclera and pars plana approximately 3.5 mm from the limbus. A pneumatic vitreous cutter was used with a vitrectomy unit (Accurus; Alcon Surgical, Fort Worth, TX, USA). All eyes underwent combined phacoemulsification through a temporal clear corneal microincision (2.2 mm). Combined phacoemulsification and posterior chamber intraocular lens implantation through a clear corneal incision was performed in 101 eyes. All the cataract procedures were finished prior to the placement of the sclerotomy incisions. A temporary 10-0 nylon suture was used at the clear cornea incision; this helped to prevent anterior chamber collapse during the cannula insertion procedure. Patients with one or more idiopathic macular holes underwent internal limiting membrane peeling.

Transient wound leakage occurred frequently in the period immediately after removal of the instruments and infusion cannula. Wound leakage was treated by the application of pressure on the posterior aspect of the beveled wound (the side of the external wound over the sclera tunnel) for a few seconds to facilitate self-sealing of the wound. In cases of continued leakage, both conjunctival and scleral incision sites were closed using single releasable 8-0 monofilament nylon sutures (Ethicon Inc., Somerville, NJ, USA). The sutures were released within 12 hours of surgery by pulling gently with forceps under topical anesthesia and slit lamp illumination.

Intraoperative time measurement

The opening time was defined as the time of speculum insertion and the closing time was defined as the time of speculum removal. The surgical operative time was defined as the interval between the opening and closing time.

Best-corrected visual acuity

The Snellen visual acuity was converted into a logarithm of the minimum angle of resolution score for analysis.

Intraocular pressure

Intraocular pressure (IOP) was measured by Goldmann applanation tonometry.

Astigmatism change

Astigmatism was measured by automatic keratometry (Auto Ref-Keratometer KR-8800; Topcon, Tokyo, Japan). The corneal topography, anterior chamber depth and volume were assessed in the 23G group using a Pentacam (Oculus Inc., Wetzlar, Germany). Automatic keratometry results and simulated K-values for corneal topography were calculated by using vector analysis; these values were used to analyze surgically induced astigmatism [4]. Surgically induced changes were determined at every point by calculating the difference between preoperative and postoperative corneal refractive power.

Patient discomfort

Patients were interviewed to assess any postoperative discomfort such as pain and sensation of the presence of a foreign body. The level of discomfort was evaluated at each visit using a 4-point (0 to 3) numerical visual analogue scale. The scale consisted of a linear line subdivided into 3 equal intervals, with the leftmost interval marked as 0, indicating no symptoms, and the rightmost interval marked as 3, indicating the worst symptoms imaginable. Verbal description of the visual analogue scale was provided for patients who did not have sufficient vision to read the scale.

Statistical analysis

Statistical analyses were performed using SPSS ver. 12.0 (SPSS Inc., Chicago, IL, USA). Wilcoxon signed rank test,

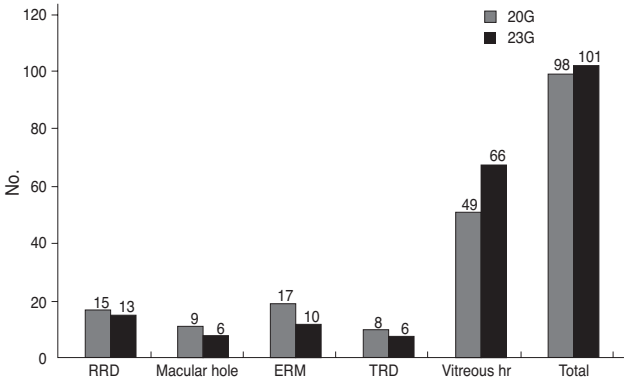


Fig. 1. Indications of surgery in the 20-gauge (20G) and 23-gauge (23G) groups. RRD = rhegmatogenous retinal detachment; ERM = epiretinal membrane; TRD = tractional retinal detachment; hr = hemorrhage.

Mann Whitney's *U*-test, and Fisher's exact test were used to evaluate statistical significance, and *p*-values less than 0.05 were regarded to be statistically significant.

Results

A total of 199 eyes of the 192 patients, consisting of 105 females (54.7%) and 87 males (45.3%) were included in this study. The mean age of the study patient population was 54.9 ± 11.7 years (range, 31 to 71 years).

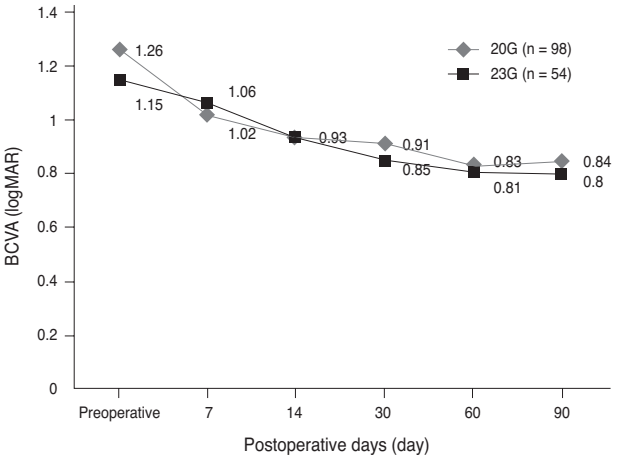
With respect to the underlying disease, vitreous hemorrhage was the most common, being found in 115 (57.8%) of the eyes. Among those, 103 (51.8%) eyes had vitreous hemorrhage due to diabetic retinopathy and 12 (6.0%) eyes had vitreous hemorrhage due to a host of retinal vascular diseases. A total of 28 (14.1%) eyes had rhegmatogenous retinal detachment, 27 (13.6%) had an idiopathic epiretinal membrane, 15 (7.5%) had a macular hole, and 14 (7.0%) study patients had experienced tractional retinal detachment (Fig. 1).

Time for surgery

The mean operation time was 88.5 ± 20.1 in the 23G releasable suture group and 102.1 ± 23.1 minutes in the 20G conventional group, respectively ($p = 0.01$, *t*-test).

Best-corrected visual acuity

Both groups showed improvement in the mean best-corrected visual acuity test; from 1.15 ± 0.23 preoperatively to 0.80 ± 0.29 at 90 days postoperatively in the 23G group; and from 1.26 ± 0.19 preoperatively to 0.84 ± 0.25 at 90 days postoperatively in the 20G group ($p = 0.01$, $p = 0.01$) (Fig. 2).



	p–value (Wilcoxon's signed rank test)				
20G	0.22	0.08	0.07	0.01	0.01
23G	0.26	0.12	0.03	0.01	0.01

Fig. 2. Postoperative visual acuity changes. BCVA = best-corrected visual acuity; logMAR = logarithm of the minimum angle of resolution; 20G = 20 gauge; 23G = 23 gauge.

Intraocular pressure

There was no statistically significant difference in the mean values of IOP postoperatively between the two groups (Table 1).

Astigmatism changes

Patients who underwent the 23G releasable suture vitrectomy technique (the 23G releasable suture group) had less severe astigmatism during the postoperative period than patients who underwent the conventional 20G vitrectomy (the 20G group) one week following the operation ($p = 0.01$, Mann-Whitney *U*-test). Statistical analysis showed that the keratometric values for the two groups were similar at baseline ($p = 0.56$), but were higher in the 20G group at 1 week post-operation. These values returned to the preoperative levels in both groups 1 month after surgery (Table 2).

Patient discomfort

Postoperative subjective discomfort assessment showed that the 23G releasable suture group experienced less discomfort at postoperative day 1 than the 20G patients ($p = 0.01$) (Fig. 3).

Suture rate and the number of sutures

In the 23G vitrectomy group, 86 of the 303 sclerotomies (28.4%) required sutures due to prolonged leakage. The

Table 1. Postoperative intraocular pressure change

Postoperative days (day)	20 Gauge (n = 98)		23 Gauge (n = 54)	
	IOP (mmHg ± SD)	*p*-value*	IOP (mmHg ± SD)	*p*-value*
Preoperative	15.6 ± 2.7		15.2 ± 3.1	
1	20.1 ± 6.3	0.08	19.5 ± 6.1	0.07
3	14.9 ± 2.9	0.56	14.3 ± 2.7	0.42
7	14.8 ± 2.8	0.65	15.0 ± 2.2	0.48
14	15.4 ± 2.3	0.76	15.2 ± 2.1	0.41
30	15.6 ± 2.1	0.54	15.8 ± 1.9	0.43

IOP = intraocular pressure; SD = standard deviation.
*Wilcoxon signed rank test.

Table 2. Surgically induced astigmatism at each postoperative time interval in a 5-mm zone

	1 wk	2 wk	1 mon	2 mon	3 mon
20 Gauge (n = 98)	0.68 ± 1.10	0.27 ± 0.69	0.08 ± 0.63	0.04 ± 0.68	0.04 ± 1.23
23 Gauge (n = 54)	0.38 ± 0.75	0.28 ± 0.68	0.06 ± 0.35	0.04 ± 0.40	0.06 ± 0.42
p-value*	0.03	0.56	0.51	0.78	0.37

Values are presented as mean ± SD (D).
*Mann-Whitney *U*-test.

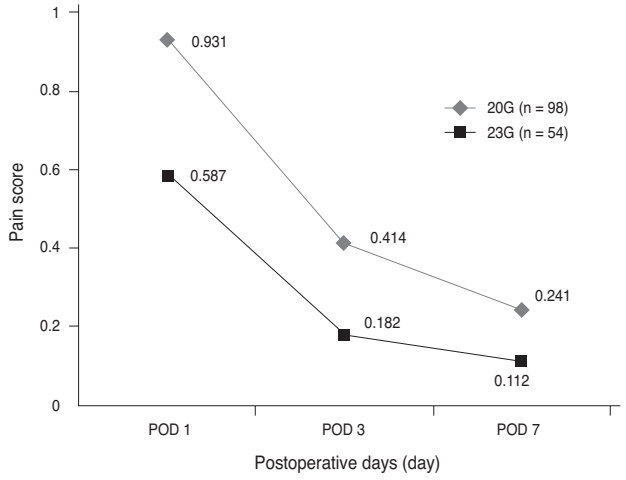


Fig. 3. Comparison of the postoperative pain scores between the 23-gauge (23G) group and the 20-gauge (20G) group. *p*-value of Mann-Whitney *U*-test: 0.04 (post operation day, POD 1), 0.12 (POD 3), and 0.37 (POD 7).

Table 3. Comparison of the sutures at the sclerotomy sites during postoperative time, in the 23-gauge group

	No. of suture (±SD)	*p*-value*
DM	1.04 ± 0.48	0.04
No DM	0.57 ± 0.21	
Total vitrectomy	1.04 ± 0.54	0.01
Partial vitrectomy	0.50 ± 0.35	

SD = standard deviation; DM = diabetes.
*Mann-Whitney *U*-test.

mean number of sutures required was 0.85 per case. Diabetic patients required a mean of 1.04 sutures per case, while non-diabetic patients required a mean of 0.57 sutures per case ($p = 0.04$). A core vitrectomy was performed in the cases of macula holes and idiopathic epiretinal membranes, and a total vitrectomy was performed in the cases of retinal detachment and diabetic retinopathy. The mean number of sutures used was 0.50 in the core vitrectomy group and 1.04 in the total vitrectomy group ($p = 0.01$) (Table 3). When the patients in the total 23G vitrectomy group were divided into the no releasable suture group and the releasable suture group, there was a significant difference in the number of patients who received each type of operation and the underlying disease present (Table 4). There was no significant difference in the final surgical outcome in the suture and sutureless groups, in the 23G group (Table 5).

Postoperative complications

Withdrawal of cannula occasionally resulted in minor subconjunctival bleeding or accumulation of liquid in the area of the sclerotomy. Applying pressure with a cotton-wool applicator stopped the bleeding. Six eyes (5.9%) in the 23G group and 3 eyes (3.0%) in the 20G group exhibited slight bleeding into the vitreous cavity in the days immediately following the surgery. None of the eyes used in the study had an IOP of <12 mmHg on any of the postoperative days. The preoperative mean anterior chamber depths and volumes were found to be similar to the postoperative mean depths and volumes in the 23G group ($p \geq 0.05$ for

Table 4. Comparison of the number of patients in the suture group and the sutureless group, for the 23-gauge group (n = 101)

	DM	No DM	*p*-value*	Total	Partial	*p*-value*
Suture group	43 (66.2)	11 (30.6)	0.01	50 (63.3)	4 (18.2)	0.01
Sutureless group	22 (33.8)	25 (69.4)		29 (36.7)	18 (81.8)	
Total	65 (100.0)	36 (100.0)		79 (100.0)	22 (100.0)	

Values are presented as number (%).
DM = diabetes
*Fisher's exact test.

Table 5. Comparison of the final surgical outcomes in the suture and sutureless groups, in the 23-gauge group

	Suture group (n = 54)	Sutureless group (n = 47)	*p*-value*
BCVA	0.83 ± 0.31	0.76 ± 0.29	0.12
IOP (mmHg)	15.9 ± 2.2	14.5 ± 1.7	0.43
Astigmatism (diopters)	0.07 ± 0.45	0.06 ± 0.44	0.78
Pain score	0.61 ± 0.12	0.52 ± 0.18	0.35
Anterior chamber depth (mm)	172 ± 42	178 ± 48	0.54
Chamber volume (mm^3)	3.78 ± 0.95	3.88 ± 1.01	0.58

All values are presented as mean ± SD.
BCVA = best-corrected visual acuity; IOP = intraocular pressure.
*Mann-Whitney *U*-test.

Table 6. Difference between the anterior chamber depth and the chamber volume at preoperative time and postoperative time, in the 23-gauge group

	Anterior chamber depth (±SD, mm)	*p*-value*	Chamber volume (±SD, mm^3)	*p*-value*
Preoperative	165 ± 41		3.28 ± 0.89	
Postoperative 1 mon	177 ± 50	0.32	3.97 ± 1.21	0.37
Postoperative 2 mon	182 ± 51	0.48	4.23 ± 1.38	0.48
Postoperative 3 mon	173 ± 47	0.39	3.83 ± 0.97	0.23

SD = standard deviation.
*Wilcoxon signed rank test.

each) (Table 6).

Discussion

After Chen [5] first introduced the concept of a sutureless self-sealing vitrectomy, Eckardt [1] introduced the 23G vitrectomy technique. This technique has been increasingly used in vitreous-retinal surgery due to its many advantages such as its ability to compensate for the weakness associated with the 25-gauge vitrectomy, the shorter operation time due to sutureless self-sealing, less conjunctival injury and postoperative inflammation, faster recovery of conjunctival and scleral surgical wounds, and faster sight restoration due to the reduced onset of corneal astigmatism [5-7].

Due to the low instrument rigidity of the 23G system, maneuvering in the peripheral portion of the eye is limited. Wimpissinger et al. [8] who compared the sutureless 23G system with the standard 20G system in pars plana vitrectomy for various vitreoretinal disorders, reported that the opening and closing times were significantly shorter and the duration of the vitrectomy was longer in the 23G group compared with the 20G group. However, the degree of retinal manipulation and the overall surgical length did not differ significantly between the groups. In our study, the mean surgical time was shorter in the 23G group than the 20G group. This difference is due to the greater advantage associated with the shorter opening and closing times as compared to the disadvantage associated with the more flexible 23G instruments and the lower efficiency in removal of the peripheral vitreous gel. The mean surgical time in this study was longer than in the reported study [8]. We believe that the surgeon's learning curve and the presence of a variety of vitreoretinal diseases may have affected the surgical results.

Surgically induced astigmatism is the main factor affecting early recovery of visual acuity after vitrectomy. Kadonosono et al. [9] reported that irregular astigmatism occurred in 67 eyes with idiopathic pre-retinal membranes after conducting the 20G pars plana vitrectomy. In a study

of 10 eyes that underwent 20G pars plana vitrectomy, Weinberger et al. [10] reported that suturing the scleral incision resulted in an increase in corneal astigmatism that continued for 1 to 3 months postoperatively.

Azar-Arevalo and Arevalo [11] reported a persistent increase in the corneal surface regularity index and surface asymmetry index for more than 6 months after conducting conventional vitrectomy. Transient corneal surface change after conventional vitrectomy has been reported to reduce postoperative corneal astigmatism by more than 5.0 diopters [12]. Bergmann et al. [13] reported that scleral cautery near the incisions changed corneal curvature by causing thermal contracture of the treated tissue and immediate central steepening. In the present study, increased astigmatism was observed in both the 20G and 23G groups immediately following the surgery, however, this decreased over time. Similarly, Wirbelauer et al. [14] described a transient increase of keratometric astigmatism one week after performing pars plana vitrectomy and its return to the preoperative level 1 month after surgery. However, astigmatism was less severe in the 23G group than in the 20G group. This indicates that the conjunctival scleral suture procedure used in the 23G group is superior to the conventional procedure in terms of surgically induced postoperative astigmatism.

The preoperative anterior chamber depths and volumes were similar to those in the 23G group. These findings suggest that wound leakage after temporary trans-conjunctival scleral suturing did not affect the anterior chamber.

Postoperatively, the 23G group showed visual recovery (Fig. 2), for which less surgically induced astigmatism could have served at 1 week post-operation (Table 2). Overall, the degree of postoperative discomfort felt by patients was significantly lower in the suture-free subgroup. The level of discomfort was confirmed by a lower score, which was measured by the visual analogue scale.

Postoperative wound leakage in sutureless vitrectomy could develop into serious complications such as hypotony maculopathy, ocular inflammation, vitreous incarceration, choroidal detachment and suprachoroidal fluid [15,16]. The residual vitreous strand surrounding the cannula can clog the ports and can lead to increased rates of complications such as fibrovascular proliferation, recurrent vitreous hemorrhage and retinal breaks leading to detachment [17]. Therefore, many studies were undertaken to determine the effect of the scleral incision shape on the complication rate. A deep and horizontal scleral tunnel incision was used when performing the sutureless vitrectomy in order to avoid complications. In contrast to direct insertion of the cannula perpendicular to the scleral surface, an oblique or oblique–parallel scleral tunnel may reduce wound leakage by effectively lengthening the wound tract and maximizing scleral reapposition [18].

However, a deep scleral tunnel incision can cause choroidal detachment and suprachoroidal hemorrhage due to insertion into the suprachoroidal space; other complications can also occur such as scleral folding, conjunctival hemorrhage due to excessive manipulation, and conjunctival pigmentation due to micro-leakage [19]. Because of the number of variables required in building a tunnel such as having different incision techniques, a different trocar-cannula system, a prominent nose, or a deep-seated eyeball, uniform prevention of wound leakage is difficult, regardless of whether the nasal or temporal approach is used. Furthermore, due to "subclinical leakage," which can occur even with successful self-sealing on the operating table, delayed hypotony may develop the following day, lasting for several days thereafter [20]. Weinberger et al. [10] reported that air or gas infusion by air-fluid exchange can prevent this leakage. However, air-fluid exchange with cataract surgery may induce intraocular lens capture due to the lens being pushed forward and later posterior capsular opacity.

Parolini et al. [21] reported that scleral sutures were unavoidable in cases of wound leaking despite wound massage. In the present study, we used temporary trans-conjunctival scleral sutures to treat incision wound leaking. It provides complete wound closure during the critical time. The advantages of this method are that the stitches are easy to perform without pain within 12 hour after surgery, are associated with minimal foreign body sensation, and prevent subsequent low intraocular pressure.

The releasable conjunctival scleral suture technique can be useful in a variety of patients, such as young patients, patients undergoing reoperation, and patients with scanty vitreous gel, which is a thin sclera associated with high-myopia. This technique can also be performed on patients with retinal vein obstruction, uveitis, diabetic retinopathy that requires excessive manipulation, proliferative diabetic retinopathy (PDR) with active fibrovascular proliferation that is refractory to pan-retinal photocoagulation and vitreoretinal traction, acute retinal necrosis, severe PDR requiring a total vitrectomy due to the risk of retinal tear, and anterior fibrovascular proliferation [21-24].

The 23G system offers advantages over the 20G system in cases where the eye is too small to establish an adequate surgical field and there is a need for a small incision in patients with a bleeding tendency. We found that the number of sutures required in total vitrectomy cases was higher than for partial vitrectomy cases. In cases of total vitrectomy for retinal detachment or diabetic retinopathy, greater force and more time was required to perform the scleral tunnel incision, and leakage continuously occured at the scleral tunnel incision site. The greater the requirement for peripheral vitrectomy with consequent careful cleaning of the vitreous at the entry sites, the greater the number of incision site sutures that is required.

This study has some potential limitations. First, this

study included a small number of patients and retrospective design without standard methods of data collection, and the two surgical methods were not performed during the same time. However, we believe that the findings were strengthened due to each group being followed-up for the same time period (at least 6 months). A major issue with this study is leakage after surgery. The 23G sutureless vitrectomy has led to reduced operating time, less patient discomfort, and fast vision recovery [1]. The 23G releasable conjunctival scleral suture vitrectomy has not only the advantage of being a suture-less technique but also has the added benefit of aiding in prevention of postoperative wound leakage or hypotony. Even though hypotony may be transient, this could develop into a serious complication. The 23G system greatly reduces the risk for hypotony.

In conclusion, the 23G releasable conjunctival scleral suture vitrectomy surgery and the 20G conventional vitrectomy surgery resulted in similar outcomes. However, the 23G releasable suture vitrectomy resulted in shorter operating times, faster wound healing, technical simplicity without conjunctival dissection and scleral suturing, less conjunctival and scleral manipulation, and reduced patient discomfort compared with the standard 20G conventional vitrectomy. The 23G releasable suture vitrectomy technique was found to be effective and safe for a variety of vitreoretinal surgical indications and offers many advantages over the conventional 20G vitrectomy approach.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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