

Comparison of Efficacy and Safety between Transconjunctival 23-Gauge and Conventional 20-Gauge Vitrectomy Systems in Macular Surgery

Tugba Goncu¹, Gokhan Gurelik², Berati Hasanreisoglu²

¹Ophthalmology Department, Nevsehir Government Hospital, Nevsehir, Turkey

²Ophthalmology Department, Gazi University School of Medicine, Ankara, Turkey

Purpose: To compare the efficacy and safety of 23-gauge transconjunctival vitrectomy with the conventional 20-gauge method in idiopathic epiretinal membrane and macular hole surgery.

Methods: Sixty-one consecutive patients undergoing vitrectomy for idiopathic epiretinal membrane and macular hole were recruited to either 20- or 23-gauge vitrectomy groups and prospectively evaluated. Surgical success rates, operating time, surgery-related complications, long-term visual outcomes, and postoperative ocular surface problems are compared in the two groups.

Results: There were 31 eyes in the 20-gauge group and 33 eyes in the 23-gauge group. The macular hole closure rate after the first surgery was 83% and 90.9% in the 20-gauge and 23-gauge groups, respectively, with no significant difference between groups ($p = 0.59$). The success rate for idiopathic epiretinal membranes cases was 100% in both groups. There was no statistically significant difference between overall surgical times ($p = 0.90$). None of the patients in either group experienced postoperative complications of severe postoperative hypotony, vitreous hemorrhage or endophthalmitis, except one eye in the 20-gauge group, which was found to have retinal detachment. In both groups, statistically significant improvement in visual acuity was achieved 1-month postoperatively ($p = 0.002$) and thereafter at all postoperative visits ($p < 0.05$). The mean ocular surface scores were significantly lower in the 23-gauge group at all postoperative visits compared with the 20-gauge group scores ($p = 0.001$).

Conclusions: Transconjunctival 23-gauge vitrectomy appears to be as effective and safe as conventional 20-gauge vitrectomy in idiopathic epiretinal membrane and macular hole surgeries.

Key Words: Epiretinal membrane, Retinal perforations, Vitreoretinal surgery

Three port 20-gauge pars plana vitrectomy has been the gold standard for vitreoretinal surgery since 1974 [1]. Over the last decade, transconjunctival sutureless vitrectomy aiming to improve patient comfort has been introduced and has progressed dramatically. Transconjunctival sutureless vitrectomy was first successfully performed by Fujii et al. [2] using 25-gauge instruments. Although instrumentation for the 25-gauge system continues to evolve, some

authors have speculated the disadvantages of the 25-gauge system as related to the excessive flexibility of the instruments, poorer illumination, decreased fluidics, postoperative wound leakage and a higher incidence of endophthalmitis [3-8]. In 2005, Eckardt [9] promoted the 23-gauge transconjunctival system, targeted at combining the benefits of the 25- and 20-gauge instrumentation, as a way to overcome some of the disadvantages of the 25-gauge system. The 23-gauge instruments are more rigid than those of the 25-gauge system and behave more like conventional 20-gauge instruments, allowing more complex maneuvers [10,11]. The 23-gauge system also utilizes oblique self-sealing scleral tunnels to reduce the potential complication of postoperative wound leakage [12].

Received: May 14, 2011 Accepted: October 21, 2011

Corresponding Author: Tugba Goncu, MD. Ragıp Uner mah, Vefa Kucuk cad, Zambak sitesi No. 46/8, 2000 Evler 50000, Nevsehir, Turkey. Tel: 90-532-490-8102, Fax: 90-384- 215-0367, E-mail: tubicon@hotmail.com

© 2012 The Korean Ophthalmological Society

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Since then, some investigators have reported results showing the effectiveness of the 23-gauge transconjunctival vitrectomy system for various vitreoretinal diseases. Transconjunctival 23-gauge vitrectomy provides potential advantages over traditional 20-gauge vitrectomy, including reduced conjunctival manipulation, increased patient comfort and recovery, faster wound healing, less conjunctival scarring, and reduced surgical time [13-16]. Although some studies have compared the 23-gauge transconjunctival vitrectomy with the conventional 20-gauge vitrectomy [16-18], there is limited number of published prospective studies [19,20].

Epiretinal membrane removal and vitrectomy accompanied with gas tamponade are the recognized treatments of choice for idiopathic epiretinal membranes (IERM) [21,22] and macular holes (IMH) [23,24], respectively. Surgical techniques for both IMH and IERM are well described and consist of similar surgical manipulations. IERM and IMH patients undergoing vitrectomy surgery do not have noticeable individual anatomic differences that would affect surgical steps during vitrectomy and thus constitute homogeneous groups, making them suitable for comparison between the transconjunctival 23-gauge vitrectomy and conventional 20-gauge vitrectomy systems in terms of safety, complications, anatomic and functional success.

In this prospective study, our goal was to assess the safety and efficacy of 23-gauge transconjunctival vitrectomy compared with 20-gauge conventional pars plana vitrectomy in IERM and IMH surgeries.

Materials and Methods

A prospective clinical trial was designed to compare 20- and 23-gauge vitrectomy systems in a group of patients with IMH and IERM requiring uncomplicated macular surgery. Institutional review board approval was acquired, and signed informed consent was obtained from all participants in accordance with the Declaration of Helsinki. The patients were recruited consecutively to each group between July 2007 and April 2009.

Inclusion criteria required that the patients present with grade 3 to 4 IMH [25] or grade 2 to 3 IERM [26] complaining of visual acuity decrement or metamorphopsia which negatively influenced quality of life. Any patients with additional ocular pathologies or ocular surface problems and patients who underwent an ocular surgery other than uncomplicated cataract surgery were excluded from the study.

In preoperative and postoperative examinations, all patients underwent best-corrected visual acuity (VA), applanation tonometry, as well as biomicroscopic anterior and posterior segment evaluation. Color fundus photographs and optical coherence tomography (OCT) examinations were performed before surgery and at postoperative vis-

its. In the IERM patients, the central macular thickness (CMT) was measured using the macular thickness protocol of OCT (Zeiss-Humphrey Instruments, San Leandro, CA, USA). Postoperative visits were performed at 1 day, 1 week, 1 month, 3 months, every 3 months until 1 year, then every 6 months subsequently. Surgeries were performed by a single experienced surgeon (GG) at a single center.

Surgical technique

All patients underwent surgery with retrobulbar anesthesia. The periocular skin was prepared with 10% povidine-iodine and 5% povidine-iodine solution instilled into the ocular surface and inferior fornix. Patients were draped, everting and covering lashes from the operative field. The vitrectomy system for all surgeries was the DORC Surgical System (Dutch Ophthalmic Research Center Inc., Zuidland, The Netherlands).

20-Gauge vitrectomy

The conjunctiva was opened in correspondence of the sclerotomy sites. Three scleral incisions were made 3.5 mm behind the limbus in the inferotemporal, superonasal, and superotemporal quadrants. The system was calibrated at 200 mmHg of vacuum and a cut rate of 2,500 per minute. After core vitrectomy, triamcinolone acetonide (Kenacort-A; Bristol-Myers-Squibb, Peapack, NJ, USA) was used to ensure that the posterior hyaloid was elevated, and total vitrectomy was performed in every case. Also, triamcinolone acetonide was used in epiretinal membrane cases to assist in membrane stripping and, in both macular hole and epiretinal membrane cases, to enhance internal limiting membrane removal. At the conclusion of each surgery, retinal breaks were checked, and peripheral vitrectomy was completed with scleral indentation under a wide-angle visualization system (EIBOS, Moller-Wedel, Germany). Endolaser photocoagulation was used to treat any retinal breaks. The sclerotomies were closed with 7-0 vicryl, and conjunctiva were closed with 8-0 vicryl suture.

23-Gauge vitrectomy

The two-step 23-gauge vitrectomy system was used as initially described by Eckardt [9]. The conjunctiva was displaced over the sclera to mismatch the conjunctival and scleral entry sites; three angled scleral tunnel incisions were made with an angled stiletto blade positioned at a 20° to 30° angle to the entry site, after which the sclera was entered with the trocars. The system was calibrated at 450 mmHg of vacuum and a cut rate of 1,500 per minute. The surgical procedures were performed as previously described for 20-gauge vitrectomy. At the end of the procedure, the infusion line was clamped, the superonasal

cannula was removed, and the sclerotomy site was immediately massaged using a cotton swab. The infusion line was then unclamped, and the sclerotomy site was inspected for any leakage. The superotemporal cannula was removed in a similar fashion. If no leak was present, the inferotemporal cannula and the infusion line were removed. If any site demonstrated persistent leakage, 8-0 vicryl sutures were placed so as to bind the sclerotomy site with the overlying conjunctiva without opening the conjunctiva. Intraocular pressure (IOP) was measured at the end of the procedure.

A total gas or air fill was used in all IMH cases. All 23-gauge patients underwent partial fluid-air exchange filling at least 1 / 3 of the eye if a complete air- or gas-fluid exchange was not part of the intended procedure. All IMH patients maintained a prone position for 1 week postoperatively. Postoperative treatment for all patients consisted of lomefloxacin 0.3% and dexamethasone 0.5% eye drops applied topically 4 times daily for 2 weeks; treatment was modified at the postoperative visits.

For gradation of cataract formation, we used the Lens Opacities Classification System III assessing the lens opacification as grades 1 through 5. Grade 1 was classified as normal, grades 2 and 3 were classified as mild opacification, and grades 4 and 5 were classified as significant cataract and combined phacoemulsification. Intraocular lens implantation was performed on significant cataracts.

The surgical times were compared in the groups. The surgical opening time was defined as the interval between the first instrument contacting the conjunctiva and readiness for vitrectomy. The times required for vitrectomy and surgical manipulations were also evaluated separately. The closing time was defined as the interval between the end of manipulation and the removal of the lid speculum. Any intraoperative and postoperative complications, such as sclerotomy site wound leakage, hypotony, retinal tear, retinal detachment or endophthalmitis, were noted. Hypotony was defined as an IOP less than 6 mmHg during the postoperative assessment.

Surgical success was defined as closure of the macular hole for IMH patients and a decrease in CMT and an at least 3-month membrane-free postoperative period for IERM patients, which was determined by OCT. Snellen VA was converted into the logarithm of the minimum angle of resolution (logMAR) for statistical analysis. VA improvement was defined as the difference between preoperative and postoperative VA at the final postoperative visit. The postoperative ocular surface reaction was qualitatively graded by slit-lamp examination using a modified scale (Table 1) [19,27].

The primary outcome variables included primary anatomical success rate; postoperative VA improvement; intraoperative complications, such as the need for conversion to the 20-gauge system, dislodgement of the 23-gauge

cannulas, and need for sclerotomy suture placement; and postoperative complications, such as wound leakage, hypotony, choroidal detachment, retinal detachment, cataract progression and endophthalmitis.

Statistical analysis

The differences between the patient groups were assessed for statistical significance using the Student's *t*-test, the Mann Whitney *U*-test, or chi-square test when appropriate. Statistical analysis was conducted using SPSS ver. 11.5 (SPSS Inc., Chicago, IL, USA), and $p < 0.05$ was considered statistically significant.

Result

Thirty-one eyes of 30 patients undergoing vitrectomy for IERM and IMH were recruited to the 20-gauge vitrectomy group and 33 eyes of 31 patients to the 23-gauge vitrectomy group. As shown in Table 2, there were no statistically significant differences at baseline in patient characteristics, diagnoses, stage of diseases, preoperative lens status, or mean preoperative IOP value between the 20- and 23-gauge vitrectomy groups (Table 2). The mean follow-up \pm standard deviation (SD) was 12.8 ± 7.9 months in the 23-gauge group and 11.5 ± 4.2 months in the 20-gauge group ($p = 0.39$).

Epiretinal membranes and/or internal limiting membranes were successfully removed from the fovea in all patients. For the IMH patients, the surgical success rate was 83.3% in the 20-gauge group and 90.9% in the 23-gauge group, with no significant difference ($p = 0.59$). In the IERM patients, the surgical success rate was 100% for both groups. In the 20-gauge group, the tamponade media was gas (sulfur hexafluoride) in 12 eyes (38.7%), air in 10 eyes (32.2%), and fluid in 9 eyes (29%). Ten eyes (30.3%) in the 23-gauge group received gas (sulfur hexafluoride) tam-

Table 1. Postoperative assessment of ocular surface

	Score	Definition
Inflammation	0	None
	1	Mild (1 quadrant or less)
	2	Moderate (1 to 3 quadrant)
	3	Severe (3 quadrant or more)
Hemorrhage	0	None
	1	Mild (1 quadrant or less)
	2	Moderate (1 to 3 quadrant)
	3	Severe (3 quadrant or more)
Conjunctival scarring	0	None
	1	Mild (1 quadrant, minimal)
	2	Moderate (1 quadrant, prominent)
	3	Severe (2 quadrant or more extensive)

ponade. Among the remaining eyes, full air-fluid exchange was performed in 17 eyes (51.5%), and partial air-fluid exchange was performed in 6 eyes (18.1%). Concomitant phacoemulsification and posterior chamber intraocular lens implantation was performed for three eyes in the 20-gauge group and for one eye in the 23-gauge group.

In the 20-gauge group, the mean preoperative VA was 20 / 160. Mean postoperative acuities were 20 / 100 ($p = 0.002$) at month 1, 20 / 72 ($p < 0.05$) at month 3, 20 / 50 ($p < 0.05$) at month 6, and 20 / 75 ($p < 0.05$) at the final visit. In the 23-gauge group, the mean preoperative VA was 20 / 112. Mean postoperative acuities were 20 / 60 ($p < 0.05$) at month 1, 20 / 60 ($p < 0.05$) at month 3, 20 / 55 ($p = 0.01$) at month 6, and 20 / 68 ($p < 0.05$) at the final visit (Fig. 1). In both groups of IERM or IMH, the VA improved significantly at 1 month postoperatively and at the final visit compared to preoperative results (Fig. 2A and 2B).

VA improvement was -0.32 ± 0.36 and -0.23 ± 0.32 logMAR in the 20- and 23-gauge groups, respectively, and we did not observe a statistically significant difference with regard to VA improvement between the two groups ($p = 0.27$).

The mean preoperative CMT value for the IERM patients was $373 \pm 118 \mu$ and $416 \pm 164 \mu$ in the 20- and 23-gauge groups, respectively. There were no statistically significant differences in the baseline mean CMT values

between the 20- and 23-gauge vitrectomy groups ($p = 0.42$). In both groups, the mean CMT was significantly reduced at 1 month, 3 months, 6 months, and at the final postoperative visits compared with preoperative values ($p < 0.05$) (Fig. 3).

In the 23-gauge group, the durations for wound opening ($p = 0.006$) and wound closing ($p = 0.003$) were sta-

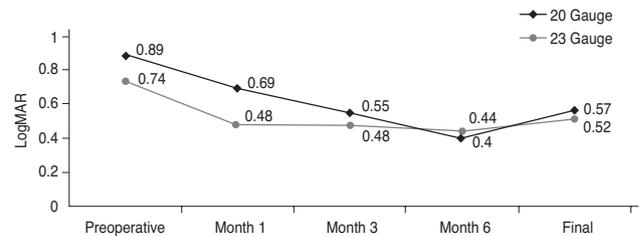


Fig. 1. Preoperative and postoperative logarithm minimum angle of resolution (logMAR) mean visual acuity (VA) observed in the 20-gauge and 23-gauge groups. In both groups, the VA improved significantly at all postoperative visits compared with preoperative values (Student's *t*-test, $p < 0.05$), and there was no significant difference in VA between the two groups preoperatively and postoperatively (Student's *t*-test, $p > 0.05$).

Table 2. Patient characteristics

Characteristics	20 Gauge	23 Gauge	<i>p</i> -value
Mean age (yr ± SD)	60.0 ± 10.5	64.4 ± 8.1	0.07*
Gender			
Male	20	17	0.43 [†]
Female	10	14	
Diagnosis			
IMH	12	11	0.79 [†]
IERM	19	22	
Stage			
IMH stage 3	3	4	0.66 [†]
IMH stage 4	9	7	
IERM stage 2	6	10	0.75 [†]
IERM stage 3	13	12	
Preoperative lens status			
Grade 1	18	15	
Grade 2-4	7	14	0.31 [†]
Grade ≥4	3	1	
Pseudophakic	3	3	
Preoperative VA (logMAR ± SD)	0.87 ± 0.38	0.84 ± 0.39	0.16*
Preoperative IOP (mmHg ± SD)	15.8 ± 2.4	15.2 ± 2.8	0.35*

IMH = idiopathic macular hole; IERM = idiopathic epiretinal membranes; VA = visual acuity; logMAR = logarithm of the minimum angle of resolution; SD = standard deviation; IOP = intraocular pressure.

*Student's *t*-test; [†]Chi-square test.

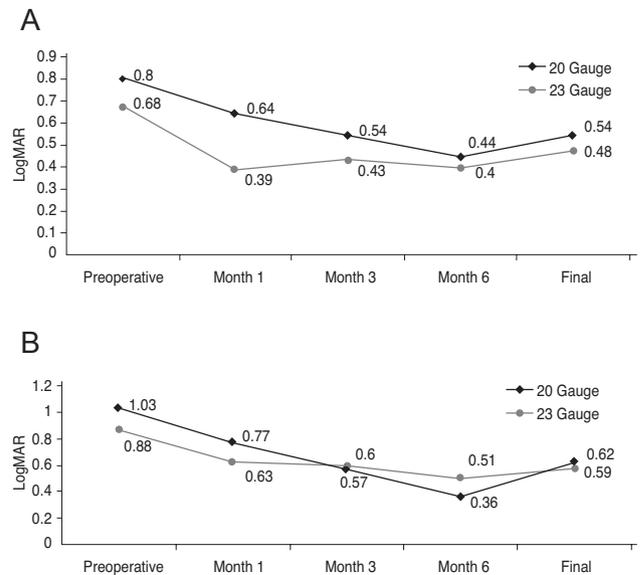


Fig. 2. (A) Visual acuity (VA) at baseline and at 1 month, 3 months, 6 months, and final visits in the idiopathic epiretinal membrane subgroup of the 20- and 23-gauge groups. VA improved significantly at 1 month postoperatively (Student's *t*-test, $p = 0.05$ and $p < 0.05$, respectively) and at the final visit (Student's *t*-test, $p = 0.006$ and $p = 0.003$, respectively) in both groups. (B) VA at baseline and at 1 month, 3 months, 6 months, and final visits in the idiopathic macular hole subgroup of the 20- and 23-gauge groups. VA improved significantly at 1 month postoperatively (Student's *t*-test, $p = 0.007$ and $p = 0.01$, respectively) and at the final visit (Student's *t*-test, $p = 0.002$ and $p = 0.035$, respectively) in both groups. LogMAR = logarithm minimum angle of resolution.

tistically significantly shorter compared with those of the 20-gauge group. There was no significant difference between the two groups regarding the duration of vitrectomy ($p = 0.19$) or retinal manipulation ($p = 0.42$). Finally, the mean duration for the entire surgery was 20 minutes 37 seconds \pm 598 seconds in the 20-gauge group and 17 minutes 51 seconds \pm 239 seconds in the 23-gauge group. There was no significant difference between the two groups ($p = 0.90$) (Table 3).

Regarding the complications of surgeries, no intraoperative complications occurred in either group. No eyes in the 23-gauge group required conversion to 20-gauge instrumentation. No 23-gauge cannula dislodgement was observed during the operation. Fifteen (15.1%) of the sclerotomy ports in the 23-gauge group needed to be sutured due to persistent wound leakage. No eyes required supplementary fluid or air/gas injection after removing the 23-gauge cannulas. Wound leakage was not observed at 1 day postoperatively. One eye in the 20-gauge group presented with retinal detachment two months after surgery. A new peripheral retinal tear was identified in this eye but was not related to the previous sclerotomy sites. No choroidal detachment, vitreous hemorrhage, or endophthalmitis developed in either group.

The mean postoperative IOP \pm SD on postoperative day 1 was 16.2 \pm 3.9 mmHg in the 20-gauge group and 14.1 \pm

2.2 mmHg in the 23-gauge group; the postoperative day 1 IOP in 23-gauge group was significantly lower than that of the 20-gauge group ($p = 0.01$) (Fig. 4). No patients in either group experienced hypotony on the first postoperative day, defined as an IOP less than 6 mmHg. An IOP less than 10 mm Hg was noted in 5 eyes (15.1%) in the 23-gauge group. Within the 20-gauge group, there were no significant differences at any visit when comparing with the preoperative values. In the 23-gauge group, the mean IOP on postoperative day 1 was significantly lower compared with the mean preoperative value ($p = 0.04$); however, this difference was not seen in other visits. Other than postoperative hypotony, eye pressure was observed to be greater than 22 mmHg in 5 eyes in the 20-gauge group and in no eyes in the 23-gauge group.

Ten (40%) of 25 phakic eyes in the 20-gauge group showed cataract progression within the postoperative period compared to 19 (65%) of 29 phakic eyes in the 23-gauge group ($p = 0.049$). Cataract progression occurred at a mean of 7.7 \pm 2.1 months after vitrectomy in the 20-gauge group versus 7.6 \pm 2.7 months after vitrectomy in the 23-gauge group ($p = 0.89$).

In the 20-gauge group, the mean postoperative ocular surface scores were 3.4 \pm 1.1 at day 1, 3.2 \pm 1.4 at week 1, and 2.67 \pm 1.3 at month 1. In the 23-gauge group, the mean postoperative ocular surface scores were 1.2 \pm 1.1 at

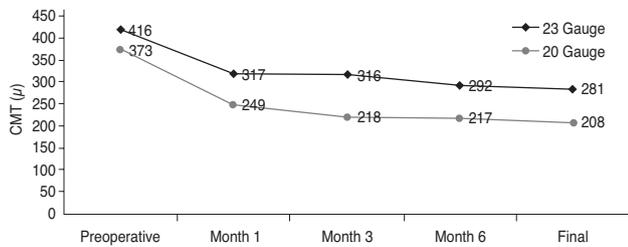


Fig. 3. Preoperative and postoperative mean central macular thickness (CMT) measurements of the idiopathic epiretinal membrane patients in the 20- and 23-gauge vitrectomy groups. No significant differences related to the mean CMT value was seen between the two groups preoperatively or postoperatively (Student's *t*-test, $p > 0.05$). In both groups, the mean CMT was significantly reduced at 1 month, 3 months, 6 months, and the final postoperative visits compared with preoperative values (Student's *t*-test, $p < 0.05$).

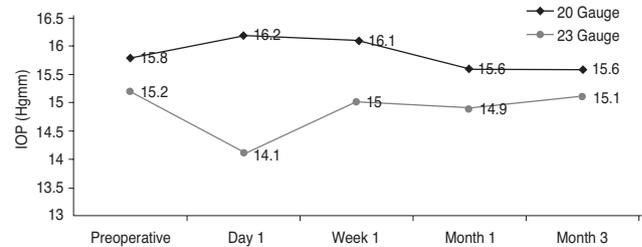


Fig. 4. Preoperative and postoperative mean intraocular pressure (IOP) in the 20- and 23-gauge groups. The mean postoperative IOP of the 23-gauge group was significantly lower on postoperative day 1 compared with the 20-gauge group (Student's *t*-test, $p = 0.01$), but there was no significant difference between the mean IOP values of the two groups thereafter (Student's *t*-test, $p > 0.05$).

Table 3. Comparison of surgical times for the treatment groups and the associated *p*-values

Mean surgery times	20 Gauge	23 Gauge	<i>p</i> -value*
Opening	2 min 23 sec \pm 42 sec	1 min 26 sec \pm 46 sec	0.006
Vitrectomy	3 min 58 sec \pm 56 sec	6 min 35 sec \pm 240 sec	0.189
Retinal manipulation	11 min 38 sec \pm 753 sec	10 min 33 sec \pm 264 sec	0.421
Closing	4 min 38 sec \pm 82 sec	54 sec \pm 18 sec	0.003
Total surgery	20 min 37 sec \pm 598 sec	17 min 51 sec \pm 239 sec	0.902

*Mann-Whitney test.

day 1, 0.6 ± 0.8 at week 1, and 0.47 ± 0.8 at month 1. The mean ocular surface score was significantly lower in the 23-gauge group at all postoperative visits compared with the 20-gauge group values ($p = 0.001$).

Discussion

In the current study, the efficacy and the safety profile between 23-gauge transconjunctival vitrectomy and conventional 20-gauge vitrectomy were evaluated in patients with IMH and IERM who underwent macular surgery. The surgical outcomes observed after the 23-gauge vitrectomies were comparable with outcomes obtained after the conventional 20-gauge vitrectomies. For macular holes, the surgical success rate after one surgery was 83.3% in the 20-gauge group and 90.9% in the 23-gauge group ($p = 0.59$), and both of these compare favorably with previously reported macular hole case series [16,23,28,29]. Vitrectomy for ERM has become a standard and beneficial procedure with a very high success rate [21,30]. The anatomical success rate was high, 100%, in both of our groups.

In both groups, statistically significant improvement in VA was achieved at 1 month postoperatively ($p = 0.002$ for the 20-gauge group, $p < 0.05$ for the 23-gauge group) and thereafter at all postoperative visits ($p < 0.05$) compared with preoperative VA. This has also been reported in other studies [13,16,17,29]. Regarding postoperative VAs, the mean VA was higher 1 month postoperatively in the 23-gauge group than in the 20-gauge group ($p = 0.025$); however, we did not see a significant difference between the two study groups 3 or 6 months postoperatively or at the final visit ($p = 0.81$, $p = 0.597$, and $p = 0.422$, respectively). Additionally, Hikichi et al. [17] and Narayanan et al. [18] also reported that 23-gauge vitrectomy is associated with faster improvement in vision. We noted that visual gain after a 23-gauge vitrectomy is comparable with that after a conventional 20-gauge vitrectomy. Although not statistically significant, we noticed a decreased mean VA of both groups at the final visit; the underlying reason was believed to be cataract progression, which was observed at a rate of 40% in the 20-gauge group and 65% in the 23-gauge group. This compares well with published data. The most common complication of macular hole surgery in phakic eyes is cataract formation, with a reported rate of 30% to 50% [31,32]. This rate is reported between 12% and 68% for patients who underwent epiretinal membrane surgery [33,34]. In our study, a borderline significance for increased cataract progression was observed in the 23-gauge group, and this most likely related to performing partial fluid-air exchange even in patients who did not require a tamponade at the end of the surgical procedure, as well as to a greater number of patients in this group having lens opacity greater than grade 1. Although our sample size is too small to make a definitive conclusion, we think that

this result is a consequence of partial fluid-air exchange at the end of surgery, rather than the 23-gauge vitrectomy system itself.

The popularity of transconjunctival sutureless vitrectomy has increased over the past years, one reason being the reduction of surgical duration. In some comparative interventional studies, the authors showed a significantly reduced operation duration using the 23-gauge system in various vitreoretinal diseases, but they did not document the amount of vitreous removed [17,20,35]. In contrast, in this study, the mean surgery time was 20 minutes 37 seconds in the 20-gauge group and 17 minutes 51 seconds in 23-gauge group. The latter seems to be shorter, but the difference was not found to be significant ($p = 0.90$). However, we observed that the 23-gauge group showed a significantly shorter duration for opening time ($p = 0.006$) and closing time ($p = 0.003$) compared to the 20-gauge group. Particularly, closing time seemed to be shorter with 23-gauge transconjunctival surgery, 54 ± 18 seconds in the 23-gauge group versus 4 minutes 38 seconds ± 82 seconds in the 20-gauge group. The vitrectomy time was 3 minutes 58 seconds (20-gauge) versus 6 minutes 35 seconds (23-gauge); vitrectomy took longer in the 23-gauge group, but the difference was not significant ($p = 0.189$). The treatment groups were similar with respect to retinal manipulation time ($p = 0.421$). A possible explanation could be that total vitrectomy and peripheral vitreous base cleaning might negate the potential time advantage of 23-gauge vitrectomy in our cases. Similarly, Wimpissinger et al. [19] found that the durations of wound opening and wound closure were significantly shorter and vitrectomy time was significantly longer with the 23-gauge system. They concluded that the time gain in wound opening and closure was equalized by a longer vitrectomy time when attempting to remove a similar amount of vitreous.

No technical difficulties occurred in our cases using the 23-gauge system during surgery, and all intraoperative maneuvers were feasible. No procedures required a switch to conventional 20-gauge sclerotomy. In 23-gauge vitrectomy, a tangential incision is made at a 20° to 30° angle through the sclera, so that suturing is not required due to the angled, self-sealing properties of the incision and the pressing effect of IOP [9,10]. Performing partial fluid/air exchange at the completion of surgery has been recommended to create a temporary tamponade and aid in the closure of the ports [6,29,36]. In our series, 11 (15%) sclerotomy ports required suturing. The intraoperative suture rate among published 23-gauge studies ranges from 0% to 26% [13,15,16,19]. The higher rate of wound suturing in the present series may reflect the confident attitude of the surgeon.

Postoperative hypotony due to leakage from sclerotomies is an important shortcoming in transconjunctival surgeries. The reported incidence of hypotony after a 23-gauge

vitrectomy ranges from 0% to 21.1% (with hypotony defined as a pressure between 6 mmHg and 10 mmHg) [13-17]. We did not observe hypotony in any of the patients in either group throughout the follow-up period. During the first few postoperative days, the 23-gauge group showed more eyes with low pressure (<10 mmHg), but no hypotony was observed. The reason for this may be our high rate of sclerotomy suturing and partial fluid/air exchange at the end of surgery. These results are comparable to the reports of Eckardt [9] and Kim et al. [13], who did not observe any hypotony after performing 23-gauge vitrectomies. In the 23-gauge group, the mean IOP on postoperative day 1 was significantly lower compared with the mean preoperative value ($p = 0.04$); however, this difference was not observed at other postoperative visits. The mean first day IOP was significantly lower in the 23-gauge group compared with the 20-gauge group ($p = 0.01$). In our surgeries, using gas tamponade and minimal fluid-air exchange at the end of the surgery, even in the cases not requiring a tamponade, might have prevented postoperative hypotony. This data confirms the protective role of gas tamponade and partial air exchange against postoperative hypotony [14,36]. We had no severe complications related to hypotony, such as choroidal effusion or vitreous hemorrhage. The eye pressure was greater than 22 mmHg in 5 eyes in the 20-gauge group and none in the 23-gauge group. This data compares well with the report of Misra et al. [20], in which they suggested that increased IOP (>40 mmHg) on postoperative day 1 is less likely with 23-gauge vitrectomy.

Sutureless sclerotomies present a theoretical increase in the risk of endophthalmitis, especially with 25-gauge surgery. We had no cases of endophthalmitis in either group. The risk of endophthalmitis after 20-gauge vitrectomy is rare, with an estimated incidence ranging from 0.039% to 0.07%; however, the risk of endophthalmitis in 23-gauge vitrectomy remains unclear, and there is limited information in the literature [10,15-17,19,37,38]. A large case series reported from the Wills Eye Institute showed an endophthalmitis rate of 0.23% (7 / 3,103 eyes) for 25-gauge vitrectomy, compared with only 0.018% (1 / 5,498 eyes) for 20-gauge vitrectomy, representing a 12-fold increased risk [39]. Recently, in a large retrospective case series, the incidence of endophthalmitis during the study period of 2007 to 2008 was 0.02% for 20-gauge compared with 0.03% for 23-gauge and 0.13% for 25-gauge vitrectomies [40]. There was no significant difference in endophthalmitis rates between any two of the three groups. Compared with the endophthalmitis rates among the same group of vitreoretinal surgeons during the previous 2 years, the endophthalmitis rates following 20-gauge and 23-gauge vitrectomy were stable, and the rate following 25-gauge vitrectomy was marginally lower. All these reports emphasized the importance of meticulous aseptic techniques, conjunctival wash-out with povidone-iodine, and misalignment of the

conjunctival and scleral openings following removal of the cannulas.

The 23-gauge system permitted us to perform a complete vitrectomy and peripheral vitreous base cleaning. Two months postoperatively, one eye in the 20-gauge group presented with retinal detachment caused by a new retinal tear which did not correspond to the sclerotomies. Complications were rare and compared favorably with previously reported 23-gauge and 20-gauge series [17,19,20,35].

In our study, there was less postoperative ocular surface inflammation and conjunctival scarring with 23-gauge vitrectomy compared with 20-gauge vitrectomy at all postoperative visits. A number of previously published studies reported that the clinical inflammation score was lower after transconjunctival 23-gauge vitrectomy compared with 20-gauge vitrectomy [17,19].

Our study has obvious limitations which are related to the relatively small number of cases and the lack of randomization in the prospective design. These create inadequacies for meaningful conclusions regarding the efficacy and safety of the 23-gauge transconjunctival vitrectomy system, especially in evaluating rare complications, such as endophthalmitis or retinal detachment. However, our promising results provide useful data to conduct further prospective, randomized, controlled clinical studies with larger sample sizes.

In our study, compared to conventional 20-gauge vitrectomy, the 23-gauge transconjunctival vitrectomy system appeared to be an equally safe and effective technique for the treatment of IMH and IERM without any major drawbacks. Although further large scale prospective studies are required, the 23-gauge vitrectomy system might be a favorable alternative to the 20-gauge vitrectomy system in macular surgery.

Conflict of Interest

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

References

1. O'Malley C, Heintz RM Sr. Vitrectomy with an alternative instrument system. *Ann Ophthalmol* 1975;7:585-8, 591-4.
2. Fujii GY, De Juan E Jr, Humayun MS, et al. Initial experience using the transconjunctival sutureless vitrectomy system for vitreoretinal surgery. *Ophthalmology* 2002;109:1814-20.
3. Lakhnani RR, Humayun MS, de Juan E Jr, et al. Outcomes of 140 consecutive cases of 25-gauge transconjunctival surgery for posterior segment disease. *Ophthalmology* 2005;112:817-24.
4. Lam DS, Yuen CY, Tam BS, et al. Sutureless vitrectomy surgery. *Ophthalmology* 2003;110:2428-9.
5. Ibarra MS, Hermel M, Prenner JL, Hassan TS. Long-term outcomes of transconjunctival sutureless 25-gauge

- vitrectomy. *Am J Ophthalmol* 2005;139:831-6.
6. Chen E. 25-Gauge transconjunctival sutureless vitrectomy. *Curr Opin Ophthalmol* 2007;18:188-93.
 7. Meyer CH, Rodrigues EB, Schmidt JC, et al. Sutureless vitrectomy surgery. *Ophthalmology* 2003;110:2427-8.
 8. Gupta OP, Weichel ED, Regillo CD, et al. Postoperative complications associated with 25-gauge pars plana vitrectomy. *Ophthalmic Surg Lasers Imaging* 2007;38:270-5.
 9. Eckardt C. Transconjunctival sutureless 23-gauge vitrectomy. *Retina* 2005;25:208-11.
 10. Kusuhara S, Ooto S, Kimura D, et al. Outcomes of 23- and 25-gauge transconjunctival sutureless vitrectomies for idiopathic macular holes. *Br J Ophthalmol* 2008;92:1261-4.
 11. Nam Y, Chung H, Lee JY, et al. Comparison of 25- and 23-gauge sutureless microincision vitrectomy surgery in the treatment of various vitreoretinal diseases. *Eye (Lond)* 2010;24:869-74.
 12. Singh RP, Bando H, Brasil OF, et al. Evaluation of wound closure using different incision techniques with 23-gauge and 25-gauge microincision vitrectomy systems. *Retina* 2008;28:242-8.
 13. Kim MJ, Park KH, Hwang JM, et al. The safety and efficacy of transconjunctival sutureless 23-gauge vitrectomy. *Korean J Ophthalmol* 2007;21:201-7.
 14. Schweitzer C, Delyfer MN, Colin J, Korobelnik JF. 23-Gauge transconjunctival sutureless pars plana vitrectomy: results of a prospective study. *Eye (Lond)* 2009;23:2206-14.
 15. Fine HF, Iranmanesh R, Iturralde D, Spaide RF. Outcomes of 77 consecutive cases of 23-gauge transconjunctival vitrectomy surgery for posterior segment disease. *Ophthalmology* 2007;114:1197-200.
 16. Gupta OP, Ho AC, Kaiser PK, et al. Short-term outcomes of 23-gauge pars plana vitrectomy. *Am J Ophthalmol* 2008;146:193-7.
 17. Hikichi T, Matsumoto N, Ohtsuka H, et al. Comparison of one-year outcomes between 23- and 20-gauge vitrectomy for preretinal membrane. *Am J Ophthalmol* 2009;147:639-43.e1.
 18. Narayanan R, Sinha A, Reddy RK, et al. Faster visual recovery after 23-gauge vitrectomy compared with 20-gauge vitrectomy. *Retina* 2010;30:1511-4.
 19. Wimpfing B, Kellner L, Brannath W, et al. 23-Gauge versus 20-gauge system for pars plana vitrectomy: a prospective randomised clinical trial. *Br J Ophthalmol* 2008;92:1483-7.
 20. Misra A, Ho-Yen G, Burton RL. 23-gauge sutureless vitrectomy and 20-gauge vitrectomy: a case series comparison. *Eye (Lond)* 2009;23:1187-91.
 21. De Bustros S, Thompson JT, Michels RG, et al. Vitrectomy for idiopathic epiretinal membranes causing macular pucker. *Br J Ophthalmol* 1988;72:692-5.
 22. Michels RG. Vitrectomy for macular pucker. *Ophthalmology* 1984;91:1384-8.
 23. Benson WE, Cruickshanks KC, Fong DS, et al. Surgical management of macular holes: a report by the American Academy of Ophthalmology. *Ophthalmology* 2001;108:1328-35.
 24. Freeman WR, Azen SP, Kim JW, et al. Vitrectomy for the treatment of full-thickness stage 3 or 4 macular holes. Results of a multicentered randomized clinical trial. The Vitrectomy for Treatment of Macular Hole Study Group. *Arch Ophthalmol* 1997;115:11-21.
 25. Gass JD. Reappraisal of biomicroscopic classification of stages of development of a macular hole. *Am J Ophthalmol* 1995;119:752-9.
 26. Gass JD. Stereoscopic atlas of macular diseases: diagnosis and treatment. 3rd ed. St. Louis: Mosby; 1987. p. 684-93.
 27. Rizzo S, Genovesi-Ebert F, Murri S, et al. 25-Gauge, sutureless vitrectomy and standard 20-gauge pars plana vitrectomy in idiopathic epiretinal membrane surgery: a comparative pilot study. *Graefes Arch Clin Exp Ophthalmol* 2006;244:472-9.
 28. Johnson MW. Improvements in the understanding and treatment of macular hole. *Curr Opin Ophthalmol* 2002;13:152-60.
 29. Tewari A, Shah GK, Fang A. Visual outcomes with 23-gauge transconjunctival sutureless vitrectomy. *Retina* 2008;28:258-62.
 30. Margherio RR, Cox MS Jr, Trese MT, et al. Removal of epimacular membranes. *Ophthalmology* 1985;92:1075-83.
 31. Kumagai K, Ogino N. Results of macular hole surgery combined with PEA and IOL. *Semin Ophthalmol* 2001;16:144-50.
 32. Simcock PR, Scalia S. Phaco-vitrectomy for full-thickness macular holes. *Acta Ophthalmol Scand* 2000;78:684-6.
 33. Pesin SR, Olk RJ, Grand MG, et al. Vitrectomy for premacular fibroplasia: prognostic factors, long-term follow-up, and time course of visual improvement. *Ophthalmology* 1991;98:1109-14.
 34. Donati G, Kapetanios AD, Pournaras CJ. Complications of surgery for epiretinal membranes. *Graefes Arch Clin Exp Ophthalmol* 1998;236:739-46.
 35. Haas A, Seidel G, Steinbrugger I, et al. Twenty-three-gauge and 20-gauge vitrectomy in epiretinal membrane surgery. *Retina* 2010;30:112-6.
 36. Nam DH, Ku M, Sohn HJ, Lee DY. Minimal fluid-air exchange in combined 23-gauge sutureless vitrectomy, phacoemulsification, and intraocular lens implantation. *Retina* 2010;30:125-30.
 37. Eifrig CW, Scott IU, Flynn HW Jr, et al. Endophthalmitis after pars plana vitrectomy: incidence, causative organisms, and visual acuity outcomes. *Am J Ophthalmol* 2004;138:799-802.
 38. Cohen SM, Flynn HW Jr, Murray TG, Smiddy WE. Endophthalmitis after pars plana vitrectomy. The Postvitrectomy Endophthalmitis Study Group. *Ophthalmology* 1995;102:705-12.
 39. Kunimoto DY, Kaiser RS; Wills Eye Retina Service. Incidence of endophthalmitis after 20- and 25-gauge vitrectomy. *Ophthalmology* 2007;114:2133-7.
 40. Scott IU, Flynn HW Jr, Acar N, et al. Incidence of endophthalmitis after 20-gauge vs 23-gauge vs 25-gauge pars plana vitrectomy. *Graefes Arch Clin Exp Ophthalmol* 2011;249:377-80.