Jpn J Ophthalmol (2015) 59:288–294
DOI 10.1007/s10384-015-0396-y

THE OFFICIAL INTERNATIONAL JOURNAL OF THE JAPANESE OPHTHALMOLOGICAL SOCIETY

CLINICAL INVESTIGATION

Comparison of microinsicion vitrectomy and conventional 20-gauge vitrectomy for severe proliferative diabetic retinopathy

Reiji Yokota[1] · Makoto Inoue[1] · Yuji Itoh[1] · Tosho Rii[2,1] · Kazunari Hirota[1] · Akito Hirakata[1]

Received: 19 December 2014 / Accepted: 21 May 2015 / Published online: 23 July 2015

Abstract
Purpose To compare the outcomes of 23-gauge (G) and 25G vitrectomy to 20G vitrectomy on eyes with severe proliferative diabetic retinopathy (PDR).
Methods The medical records of 424 eyes of 347 patients with severe PDR were reviewed. There were 80 eyes that had 23G, 174 eyes that had 25G, and 170 eyes that had 20G vitrectomy. The incidences of postoperative vitreous hemorrhage, intraoperative retinal breaks, retinal detachment, and neovascular glaucoma were compared.
Results The incidence of intraoperative retinal breaks was significantly lower in the 23G group (21 %) than in the 20G group (35 %, $P = 0.03$) but not in the 25G group (26 %, $P = 0.057$). The incidence of postoperative retinal detachment was not significantly different among the three groups ($P = 0.73$). The incidence of postoperative vitreous hemorrhage that developed ≥1 month after vitrectomy was not different whether the eyes had panretinal photocoagulation or not ($P = 0.15$). The incidence of postoperative neovascular glaucoma was significantly lower in the 25G group (3 %) than in the 20G group (11 %, $P = 0.01$) but not significant compared with that in the 23G group (8 %, $P = 0.72$).
Conclusion The lower incidence of intraoperative retinal breaks and postoperative neovascular glaucoma after microincision vitrectomy indicates that microincision vitrectomy should be considered for eyes with severe PDR.

✉ Makoto Inoue
inoue@eye-center.org

[1] Kyorin Eye Center, Kyorin University School of Medicine, 6-20-2 Shinkawa, Mitaka, Tokyo 181-8611, Japan

[2] Department of Ophthalmology, Shin Kong Wu Ho-Su Memorial Hospital, Taipei, Taiwan

Keywords Proliferative diabetic retinopathy · Microincision vitrectomy · Pars plana vitrectomy · Neovascular glaucoma

Introduction

Proliferative diabetic retinopathy (PDR) is a vision-threatening disease [1, 2]. The incidence of diabetic retinopathy increases with increasing duration of diabetes, and nearly all patients with type 1 and more than 60 % with type 2 diabetes develop some signs of retinopathy after 20 years [3]. Pars plana vitrectomy (PPV) has been shown to relieve vitreoretinal traction, remove vitreal opacities, and stabilize the proliferative processes [4–10]. Vitreous hemorrhage, severe fibrovascular proliferation with tractional retinal detachment (RD), and tractional rhegmatogenous RDs that affect the macula are classic indications for PPV [7–9].

Microincision vitrectomy surgery (MIVS) with 25-gauge (G) and 23G instruments requires no scleral suturing, which leads to less surgical trauma to the conjunctiva and no postoperative suture-related astigmatism. MIVS also reduces sclerotomy-related retinal breaks compared to conventional 20G vitrectomy [11–13]. MIVS allows a faster recovery of the postoperative visual acuity and fewer intraoperative retinal breaks, and it appears to be as effective as conventional 20G vitrectomy for PDR [14–19].

One severe postoperative complication of PPV for PDR is neovascular glaucoma, and transconjunctival sutureless surgery has the advantages of minimal conjunctival incisions and maintenance of untouched conjunctiva for glaucoma filtering surgery if needed.

The purpose of this study was to compare the effects of 20G vitrectomy to that of 23G and 25G vitrectomy in PDR

patients. To accomplish this, we examined the medical records of patients who had undergone 20G, 23G, and 25G vitrectomy to determine whether MIVS significantly improved the visual outcomes and reduced the incidence of intraoperative and postoperative complications.

Materials and methods

Patients

We reviewed the medical records of patients with severe PDR who had undergone primary vitrectomy at the Kyorin Eye Center from September 2007 to January 2011. One hundred seventy eyes of 138 patients had 20G vitectomy (1500 cut per min; cpm), 80 eyes of 66 patients had 23G vitrectomy (2500 cpm), and 174 eyes of 143 patients had 25G vitectomy (1500 or 2500 cpm). All surgeries were performed with the Accurus® Surgical System (Alcon Laboratories, Inc., Fort Worth, TX, USA).

All the patients received a detailed explanation of the surgical and ophthalmic examinations and provided informed consent. The procedures adhered to the tenets of the Declaration of Helsinki. The study protocol was approved by the Institutional Review Committee of the Kyorin University School of Medicine, and all the patients consented to our review of their medical records. This clinical study was registered at the United States National Institutes of Health (http://www.clinicaltirals.gov) as "Comparison of Small-gauge Vitrectomy and Conventional Vitrectomy for Proliferative Diabetic Retinopathy" (reference no. NCT01758757).

The inclusion criteria were patients who had persistent vitreous hemorrhage, fibrovascular proliferation affecting the macula, or tractional RD and who had a follow-up for more than 6 months. Eyes that underwent vitrectomy for diabetic macular edema were excluded. The average postoperative follow-up period was 18.5 ± 10.7 (mean ± SD) months in the 20G group, 19.9 ± 10.1 months in the 23G group, and 13.8 ± 10.4 months in the 25G group. The surgeries were performed by 11 vitreoretinal specialists with comparable surgical skills and experiences (each with >500 vitrectomy cases) at the Kyorin Eye Center.

During the vitrectomy, all cataractous lenses were removed, and the lenses of all patients >55 years old were removed [20]. The lenses were removed by phacoemulsification with an implantation of an intraocular lens. Triamcinolone acetonide (MaQaid®, Wakamoto Pharmaceutical Co., Ltd., Tokyo, Japan, or Kenacort-A®, Bristol Pharmaceuticals KK, Tokyo, Japan) was injected intravitreally to make the vitreous cortex and internal limiting membrane (ILM) more visible. Wherever a posterior vitreous detachment was not present, core vitrectomy was performed, then the fibrovascular membrane was dissected with either vitreous cutters or scissors. All patients underwent peripheral vitreous dissection with scleral indentation and endophotocoagulation up to the ora serrata when necessary. The scleral incisions were sutured with 7–0 vicryl (polyglactin 910) after 20G vitrectomy and also after 23G and 25G vitrectomy when leakage from the scleral incisions was found.

Evaluation of preoperative factors and postoperative complications

All patients had a comprehensive ophthalmologic examination both before and after surgery. The examinations included measurements of the best corrected visual acuity (BCVA), binocular indirect ophthalmoscopy, non-contact lens slit-lamp biomicroscopy, and fundus photography. The medical records of patients were reviewed, and the preoperative data evaluated were the age, preoperative BCVA, presence of tractional RD, tractional RD combined with rhegmatogenous RD, tractional RD associated with macular detachment, vitreous hemorrhage, neovascular glaucoma (presence of rubeosis iridis and angle neovascularization), preoperative panretinal photocoagulation, preoperative injection of intravitreal bevacizumab (1.25 mg, F. Hoffmann-La Roche Ltd., Zurich, Switzerland), and status of the lens. The intraoperative data reviewed in the combined cataract and vitreous surgery cases were the intraoperative use of scissors, use of bimanual operation, use of liquid perfluorocarbon, gas, or silicone oil tamponade, and intraoperative iatrogenic retinal tears. The postoperative data were reviewed for retinal breaks related to the scleral incisions, postoperative RD, RD that could not be reattached, postoperative vitreous hemorrhage developing after 1 month, newly developed postoperative neovascular glaucoma, revision of vitrectomy to wash out postoperative persistent vitreous hemorrhage, presence of neovascularization of the scleral wounds, which was detected at the revision of vitrectomy for postoperative vitreous hemorrhage, and BCVA at the final visit.

Statistical analyses

The statistical analyses were performed with one-way analysis of variance and the Kruskal-Wallis test. In addition, the Tukey-Kramer and Steel-Dwass tests were used as post hoc tests. A P value <0.05 was considered significant. The decimal BCVA was converted to the logarithm of the minimum angle of resolution (logMAR) units, which was used for the statistical analyses.

Results

Baseline and demographic data

The mean age was 54.6 ± 11.8 years (range 31–88 years) in the 20G group, 50.6 ± 12.8 years (range 24–80 years) in the 23G group, and 56.5 ± 12.7 years (range 24–85 years) in the 25G group (Table 1). The differences in the ages among the three groups were significant ($P = 0.002$). The differences in the preoperative BCVA, preoperative panretinal photocoagulation, status of the lens, and severity of PDR, presence of tractional RD, presence of tractional RD with rhegmatogenous RD, presence of tractional RD with macular detachment, presence of vitreous hemorrhage, and presence of neovascular glaucoma were not significant.

Surgical results and intraoperative complications

The incidence of lens-sparing surgery was significantly lower in the 20G group ($P = 0.0001$) than in the 23G and 25G groups ($P = 0.0083$, Table 2). The cases with combined cataract surgery with IOL implantation were more frequent in the 20G group ($P = 0.0007$) than in the 23G and 25G groups ($P = 0.018$). Intraoperative iatrogenic retinal breaks occurred in 60 eyes (35 %) in the 20G group, 17 eyes (21 %) in the 23G group, and 45 eyes (26 %) in the 25G group. The incidence of intraoperative iatrogenic retinal breaks was significantly lower in the 23G group than in the 20G group ($P = 0.024$), but not in the 25G group ($P = 0.054$). The use of scissors and the bimanual technique was not significantly different among the three groups ($P = 0.06$, $P = 0.46$), but the use of scissors in the 25G group tended to be lower than in the 20G group. Perfluorocarbon liquid was used more often in the 20G group than in the 25G group ($P = 0.04$). The use of gas or silicone oil tamponade in the three groups was not significantly different ($P = 0.36$). The sclerotomy sites were sutured in all 170 eyes (100 %) of the 20G group, 26 of 80 eyes (33 %) of the 23G group, and 8 of 174 eyes (5 %) of the 25G group ($P < 0.0001$, Table 2; Fig. 1).

Postoperative status and complications

The BCVA at the final visit was not significantly different among the three groups ($P = 0.70$, Table 3). The incidence of retinal breaks related to sclerotomies was not significantly different among the three groups ($P = 0.13$), but the incidence in the 23G group (1 %) and the 25G group (0 %) tended to be lower than that in the 20G group (2 %). The incidence of postoperative RD was not significantly different among the three groups ($P = 0.73$). The incidence of postoperative vitreous hemorrhage developing more than 1 month after vitrectomy was not significantly different among the three groups ($P = 0.15$), but the cases of neovascularization related to sclerotomy that were detected during the revision of vitrectomy to remove postoperative persistent vitreous hemorrhage after the wash out tended to be lower in the 23G group (0 %) and 25G group (13 %) than in the 20G group (40 %, $P = 0.11$).

Postoperative neovascular glaucoma, which was not present preoperatively, developed in 18 eyes (11 %) in the 20G group, in 6 eyes (8 %) in the 23G group, and in 5 eyes (3 %) in the 25G group ($P = 0.02$, Kruskal-Wallis test). The incidence of postoperative neovascular glaucoma in

Table 1 Baseline of the characteristics of the subjects

Group	20G	23G	25G	*P* value
Eyes	170	80	174	
Age	54.6*	50.6*·**	56.5**	0.002†
Preop logMAR BCVA	1.55	1.53	1.51	0.93†
Tractional RD	79 (46 %)	43 (54 %)	77 (44 %)	0.57‡
Rhegmatogenous RD	23 (14 %)	10 (13 %)	22 (13 %)	0.96‡
Macular detachment#	33 (37 %)	19 (43 %)	39 (47 %)	0.38‡
Preop NVG	9 (5 %)	3 (4 %)	4 (2 %)	0.35‡
VH	126 (74 %)	60 (75 %)	118 (69 %)	0.33‡
No preop PRP	37 (22 %)	17 (21 %)	46 (26 %)	0.51‡
Phakia/IOL	153/17	72/8	146/28	0.18‡

Preop preoperative, *RD* retinal detachment, *NVG* neovascular glaucoma, *VH* vitreous hemorrhage, *PRP* panretinal photocoagulation, *IOL* intraocular lens

† One-way analysis of variance

‡ Kruskal-Wallis test

* $P = 0.04$ (Tukey-Kramer test)

** $P = 0.001$ (Tukey-Kramer test)

Macular detachment among eyes with retinal detachment

Table 2 Surgical procedures and intraoperative complications

Group	20G	23G	25G	*P* value[#]
Eyes	170	80	174	
Lens-sparing vitrectomy[##]	41 (27 %)**	40 (56 %)**	63 (43 %)**	<0.001
Combined cataract surgery with IOL	102 (60 %)*·**	28 (35 %)**	79 (45 %)*	<0.001
Use of scissors	52 (31 %)	23 (30 %)	35 (20 %)	0.06
Use of bimanual technique	13 (8 %)	10 (12 %)	16 (9 %)	0.46
Iatrogenic break	60 (35 %)[†]	17 (21 %)[†]	45 (26 %)	0.04
PFCL	12 (7 %)[‡]	2 (3 %)	3 (2 %)[‡]	0.03
Gas or silicone oil tamponade	75 (44 %)	34 (43 %)	64 (37 %)	0.36
Eyes with sutured sclerotomies	170 (100 %)**	26 (33 %)**	8 (5 %)**	<0.0001

IOL intraocular lens, *PFCL* perfluorocarbon liquid

[#] Kruskal-Wallis test

* $P < 0.05$

** $P < 0.01$

[†] $P = 0.02$

[‡] $P = 0.04$ (Steel-Dwass test)

[##] Among eyes with preoperative phakic eyes

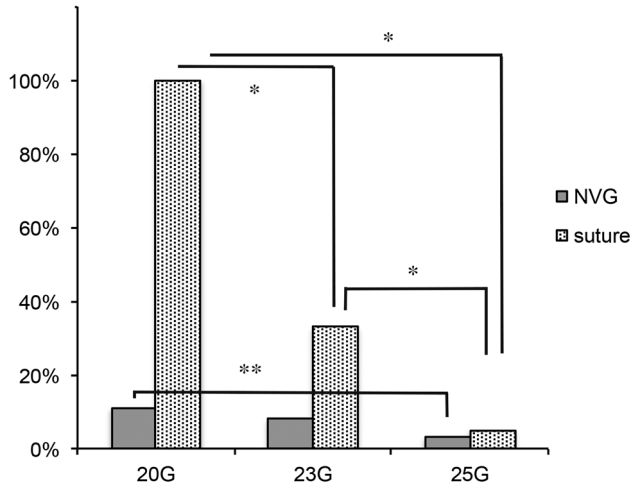

Fig. 1 The incidence of postoperative neovascular glaucoma and eyes with sutured sclerotomies. The lower incidences of sutured sclerotomies with smaller incision are most likely the reason for lower incidence of postoperative neovascular glaucoma. *NVG* neovascular glaucoma, *suture* eyes with sutured sclerotomies, *P* value is evaluated with Steel-Dwass test. *$P < 0.01$, **$P = 0.01$

the 25G group was significantly lower than that in the 20G group ($P = 0.01$, Steel-Dwass test) but not than that in the 23G group (6 eyes; 8 %, $P = 0.72$). The incidence of postoperative neovascular glaucoma was significantly higher in eyes with sutured sclerotomies (19 of 204 eyes; 9.3 %) than in those without sutures (10 of 220 eyes; 4.5 %, $P = 0.040$, Fisher's exact probability test). A preoperative injection of intravitreal bevacizumab was performed in 11 eyes in the 20G group, 2 eyes in the 23G group, and none of the eyes in the 25G group ($P = 0.002$, Kruskal-Wallis test). Among the eyes without preoperative neovascular glaucoma, postoperative neovascular glaucoma developed after the intravitreal bevacizumab injection for severe proliferation in four eyes in the 20G group, one eye in the 23G group, and none of the eyes in the 25G group ($P = 0.13$, Kruskal-Wallis, test). These findings indicate that the use of antivascular endothelial growth factor (VEGF) may not affect the development of postoperative neovascular glaucoma.

The preoperative factors in eyes with intraoperative iatrogenic retinal breaks and postoperative late vitreous hemorrhage are shown in Tables 4 and 5. The presence of tractional RD, vitreous hemorrhage, and panretinal photocoagulation, which might have affected the incidence of intraoperative iatrogenic breaks, was not significantly different among the three groups. However, the incidence of iatrogenic breaks in the 23G and 25G groups tended to be lower than in the 20G group. The incidence of postoperative late vitreous hemorrhage was also not significantly different among the three groups whether the eyes had tractional RD, panretinal photocoagulation, lens-sparing vitrectomy, or pseudophakia. However, the incidence of postoperative late vitreous hemorrhage in the eyes that had preoperative complete panretinal photocoagulation tended to be lower in the 25G group (13 %; 6/48 eyes) than in the 20G group (29 %; 27/93 eyes).

Discussion

The postoperative complications associated with PPV performed for severe PDR include vitreous hemorrhage, fibrovascular ingrowth, anterior hyaloid fibrovascular proliferation, retinal breaks, and RDs [21, 22]. Fibrous

Table 3 Postoperative outcome and complications

Group	20G	23G	25G	*P* value
Eyes	170	80	174	
Postop BCVA at the final visit (logMAR)	0.63	0.59	0.56	0.70†
Retinal breaks related to the scleral wounds	4 (2 %)	1 (1 %)	0 (0 %)	0.13‡
Postop RD	7 (4 %)	2 (3 %)	8 (5 %)	0.73‡
Eyes without reattachment (included SO filled eye)	3	1	4	0.96‡
Postoperative VH developed more than 1 month after vitrectomy	40 (24 %)	23 (29 %)	32 (18 %)	0.15‡
Revision of vitrectomy to remove postoperative VH	15 (9 %)	6 (8 %)	8 (5 %)	0.29‡
Neovascularization at the sclerotomy wounds**	6 (40 %)	0 (0 %)	1 (13 %)	0.11‡
Postop NVG	18 (11 %)*	6 (8 %)	5 (3 %)*	0.02‡

BCVA best corrected visual acuity, *RD* retinal detachment, *SO* silicone oil, *VH* vitreous hemorrhage, *NVG* neovascular glaucoma

† One-way analysis of variance

‡ Kruskal-Wallis test

* $P = 0.01$ (Steel-Dwass test)

** Identified during vitrectomy to remove postoperative VH

Table 4 Preoperative status in eyes with intraoperative iatrogenic retinal breaks

Group	20G	23G	25G	*P* value*
TRD w/wo RRD	46/90 (51 %)	17/44 (39 %)	36/83 (43 %)	0.35
VH	38/126 (30 %)	13/60 (22 %)	24/118 (20 %)	0.17
PRP	20/37 (54 %)	14/17 (82 %)	35/46 (76 %)	0.13

TRD tractional retinal detachment, *RRD* rhegmatogenous retinal detachment, *w/wo* with or without, *VH* vitreous hemorrhage, *PRP* panretinal photocoagulation

* Kruskal-Wallis test

Table 5 Preoperative status of eyes with postoperative vitreous hemorrhage developing more than 1 month after surgery

Group	20G	23G	25G	*P* value*
TRD w/wo RRD	25/90 (28 %)	14/44 (32 %)	15/83 (18 %)	0.17
PRP not performed	3/37 (8 %)	3/17 (18 %)	7/46 (15 %)	0.52
Preop complete PRP	27/93 (29 %)	13/40 (31 %)	6/48 (13 %)	0.05
Preop incomplete PRP	10/40 (25 %)	7/23 (30 %)	19/80 (24 %)	0.81
Phakic lens preservation	12/41 (29 %)	10/40 (25 %)	17/63 (27 %)	0.91
Preop IOL	2/17 (12 %)	0/8 (0 %)	1/28 (4 %)	0.44

TRD tractional retinal detachment, *RRD* rhegmatogenous retinal detachment, *PRP* panretinal photocoagulation, *IOL* intraocular lens

* Kruskal-Wallis test

ingrowth may occur soon or at a later time after the vitrectomy and may be self-limiting [21]. However, fibroplasia at the scrlotomy sites with scarring within the vitreous base may contribute to the development of anterior hyaloid fibrovascular proliferation [22]. Lee and associates [23] report that the early postoperative occurrence of vitreous hemorrhage after 25G vitrectomy for PDR was found in 45.2 % of the patients but it did not affect the early visual recovery.

A late postoperative vitreous hemorrhage that developed at an average of 9 weeks is reported to be caused by fibrovascular proliferation around the sclerotomy sites created during the initial PPV [24]. The proliferative membranes were histologically similar to the fibrovascular proliferation seen in the ischemic retina in eyes with PDR. The membranes expanded from the residual vitreous incarcerated in the sclerotomies of 20G vitrectomy [24]. Thus, we evaluated the incidence of late postoperative vitreous hemorrhage that developed more than 1 month after surgery.

A significant correlation has been found between the severity of the postoperative vitreous hemorrhage and the

presence of neovascularization at the entry site detected by high-resolution anterior segment ultrasonography 2 months after conventional vitrectomy for PDR [25]. In the first year of follow-up, all patients requiring revision vitrectomy for postoperative vitreous hemorrhage had a trapezoidal image in the anterior segment ultrasonograms indicating the most severe grade of neovascularization at the entry site. Bhende and associates [26] report that more extensive surgery for vitreous hemorrhage after vitrectomy for PDR was required in eyes with fibrovascular proliferation at the sclerotomy site detected by ultrasound biomicroscopy. Hershberger and associates [27] report that the presence of fibrovascular ingrowth was correlated with the development of recurrent postoperative vitreous hemorrhage after conventional vitrectomy for PDR. Anterior peripheral retinal cryotherapy combined with cryotherapy of the sclerotomy sites appeared to be helpful adjunct procedures in eyes with PDR to inhibit fibrovascular ingrowth and prevent recurrent vitreous hemorrhage [28, 29]. The treatment of the inner sclerotomy site with either cryopexy or an argon laser at the completion of surgery is reported to be more effective in reducing recurrent late postoperative vitreous hemorrhage than without the inner screlotomy treatment [30, 31].

We assumed that smaller incisions may reduce neovascularization at the sclerotomies and reduce the incidence of postoperative late vitreous hemorrhage. However, the incidence of postoperative vitreous hemorrhage and neovascularization at the scleral wounds was not significantly different between the smaller and conventional incisions, and even the incidence of neovascularization at the sclerotomies after MIVS was lower than that after conventional vitrectomy. The incidence of late postoperative vitreous hemorrhage appeared to be lower in the 25G group when preoperative panretinal photocoagulation was performed although no significant difference was found in the eyes that had preoperative panretinal photocoagulation. Late postoperative vitreous hemorrhage is reported to be caused mostly by neovascularization at the screlotomies [24]. When preoperative panrertinal photocoagulation was performed and the activity of neovascularization in the eye was controlled, MIVS was more beneficial in avoiding postoperative vitreous hemorrhage.

A significant amount of vitreous incarceration that blocked the inner lip of the screlotomies was seen with an endoscope after 25G and 23G vitrectomy for vitreous hemorrhage [32]. However, the increased vitreous incarceration was not significantly associated with an increased risk of complications [32]. Our results indicate that MIVS is as effective as conventional vitrectomy in the visual outcome in eyes with PDR, and the incidence of iatrogenic retinal breaks in the 23G group with 2500 cpm was less than that in the 20G group with 1500 cpm. The higher cutting rate of a vitreous cutter may reduce the incidence of iatrogenic breaks and may be the reason why the incidence of iatrogenic breaks in the 25G group at 1500 and 2500 cpm was not significantly lower. Issa and associates [33] report that the incidence of iatrogenic retinal breaks during vitrectomy for PDR was not significantly different between the 20G and 23G group, and the incidence of iatrogenic retinal breaks around the vascular arcade was significantly lower in the 23G group. These findings suggest that MIVS can reduce the incidence of iatrogenic retinal breaks when proliferative membranes within the vascular arcade are removed. The incidence of retinal breaks related to the screlotomies was not significant but the incidence tended to be lower in the 25G and 23G groups. The cannula system used for MIVS reduced the incidence of retinal breaks related to the sclerotomies by reducing the incarcerated vitreous to the sclerotomy wounds [13].

Our results show that the incidence of postoperative neovascular glaucoma was significantly lower in the 25G group than in the 20G group even though none of the eyes in the 25G group had preoperative anti-VEGF injection. A lower incidence of neovascular glaucoma was also found in the combined cataract surgery with 25G vitrectomy, probably because the removal of the lens allowed more intensive intraoperative peripheral endophotocoagulation. Our results also show that the sclerotomy closures with absorbable sutures may increase the incidence of postoperative neovascular glaucoma.

This study has several limitations. This was a retrospective, nonrandomized study conducted in a single academic hospital, and the number of patients in each group was small and different among the groups. In addition, the selection of gauge sizes of vitrectomy may depend on the preference of the surgeons and the general trend toward a particular gauge size of vitrectomy for PDR at the time of the surgery during the 5-year period of the study. Systemic conditions including circulating levels of glycosylated hemoglobin (HbA1c), history of hypertension at the time of surgery, and use of a wide-angle viewing system were not compared among the three groups. Therefore, further studies with larger and equal sample sizes are needed to confirm these results.

In conclusion, MIVS has advantages over 20G vitrectomy including a reduction of postoperative complications in eyes with PDR, a reduction of iatrogenic retinal breaks when proliferative membranes are dissected, and a reduction of retinal breaks related to the sclerotomy. In addition, a reduction of the postoperative neovascular glaucoma and preservation of untouched conjunctiva is also an advantage of MIVS for PDR.

Acknowledgments This clinical study has been registered at the US National Institutes of Health (http://www.clinicaltirals.gov) as

"Comparison of Small-gauge Vitrectomy and Conventional Vitrectomy for Proliferative Diabetic Retinopathy," reference no. NCT01758757.

Conflicts of interest R. Yokota, None; M. Inoue, None; Y. Itoh, None; T. Rii, None; K. Hirota, None; A. Hirakata, None.

References

1. Moss SE, Klein R, Klein BE. The 14-year incidence of visual loss in a diabetic population. Ophthalmology. 1998;105:998–1003.
2. Grauslund J, Green A, Sjølie AK. Blindness in a 25-year follow-up of a population-based cohort of Danish type 1 diabetic patients. Ophthalmology. 2009;116:2170–4.
3. Klein R, Klein BE, Moss SE, Cruickshanks KJ. The Wisconsin epidemiologic study of diabetic retinopathy, XII: the 14-year incidence and progression of diabetic retinopathy and associated risk factors in type 1 diabetes. Ophthalmology. 1998;105:1801–15.
4. Michels RG. Proliferative diabetic retinopathy: pathophysiology of extraretinal complications and principles of vitreous surgery. Retina. 1981;1:1–17.
5. The Diabetic Retinopathy Vitrectomy Study Research Group. Early vitrectomy for severe vitreous hemorrhage in diabetic retinopathy. Two-year results of a randomized trial. Diabetic Retinopathy Vitrectomy Study report 2. Arch Ophthalmol. 1985;103:1644–52.
6. Smiddy WE, Flynn HW Jr. Vitrectomy in the management of diabetic retinopathy. Surv Ophthalmol. 1999;43:491–507.
7. Gündüz K, Bakri SJ. Management of proliferative diabetic retinopathy. Compr Ophthalmol Update. 2007;8:245–56.
8. Mason JO 3rd, Colagross CT, Vail R. Diabetic vitrectomy: risks, prognosis, future trends. Curr Opin Ophthalmol. 2006;17:281–5.
9. Mohamed Q, Gillies MC, Wong TY. Management of diabetic retinopathy: a systematic review. JAMA. 2007;298:902–16.
10. Abe S, Yamamoto T, Kashiwagi Y, Kirii E, Goto S, Yamashita H. Three-dimensional imaging of the inner limiting membrane folding on the vitreomacular interface in diabetic macular edema. Jpn J Ophthalmol. 2013;57:553–62.
11. Fujii GY, De Juan E, Jr Humayun MS, Pieramici DJ, Chang TS, Awh C, et al. A new 25-guage instrument system for transconjunctival sutureless vitrectomy surgery. Ophthalmology. 2002;109:1807–12.
12. Eckardt C. Transconjunctival sutureless 23-gauge vitrectomy. Retina. 2005;25:208–11.
13. Scartozzi R, Bessa AS, Gupta OP, Regillo CD. Intraoperative sclerotomy-related retinal breaks for macular surgery, 20- vs 25-gauge vitrectomy systems. Am J Ophthalmol. 2007;143:155–6.
14. Park DH, Shin JP, Kim SY. Comparison of clinical outcomes between 23 and 20-gauge vitrectomy in patients with proliferative diabetic retinopathy. Retina. 2010;30:1662–70.
15. Farouk MM, Naito T, Sayed KM, Nagasawa T, Katome T, Radwan G, et al. Outcomes of 25-gauge vitrectomy for proliferative diabetic retinopathy. Graefes Arch Clin Exp Ophthalmol. 2011;249:369–76.
16. Ozone D, Hirano Y, Ueda J, Yasukawa T, Yoshida M, Ogura Y. Outcomes and complications of 25-gauge transconjunctival sutureless vitrectomy for proliferative diabetic retinopathy. Ophthalmologica. 2011;226:76–80.
17. Yang SJ, Yoon SY, Kim JG, Yoon YH. Transconjunctival sutureless vitrectomy for the treatment of vitreoretinal complications in patients with diabetes mellitus. Ophthalmic Surg Lasers Imaging. 2009;40:461–6.
18. Schoenberger SD, Miller DM, Riemann CD, Foster RE, Sisk RA, Hutchins RK, et al. Outcomes of 25-gauge pars plana vitrectomy in the surgical management of proliferative diabetic retinopathy. Ophthalmic Surg Lasers Imaging. 2011;42:474–80.
19. Arumí JG, Boixadera A, Martínez-Castillo V, Corcóstegui B. Transconjunctival sutureless 23-gauge vitrectomy for diabetic retinopathy. Review. Curr Diabetes Rev. 2009;5:63–6.
20. Beebe DC, Shui YB, Siegfried CJ, Holekamp NM, Bai F. Preserve the (intraocular) environment: the importance of maintaining normal oxygen gradients in the eye. Jpn J Ophthalmol. 2014;58:225–31.
21. Kreiger AE. Wound complications in pars plana vitrectomy. Retina. 1993;13:335–44.
22. Lewis H, Abrams GW, Williams GA. Anterior hyaloidal fibrovascular proliferation after diabetic vitrectomy. Am J Ophthalmol. 1987;104:607–13.
23. Lee BJ, Yu HG. Vitreous hemorrhage after the 25-gauge transconjunctival sutureless vitrectomy for proliferative diabetic retinopathy. Retina. 2010;30:1671–7.
24. Sawa H, Ikeda T, Matsumoto Y, Niiya A, Kinoshita S. Neovascularization from scleral wound as cause of vitreous rebleeding after vitrectomy for proliferative diabetic retinopathy. Jpn J Ophthalmol. 2000;44:154–60.
25. Steel DH, Habib MS, Park S, Hildreth AJ, Owen RI. Entry site neovascularization and vitreous cavity hemorrhage after diabetic vitrectomy. The predictive value of inner sclerostomy site ultrasonography. Ophthalmology. 2008;115:525–32.
26. Bhende M, Agraharam SG, Gopal L, Sumasri K, Sukumar B, George J, et al. Ultrasound biomicroscopy of sclerotomy sites after pars plana vitrectomy for diabetic vitreous hemorrhage. Ophthalmology. 2000;107:1729–36.
27. Hershberger VS, Augsburger JJ, Hutchins RK, Raymond LA, Krug S. Fibrovascular ingrowth at sclerotomy sites in vitrectomized diabetic eyes with recurrent vitreous hemorrhage: ultrasound biomicroscopy findings. Ophthalmology. 2004;111:1215–21.
28. Yeh PT, Yang CM, Yang CH, Huang JS. Cryotherapy of the anterior retina and sclerotomy sites in diabetic vitrectomy to prevent recurrent vitreous hemorrhage: an ultrasound biomicroscopy study. Ophthalmology. 2005;112:2095–102.
29. Neely KA, Scroggs MW, McCuen BW 2nd. Peripheral retinal cryotherapy for postvitrectomy diabetic vitreous hemorrhage in phakic eyes. Am J Ophthalmol. 1998;126:82–90.
30. Steel DH, Connor A, Habib MS, Owen R. Entry site treatment to prevent late recurrent postoperative vitreous cavity haemorrhage after vitrectomy for proliferative diabetic retinopathy. Br J Ophthalmol. 2010;94:1219–25.
31. Nadal J, Carreras E, Canut MI. Endodiathermy plus photocoagulation as treatment of sclerotomy site vascularization secondary to pars plana vitrectomy for proliferative diabetic retinopathy. Retina. 2012;32:1310–5.
32. Nagpal M, Wartikar S, Nagpal K. Comparison of clinical outcomes and wound dynamics of sclerotomy ports of 20, 25, and 23 gauge vitrectomy. Retina. 2009;29:225–31.
33. Issa SA, Connor A, Habib M, Steel DH. Comparison of retinal breaks observed during 23 gauge transconjunctival vitrectomy versus conventional 20 gauge surgery for proliferative diabetic retinopathy. Clin Ophthalmol. 2011;5:109–14.