Original Article

Surgical Outcomes of 25-Gauge Transconjunctival Vitrectomy Combined With Cataract Surgery for Vitreoretinal Diseases

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Abstract

Introduction: To report surgical outcomes of 25-gauge transconjunctival vitrectomy combined with cataract surgery for the management of a variety of vitreoretinal diseases. Materials and Methods: A retrospective, interventional case study was conducted. Chart review of a consecutive series of 150 eyes of 144 patients who underwent 25-gauge vitrectomy combined with phacoemulsification and intraocular lens implantation for epiretinal membrane (n = 62), refractory macular oedema associated with retinal vascular disorders (n = 29), idiopathic macular hole (n = 21), non-clearing vitreous haemorrhage (n = 18), rhegmatogenous retinal detachment (n = 11), tractional retinal detachment associated with proliferative diabetic retinopathy (n = 7), and subretinal haemorrhage (n = 2). Main outcome measures included pre- and postoperative visual acuity, operating time, intraocular pressure, intra- and postoperative complications. Results: The mean follow-up period was 9.7 months (range, 6 to 26). The mean overall visual acuity improved from 20/100 preoperatively to 20/38 at final visit (*P* <0.001). Statistically significant improvement of visual acuity was also observed in each subgroup. Operative time was shortened in macular surgery. No intraoperative complications were noted attributable to small-gauge instruments and no cases required conversion to 20-gauge standard instrumentation. However, 12 eyes (8%) required suture placement to at least one sclerotomy site. Postoperative intraocular pressure remained stable in most cases except 18 eyes (13%) with transient hypotony during the first week after surgery. One case of retinal detachment but no case of endophthalmitis was observed throughout the follow-up period. Conclusions: 25-gauge vitrectomy combined with cataract surgery is a safe and effective system for the management of a variety of vitreoretinal diseases, especially cases requiring minimal intraocular manipulation. Further study is recommended to evaluate potential postoperative complications.

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Key words: Minimally invasive surgery, Vitreous surgery

Introduction

The recent development of 25-gauge instrumentation for vitreous surgery has promoted a great interest in the transconjuctival sutureless vitrectomy system.[1,2] Similar to the trend towards minimally invasive surgical intervention in the case of current cataract surgery, smaller incisions with self-sealing wounds in vitrectomy might decrease surgical trauma and operating time, possibly resulting in surgical outcomes comparable or superior to those of 20-gauge conventional vitrectomy. Many authors have reported the feasibility and safety of a new 25-gauge instrument system. The nature of sutureless small gauge vitrectomy leads to less traumatic conjunctival and scleral invasion, less surgically induced astigmatism, and less postoperative patient discomfort, and theoretically facilitates early visual recovery.[1-5] However, cataract progression, a major postoperative complication of vitrectomy, has a high incidence of presentation (79.3%), even using this novel intervention, as reported by Ibarra and associates.[4] To prevent postoperative cataract progression, vitrectomy

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combined with cataract surgery offers better long-term visual rehabilitation and has been performed in combination with the conventional 20-gauge instrumentation.[6] To enhance the advantage of conjunctiva-preserved vitrectomy, cataract combined surgery should be performed through clear corneal wound without conjunctival peritomy.[5]

In this report, we evaluated the safety and efficacy of 25-gauge transconjuctival vitrectomy combined with phacoemulsification and intraocular lens implantation through a clear corneal incision for a variety of vitreoretinal disorders, in a consecutive large series of 150 eyes.

Materials and Methods

We retrospectively reviewed a consecutive series of 150 eyes of 144 patients who underwent 25-gauge transconjunctival vitrectomy simultaneously combined with phacoemulsification and intraocular lens implantation through a clear corneal self-sealing wound at the Department of Ophthalmology, Osaka University Hospital from April 2003 to January 2005. Surgical indications were idiopathic epiretinal membrane (n = 62), refractory macular oedema associated with retinal vascular diseases (n = 29), idiopathic macular hole (n = 21), non-clearing vitreous haemorrhage (n = 18), rhegmatogenous retinal detachment (n = 11), tractional retinal detachment associated with proliferative diabetic retinopathy (n = 7), and subretinal haemorrhage (n = 2). Only eyes with at least 6 months' follow-up were included in the present study. All of the study eyes had cataracts, with the grades ranging from moderate-to-severe opacity. Instructional review board approval and complete informed consent was obtained for all patients, and all interventions followed the standard of care practice for these vitreoretinal diseases.

Patient medical records were reviewed, and the data collected include patient's age, gender, preoperative and postoperative Snellen visual acuity, operating time, intraocular pressure, results of anterior segments and fundus examination, and intraoperative and postoperative complications. For the assessments of macular status, patients diagnosed with idiopathic epiretinal membrane, macular hole, or macular oedema underwent preoperative and postoperative optical coherence tomography. In patients with macular oedema associated with retinal vascular disorders, fluorescein angiography was performed before and one month after surgery.

Before surgery, all patients underwent local monitored anaesthesia care and received topical and/or peribulbar anaesthesia using 2% lidocaine. Further local anaesthesia was administered topically during surgery as needed. No patients underwent retrobulbar anaesthesia or general anaesthesia. The standard protocols for cataract surgery combined with transconjunctival 25-gauge vitrectomy were shown in Figure 1. In brief, insertion of beveled trocars was performed before the creation of clear corneal wound for cataract surgery. The trocars for transscleral cannulas were placed through the pars plana in the superonasal, superotemporal and inferotemporal quadrants for the site of infusion and insertion of intraocular instruments following displacement of the conjunctiva, to purposefully misalign the conjunctiva and sclera incisions. After setting of microcannulas with trocars, phacoemulsification and intraocular lens implantation were performed as technique common to every case. In each case, a foldable acrylic intraocular lens (MA60BA, Alcon Lab Ltd, USA) was inserted through a 3.0-mm clear corneal wound using an injector system or lens forceps without enlargement of the corneal wound. During vitrectomy, sutureless contact lens ring was used.[7] All eyes underwent core vitrectomy followed by separation and removal of posterior hyaloid membrane. In eyes with idiopathic macular holes and refractory macular oedema, the internal limiting membrane was dissected and

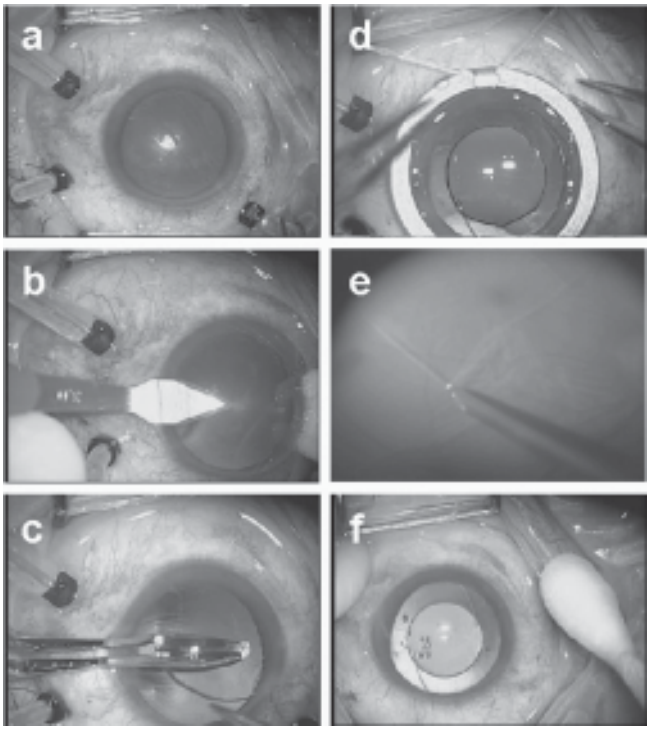

Fig. 1. Surgical procedures of clear corneal phacoemulsification combined with 25-gauge transconjunctival sutureless vitrectomy. a. Placement of the transscleral microcannulas through the pars plana in the superornasal, superotemporal and inferotemporal quadrants. b. Clear corneal incision from the temporal side for phacoemulsification. c. Insertion of a foldable acrylic intraocular lens through the 3.0-mm self-sealing wound. d. Sutureless contact lens ring is placed for vitrectomy. e. Intravitreal manipulation using 25-gauge instruments under the endoillumination with xenon light source. f. The eye immediately after removal of all microcannulas. The sutureless and self-sealing of the temporal corneal incision and three scleloromies are completely achieved.

Table 1. Overall Patient Profile and Surgical Outcomes

Diagnosis (n)	Mean age (± SD) (y)	Mean pr. LogMAR (± SD)	Mean po. final LogMAR (± SD)	Mean pre. IOP (± SD)	Mean po. day 1 IOP (± SD)	Mean Po. week 1 IOP (± SD)	Mean Po. week 4 IOP (± SD)	Mean operating time (min)	Mean follow-up (± SD) (mo)
Total (150)	62.1 ± 10.6	0.7 ± 0.5	0.3 ± 0.2	14.4 ± 3.8	11.2 ± 5.3	13.6 ± 7.8	14.3 ± 3.3	42.7 ±24.5	9.7 ± 5.8
ERM (62)	63.9 ± 9.8	0.4 ± 0.3	0.2 ± 0.2	13.3 ± 3.5	10.1 ± 4.7	12.2 ± 3.1	13.1 ± 3.7	28.1 ± 8.7	9.2 ± 5.7
DME (29)	57.8 ± 12.1	0.7 ± 0.3	0.5 ± 0.4	14.5 ± 4.0	11.3 ± 3.7	13.0 ± 3.5	15.4 ± 4.3	34.8 ± 15.6	8.3 ± 6.5
MH (21)	64.2 ± 8.4	0.6 ± 0.3	0.3 ± 0.2	14.8 ± 4.3	14.6 ± 5.4	14.9 ± 3.7	15.9 ± 4.2	41.4 ± 7.6	10.7 ± 5.8
NCVH (18)	61.3 ± 11.9	1.2 ± 0.6	0.6 ± 0.5	14.6 ± 3.7	10.4 ± 6.2	14.1 ± 3.3	14.7 ± 3.0	44.3 ± 18.0	10.3 ± 5.2
RRD (11)	61.6 ± 6.3	0.7 ± 0.6	0.3 ± 0.2	17.6 ± 3.2	16.5 ± 7.5	16.2 ± 3.1	15.6 ± 2.7	58.9 ± 21.9	9.3 ± 2.6
TRD (7)	58.2 ± 9.9	1.1 ± 0.5	0.8 ± 0.4	15.4 ± 1.7	10.8 ± 3.3	12.0 ± 4.5	15.3 ± 3.9	74.5 ± 22.1	9.8 ± 5.7
SRH (2)	74.0 ± 5.7	1.7 ± 0.5	1.5 ± 0.1	19.5 ± 3.6	10.5 ± 2.1	9.5 ± 2.1	13.5 ± 0.7	40.0 ± 7.1	11.5 ± 0.7

DME: diabetic macular oedema; ERM: epiretinal membrane; IOP: intraocular pressure; LogMAR: logarithm of the minimum angle of resolution; MH: macular hole; NCVH: non-clearing vitreous haemorrhage; n: number of eyes; po.: postoperative; pr.: preoperative; RRD: rhegmatogenous retinal detachment; SD: standard deviation; SRH: subretinal haemorrhage; TRD: tractional retinal detachment

Table 2. Intra- and Postoperative Complications in 25-gauge Vitrectomy

	Eyes	(%)
Intraoperative complications		
Inadvertent retinal breaks	4/150	(2.7)
Breakage of vitreous cutter	1/150	(0.67)
Postoperative complications		
Transient hypotony (IOP <8 mm Hg)	18/138	(13.0)
Choroidal detachment due to hypotony	1/138	(0.72)
Retinal detachment	1/150	(0.67)

IOP: intraocular pressure

removed using indocyanine green staining at the discretion of the surgeon, followed by the use of 25-gauge needle and forceps. When fluid air exchange was performed, 20% sulfur hexafluoride or sterile air was used. At the end of surgery, endoillumination with scleral indentation was performed in each case to identify any other peripheral retinal pathology. The infusion line was then clamped, the superotemporal and superornasal cannulas were removed with repositioning of conjunctiva to cover the sclerotomy. Finally, the inferotemporal cannula with infusion line was removed followed by repositioning and inspection of the conjunctiva. Topical antibiotic ointment was administered, and the eye was patched and shielded. For surgery, Alcon Accurus vitrectomy system (Alcon Lab Ltd, USA) and Legacy cataract surgical system (Alcon Lab Ltd, USA) were used. The trocars and cannulas system for cases done with the Accurus machine were from the Dutch Ophthalmic Research Center or Alcon Ophthalmic Laboratory.

For data analysis, Snellen visual acuity was converted into a logarithm of the minimal angle of resolution (LogMAR) score. Hypotony was defined as an intraocular pressure of less than 8 mm Hg. A paired Student's *t*-test was used to make statistical comparisons between preoperative and postoperative visual acuity (LogMAR) and intraocular pressure. For non-parametric analysis, Fisher's exact probability test was conducted. A value of $P < 0.05$ was taken to indicate statistical significance.

Results

One hundred and fifty eyes of 144 patients underwent transconjunctival 25-gauge vitrectomy combined with clear corneal cataract surgery. Eighty-three women and 61 men, with a mean age of 62.1 years, were observed for a mean of 9.7 months, ranging from 6 to 26 months. Mean overall visual acuity was improved from 20/100 (LogMAR, 0.69 ± 0.47) preoperatively to 20/38 (LogMAR, 0.33 ± 0.21) at final visit ($P < 0.001$). The overall results in each subgroup are summarised in Table 1. The mean overall preoperative intraocular pressure was 14.4 ± 3.8 mm Hg (mean ± standard deviation), ranging from 9 to 27. The mean overall postoperative intraocular pressure on day 1, week 1, and at final visit were 11.2 ± 5.3 mm Hg (range, 1 to 31), 13.6 ± 7.8 mm Hg (range, 6 to 24) and 14.3 ± 3.3 mm Hg (range, 11 to 23), respectively. The decrease in intraocular pressure was statistically significant on postoperative day 1 ($P < 0.001$), but no differences were significant thereafter ($P > 0.05$). Implantation of a foldable intraocular lens through the 3.0-mm clear corneal incision was successfully conducted in all study eyes. No case required suture to the clear corneal wound intraoperatively and throughout the postoperative follow-up period. Suture placement to at least one sclerotomy site was required in 12 eyes (8%). Seven eyes were the cases with rhegmatogenous retinal detachments and 5 eyes were those with tractional retinal detachment associated with proliferative diabetic retinopathy or branch retinal vein occlusion. All of these cases required peripheral vitreous shaving with scleral indentation and/or intraocular manipulation at the peripheral retina. One entry site required enlargement to remove a broken tip of a 25-gauge vitreous cutter during surgery, but no cases required conversion to conventional 20-gauge

instrumentation and no other intraoperative complications attributable to small-gauge vitrectomy occurred. In 4 eyes (2.7%), peripheral retinal breaks were encountered intraoperatively and simultaneously treated with laser photocoagulation. No other complications were found in these eyes throughout the follow-up visits.

In the 138 eyes without suture placement to the sclerotomies at conclusion of surgery, hypotony was seen in 18 eyes (13%) at postoperative day 1. Transient hypotony in these eyes improved spontaneously within 1 week except one eye with choroidal detachment requiring suture placement to sclerotomies. Of the 138 eyes, hypotony in eyes with gas tamponade (1 of 32 eyes; 3.1%) was significantly less (P <0.05) than those without gas tamponade (17 of 106 eyes; 16.0%). Postoperatively, one eye (0.7%) developed an inferior retinal detachment 2 months after surgery for diffuse diabetic macular oedema and subsequently underwent a successful surgical repair by 20-gauge vitrectomy. Throughout the follow-up period, no eyes developed persistent hypotony, low-tension maculopathy, and endophthalmitis. Incidence of intra- and postoperative troubles and complications are summarised in Table 2.

In the 65 eyes that underwent vitrectomy for an idiopathic epiretinal membrane, membrane removal was successfully removed in all cases without any intraoperative complications. No recurrence of membrane proliferation was observed during the study period. The mean preoperative visual acuity was 20/51 (LogMAR, 0.41 ± 0.33). The mean visual acuity at the final visit was 20/33 (LogMAR, 0.22 ± 0.21) and the difference from preoperative value was statistically significant (P = 0.014). The mean operating time was 28.1 ± 8.7 minutes.

Of the 29 eyes that underwent vitrectomy for macular oedema refractory to laser photocoagulation and/or local injection of triamcinolone, the underlying pathology for macular oedema was as follows: diabetic retinopathy (n = 17), branch retinal vein occlusion (n = 7), central retinal vein occlusion (n = 4) and idiopathic telangiectasis (n = 1). Internal limiting membrane removal and intravitreal injection of triamcinolone were performed in all eyes with diabetic retinopathy. Retinal thickness at macular measured by optical coherence tomography was effectively decreased in all study eyes after surgery (data not shown). The mean preoperative visual acuity was 20/108 (LogMAR, 0.73 ± 0.29). The mean visual acuity was significantly improved to 20/63 (LogMAR, 0.49 ± 0.44) at the final visit (P = 0.028). The mean operating time was 34.8 ± 15.6 minutes.

Of the 21 eyes of 21 patients who underwent combined surgery for an idiopathic macular hole, 7 eyes were diagnosed as stage II, 12 eyes as stage III, and the other 2 eyes as stage IV preoperatively on the basis of optical coherence tomography. Successful closure of the hole was achieved in all cases by the initial surgery with the use of 20% sulfur hexafluoride as a long-acting tamponade. The mean preoperative visual acuity was 20/87 (LogMAR, 0.63 ± 0.33), and it improved significantly to a mean visual acuity of 20/42 (LogMAR, 0.32 ± 0.24) at the final visit (P = 0.021). The mean operating time was 41.4 ± 7.6 minutes.

In 16 eyes of 14 patients who underwent surgery for non-clearing vitreous haemorrhage, the underlying pathology for haemorrhage was as follows: proliferative diabetic retinopathy (n = 9), branch retinal vein occlusion (n = 4), central retinal vein occlusion (n = 2) and macro aneurysm (n = 1). The mean preoperative visual acuity was 20/400 (LogMAR, 1.23 ± 0.62). The mean visual acuity was significantly improved to 20/80 (LogMAR, 0.61 ± 0.49) at the final visit (P <0.01). The mean operating time was 44.3 ± 18.0 minutes.

Of the 11 eyes with rhegmatogenous retinal detachment, retinal reattachment was successfully achieved by the initial surgery. Peripheral vitreous shaving was performed in all eyes with use of 20% sulfur hexafluoride as a long-acting tamponade. Seven eyes (64%) required suture placement to at least one entry site, but hypotony did not occur in any of these cases and no other postoperative complications were observed in all 11 eyes in this subgroup throughout the follow-up examination. The mean preoperative visual acuity was 20/112 (LogMAR, 0.74 ± 0.57), and it improved significantly to a mean visual acuity of 20/42 (LogMAR, 0.33 ± 0.24) at the final visit (P = 0.021). The mean operating time was 58.9 ± 21.9 minutes.

In the 7 eyes that underwent surgery for tractional retinal detachment, the underlying pathology was proliferative diabetic retinopathy (n = 5) and branch retinal vein occlusion (n = 2). Dissection of the tractional membranes was performed by bimanual techniques under the chandelier lighting system with xenon light source. Gas tamponade was performed in 5 of 7 eyes (71%); 3 eyes with 20% sulfur hexafluoride and 2 eyes with sterile air. Revision for the management of residual non-clearing vitreous haemorrhage was carried out on 1 eye of a diabetic patient (14%). No eyes required conversion to 20-gauge system. The mean preoperative visual acuity was 20/263 (LogMAR, 1.12 ± 0.46), and it improved significantly to a mean visual acuity of 20/133 (LogMAR, 0.83 ± 0.44) at the final visit (P = 0.019). The mean operating time was 74.5 ± 22.1 minutes.

Discussion

Sutureless vitrectomy is a modern surgical style that has

been developing over the past several years.[8] Vitrectomy using 20-gauge instruments introduced through self-sealing scleral tunnel sclelotomies was initially reported.[9-11] However, conjunctival dissection and suturing were nevertheless required in their series and complications attributed to the self-sealing sclerotomies, including wound leakage, vitreous incarceration, retinal tears and dialysis, were revealed afterward.[12] Decreasing the size of instrumentation for transconjunctival vitrectomy was then developed as 23-gauge vitrecomy.[13,14] More recently, Fujii and associates[1,2] developed a 25-gauge transconjunctival system that allows minimally invasive and sutureless vitrectomy through cannulated sclerotomies. During the past several months, some groups further reported favourable surgical outcomes of 25-gauge vitrectomy for several vitreoretinal disorders.[3,4] Despite the less invasive nature of small-gauge vitrectomy, cataract progression, a major postoperative complication of crystalline lens-sparing vitrectomy, still presents in a high incidence (79.3%).[4] To prevent postoperative cataract progression, vitrectomy combined with cataract surgery offers better long-term visual rehabilitation and has been performed in combination with conventional 20-gauge instrumentation. To enhance the advantage of conjunctiva-preserved vitrectomy, cataract surgery through a clear corneal incision without conjunctival peritomy was conducted and evaluated herein.

In the present study, 25-gauge transconjunctival vitrectomy combined with clear corneal incision cataract surgery offered early visual recovery and stable visual rehabilitation. Wounds of clear corneal incision were well adapted even in the patients with transient postoperative hypotony or those requiring prone position after surgery. No intra- and postoperative complications attributable to the design of clear corneal wound were observed throughout the follow-up period, indicating the safety and efficacy of this wound design suitable in combination with 25-gauge transconjunctival vitrectomy.

Overall surgical outcomes in our series were comparable or better than those after 25-gauge lens-sparing vitrectomy.[3,4] We evaluated 5 assessment parameters in the present study: anatomic recovery of posterior segment pathology, changes in visual acuity, operating time, intraocular pressure, and intraoperative and postoperative complications. Anatomic recovery was achieved in all of the study eyes in each subgroup after the initial surgery. Epiretinal membrane was successfully peeled in all eyes without recurrence. Macular hole closure and retinal reattachment were achieved in the study eyes without any visual threatened complications. Statistically significant improvement of visual acuity after surgery was seen for all eyes and for the epiretinal membrane, macular oedema, macular hole, non-clearing vitreous haemorrhage, and retinal detachment subgroups. No eyes in our series suffered secondary visual disturbance caused by cataract progression, but one diabetic eye with subsequent retinal detachment required 20-gauge vitrectomy for retinal reattachment. Limiting to macular diseases, operating time was effectively shortened in all subgroups in comparison with conventional 20-gauge procedure. In contrast, overall surgical time for eyes with retinal detachment is not less than that of conventional system. Although transient hypotony existed post-operatively, intraocular pressure spontaneously recovered to normal range within 1 week in most cases. The incidence of postoperative hypotony might be decreased along with the learning curves of surgeons. Since the incidence of postoperative hypotony in eyes with gas tamponade was significantly lower than those without gas tamponade, intravitreal injection of sterile air or long-acting gas might be a useful technique to prevent postoperative hypotony.[3]

Theoretical concerns related to the self-sealing sclerotomy, such as vitreous incarceration to the scleral wound and endophthalmitis, were not seen in our series. This result is compatible with other recent reports.[3,4] In our series, we performed scleral indentation for 360 degrees in all cases to identify any other peripheral retinal pathology. If necessary, the peripheral vitreous that could cause vitreous incarceration to the sclerotomy site was removed as much as possible, similar to the procedure done in 20-gauge vitrectomy. Aggressive removal of peripheral vitreous might lead to dysfunction of self-sealing in the 25-gauge system, but we did not hesitate to place a suture to the sclerotomy if a leaking bleb existed. These surgical procedures might be the reasons why the rate of postoperative retinal detachment (0.7%) in our series was much lower than that expected in 25-gauge lens-sparing vitrectomy and conventional 20-gauge vitrectomy.[3-5]

In the present study, no eyes required conversion to conventional 20-gauge system during 25-gauge vitrectomy. However, one eye required the use of 20-gauge forceps to remove a broken tip of a 25-gauge cutter during surgery. Fragility and lack of 25-gauge instruments for the effective dissection of complicated fibrovascular tissues might be the limitation for expanding the surgical indication of 25-gauge system at present.[15] Further study is warranted to determine if more complicated cases such as fibrovascular proliferation should be indicated to cataract surgery combined with 25-gauge vitrectomy.

In conclusion, our study, including a consecutive series of 150 eyes, demonstrated that 25-gauge transconjunctival vitrectomy combined with cataract surgery using a clear corneal wound demonstrated favourable anatomic results and long-term stable visual rehabilitation with minimal surgically induced complications in a variety of vitreoretinal pathology. This system is especially good for macular

surgery without complicated and peripheral pathology. Because of the retrospective and uncontrolled nature of the present study, a prospective, randomised, large-series trial is recommended to precisely evaluate the surgical outcomes of 25- and 20-gauge vitrectomy.

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