

Outcomes of 140 Consecutive Cases of 25-Gauge Transconjunctival Surgery for Posterior Segment Disease

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Purpose: To evaluate the safety and efficacy of 25-gauge instrumentation for a variety of vitreoretinal conditions on previously nonvitrectomized eyes.

Design: Single-center, retrospective, interventional case series.

Participants: One-hundred forty eyes of 140 patients were evaluated at the Doheny Retina Institute from July 2002 to July 2003.

Intervention: All patients underwent surgical procedures using the Millennium 25-gauge Transconjunctival Standard Vitrectomy system. Twenty eyes (14.3%) underwent procedures without vitrectomy.

Main Outcome Measures: Postoperative visual acuity (VA), intraocular pressure, surgical time, postoperative inflammation, complications, and number of sutured sites.

Results: No intraoperative complications were noted. No cases required conversion to 20-gauge machines. Ten cases (7.1%) involved single-site sclerotomy suture placement due to bleb formation at the conclusion of the procedure, but 5 of these entry sites were enlarged to facilitate larger instrumentation for tissue manipulation. Median VA improved from 20/250 (logarithm of the minimum angle of resolution, 1.08 ± 0.47) preoperatively to 20/60 (0.47 ± 0.30) ($P < 0.0001$) at final visit. Mean follow-up was 33.8 ± 9.7 weeks, and all eyes were observed for a minimum of 12 weeks. Mean total surgical time was 17.4 ± 6.9 minutes. Intraocular pressures remained stable throughout the postoperative course. Five eyes (3.8%) presented on day 1 with shallow choroidal detachments, but all resolved by day 7, and none required volume infusion during the postoperative period. All but one of these cases was within the first 50 procedures performed. No detectable inflammation was noted in any eyes by 4 weeks postoperatively. No case of retinal detachment or endophthalmitis was recorded.

Conclusions: Transconjunctival surgery using 25-gauge instrumentation may hasten postoperative recovery by decreasing overall surgical time and postoperative inflammation. Procedures requiring minimal intraocular manipulation did not require sutures and, thus, may be better suited for this surgical modality. *Ophthalmology* 2005;112:817–824 © 2005 by the American Academy of Ophthalmology.

The advent of 25-gauge instrumentation allows for minimally invasive vitreoretinal surgery utilizing smaller sutureless incisions, as compared with conventional pars plana vitrectomy (PPV). This trend towards minimally invasive surgical intervention was the case for phacoemulsification,^{1–5} in which smaller sutureless incisions decreased ocular trauma and surgical time, resulting in decreased postoperative inflammation and faster patient recovery.

Previous authors have described methods of creating sutureless incisions for vitreoretinal surgery.^{6–11} Chen¹² described tunnel-based sclerotomies, but the procedure still required performing a conjunctival peritomy and suturing. Also, there was no mention of surgical time, degree of postoperative inflammation, and relative speed of recovery. Numerous complications were also reported using the tunnel-based sclerotomies. Milibak and Suveges⁶ placed su-

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tures in 10 of the 17 procedures (59%) performed, and 6 eyes (35%) exhibited wound leakage after surgery. Jackson⁹ revealed that 10 of their 30 eyes (33%) exhibited wound leakage, 2 eyes (7%) exhibited vitreous incarceration, and 1 eye each (3%) exhibited retinal incarceration, wound extension, wound dehiscence, and wound hemorrhage.

Previous reports have outlined the instrumentation and surgical technique associated with the Bausch & Lomb (St. Louis, MO) Millennium 25-gauge Transconjunctival Standard Vitrectomy system.^{13,14} In this report, we examine the safety and efficacy of this system in 140 previously nonvitrectomized eyes for a variety of vitreoretinal disorders.

Patients and Methods

Institutional review board approval to review patient data was obtained for this study, all patients signed an informed consent form before intervention, and all data were collected in accordance with compliance guidelines outlined by the Health Insurance Portability and Accountability Act of 1996.

We retrospectively reviewed a consecutive series of 140 nonvitrectomized eyes of 140 patients who underwent 25-gauge transconjunctival posterior segment surgical procedures performed by 5 surgeons (MSH, EDJ, JIL, LPC, TSC) at the Doheny Retina Institute from July 2002 to July 2003. Surgical indications were idiopathic epiretinal membrane (ERM) (29 cases), choroidal neovascular membrane (CNVM) (23), nonclearing vitreous hemorrhage (NCVH) (18), tractional retinal detachment (TRD) from proliferative diabetic retinopathy (PDR) (13), branch retinal vein occlusion (BRVO) (12), macular hole (MH) (11), rhegmatogenous retinal detachment (RRD) (10), dislocated intraocular lens (IOL) (6), persistent diabetic macular edema (DME) (6), vitreous opacities (5), central retinal vein occlusion (CRVO) (4), retained lens fragments (2), and aqueous misdirection (1).

Patient medical records were reviewed, and the following data were collected: age, gender, preoperative and postoperative Snellen visual acuity (VA), applanation tonometry for intraocular pressure (IOP), and results of anterior segment and fundus examinations. All Snellen visions were converted into a logarithm of the minimal angle of resolution (logMAR) score. Eyes with BRVO underwent fluorescein angiography to determine the degree of retinal perfusion. Optical coherence tomography (OCT) was performed to measure the degree of macular edema (i.e., BRVO, DME) and to disclose the vitreomacular interface in cases of an MH. Eyes in which visualization of the fundus was not possible underwent ultrasonographic examination. The paired *t* test value of <0.05 was used to denote statistical significance. Intraoperative surgical times were determined by viewing surgical videotapes of each procedure and were subdivided into 4 parameters: opening (time between microscope focusing on eye to start of intraocular manipulation or vitrectomy cutter/suction), procedural (surgery/vitrectomy), closing (removing cannulas, suturing, and injecting subconjunctival agents), and total operative time.

Safety and efficacy outcomes were evaluated. Surgical procedures were monitored for incidence of sclerotomy site wound leakage, extension, hemorrhage, and dehiscence. Also, vitreous or retinal prolapse and incarceration as well as retinal tears and dialyses at the transconjunctival site were monitored. We believe our study may have the power to address these possible issues. The rates of retinal detachment, endophthalmitis, and suprachoroidal hemorrhage, although very small, were examined as well, but our study may lack the power to comment on these rates, due to their relatively low incidence.

Inclusion criteria included follow-up of at least 12 weeks, ability to tolerate monitored anesthesia care with local peribulbar block, and no previous vitreous surgery except laser photocoagulation or photodynamic therapy. Exclusion criteria included requirement of general anesthesia, history of glaucoma filtration surgery that would preclude transconjunctival sclerotomy, signs of grade C or greater proliferative vitreoretinopathy (PVR), and history of anterior segment optical opacity (i.e., corneal scarring, bullous keratopathy, or significant posterior subcapsular cataract) that would preclude adequate posterior visualization.

Before the surgical procedure, all patients underwent local monitored anesthesia care and received either retrobulbar or peribulbar anesthesia. Then the patient's periocular skin was prepared thoroughly with 5% povidone-iodine (Betadine, Purdue Fredrick Co., Norwalk, CT), followed by instillation of a drop of povidone-iodine into the inferior conjunctival fornix. Further local anesthesia to the operative field was administered as needed. No patient underwent general anesthesia.

All 25-gauge surgical procedures were performed using the Millennium 25-gauge Transconjunctival Standard Vitrectomy system. The surgical approach consists of first displacing the conjunctiva immediately above the designated sclerotomy site to disallow communication between the two entry sites. Next, a transconjunctival cannula is inserted using a beveled trocar to create a conjunctival/scleral incision measuring 0.5 mm in diameter. Three cannulas, in the inferotemporal, superotemporal, and superonasal quadrants, are placed in this fashion. A 25-gauge infusion cannula is placed in the inferotemporal site, and sclerotomy plugs may be placed in the other two sites. Either a sutureless or a sutured contact lens is then used to facilitate posterior visualization.

Each vitreoretinal surgery then varied slightly depending upon the diagnosis. Specifically, for example, most eyes with ERM underwent a core vitrectomy using the 25-gauge vitreous cutter, followed by peeling of the membrane using the 25-gauge microforceps (Bausch & Lomb). If no tractional component was found upon surgical examination, then surgeons performed membrane peeling without vitrectomy. Eyes with NCVH, aqueous misdirection, vitreous opacities, RRD, TRD, and MH underwent core vitrectomy and release of any epiretinal or tractional forces on the macula, including posterior hyaloid separation when necessary. Eyes with dislocated IOLs or retained lens fragments underwent vitrectomy, followed by careful fragmentation of any retained lens material, paying careful attention to tractional forces on the retina. Eyes with PDR underwent indirect laser photocoagulation, performed with the infusion cannulas in place in all cases. Eyes with BRVO underwent 25-gauge transvitreal limited arteriovenous-crossing manipulation without vitrectomy, using a flexible/extendable pick (Bausch & Lomb), or core vitrectomy followed by arteriovenous adventitial sheathotomy. Eyes with CNVM underwent either transvitreal submacular injection of triamcinolone acetonide (Kenalog, Bristol-Myers-Squibb, New York, NY) without vitrectomy or PPV, subretinal tissue plasminogen activator injection, and partial fluid-air exchange (FAX) for cases involving submacular hemorrhage. Steroid or tissue plasminogen activator was infused subretinally via a retinotomy site approximately 4 disc diameters from the foveal center. Similarly, eyes presenting with persistent DME underwent core vitrectomy if tractional forces upon the macula were suspected as a possible cause in conjunction with intravitreal injection of triamcinolone acetonide. Eyes presenting with CRVO underwent core vitrectomy, followed by radial optic neurectomy or intravitreal steroid injection. When required, FAX and/or air-gas exchange (14% perfluoropropane) was performed.

At the end of each surgical procedure, entry-site cannulas were removed and examined for localized bleb formation from fluid, air, or gas, which would then require suture placement. The infusion cannula was the last to be removed, so as to maintain chamber

Table 1. Overall Patient Data by Diagnosis

| Diagnosis (N) | Mean Age (± SD) (yrs) | MPo IOP/MPo 1 Day IOP/MPo 1 Week IOP/ MPo 1 Month IOP (mmHg) | | | | MPo logMAR VA (± SD) | Mean Final logMAR VA (± SD) | MOT/MPT/MCT/ MTT (min) | | | | Mean Follow-up (± SD) (wks) |
|---------------|-----------------------------|---|------|------|------|-------------------------------|---|---------------------------|------|-----|------|--------------------------------------|
| | | | | | | | | | | | | |
| ERM (29) | 66.9 ± 12.9 | 15.6 | 13.9 | 15.9 | 16.4 | 0.7 ± 0.3 | 0.3 ± 0.2 | 0.6 | 13.8 | 0.7 | 15.0 | 33.8 ± 9.0 |
| CNVH (23) | 77.7 ± 14.3 | 16.8 | 15.9 | 16.7 | 16.2 | 1.3 ± 0.4 | 0.9 ± 0.3 | 0.5 | 9.0 | 0.6 | 10.2 | 32.2 ± 12.0 |
| NCVH (18) | 61.4 ± 14.3 | 15.3 | 15.7 | 14.9 | 15.8 | 1.4 ± 0.5 | 0.3 ± 0.2 | 0.4 | 18.8 | 0.6 | 19.8 | 28.9 ± 9.2 |
| TRD (13) | 53.2 ± 11.4 | 17.3 | 16.2 | 16.8 | 16.0 | 1.2 ± 0.4 | 0.5 ± 0.3 | 0.5 | 28.4 | 1.5 | 30.4 | 27.9 ± 6.0 |
| BRVO (12) | 68.7 ± 9.2 | 16.1 | 17.5 | 15.5 | 17.4 | 1.0 ± 0.4 | 0.5 ± 0.2 | 0.5 | 11.3 | 0.7 | 12.4 | 41.6 ± 7.6 |
| MH (11) | 74.2 ± 5.5 | 16.3 | 15.5 | 18.5 | 15.5 | 1.0 ± 0.5 | 0.4 ± 0.2 | 0.5 | 15.9 | 0.8 | 17.3 | 40.5 ± 7.0 |
| RRD (10) | 60.6 ± 7.3 | 14.4 | 17.2 | 18.3 | 17.9 | 1.2 ± 0.3 | 0.5 ± 0.3 | 0.5 | 27.6 | 2.2 | 30.3 | 30.4 ± 10.1 |
| DIS IOL (6) | 67.8 ± 13.4 | 14.8 | 15.7 | 16.3 | 16.8 | 0.9 ± 0.6 | 0.4 ± 0.2 | 0.5 | 15.0 | 0.7 | 16.1 | 39.3 ± 7.7 |
| DME (6) | 70.5 ± 8.2 | 17.7 | 17.2 | 16.7 | 17.7 | 0.8 ± 0.4 | 0.4 ± 0.2 | 0.6 | 15.0 | 1.0 | 16.6 | 33.8 ± 8.2 |
| VIT OPAC (5) | 58.2 ± 18.9 | 15.8 | 18.4 | 17.4 | 19.2 | 1.3 ± 0.5 | 0.3 ± 0.1 | 0.5 | 14.4 | 0.7 | 15.6 | 34.6 ± 10.0 |
| CRVO (4) | 75.0 ± 3.7 | 19.8 | 20.5 | 17.5 | 16.0 | 1.4 ± 0.4 | 0.6 ± 0.1 | 0.5 | 15.3 | 0.8 | 16.5 | 37.3 ± 7.8 |
| RLF (2) | 60.5 ± 4.9 | 29.5 | 10.0 | 14.0 | 15.0 | 1.5 ± 0.7 | 0.6 ± 0.2 | 0.4 | 18.5 | 0.6 | 19.5 | 38.0 ± 8.5 |
| AQ MIS (1) | 76.0 ± 0.0 | 19.0 | 16.0 | 8.0 | 20.0 | 0.4 ± 0.0 | 0.48 ± 0.0 | 0.5 | 12.5 | 0.5 | 13.5 | 36.0 ± 0.0 |
| Overall (140) | 67.1 ± 13.7 | 16.3 | 15.9 | 16.4 | 16.6 | 1.1 ± 0.5 | 0.5 ± 0.3 | 0.5 | 16.0 | 0.9 | 17.4 | 33.8 ± 9.7 |

AQ MIS = aqueous misdirection; BRVO = branch retinal vein occlusion; CNVM = choroidal neovascular membrane; CRVO = central retinal vein occlusion; DIS IOL = dislocated intraocular lens; DME = diabetic macular edema; ERM = epiretinal membrane; IOP = intraocular pressure; logMAR = logarithm of the minimum angle of resolution; MCT = mean closure time; MH = macular hole; MOT = mean opening time; MPo = mean postoperative; MPo = mean preoperative; MPT = mean procedure time; MTT = mean total time; N = no. of eyes; NCVH = nonclearing vitreous hemorrhage; RLF = retained lens fragments; RRD = rhegmatogenous retinal detachment; SD = standard deviation; TRD = tractional retinal detachment; VA = visual acuity; VIT OPAC = vitreous opacities.

stability. However, if a shallow anterior chamber was noted or if tactile pressure was noted to be soft at the conclusion of the case, then additional volume was injected via a 30-gauge needle and tuberculin syringe. Subconjunctival antibiotics and steroids were then injected in many cases. Patients were evaluated postoperatively on day 1, and then approximately 1 week and 4 weeks later. The degree of intraocular inflammation was determined according to the Kimura classification.¹⁵

Results

Overall results are summarized in Table 1. Overall, 71 men and 69 women, with a median age of 67 years (mean, 67.1 ± 13.7 [standard deviation]), were observed for a mean of 33.8 ± 9.7 weeks. Minimum follow-up time was 12 weeks. Median preoperative VA was 20/250 (logMAR, 1.08 ± 0.47), and median postoperative VA at final visit was 20/60 (0.47 ± 0.3) ($P < 0.0001$) (Fig 1). Mean preoperative IOP was 16.3 ± 4.1 mmHg, and mean postoperative IOPs at 1 day, 1 week, and final visit were 15.9 ± 6.2 ($P = 0.46$), 16.4 ± 5.7 ($P = 0.73$), and 16.6 ± 3.2 ($P = 0.8$) mmHg, respectively (Fig 2). Mean total surgical time was 17.4 ± 6.9 minutes. Mean opening time was 0.5 ± 0.2 minutes, mean procedure/vitreotomy time was 16.0 ± 6.5 minutes, and mean closing time was 0.9 ± 0.8 minutes (Fig 3). Ninety-three eyes (66.4%) were phakic, and 47 eyes (33.6%) were pseudophakic. No case required conversion to 20-gauge machines and standard 20-gauge PPV instrumentation.

Suture placement was necessary in 10 cases, 5 each of TRD and RRD, in which one site for each case formed a localized bleb. In all 10 cases, the sutured site was near the surgeon's dominant hand, which did most of the intraocular manipulation. Also, in 5 of these cases (50%), all TRD secondary to PDR, one entry site required enlargement to facilitate membrane peeling/cutting scissors that could not be placed through the 25-gauge trocar port. No conversion to 20-gauge infusion or machinery was necessary. No

intraoperative complications were reported. Additional fluid injection via a 30-gauge needle was performed in 18 cases (12.9%). Of these, 6 were TRD cases; 4, RRD; 5, NCVH; and 3, BRVO. No sutures were placed in any of these.

Membrane removal was performed successfully in all 29 ERM cases, and 7 eyes (24%) did not require vitrectomy due to the presence of posterior vitreous detachment so as to minimize intraocular manipulation. Median VA improved from 20/100 (logMAR, 0.70 ± 0.32) to 20/40 (logMAR, 0.29 ± 0.16) over 33.8 ± 9.0 weeks, IOP remained stable throughout, and procedural and total operative times were 13.8 ± 2.6 and 15.0 ± 2.6 minutes, respectively. No eyes exhibited inflammation at 4 weeks.

Subretinal administration of a pharmacologic agent was performed in all 23 CNVM eyes, with 12 (52%) undergoing PPV, partial FAX, and administration of tissue plasminogen activator through a retinotomy site for associated submacular hemorrhage and 11 (48%) undergoing subfoveal administration of triamcinolone acetonide without vitrectomy for CNVM unassociated with hemorrhage. Median VA improved from 20/400 (logMAR, 1.27 ± 0.37) to 20/70 (logMAR, 0.54 ± 0.19) over 32.2 ± 12.0 weeks, and procedural and total operative times were 9.0 ± 3.1 and 10.2 ± 3.2 minutes, respectively. One eye that underwent subfoveal triamcinolone acetonide without vitrectomy experienced an IOP spike on day 1 to 46 mmHg, but was controlled by 2 topical antiglaucoma drops. No choroidal detachments were noted, and all eyes were quiet at 2 weeks.

For NCVH, 16 of 18 eyes (89%) were secondary to PDR, and 2 were due to CRVO (11%). All underwent preoperative B-scan ultrasonography that revealed no other pathology. Median VA improved from 20/400 (logMAR, 1.42 ± 0.51) to 20/40 (logMAR, 0.32 ± 0.21), IOP remained stable throughout the postoperative course, and procedural and total operative times were 18.8 ± 2.1 and 19.8 ± 2.1 minutes, respectively. This included indirect laser photocoagulation with the infusion cannulas in place in all cases.

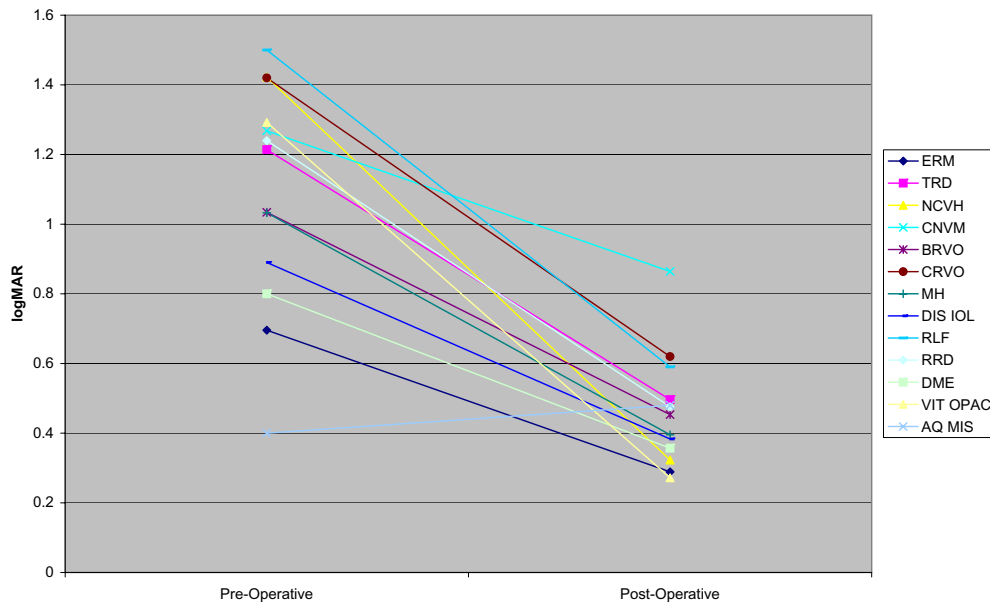


Figure 1. Preoperative and postoperative visual acuity (logarithm of the minimum angle of resolution [logMAR]) observed for each diagnosis in 140 consecutive cases of Transconjunctival Standard Vitrectomy. Postoperative visual acuities were performed at 4 weeks postoperatively. Visual improvement was noted in all diagnoses. AQ MIS = aqueous misdirection; BRVO = branch retinal vein occlusion; CNVM = choroidal neovascular membrane; CRVO = central retinal vein occlusion; DIS IOL = dislocated intraocular lens; DME = persistent diabetic macular edema; ERM = idiopathic epiretinal membrane; MH = macular hole; NCVH = nonclearing vitreous hemorrhage; RLF = retained lens fragments; RRD = rhegmatogenous retinal detachment; TRD = tractional retinal detachment; VIT OPAC = vitreous opacities.

No postoperative complications occurred, and all eyes were quiet at 4 weeks.

All 13 eyes with TRD required vitrectomy, dissection of the tractional components, and either endolaser or indirect laser photocoagulation. Median VA improved from 20/400 (logMAR,

1.21 ± 0.38) to 20/60 (logMAR, 0.50 ± 0.30), and procedural and total operative times were 28.4 ± 1.4 and 30.4 ± 1.9 minutes, respectively. Five sclerotomy sites of 5 eyes required 1 suture each due to site enlargement to facilitate passage of membrane peeling/cutting scissors for tissue dissection. Although IOP remained sta-

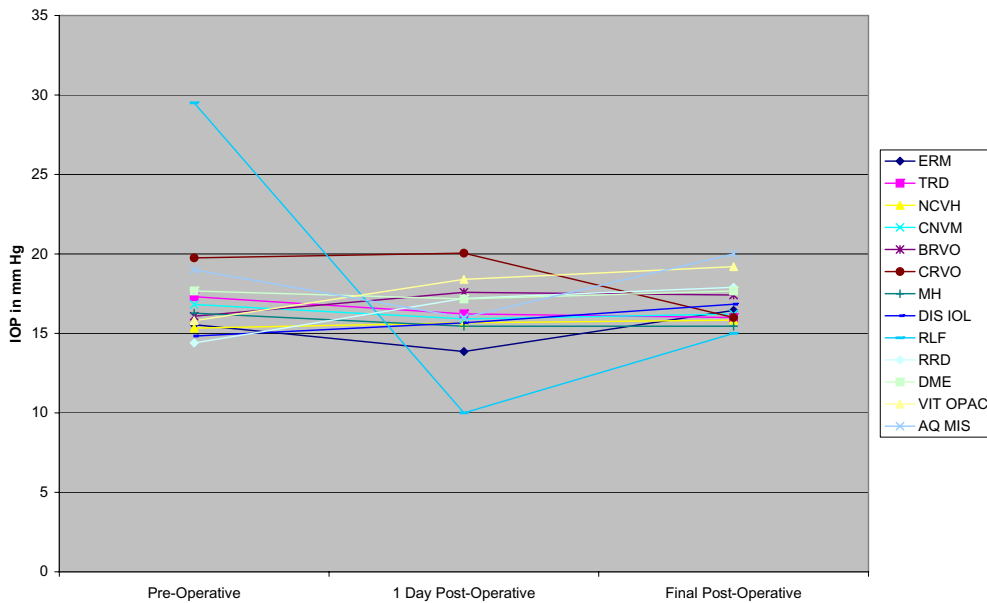


Figure 2. Preoperative and postoperative intraocular pressure (IOP) (millimeters of mercury [mmHg]) observed for each diagnosis in 140 consecutive cases of Transconjunctival Standard Vitrectomy. AQ MIS = aqueous misdirection; BRVO = branch retinal vein occlusion; CNVM = choroidal neovascular membrane; CRVO = central retinal vein occlusion; DIS IOL = dislocated intraocular lens; DME = persistent diabetic macular edema; ERM = idiopathic epiretinal membrane; MH = macular hole; NCVH = nonclearing vitreous hemorrhage; RLF = retained lens fragments; RRD = rhegmatogenous retinal detachment; TRD = tractional retinal detachment; VIT OPAC = vitreous opacities.

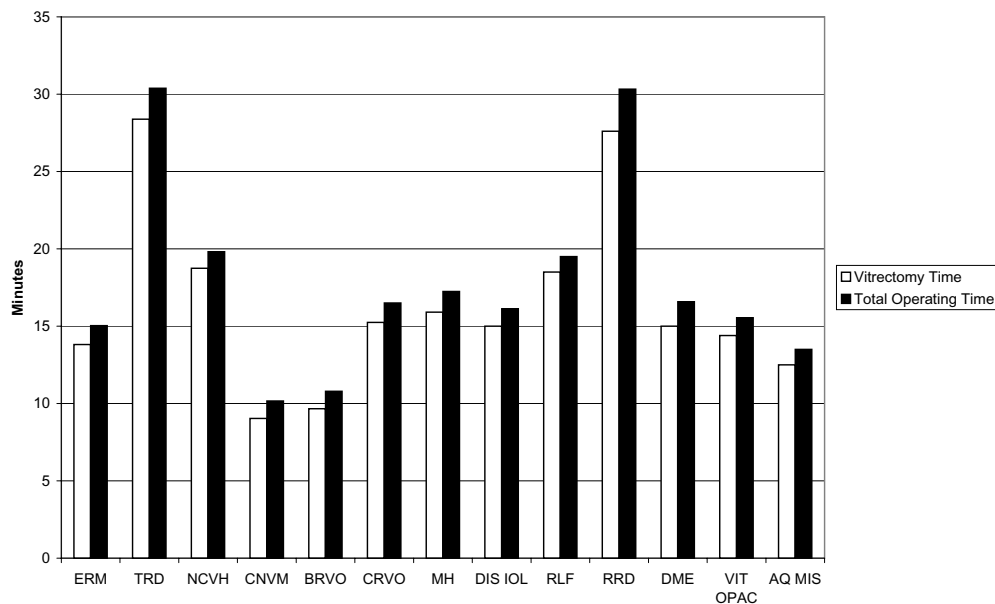


Figure 3. Vitrectomy time and total operating time observed for each diagnosis in 140 consecutive cases of Transconjunctival Standard Vitrectomy. AQ MIS = aqueous misdirection; BRVO = branch retinal vein occlusion; CNVM = choroidal neovascular membrane; CRVO = central retinal vein occlusion; DIS IOL = dislocated intraocular lens; DME = persistent diabetic macular edema; ERM = idiopathic epiretinal membrane; MH = macular hole; NCVH = nonclearing vitreous hemorrhage; RLF = retained lens fragments; RRD = rhegmatogenous retinal detachment; TRD = tractional retinal detachment; VIT OPAC = vitreous opacities.

ble throughout the postoperative course in most eyes, 2 eyes exhibited shallow choroidal detachments, which resolved by day 7. Trace inflammation was detected in 3 eyes at 4 weeks, and all of these eyes had suture placement.

Transvitreal limited arteriovenous-crossing manipulation without vitrectomy, a procedure we previously described (Lakhanpal RR, Javaheri M, Humayun MS. Transvitreal limited arteriovenous-crossing manipulation without vitrectomy for complicated BRVO using 25-gauge instrumentation. Paper presented at: American Society of Retina Specialists meeting, July, 2004; Coronado, CA), was performed in 8 of 12 BRVO cases. In this procedure, a blunt flexible–extendable pick (MADLAB, Los Angeles, California; Bausch & Lomb, St. Louis, MO) is introduced into the vitreous through the superonasal cannula, lifting the proximal, distal, and crossing points of the arteriovenous juncture until dislodgement of the clot and a column of red blood cells is seen, signaling reperfusion of blood flow in the previously occluded vein. In the other 4 cases, core vitrectomy and stripping of the posterior hyaloid were performed, followed by lysis of the common adventitial sheath (arteriovenous adventitial sheathotomy). Median VA improved from 20/200 (logMAR, 1.03±0.36) to 20/60 (logMAR, 0.45±0.23), and mean preoperative and postoperative foveal thicknesses by OCT were measured to be 350 μ m, and 200 μ m, respectively. Procedural and total operative times were 11.3±2.6 and 12.4±2.7 minutes, respectively; IOP remained stable throughout the postoperative course; and 10 of 12 eyes (83.3%) were quiet at 1 week.

All 11 MHs, documented as stage III preoperatively by OCT, appeared sealed by clinical examination and OCT postoperatively after use of perfluoropropane (14%) as a long-acting tamponade. Median VA improved from 20/200 (logMAR, 1.03±0.45) to 20/50 (logMAR, 0.40±0.24); procedural and total operative times were 15.9±1.9 and 17.3±1.9 minutes, respectively; and no inflammation was noted in any eye after 4 weeks.

No signs of PVR were noted in the 10 RRD cases, and all were reattached successfully with vitrectomy, dissection of the trac-

tional components, and, in some cases, indirect laser photocoagulation or endolaser followed by FAX or gas exchange using 14% perfluoropropane (3 eyes). Eyes were assessed for indications of pneumatic retinopexy before surgery, but were felt to be poor candidates: 7 had multiple tears several clock hours apart, 2 were pseudophakic with several tears, and 1 had 2 superior breaks with extension of subretinal fluid inferiorly, involving >6 clock hours. No intraoperative complications were noted, median VA improved from 20/400 (logMAR, 1.24±0.31) to 20/60 (logMAR, 0.48±0.26), and procedural and total operative times were 27.6±1.4 and 30.3±2.2 minutes, respectively. Five sclerotomy sites of 5 eyes required suture placement due to localized bleb formation. Three of these had undergone 14% perfluoropropane infusion, and there was evidence of gas bubble formation under the conjunctival sclerotomy site. Three eyes presented on postoperative day 1 with shallow choroidal detachments that resolved by day 7.

All 6 eyes with dislocated IOLs underwent core vitrectomy, either successful lens repositioning in the sulcus (5) or lens exchange (1), and fixation without complications. Median VA improved from 20/160 (logMAR, 0.89±0.59) to 20/50 (logMAR, 0.38±0.25), and procedural and total operative times were 15.0±1.9 and 16.1±1.8 minutes, respectively. Although the lens repositioning procedures averaged 13.5 minutes, the lone lens exchange procedure time was 22.5 minutes. No eyes exhibited detectable inflammation by 2 weeks, and IOP remained stable. The 6 eyes with persistent DME underwent core vitrectomy due to vitreomacular traction, followed by triamcinolone acetonide injection without complications and stable IOP, resulting in median VA improving from 20/125 (logMAR, 0.80±0.36) to 20/40 (logMAR, 0.36±0.17). Procedural and total operative times were 15.0±2.9 and 16.6±2.8 minutes, respectively. Patients with vitreous opacities underwent core vitrectomy without complication, with median VA improving from 20/400 (logMAR, 1.30±0.49) to 20/40 (logMAR, 0.27±0.14), and procedural and total operative times were 14.4±1.4 and 15.6±1.3 minutes, respectively. One of the patients

also underwent intravitreal injection of amphotericin B (Fungizone, Bristol-Meyers-Squibb) for presumed fungal infection. No postoperative complications were noted, and no eyes exhibited detectable inflammation at 4 weeks.

All 4 eyes with CRVO underwent core vitrectomy and radial optic neurotomy using a microvitrectoretinal blade, as described by Opremacak et al,¹⁶ without complications. Median VA improved from 20/520 (logMAR, 1.42±0.41) to 20/80 (logMAR, 0.62±0.05), with procedural and total operative times being 15.3±0.96 and 16.5±0.7 minutes, respectively. Uneventful vitrectomy, followed by pars plana phacofragmentation of nuclear lens material, was performed for retained lens fragments, improving median VA from 20/600 (logMAR, 1.5±0.71) to 20/80 (logMAR, 0.59±0.16), with procedural and total operative times being 18.5±3.5 and 19.5±3.2 minutes, respectively. No postoperative complications were noted. Finally, uncomplicated synechialysis and peripheral iridectomy were performed in 1 eye with aqueous misdirection, with VA decreasing from 20/50 to 20/60.

Discussion

Minimally invasive vitreoretinal surgery has been proposed in the past by other authors.^{6–11} Chen¹² proposed sutureless tunnel-based sclerotomies, but his series revealed difficulty in passage of conventional instrumentation along with several complications, including wound extension, dehiscence, and leakage; vitreous and/or retinal incarceration; hemorrhage; retinal tears; and dialysis.^{6,9,12} Also, although these were touted to be minimally invasive, conjunctival dissection and suturing were usually required. Some of the previous studies, such as Chen¹² and Jackson,⁹ did not present any VA, IOP, intraoperative time, or follow-up time. Milibak and Suveges⁶ did include mean follow-up time in their study (74.2 days), but listed no other objective data.

We have reported all these parameters in this study. In terms of technique, perhaps we would have experienced complications similar to these authors' had we not modified our technique. For example, although our technique does not involve scleral tunnel formation, our technique also obviates the need for suture placement in the absence of wound dehiscence, leakage, or extension. The difference between our rates of sclerotomy closure and these authors' rates may lie in the fact that our sclerotomy sites are inspected thoroughly at the end of the case for bleb formation under the conjunctival site. Also, by removing the infusion cannula as the last step and then reassessing chamber stability, we are able to recognize times when further infusion is required. Finally, even in cases without bleb formation, if a shallow chamber was recognized, volume infusion via a 30-gauge needle was performed. With these modifications, we believe our outcomes greatly improved.

We had 10 cases (7.1%) requiring suture placement at a single sclerotomy site, but none required conversion to standard 20-gauge machinery, instrumentation, or infusion. Fifty percent of the sutured sites were secondary to site enlargement for membrane peeling/cutting scissors that were difficult to pass through the relatively smaller 25-gauge trocar port in TRD cases. In the other 5 cases, all RRD, extensive intraocular manipulation of the surgeon's dominant hand site probably caused wound extension, thus requiring suture placement. Partial subconjunctival leakage

of air or gas in 3 of these cases signaled that the site required suture placement. Thus, improvement in technique allowed for better recognition and intervention in these cases.

Several advantages of 25-gauge instrumentation over standard 20-gauge PPV are apparent. First, certain nonessential steps may be eliminated. For example, the need for conjunctival peritomy, and the resultant bleeding that occurs in certain predisposed eyes, is eliminated. Postoperative irritation from exposed sutures is eliminated; thus, these eyes exhibit less inflammation on the first postoperative day and may exhibit less discomfort than eyes undergoing a comparable 20-gauge procedure. Second, although 20-gauge instrumentation allows for nonvitrectomy procedures, we believe 25-gauge instrumentation may have the added advantages of performing these without sutures, in less overall time, and with less postoperative inflammation. We performed 20 surgeries in this series (14.3%) without vitrectomy, but only for selected indications when limited intraocular tissue dissection was required or when no proliferative or tractional components were noted. For example, all procedures done without vitrectomy were performed for ERM (7), CNVM (6), or BRVO (7). No procedures without vitrectomy were performed for TRD from PDR or RRD where significant proliferative and tractional components may have been encountered and significant tissue dissection would have been required. However, with such a small study group of eyes in which nonvitrectomy procedures were performed, we cannot adequately determine the efficacy, particularly in comparison to 20-gauge surgery. Further study in a randomized prospective manner comparing vitrectomy with nonvitrectomy for these selected indications is warranted before making such a determination.

A third potential advantage of 25-gauge instrumentation may be that surgical time is reduced due to the elimination of certain steps associated with opening and closing, such as peritomy, sclerotomy closure, and conjunctival peritomy closure. In a previous study done at our institution,¹³ the difference between 25- and 20-gauge systems was found to be statistically significant for the opening and closing steps only. Thus, the time spent performing vitrectomy and intraocular manipulation remained largely unchanged.

Also, we subjectively observed in the immediate postoperative period a less traumatic external appearance with the 25-gauge cases than with comparable 20-gauge cases, possibly due to less surgical manipulation. Several studies have already demonstrated that small-incision cataract surgery induces less postoperative astigmatism than standard extracapsular cataract extraction.^{3–5} We contend that the same principle is true of 25-gauge cases versus standard 20-gauge cases. Sutures required in many of the cases were for the contact lens, and these were removed at the end of each case. Sutureless surgery avoids the local inflammatory reaction to the suture materials. For example, the frequency of the inflammatory reaction previously has been reported to be 5% with polyglycolic acid suture material and as high as 32% with Dacron (INVISTA, Wichita, KS).¹⁷ By postoperative day 7, 90% of patients exhibited faint or ≥1 inflammation according to the Kimura classification.¹⁵ By the 4-week postoperative visit, none of the patients exhibited detectable inflammation by slit-lamp examination. This

compares favorably to previous 20-gauge studies in which postoperative inflammation by day 30 still revealed faint or moderate inflammation in nearly half the patients examined.^{18,19}

Certain lessons have also been learned since the initial experience with 25-gauge vitrectomy at our institution (*Invest Ophthalmol Vis Sci* 44:abstract 2025, 2003). First of all, case selection is the most important factor for success. This, along with the fact that we only examined previously nonvitrectomized eyes, is perhaps why such a small sample size was noted for 1 year at such a large institution with 5 surgeons. We contend that surgical procedures requiring minimal intraocular manipulation and exhibiting minimal fibrovascular proliferation are optimal for 25-gauge instrumentation, such as those for ERM, CNVM, NCVH, MH, BRVO, and DME. Cases of RRD were chosen specifically if PVR was minimal or absent. Also, surgeries for TRD were performed if minimal fibrovascular proliferation was present. Specifically for these latter 2 diagnoses, further study will be required to determine the adequacy of 25-gauge instrumentation, due to the fact that sutures were required for these procedures. Perhaps the increased intraocular manipulation necessary for these 2 diagnoses may preclude their use with 25-gauge instrumentation in the future. Second, adequate preparation using povidone–iodine is important, due to the potential increased risk of inoculating the vitreous with conjunctival flora during trochar insertion through the sclerotomy site. Not performing a conjunctival peritomy potentially increases the risk as well. Although we did not experience any cases of endophthalmitis in our study, the theoretical risk is a consideration for any transconjunctival procedure. Thus, we believe that adequate povidone–iodine preparation may reduce, but not completely negate, the risk of endophthalmitis. Third, the infusion line should be the last to be removed, to optimize IOP and maintain chamber stability.

Fourth, examination of the conjunctiva overlying the sclerotomy sites for the presence of blebs may determine if any leakage exists and if sutures require placement. If air or gas has been injected, bubbles would indicate the same circumstances. Fifth, after waiting for a minute at the end of the case, if re-examination reveals reduced chamber stability, then re-infusion of fluid with a 30-gauge needle may be performed as the final step. In our series, this was done in 18 cases (12.9%). Of these, 6 were TRD cases; 4, RRD; 5, NCVH; and 3, BRVO. No sutures were placed in any of these. Perhaps increased intraocular manipulation may have been required for these with the passage of numerous instruments, resulting in transient hypotony at the end of the case. None exhibited hypotony or choroidal detachments on postoperative day 1.

Furthermore, although we noted very few cases of postoperative hypotony or choroidal detachments, the most likely time for these cases was within the first 24 hours following resolution. None of our cases required reperfusion injection outside of the operating room after completion of the procedure. One report, however (*Invest Ophthalmol Vis Sci* 44:abstract 2026, 2003), noted that 14% of eyes required supplemental gas, air, or saline 2 to 6 hours after the procedure, due to potential hypotony complications. We

did not have such complications in our study group, as no eye required postoperative volume infusion after surgery. However, none of our patients were assessed at that same time frame after surgery, so an adequate comparison cannot be made. We may conclude from both of these studies that transient hypotony may be encountered in a small subgroup of patients, probably those requiring more extensive intraocular manipulation.

On the other hand, 1 eye in our study presented on day 1 with an IOP of 46 mmHg after subretinal triamcinolone acetonide injection, but was adequately controlled with medical management of 2 glaucoma drops. Of the 11 eyes injected with triamcinolone acetonide in our series, this was the only one with such an event. Later, we determined that the patient had previously responded to topical steroids after cataract extraction in a similar fashion. Perhaps the relatively lower IOP of the other eyes on day 1 kept the mean IOP within the normal range, but none had an IOP of <10 mmHg. Also, none presented with blebs or choroidal detachments on the first postoperative day.

Certain concerns do remain, however. First, transient hypotony may exist within the first 24 hours after 25-gauge procedures without suture placement. Second, although the overall surgical time was less than that of 20-gauge vitrectomy, the actual procedural time was comparable, due to the smaller 25-gauge port diameter, reduced cutting, and aspiration speeds; thus, the vitrectomy/procedure time may be similar or even prolonged in some 25-gauge cases, particularly if fibrovascular proliferation is noted. This is perhaps why the TRD and RRD cases were relatively longer than the others in the series, and may be the reason why dense fibrovascular proliferation may be a relative contraindication for 25-gauge instrumentation procedures in the future. Third, we lack the power in this study to comment adequately on whether air or gas tamponade may not require suture placement. In fact, 3 cases involving perfluoropropane did require suture placement. A much larger sample group would be required to answer that question. Fourth, our study group consisted of previously nonvitrectomized eyes. Thus, we cannot adequately comment on 25-gauge procedures for eyes that have previously undergone vitrectomy, and thus do not intend to state that the same success rate will be achieved in that group. Furthermore, we do not have a control sample of 20-gauge eyes with these diagnoses to compare, and thus do not contend that our approach has any outcome advantages over the standard 20-gauge pars plana approach. Fifth, intraocular illumination needs to be improved, and the inherent flexibility of 25-gauge instruments within the eye may affect bimanual technique in some hands. Finally, inherent cost disadvantages exist if one chooses to use 25-gauge instrumentation. Purchasing and using 2 operating systems may not be feasible for many vitreoretinal surgeons, and thus these advantages we propose may be insignificant. Moreover, 25-gauge surgery has a learning curve that may be time consuming and viewed as inefficient. We believe that these judgments should be based upon each surgeon's volume and patient population.

In conclusion, we contend that select vitreoretinal conditions requiring minimal intraocular manipulation and tissue dissection, such as DME, ERM, NCVH, MH, limited

arteriovenous-crossing manipulation, or RRD without PVR, may be performed safely using 25-gauge instrumentation without the need for suture placement, whereas extensive manipulation usually required suture placement or volume infusion as the final step. Although the overall surgical time is lessened, the vitrectomy/procedure time is comparable to that of 20-gauge procedures. Under optimal conditions, 25-gauge procedures induce minimal ocular trauma, decrease the inflammatory response, and may allow for overall faster patient recovery. Further study is warranted to determine if procedures involving more extensive fibrovascular proliferation should be performed.

References

1. Cleasby GW. The advantages and disadvantages of Kelman phacoemulsification (KPE). *Ophthalmology* 1979;86:1973-9.
2. Kraff MC, Sanders DR. Planned extracapsular extraction versus phacoemulsification with IOL implantation: a comparison of concurrent series. *J Am Intraocul Implant Soc* 1982;8:38-41.
3. Sanders DR, Spigelman A, Kraff C, et al. Quantitative assessment of postsurgical breakdown of the blood-aqueous barrier. *Arch Ophthalmol* 1983;101:131-3.
4. Kaiya T. Observation of blood-aqueous barrier function after posterior chamber intraocular lens implantation. *J Cataract Refract Surg* 1992;18:320-4.
5. Oshika T, Yoshimura K, Miyata N. Postsurgical inflammation after phacoemulsification and extracapsular extraction with soft or conventional intraocular lens implantation. *J Cataract Refract Surg* 1992;18:356-61.
6. Milibak T, Suveges I. Complications of sutureless pars plana vitrectomy through self-sealing sclerotomies [letter]. *Arch Ophthalmol* 1998;116:119.
7. Kwok AK, Tham CC, Lam DS, et al. Modified sutureless sclerotomies in pars plana vitrectomy. *Am J Ophthalmol* 1999;127:731-3.
8. Schmidt J, Nietgen GW, Brieden S. Self-sealing, sutureless sclerotomy in pars plana vitrectomy [in German]. *Klin Monatsbl Augenheilkd* 1999;215:247-51.
9. Jackson T. Modified sutureless sclerotomies in pars plana vitrectomy [letter]. *Am J Ophthalmol* 2000;129:116-7.
10. Lam DS, Chua JK, Leung AT, et al. Sutureless pars plana anterior vitrectomy through self-sealing sclerotomies in children. *Arch Ophthalmol* 2000;118:850-1.
11. Rahman R, Rosen PH, Riddell C, Towler H. Self-sealing sclerotomies for sutureless pars plana vitrectomy. *Ophthalmic Surg Lasers* 2000;31:462-6.
12. Chen JC. Sutureless pars plana vitrectomy through self-sealing sclerotomies. *Arch Ophthalmol* 1996;114:1273-5.
13. Fujii GY, de Juan E Jr, Humayun MS, et al. A new 25-gauge instrument system for transconjunctival sutureless vitrectomy surgery. *Ophthalmology* 2002;109:1807-12, discussion 1813.
14. 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.
15. Hogan MJ, Kimura SJ, Thygeson P. Signs and symptoms of uveitis. I: anterior uveitis. *Am J Ophthalmol* 1959;47:162-3.
16. Opremcak EM, Bruce RA, Lomeo MD, et al. Radial optic neurotomy for central retinal vein occlusion: a retrospective pilot study of 11 consecutive cases. *Retina* 2001;21:408-15.
17. Turkalj JW, Carlson AN, Manos JP, Apple DJ. Is the sutureless cataract incision a valve for bacterial inoculation? *J Cataract Refract Surg* 1995;21:472-6.
18. Tardif YM, Schepens CL, Tolentino FI. Vitreous surgery. XIV. Complications from sclerotomy in 89 consecutive cases. *Arch Ophthalmol* 1977;95:229-34.
19. Bannerman TL, Rhoden DL, McAllister SK, et al. The source of coagulase-negative staphylococci in the Endophthalmitis Vitrectomy Study: a comparison of eyelid and intraocular isolates using pulsed-field gel electrophoresis. *Arch Ophthalmol* 1997;115:357-61.