Outcomes of 77 Consecutive Cases of 23-Gauge Transconjunctival Vitrectomy Surgery for Posterior Segment Disease

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Purpose: To describe the initial experience, effectiveness, and safety profile of 23-gauge instrumentation for a variety of vitreoretinal conditions.

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

Participants: Seventy-seven eyes of consecutive patients who underwent 23-gauge transconjunctival vitrectomy surgery by a single surgeon at the Manhattan Eye, Ear, and Throat Hospital from October 2004 through October 2005.

Intervention: All patients underwent 3-port 23-gauge vitrectomy using Dutch Ophthalmic Research Corporation instrumentation and an Alcon Accuris Vitrector.

Main Outcome Measures: Postoperative visual acuity at months 1 and 3, intraoperative and postoperative complications, and operative time.

Results: Mean acuity improved from 20/190 at baseline to 20/108 ($P<0.0001$) and 20/74 ($P<0.0001$) at months 1 and 3, respectively. By diagnosis, patients with epiretinal membrane (n = 20) improved from 20/124 to 20/93 ($P = 0.0046$), macular hole (n = 18) from 20/174 to 20/57 ($P = 0.0007$), rhegmatogenous retinal detachment (RD) (n = 14) from 20/248 to 20/51 ($P = 0.0004$), tractional RD (n = 12) from 20/175 to 20/62 ($P = 0.0159$), nonclearing vitreous hemorrhage (n = 12) from 20/1345 to 20/189 ($P = 0.0004$), vitreomacular traction (n = 4) from 20/145 to 20/124 ($P = 0.7525$), and retained lens fragments (n = 4) from 20/308 to 20/140 ($P = 0.0972$). One patient who underwent diagnostic vitrectomy had stable 20/50 acuity. Two patients had hypotony on postoperative day 1, 1 patient required a sutured sclerotomy intraoperatively, and no patients developed choroidal effusions. No intraoperative tears were noted. Surgical times collected on 17 patients during the final month of the study demonstrated a mean opening time (range) of 103 seconds (70–162), mean closing time of 75 seconds (17–470), and net operating time of 24.1 minutes (7.1–74.6).

Conclusions: Twenty-three–gauge instrumentation is effective for a variety of vitreoretinal surgical indications. The safety profile compared favorably with published rates for 25-gauge systems. *Ophthalmology 2007; 114:1197–1200 © 2007 by the American Academy of Ophthalmology.*

Sutureless posterior segment surgery provides numerous potential advantages over traditional 20-gauge vitrectomy, including faster wound healing, diminished conjunctival scarring, improved patient comfort, decreased postoperative inflammation, and reduced postoperative astigmatic change.[1–9] Eliminating suturing may also shorten surgical opening and closing times.[10] Several authors have previously described 25-gauge sutureless transconjunctival pars plana vitrectomy (PPV) systems. However, compared with traditional 20-gauge systems, postoperative rates of wound leakage, hypotony, and choroidal detachment may be higher[10–12] (Gupta OP, Weichel ED, Fineman MS, et al. Postoperative complications associated with 25-gauge pars plana vitrectomy. Poster presented at: Retina Society Annual Meeting, September 2005, Coronado, California) (Gupta A, Gonzales CR, Lee SY, et al. Transient postoperative hypotony following transconjunctival 25 gauge vitrectomy. Paper presented at: Association for Research in Vision and Ophthalmology meeting, May 2003, Fort Lauderdale, Florida). Additionally, several reports have documented intraoperative and postoperative retinal tears and detachments, potentially as a result of lack of adequate peripheral vitrectomy with the more flexible instruments

Originally received: June 8, 2006.
Accepted: February 14, 2007. Manuscript no. 2006-618.

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No authors have any proprietary interests in any of the devices mentioned in the article. The work was supported in part by a Heed Foundation (Cleveland, Ohio) Fellowship (to HFF) and a grant from the Macula Foundation, Inc., New York, New York.

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ISSN 0161-6420/07/$–see front matter
doi:10.1016/j.ophtha.2007.02.020

and excessive vitreoretinal traction at sclerotomy sites[13,14] (Gupta OP, Weichel ED, Fineman MS, et al. Postoperative complications associated with 25-gauge pars plana vitrectomy. Poster presented at: Retina Society Annual Meeting, September 2005).

A new approach using a 23-gauge system may obviate some of these shortcomings. The instruments are less flexible and behave more like traditional 20-gauge instruments, allowing more thorough peripheral vitrectomy and higher-complexity maneuvers. This instrument system utilizes tunneled sclerotomy through the use of a slanted microvitreoretinal blade followed by a blunt trocar, which may provide an improved self-sealing incision. This study examines the safety and efficacy of 23-gauge vitrectomy in a consecutive series of cases.

Materials and Methods

Approval was obtained from the Lenox Hill Hospital institutional review board for this study. All subjects signed an informed consent document before surgery. All surgical cases performed by a single surgeon (RFS) at a single site from October 2004 through October 2005 were included. Data abstracted from these consecutive charts included patient age, date of operation, indication for surgery, operative eye, visual acuity (VA) (preoperative visit, postoperative day 1, monthly postoperative visits, final visit), intraocular pressure (IOP) (preoperative visit, postoperative day 1, maximum postoperative pressure), postoperative inflammation at 1 week and 1 month, phakic status (phakic, cataract, pseudophakic, aphakic), glaucoma (present, suspect, absent), anterior segment findings, and posterior segment findings.

The indications for surgery included epiretinal membrane, macular hole, rhegmatogenous retinal detachment (RD), tractional RD, nonclearing vitreous hemorrhage, retained lens fragments, vitreomacular traction, and diagnostic vitrectomy. Outcome variables included postoperative VA, conversion to 20-gauge instrumentation, sclerotomy suture placement, leakage, hypotony, choroidal detachment, postoperative retinal tear or detachment, and need for additional operations or procedures.

All patients received sedation and local anesthesia consisting of approximately 5 ml of a retrobulbar injection of a 50:50 mixture of 4% lidocaine and 0.75% bupivicaine. Supplemental anesthesia was administered as necessary. Patients' skin and lashes were prepared with 5% povidine–iodine (Betadine, Purdue Frederick Co., Norwalk, CT) solution, and the ocular surface was prepared with povidine–iodine solution. The Accurus Vitrector (Alcon Laboratories, Inc., Fort Worth, TX) was used for all surgical procedures. A 23-gauge 3-port vitrectomy setup was used for all 23-gauge cases. The conjunctiva was displaced approximately 1 to 3 mm with a pressure plate with a central opening 3.5 mm from the edge (DORC, Zuidland, The Netherlands). The 23-gauge 45° stiletto blade was inserted through the conjunctiva and sclera, parallel to the limbus, at an angle of approximately 20° to the sclera, 3.5 mm posterior to the limbus through the central opening. The blunt microtrocar was then inserted, while maintaining apposition of the conjunctival and scleral openings with the pressure plate, and a cannula was inserted into each wound. Constant pressure was maintained on the pressure plate while removing the stiletto blade and inserting the microtrocar to avoid displacement of the conjunctiva from the scleral opening (Fig 1 [all figures available at http://aaojournal.org]).

During the final month of the study (October 2005), operative times were prospectively collected. Surgical opening time was defined as the interval between the first instrument contacting the conjunctiva through the placement of all cannulae and the infusion line. The closing time was defined as the time required to remove the cannulae and infusion line. The operative time was defined as the interval between opening and closing times.

Snellen VAs were converted into logarithm of the minimum angle of resolution (logMAR). The paired t test was used to compare means with a statistical significance threshold at $P<0.05$.

Results

All 77 patients (39 female, 38 male) were followed for a minimum of 3 months, or additional information was obtained from the referring physician in cases with <3 months' follow-up. Mean follow-up time (± standard deviation) was 244±125 days. There were 42 right and 35 left eyes in this group. Indications for surgery (number of eyes) were epiretinal membrane (20), macular hole (18), rhegmatogenous RD (14), tractional RD (12), vitreomacular traction (4), retained lens fragments (4), nonclearing vitreous hemorrhage (4), and diagnostic vitrectomy (1).

Overall, mean preoperative acuity was 20/190. Mean postoperative acuities were 20/108 ($P<0.0001$) at month 1, 20/74 ($P<0.0001$) at month 3, 20/94 ($P<0.0001$) at month 6, 20/60 ($P<0.01$) at month 12, and 20/69 ($P<0.0001$) at final visit (Fig 2). By diagnosis (Figs 3, 4), patients with epiretinal membrane improved from 20/124 to 20/93 ($P = 0.0046$); macular hole, from 20/174 to 20/57 ($P = 0.0007$); rhegmatogenous RD, from 20/248 to 20/51 ($P = 0.0004$); tractional RD, from 20/175 to 20/62 ($P = 0.0159$); nonclearing vitreous hemorrhage, from 20/1345 to 20/189 ($P = 0.0004$); vitreomacular traction, 20/145 to 20/124 ($P = 0.7525$); and retained lens fragments, from 20/308 to 20/140 ($P = 0.0972$). One patient who underwent diagnostic vitrectomy had stable vision at 20/50 (Table 1 [available at http://aaojournal.org]).

Of 20 patients who had surgery for a macular hole, 19 (95%) had documented visual, clinical, and optical coherence tomography documentation of hole closure. The patient who failed macular hole surgery had undergone a previous vitrectomy by a referring retina specialist and declined an additional operation.

Of 14 patients who underwent surgery for repair of rhegmatogenous RD, 2 (13%) required an additional operative procedure due to recurrent detachment. Both recurrences were remote from the initial surgery, 6 and 13 weeks postoperatively, long after absorption of the 20% to 25% sulfur hexafluoride tamponade. The patient who redetached 6 weeks postoperatively had a small peripheral retinal tear at 12-o'clock, 2 clock hours away from either sclerotomy. The patient who redetached 13 weeks postoperatively had evidence of proliferative vitreoretinopathy. All patients who underwent surgery for tractional RD had stable or improved vision after surgery.

One patient with retained lens fragments, intraocular inflammation, and increased IOP underwent PPV and lensectomy. The inflammation did not abate after the vitrectomy, and because of the development of a small hypopyon on postoperative day 6, a vitreous tap and injection of intravitreal antibiotics were performed for presumed endophthalmitis. The inflammation did not resolve after the antibiotics, and because the culture showed no growth for bacteria or fungi, the patient was administered intravitreal corticosteroids. The inflammation abated promptly and did not recur. This case was not associated with intraoperative complications or postoperative hypotony.

Two patients experienced hypotony on the first postoperative day, defined as IOP below 6 mmHg, with pressures of 5 and 4 mmHg. Neither case had received a gas tamponade. Both cases resolved within 1 week, and neither patient had been on previous

glaucoma therapy. Vitreous incarceration to the wound was not noted in either patient. There were no instances of choroidal effusion postoperatively. Forty of 77 patients (51.9%) received a gas tamponade. One patient required a suture to the 23-gauge sclerotomy site at the time of surgery due to leakage of gas. No cannulae slipped out of a sclerotomy before closure. Eleven patients were treated with topical and/or oral medications for high postoperative pressures secondary to intraocular gas tamponade or from use of topical prednisolone acetate. Three of the patients with elevated postoperative pressure had a history of glaucoma. Eleven patients were noted to have a subconjunctival hemorrhage on postoperative day 1. No patient had observable loss of gas under the conjunctiva during the postoperative period. No case required any of the sclerotomies to be converted to 20 gauge. Of the 77 cases, 41 eyes were phakic, 37 eyes were pseudophakic, and 1 eye was aphakic. In one case, the infusion cannula likely contacted the crystalline lens. The patient required cataract surgery within 2 months of vitrectomy.

Seventeen cases were prospectively timed during the final month of the study to obtain an estimate of opening, closing, and operative times. The indications for surgery (number of eyes) in this group were epiretinal membrane (7), macular hole (2), rhegmatogenous RD (1), tractional RD (5), retained lens fragments (1), and nonclearing vitreous hemorrhage (1). Mean opening time was 103 seconds (range, 70–162). The mean closing time was 75 seconds (17–470). The net operative time between opening and closing was 24.1 minutes (7.1–74.6).

Discussion

Twenty-three–gauge vitrectomy systems were introduced to provide sutureless transconjunctival surgery similar to that of 25-gauge systems, but with instrument functionality and stiffness that more closely mirror traditional 20-gauge systems. The sclerotomy wound is constructed in a manner different from that of either 20- or 25-gauge, which typically enters the eye normal to the scleral surface, producing a full-thickness hole in the sclera. In 20-gauge surgery, the hole is so large that it needs to be closed with a suture, and in 25-gauge, the hole is small enough that suture closure is not thought to be necessary. In 23-gauge surgery, the incision is an angled self-sealing tunnel incision. Because tunnel incisions, such as those used in cataract surgery, can self-seal, use of a tunnel incision gives us the opportunity to use larger-gauge vitrectomy instruments and still have wounds that do not require suture closure. In this strategy, design compromises necessary to produce 25-gauge instruments are obviated to a large extent. This study was designed to retrospectively review safety data, including the incidence of leakage, hypotony, choroidal detachments, and intraoperative or postoperative retinal tear and detachment, as well as the need for suture placement and conversion to 20-gauge instrumentation. The efficacy of the system was evaluated by comparing VA results preoperatively and postoperatively and evaluating the efficiency of the system with prospective surgical opening and closing durations.

Tunneled sclerotomies for vitrectomy surgery were described in 1996, but still required opening of the conjunctiva and were frequently associated with bleeding from sclerotomy sites and wound leakage requiring sutures.[2] Many modifications have been made to improve the technique.[1,3–8] Traditional 20-gauge sclerotomies have a 1.15-mm width, requiring sutures. Sutureless 25-gauge vitrectomy utilizes a nontunneled sclerotomy that is maintained by a polyimide tube that in turn allows passage of 0.5-mm instruments through its inner lumen, and tunneled 23-gauge vitrectomy employs a 0.72-mm sclerotomy.[15] If the scleral thickness 3.5 mm posterior to the limbus is 0.6 mm, then a 25° tunneled wound would be roughly 1.4 mm long (thickness/sine[angle]).

Eckardt described transconjunctival sutureless 23-gauge vitrectomy in a series of 41 patients who underwent surgery using the DORC system.[15] Intraoperative and postoperative issues were noted, including that 15 of 41 patients had slight episcleral bleeding from sclerotomies; no patients had postoperative hypotony or subconjunctival gas or required sutures; and 2 patients with proliferative diabetic retinopathy had postoperative vitreous hemorrhage. However, operative times and visual outcomes were not reported. Eckardt noted that the 23-gauge system, as compared with the 25-gauge, provided for improved wound closure and reduced instrument flexibility.

There is evidence in the literature that nontunneled 25-gauge sclerotomies frequently do not self-seal. One series reported a 14% incidence of hypotony requiring additional gas or saline tamponade within 2 to 6 hours postoperatively (Gupta A, Gonzales CR, Lee SY, et al. Transient postoperative hypotony following transconjunctival 25 gauge vitrectomy. Paper presented at: ARVO meeting, May 2003, Fort Lauderdale, FL). Gupta indicated that 22% (9/41) of fluid-filled eyes that underwent 25-gauge vitrectomy required sclerotomy suture placement or suffered postoperative hypotony (Gupta OP, Weichel ED, Fineman MS, et al. Postoperative complications associated with 25-gauge pars plana vitrectomy. Poster presented at: Retina Society Annual Meeting, September 2005). In a review of 140 consecutive 25-gauge cases, Lakhanpal et al reported that 7.1% of eyes (10/140) required a suture for adequate closure and 3.8% (5/140) demonstrated postoperative choroidal detachment.[10] Even these figures underestimate the true incidence of hypotony in vitrectomized eyes after 25-gauge surgery, as the authors note that 18.6% of patients (26/140) in the series did not undergo vitrectomy: 11 patients with intralesional injection for choroidal neovascularization, 9 patients with arteriovenous manipulation for branch vein occlusion, and 7 patients with epiretinal membrane peeling with no vitrectomy. Hypotony, even if transient, is not a benign condition and may increase the postoperative risks for serious complications, including retinal or vitreal incarceration, suprachoroidal hemorrhage, and endophthalmitis.[11,12]

In the present series of 77 patients who underwent vitrectomy with 23-gauge instrumentation, 1 suture was placed due to wound leak concerns intraoperatively, and 2 patients (2.8%) had an IOP of 5 mmHg or below on the first postoperative day. No patients developed choroidal detachment or required a postoperative supplemental gas tamponade. We believe this is related to the improved closure of tunneled 23-gauge sclerotomies relative to 25-gauge nontunneled closures. However, some surgeons now use a gas fill to plug 25-gauge sclerotomies,[16] which can increase the risk of cataract and secondary retinal tears and adds operative time, or perform only a limited peripheral vitrectomy.

This study did not investigate a direct comparison between 23- and 25-gauge techniques.

Excessive instrument flexibility hampers thorough removal of the peripheral vitreous. Ibarra et al noted that a "more prominent residual vitreous skirt could cause significant anterior vitreoretinal traction and subsequent retinal tears or detachments beyond the immediate postoperative period with an increased incidence of 25-gauge cases."[13] The RD rates in the series from Ibarra et al and Fujii et al[14] were 2.2% and 2%, respectively. Gupta noted a 2.9% rate of intraoperative retinal tears. The apparent increased rate of RDs after 25-gauge surgery might be related to decreased illumination from smaller-bore light pipes leading to missed intraoperative breaks (Gupta OP, Weichel ED, Fineman MS, et al. Postoperative complications associated with 25-gauge pars plana vitrectomy. Poster presented at: Retina Society Annual Meeting, September 2005). In our series of 77 patients, no intraoperative sclerotomy site tears were noted, and no patient without a prior retinal detachment developed a subsequent detachment.

Sutureless surgery offers the potential to decrease the duration of opening and closing sclerotomies compared with traditional 20-gauge surgery. The 23-gauge system had mean opening, closing, and procedure times of 1.7, 1.3, and 24.1 minutes, respectively. These are comparable to, but slightly longer than, the durations published by Lakhanpal et al for the series of 140 patients who underwent 25-gauge surgery, in which the mean opening, closing, and procedure times were 0.5, 0.9, and 16.0 minutes.[10] One might have expected our 23-gauge series to demonstrate faster procedure times owing to more efficient cutting, which was not the case. This may be explained, in part, because 18.6% of patients in the Lakhanpal series did not undergo a vitrectomy, as previously described. The 23-gauge opening times were longer most likely because the system utilizes a 2-step opening with a stiletto blade for tunneled wound creation.

The visual outcomes of 23-gauge vitrectomy are positive, with statistically significant improvements in logMAR acuity across all groups and in the following subgroups: macular hole, rhegmatogenous RD, and tractional RD. Visual outcomes in patients with retained lens fragments, nonclearing vitreous hemorrhage, and diagnostic vitrectomy were not statistically significant. These subgroups had smaller sample sizes, and several patients, such as those with retained lens fragments and the patient who underwent diagnostic vitrectomy, underwent surgery for goals other than improvement in acuity.

Twenty-three–gauge vitrectomy systems do have important limitations that they share with 25-gauge. Currently, there is no fragmatome smaller than 20-gauge. Although cortical and small nuclear lenticular fragments may be removed with a 23-gauge cutter, large nuclear pieces require at least one 20-gauge sclerotomy. The cannulae are more difficult to insert than in 25-gauge systems because of the additional steps required. However, the opening times for the cases in this series were <2 minutes. Lastly, there are fewer 23-gauge instruments commercially available than 25-gauge, as the system has been more recently introduced, although any 25-gauge instrument can be used in 23-gauge surgery, but not vice versa.

The transconjunctival 23-gauge vitrectomy approach appears effective for sutureless transconjunctival posterior segment surgery with an acceptable safety profile. Rates of sclerotomy leakage, hypotony, and choroidal detachment were favorable compared with or lower than previously published rates in 25-gauge systems.[14] Rates of intraoperative and postoperative retinal tears and detachments also appeared comparable to or lower than published rates for 25-gauge systems. Overall visual outcomes demonstrated a highly statistically significant improvement, also evident in the larger subgroups by indication. Further study directly comparing 23-gauge and 25-gauge systems might provide relative safety and efficacy data.

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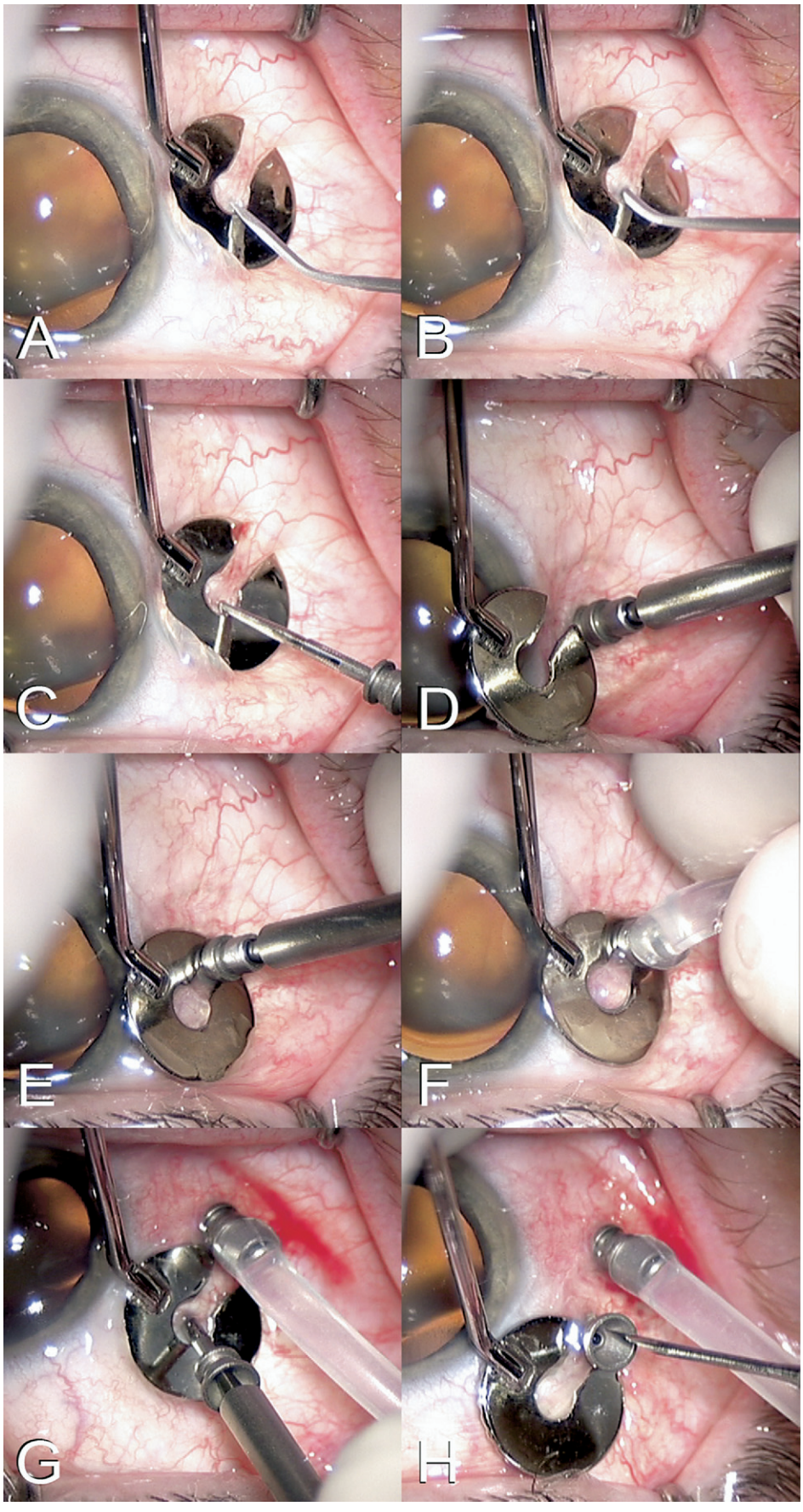
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Figure 1. **A**, A toothed pressure plate is used to displace the conjunctiva and steady the globe. The opening in the pressure plate is centered 3.5 mm from the edge of the plate. **B**, An angled 23-gauge microvitreoretinal blade is used to enter the sclera at a shallow angle. This produces a tunnel incision through the sclera. **C**, A blunt trocar is introduced into the tunnel incision created by the blade. **D**, After the distal part of the blunt trocar is inserted, the direction of the trocar is angled to be normal with the eye, and the cannula is fully inserted. **E**, The pressure plate is designed to fit in the groove of the cannula to steady the cannula. **F**, The infusion tubing goes over the cannula instead of through the cannula, as is common in 25-gauge surgery. **G**, Additional sclerotomies are made in a similar fashion. **H**, The pressure plate is being used to control the instrument cannula as the trocar is being removed. Note that the instrument cannula has a conical inner contour, which makes insertion of instruments easier.

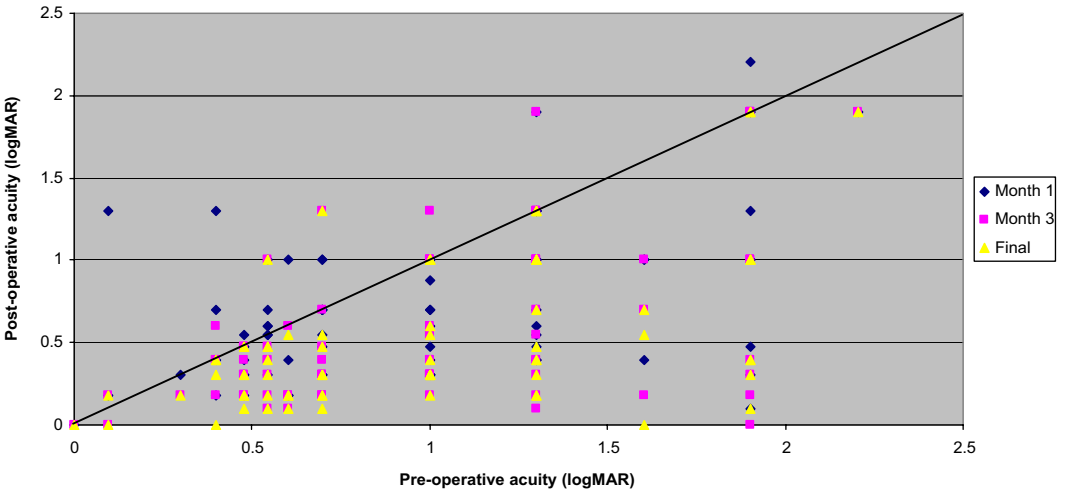

Figure 2. Postoperative versus preoperative visual acuity (logarithm of the minimum angle of resolution [logMAR]) observed at month 1 and final time points in 77 consecutive cases of 23-gauge pars plana vitrectomy. Data points below the diagonal line reflect an improvement in acuity.

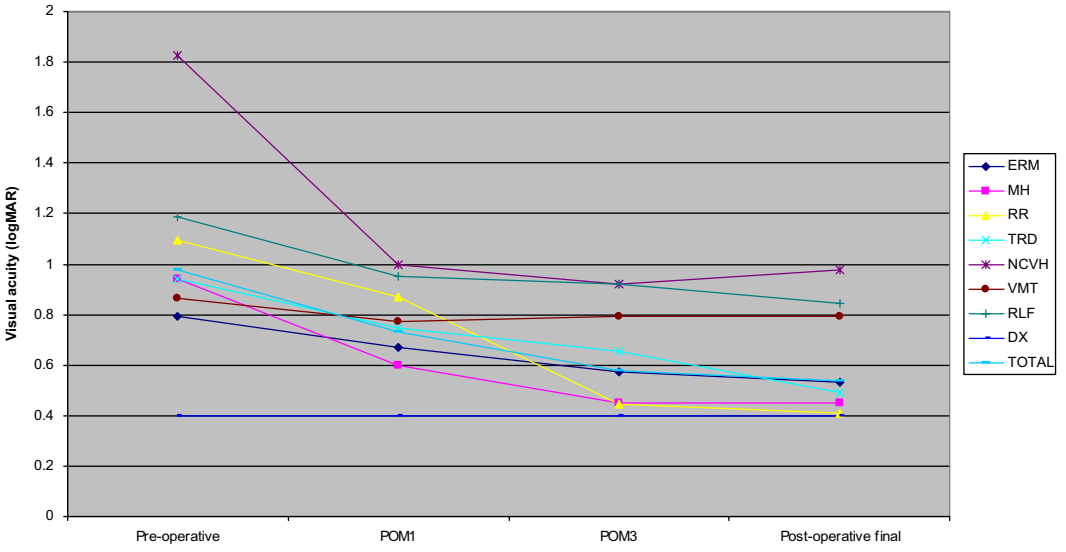

Figure 3. Logarithm of the minimum angle of resolution (logMAR) visual acuity by diagnosis at standard time points. DX = diagnostic; ERM = epiretinal membrane; MH = macular hole; NCVH = nonclearing vitreous hemorrhage; POM1 = postoperative month 1; RLF = retained lens fragments; RR = rhegmatogenous retinal detachment; TRD = tractional retinal detachment; VMT = vitreomacular traction.

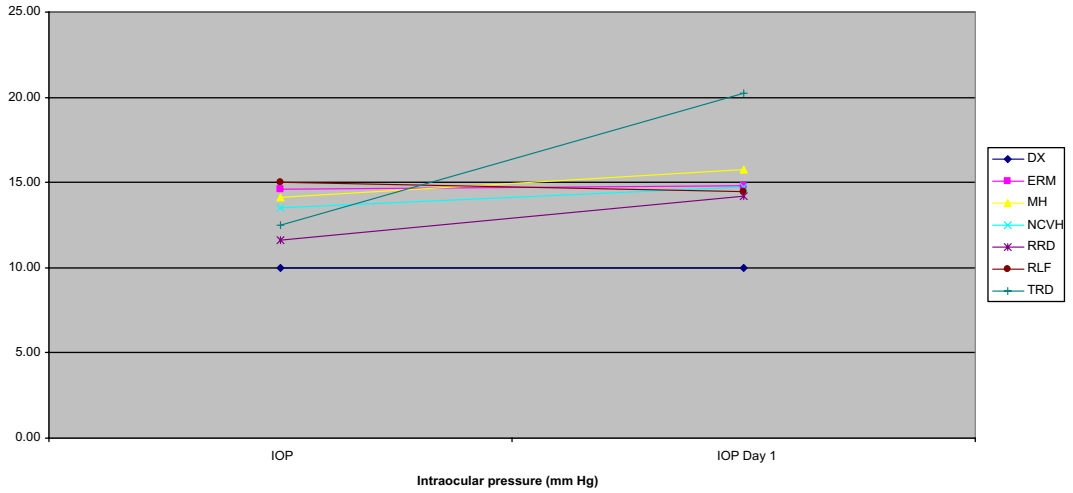

Figure 4. Preoperative versus postoperative day 1 intraocular pressure (IOP). DX = diagnostic; ERM = epiretinal membrane; MH = macular hole; NCVH = nonclearing vitreous hemorrhage; RLF = retained lens fragments; RRD = rhegmatogenous retinal detachment; TRD = tractional retinal detachment.

Table 1. Summary of Preoperative and Postoperative Acuity

		Preoperative		Postoperative Month 1		Postoperative Month 3		Final		P Values		
Indication	**Patients**	*logMAR*	*Snellen*	*logMAR*	*Snellen*	*logMAR*	*Snellen*	*logMAR*	*Snellen*	*Month 1*	*Month 3*	*Final*
ERM	20	0.793	124	0.668	93	0.572	75	0.531	68	0.0774	0.0060	0.0046
MH	18	0.940	174	0.596	79	0.450	56	0.451	57	0.0007	<0.0001	<0.0001
RRD	14	1.094	248	0.868	147	0.443	55	0.409	51	0.2488	0.0008	0.0004
TRD	12	0.941	175	0.745	111	0.654	90	0.493	62	0.2880	0.1453	0.0159
NCVH	4	1.828	1345	0.996	198	0.920	166	0.976	189	0.1289	0.1324	0.1293
VMT	4	0.862	145	0.774	119	0.794	124	0.794	124	0.6643	0.7525	0.7525
RLF	4	1.187	308	0.952	179	0.920	166	0.845	140	0.2483	0.2109	0.0972
Dx	1	0.398	50	0.398	50	0.398	50	0.398	50	NA	NA	NA
Total	77	0.978	190	0.733	108	0.578	76	0.536	69	0.0001	<0.0001	<0.0001

Dx = diagnostic; ERM = epiretinal membrane; logMAR = logarithm of the minimum angle of resolution; MH = macular hole; NA = not applicable; NCVH = nonclearing vitreous hemorrhage; RLF = retained lens fragments; RRD = rhegmatogenous retinal detachment; TRD = tractional retinal detachment; VMT = vitreomacular traction.
Snellen acuity reported as 20/*x*.