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Intraoperative Retinal Tear Formation and Postoperative Rhegmatogenous Retinal Detachment in Transconjunctival Cannulated Vitrectomy Systems Compared With the Standard 20-Gauge System

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Objective: To compare 20-gauge standard pars plana vitrectomy (PPV) with transconjunctival cannulated PPV in the development of intraoperative retinal breaks and postoperative rhegmatogenous retinal detachments (RRDs) in a large series of patients undergoing PPV for macular pucker or macular hole.

Methods: This study was conducted at an academic tertiary care vitreoretinal practice in Milwaukee, Wisconsin. Patients undergoing 3-port PPV with standard 20-gauge instrumentation were compared with patients undergoing 3-port PPV with transconjunctival cannulated systems, including 20 gauge, 23 gauge, and 25 gauge, from January 1, 2003, through December 31, 2009. The main outcome measures were rates of intraoperative retinal breaks and postoperative RRD.

Results: Four hundred twenty-six unique eyes met inclusion criteria. Fifty-four of 426 eyes (12.7%) were diagnosed as having new retinal tears intraoperatively as

follows: 47 of 204 patients (23.0%) undergoing the standard 20-gauge procedure developed intraoperative retinal tears compared with 7 of 211 patients (3.3%) undergoing the transconjunctival cannulated procedure (risk ratio [RR], 0.12; 95% CI, 0.05-0.26; $P < .001$). Patients experiencing intraoperative retinal tears were not at increased risk of developing postoperative RRD (RR, 1.4; 95% CI, 0.39-5.0; $P = .61$). Although a trend was present, transconjunctival cannulated vitrectomy was not significantly protective against the development of postoperative RRD (RR, 0.60; 95% CI, 0.17-1.3; $P = .14$).

Conclusion: Transconjunctival cannulated PPV, including 20-gauge, 23-gauge, and 25-gauge systems, is associated with significantly reduced rates of intraoperative retinal tear formation compared with standard 20-gauge PPV.

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TECHNIQUES AND INSTRUMENTATION for pars plana vitrectomy (PPV) for macular pucker and macular hole continue to evolve. The latest advances include small-gauge, transconjunctival, cannulated systems; the first report on these systems was made in 2002 by Fujii and colleagues,¹ who assessed a 25-gauge system. Since that time, 23-gauge systems and 20-gauge transconjunctival cannulated systems have been developed. Potential advantages of transconjunctival cannulated vitrectomy systems include improved fluidics, a more tightly contained system, smoother entry and exit, port positioning closer to the tip for closer shaving, reduced need for sclerotomy suturing, and decreased surgical time. A recent systematic review² formalized other potential advantages, including decreased postoperative inflammation, increased postoperative comfort, and

reduced time to obtain visual acuity improvement. This report also concluded that transconjunctival cannulated vitrectomy systems demonstrated an acceptable safety profile compared with standard 20-gauge PPV.

The aim of this study was to compare standard 20-gauge PPV with transconjunctival cannulated PPV in the development of intraoperative retinal breaks and postoperative rhegmatogenous retinal detachments (RRDs) in a large series of patients undergoing PPV for macular pucker or macular hole at a tertiary care vitreoretinal practice.

METHODS

Institutional review board approval was obtained for this record review. To identify all patients who underwent vitrectomy, a billing record search was performed using *Current Procedural Terminology*³ codes 67036, 67038, 67040, 67041, and 67042 for cases from Janu-

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ary 1, 2003, through December 31, 2009. A total of 2001 procedures were identified. The list was then inspected to eliminate procedures performed for preoperative diagnoses other than macular pucker or macular hole, and 528 procedures remained. The medical records were then reviewed and additional exclusions were applied: 18 procedures were excluded because of follow-up less than 60 days, 12 procedures because of incomplete medical records, and 29 procedures because they were the second or third procedures on the same eye. The 43 eyes that experienced prior rhegmatogenous retinal detachment were excluded and will be considered in a separate article. After all exclusion criteria were applied, 426 unique eyes remained. The operations were performed at a single tertiary-care academic referral center by one of 5 attending surgeons, with the assistance of a vitreoretinal fellow.

Three-port vitrectomy was performed using 1 of 2 types of vitrectomy instruments (Alcon Accurus; Alcon Inc, or the Bausch and Lomb Millennium; Bausch and Lomb). We defined standard 20-gauge PPV as a transscleral, noncannulated approach that used scleral incisions of approximately 0.9 mm that required sutured closure. Differing systems were used for the 20-gauge (Synergetics; Synergetics Inc), 23-gauge (Alcon packs), and 25-gauge (either the Alcon or Bausch and Lomb packs) transconjunctival operations. All transconjunctival approaches involved a 1-stage incision/insertion process using a central trocar sclerotomy blade over which a nitinol-based cannula was sheathed. After insertion of this trocar/cannula assembly at each sclerotomy site, the trocar was withdrawn, leaving the cannula in place for instrument access to the vitreous cavity. At the end of the vitrectomy, the cannulas were removed with their lumens plugged with either an endoillumination or cannula plug.

The layers and extent of membrane stripping were at the discretion of the attending surgeon. The use of intraoperative dyes, triamcinolone acetonide, suture to close sclerotomies, and postoperative tamponade was also at the attending surgeon's discretion. After PPV and before wound closure, all patients underwent a full scleral-depressed peripheral retinal examination to assess for the presence of retinal breaks, usually by both the attending surgeon and the fellow. Any newly discovered breaks were treated intraoperatively with laser photocoagulation or cryopexy.

The medical records were reviewed and the following variables were collected: age at time of the procedure, sex, laterality, preoperative diagnosis, lens status, preoperative diagnosis of diabetes mellitus, history of RRD or retinal tears in the contralateral eye, family history of RRD in a first-degree relative, history of notable trauma to the operative eye, the presence of lattice degeneration, the spherical equivalent refractive error if phakic, the axial length when available, preoperative pinhole visual acuity, the presence of clinical posterior vitreous detachment by slitlamp biomicroscopy, prior retinal tears in the operative eye, prior vitrectomy in the operative eye, the gauge and type of vitrectomy handpiece used, whether membranes were stripped at the time of the operation, whether the hyaloid was already separated at the time of the operation, whether dyes were used to visualize the membranes, whether triamcinolone was used to visualize the vitreous or membranes, whether tamponade was applied, last follow-up visit date and visual acuity, and whether the patient experienced an RRD in the follow-up period. The data were compiled (Microsoft Excel 2007; Microsoft Inc) and analyzed (SPSS version 16; SPSS Inc). Statistical significance was set at $P = .05$. Logistic regression models were constructed to compute univariate risk ratios.

RESULTS

Of the 426 unique eyes included in the study, 216 were right eyes and 210 were left eyes. There were 150 men

Table. Surgical Gauge and Development of Intraoperative Retinal Breaks and Postoperative Retinal Detachments

Gauge	Eyes, No.	No. (%)	
		Intraoperative Retinal Breaks	Postoperative Retinal Detachments
Standard			
20 Gauge	204	47 (23.0)	12 (5.9)
Transconjunctival			
20 Gauge	59	1 (1.7)	0
23 Gauge	76	3 (3.9)	1 (1.3)
25 Gauge	76	3 (3.9)	5 (6.6)
Total	211	7 (3.3)	6 (2.8)
Total^a	426	54 (12.7)	21 (4.9)

^aThe surgical gauge data are missing for 11 eyes; therefore, the sum of the first row is 415 vs 426.

and 276 women. Two-hundred eighty-two eyes (66.2%) were phakic, 140 eyes (32.9%) were pseudophakic, and 4 eyes (0.9%) were aphakic. Two-hundred forty-one eyes (56.6%) underwent PPV for macular pucker and 185 eyes (43.4%) underwent PPV for macular hole. Twenty-three eyes (5.4%) had a history of PPV in the study eye, and 77 eyes (18.1%) underwent an additional concurrent surgical procedure at the time of PPV. Additional procedures included phacoemulsification, intraocular lens implantation, temporary keratoprosthesis, penetrating keratoplasty, lamellar keratoplasty, and strabismus surgery. Follow-up ranged from 60 to 2532 days (mean [SD], 466 [478]; median, 272 days). The distribution of surgical gauges is reported in the **Table**.

INTRAOPERATIVE RETINAL TEARS

Intraoperatively, 54 of 426 eyes (12.7%) were diagnosed as having new retinal tears. Transconjunctival cannulated vitrectomy was found to be highly protective against intraoperative retinal tears as follows: 47 of 204 patients (23.0%) undergoing the standard 20-gauge procedure experienced intraoperative retinal tears compared with 7 of 211 patients (3.3%) undergoing transconjunctival cannulated surgery (Table). This resulted in a risk ratio of 0.12 (95% CI, 0.05-0.26; $P < .001$). Patients undergoing PPV for macular hole were 2.7 times more likely than those undergoing PPV for epiretinal membrane to be diagnosed as having intraoperative retinal tears (95% CI, 1.5-4.9; $P = .001$). Intraoperative retinal tears were not as strongly related to the mechanical induction of a posterior vitreous separation (hyaloid stripping); the univariate logistic regression model for hyaloid stripping yielded a risk ratio of 1.8, but was not statistically significant (95% CI, 1.0-3.2; $P = .054$). Patients in whom a family history of RRD was present in a first-degree relative were 5.9 times more likely than those without such a family history to be diagnosed as having intraoperative retinal tears (95% CI, 1.5-23.0; $P = .01$). Patients with preoperative diagnosis of lattice degeneration were 3.4 times more likely than were patients without lattice to develop intraoperative retinal tears (95% CI, 1.4-8.3; $P = .007$).

Factors that were not found to be significantly associated with the development of intraoperative retinal breaks included sex, diabetes mellitus, pseudophakia, prior ocular trauma, preoperative posterior vitreous detachment, prior retinal tear, axial length, refractive spherical equivalent (if phakic), or intraoperative dye use (all $P > .05$).

POSTOPERATIVE RHEGMATOGENOUS RETINAL DETACHMENTS

Twenty-one of 426 eyes (4.9%) experienced RRD in the follow-up period. The mean (SD) time to diagnosis of RRD was 132 (178) days (median, 55; range, 7-699 days). Patients with a history of retinal tear in the operative eye were 4.3 times more likely than were those without the history to develop postoperative RRD (95% CI, 1.2-16; $P = .03$). Interestingly, patients experiencing intraoperative retinal tears were not at increased risk of developing postoperative RRD (risk ratio, 1.4; 95% CI, 0.39-5.0; $P = .61$). Transconjunctival cannulated vitrectomy was also not significantly protective against the development of postoperative RRD (risk ratio, 0.60; 95% CI, 0.17-1.3; $P = .14$). Subgroup analysis of the gauge of PPV found that, when compared with standard 20-gauge, there was no significant difference in the development of postoperative RRD for 20-gauge ($P = .07$), 23-gauge ($P = .20$), or 25-gauge ($P = .78$) transconjunctival cannulated systems.

Factors that were not found to be significantly associated with the development of postoperative RRD included indication for PPV, age, sex, diabetes mellitus, pseudophakia, prior ocular trauma, lattice degeneration, family history of RRD in a first-degree relative, preoperative posterior vitreous detachment, axial length, refractive spherical equivalent (if phakic), the need to induce a posterior vitreous detachment at the time of the operation, or intraoperative dye use (all $P > .05$).

VISUAL ACUITY OUTCOMES

Overall, visual acuity improved after vitrectomy; the average preoperative visual acuity was 20/115 compared with 20/76 postoperatively ($P < .001$ by paired samples *t* test). Patients without postoperative RRD did better, with an average postoperative visual acuity of 20/74 compared with 20/180 in patients with postoperative RRD ($P < .001$).

COMMENT

Among the reasons that transconjunctival cannulated PPV is thought to be desirable compared with standard 20-gauge PPV is the presence of the cannula, which allows the vitrectomy instrument to partially bypass the vitreous base. This is thought to reduce the repeated traction at the vitreous base and therefore reduce the chance of developing a retinal break at the sclerotomy site. This logic, taken farther, could mean that postoperative RRD could be reduced by using a cannulated PPV system.

The present study allows for the assessment of the development of intraoperative retinal breaks for 2 reasons. First, at the conclusion of each PPV and before wound closure, a full scleral depressed examination was

performed to assess for peripheral retinal breaks or detachments while the patient was in the operative suite. Second, the result of this examination was reported in the dictated operative note. Each operative note was inspected during data acquisition.

The results of the present study support the theory that transconjunctival cannulated PPV reduces the rate of intraoperative retinal breaks. Twenty-three percent of standard 20-gauge PPV cases had intraoperative retinal breaks compared with 3.8% of patients undergoing transconjunctival cannulated PPV ($P < .001$). In other studies⁴⁻²¹ of transconjunctival cannulated PPV, the rates of intraoperative retinal break formation were noted to be between none and 17%. Considering the large range, a more informative assessment of the literature may be needed to consider studies comparing standard 20-gauge PPV with transconjunctival cannulated PPV performed by the same surgeons in the same patient population. Scartozzi and colleagues⁷ reported on the largest of this type of investigation and found a 6.4% (14 of 219 eyes) intraoperative retinal break rate with standard 20-gauge PPV compared with a 3.1% (4 of 128) rate in patients undergoing 25-gauge PPV. This difference was not statistically significant ($P = .22$). Smaller studies^{8-10,12} demonstrated a statistically nonsignificant trend for fewer intraoperative retinal tears, and others^{16,18,20,21} reported no intraoperative breaks in either group. To the best of our knowledge, our study is the first that has found a statistically significant reduction in the rate of intraoperative retinal break formation using transconjunctival cannulated PPV.

Although we noted a trend toward fewer postoperative RRDs in patients undergoing transconjunctival cannulated PPV (2.8%) compared with standard 20-gauge PPV (5.9%), this was not a statistically significant difference ($P = .15$). However, our study was not sufficiently powered to attribute significance to this difference. Approximately 582 patients in each group would have been necessary to achieve such significance at an α level of .05 with 80% power. Furthermore, subgroup analysis of the transconjunctival cannulated PPV compared with standard PPV failed to demonstrate significant differences. Prompt intraoperative recognition and treatment of intraoperative retinal breaks likely contributed to this result. Our rates of postoperative RRD for transconjunctival cannulated vitrectomy are similar to those of other studies,^{4-6,10-20,22} which range from none to 8.3%. None of those studies, which compared standard 20-gauge PPV with transconjunctival cannulated PPV, demonstrated a significant difference in the rates of postoperative RRD.

This investigation included 5 attending vitreoretinal surgeons' experiences and 3 different transconjunctival gauges; these features increase the generalizability of the findings. However, potential unidentified confounding and bias can also occur. A subgroup analysis based on each surgeon found no statistically significant differences in the rates of intraoperative retinal breaks or postoperative RRDs in this study. Use of each of the PPV systems was at the discretion and preference of the attending surgeon. There was asymmetric use of the different gauges, with some surgeons favoring 20-gauge transconjunctival over 23-gauge or 25-gauge and vice versa. This is one

of the weaknesses of retrospective designs in general and this study in particular. In addition, the rate of adoption of transconjunctival surgical systems was uncontrolled.

In summary, this 5-surgeon retrospective study found that transconjunctival cannulated PPV including 20-gauge, 23-gauge, and 25-gauge transconjunctival systems offers significantly reduced rates of intraoperative retinal tear formation compared with the standard 20-gauge PPV. This was not associated with a statistically significant reduction in the rate of postoperative RRD, although a trend to that effect was demonstrated.

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