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Outcomes of Pars Plana Vitrectomy in Combination With Penetrating Keratoplasty

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Abstract

Purpose: To report indications and outcomes of combined pars plana vitrectomy and penetrating keratoplasty (PPV-PKP). **Methods:** A review of all patients who underwent PPV-PKP at the Illinois Eye and Ear Infirmary from January 1, 2001 to May 31, 2013, was performed. Ninety eyes of 90 patients were identified. Survival analysis was utilized to assess differences in retinal detachment (RD) and corneal graft failure rates among groups based on clinical and surgical variables. **Results:** Seventy-nine eyes met the inclusion criteria. Most common indications for vitrectomy and corneal transplantation were RD (65%) and corneal decompensation (43%), respectively. The preoperative and final visual acuity (VA) logarithm of the minimum angle of resolution values were 2.7 (0.31) and 2.5 (0.67) (hand motions; mean [SD]; $P = .02$); 15% of eyes were $\geq$20/400 and 15% gained $\geq$2 lines of vision following surgery. Corneal graft failure occurred in 51% (40 eyes), recurrent RD in 28% (22 eyes), and hypotony in 25% (20 eyes). Silicone oil endotamponade was associated with postoperative RD ($P = .045$), and previous ocular trauma was associated with postoperative corneal graft failure ($P = .023$). **Conclusion:** Combined PPV-PKP surgery was likely to achieve stabilization of VA, with a minority of eyes achieving modest gains in VA.

Keywords

vitrectomy, penetrating keratoplasty, combined vitrectomy and penetrating keratoplasty, retinal detachment, trauma, temporary keratoprosthesis

Introduction

Vitreoretinal disorders requiring surgical intervention may arise in the setting of corneal pathology that prevents adequate intraoperative visualization of the posterior segment. These complicated cases are most commonly addressed via pars plana vitrectomy (PPV) facilitated by the placement of a temporary keratoprosthesis.[1,2] In some cases, an open-sky approach may be preferred.[3-8] Penetrating keratoplasty (PKP) is typically performed at the conclusion of the surgical procedure to confer improved visual function and facilitate ophthalmoscopic examination in the postoperative period. Less commonly, the pathologic host cornea may be restored to the same eye or vitreoretinal surgery may be facilitated by endoscopy, though in the setting of significant corneal pathology, these approaches limit postoperative visual acuity (VA) and preclude postoperative ophthalmoscopic examination. For these reasons, PKP performed in combination with PPV (PPV-PKP) remains the procedure of choice in most centers with access to corneal tissue suitable for transplantation. Placement of a permanent keratoprosthesis is considered if the likelihood of graft failure is high.[9]

Ocular trauma with resultant corneal opacity and vitreoretinal pathology has been reported to be the most common indication for combined PPV-PKP; however, few series have included nontraumatized eyes.[3-7,10] In the most recent series from North America, Khouri et al[4] reported the outcome of 24 eyes from 2001 to 2008, half of which suffered trauma. Dong et al[3] reported on 107 eyes that sustained traumatic injury between 1994 and 2002. The risk factors for recurrent retinal detachment (RD) and corneal graft failure, 2 critical metrics in PPV-PKP surgery, have not been assessed in a systematic fashion. In cases of complex RD, there is concern among anterior and posterior segment surgeons that silicone oil endotamponade may cause early corneal graft failure.[11,12]

The utility of achieving visual rehabilitation via combined PPV-PKP is controversial, as most studies have reported

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modest gains in relatively small case series and lack long-term follow-up data or analysis of factors associated with surgical failure. In this study, we report the results of a large series of patients undergoing combined PPV-PKP surgery for both traumatic and nontraumatic etiologies including longitudinal survival analyses for durable retinal reattachment and corneal graft clarity. Our sample is the largest reported in North America and includes more nontraumatized eyes than any other published report.[1,3-8,13,14] The goals of the study were (1) to determine the natural history of retinal reattachment and graft clarity following PPV-PKP and (2) to assess risk factors associated with recurrent RD and corneal graft failure.

Methods

A retrospective review of the surgical billing records at the University of Illinois Hospital and Health Science System from January 2001 to May 2013 was performed to identify all patients who underwent PPV and corneal transplantation (PPV-PKP) in a single surgical encounter.

Demographics, ocular history, concomitant surgical procedures performed, preoperative and postoperative visual acuities at months 1, 6, 12, and final follow-up, occurrence of surgical and postoperative complications, and final anatomic outcomes were recorded for all patients. The study data were collected using Research Electronic Data Capture tools hosted at the Center for Clinical and Translational Science, University of Illinois at Chicago. Research Electronic Data Capture is a secure, web-based application designed to support data capture for research studies.[15] The study was approved by the institutional review board of the University of Illinois at Chicago.

The surgical technique involved a corneal surgeon placing the temporary keratoprosthesis (if utilized), followed by a vitreoretinal surgeon performing 3-port PPV and any additional procedures as detailed in the Results section. A glaucoma specialist performed implantation or revision of a glaucoma drainage implant (GDI) in some cases. Vitrectomy instrumentation employed was as follows: 20 gauge in 26 eyes (33%), 23 gauge in 20 eyes (25%), 25 gauge in 15 eyes (19%), and instrument gauge not reported in 18 eyes (23%). Sixty-three (80%) surgeries utilized an Eckardt temporary keratoprosthesis. In 11 cases, vitrectomy was performed without a temporary keratoprosthesis, either via the existing cornea followed by PKP or with PKP performed at the outset of the surgical procedure. Five vitrectomies were performed open sky with subsequent PKP. A corneal surgeon performed corneal transplantation in all cases. In cases employing endotamponade, gas or silicone oil infusion was completed after corneal transplantation was performed.

Visual acuity measures were performed using a Snellen chart and converted to logarithm of the minimum angle of resolution (logMAR) notation for further analysis.[16] Non-Snellen acuities were assigned numerical logMAR values as described by Roberts et al.[17]

Data analysis was performed using Stata Statistical Software version 12.0 (StataCorp, College Station, Texas). In order to identify factors affecting surgical outcomes, the Kaplan-Meier method was used to estimate survival functions of retinal attachment and corneal graft clarity, and the log-rank test was utilized to compare survival functions among groups based on the presence or absence of relevant clinical features, including history of trauma, history of RD, prior corneal transplantation, presence of proliferative vitreoretinopathy (PVR), and concomitant injection of silicone oil during combined PPV-PKP surgery.

Results

A total of 90 eyes from 90 patients were identified; 11 were excluded from the analysis due to insufficient documentation in the medical record and the remaining 79 eyes (41 right eyes; 31 females) included in the study. Sixty-five eyes (82%) underwent a single PPV-PKP procedure, 11 eyes had 2 combined surgeries, and 3 eyes required a third combined procedure.

The initial preoperative visual acuities in operated eyes ranged from counting fingers (CFs) to light perception (LP) in all but 4 eyes; 1 eye had no LP (NLP) preoperatively, 2 eyes measured 20/400, and 1 eye 20/150 (indication for vitrectomy in this case was placement of a pars plana GDI). The overall mean preoperative VA was logMAR 2.7 (0.31) (hand motions; mean [SD]). Eighteen (26%) eyes had significantly reduced vision in the fellow eye at the time of surgery (<20/400). There was no significant difference in the preoperative VA of operated eyes with poor fellow eye vision (<20/400) compared to operated eyes with better fellow eye vision (>20/400).

Only 2 eyes had not undergone previous intraocular surgery. Thirty-eight (48%) eyes had undergone at least 1 previous vitrectomy and 17 (22%) eyes had undergone at least 1 PKP or Descemet stripping automated endothelial keratoplasty. Of the 42 eyes with a history of ocular trauma, 36 (86% of traumatized eyes) had sustained prior open globe injury. The mean interval between ocular injury and the first combined PPV-PKP procedure was 41 months (range, 0.27-779 months). Eighteen (23%) eyes had preexisting glaucoma. The most common preoperative ophthalmic disorders are listed in Table 1, and the indications for corneal transplantation and vitrectomy are shown in Tables 2 and 3, respectively.

Associated vitreoretinal procedures performed included endolaser photocoagulation (48 eyes; 61%), membranectomy (37 eyes; 47%), retinectomy (21 eyes; 27%), and placement of scleral buckle (5 eyes; 6%). Fifty-two (66%) eyes received endotamponade: C_3F_8 gas (7 eyes; 9%), SF_6 gas (1 eye; 1%), air (2 eyes; 3%), or silicone oil (44 eyes; 56%). Twenty-eight (38%) eyes underwent concomitant intraocular surgery in addition to vitreoretinal surgery and corneal transplantation, as detailed in Table 4.

The mean VA prior to surgery, at postoperative months 1, 6, 12, and at final follow-up is shown in Figure 1. The overall average follow-up interval was 26 months (range, 0.03-122 months). Twelve (15%) eyes were ≥20/400, with follow-up of 32 (22) months (mean [SD]; range, 15-96 months), including 1 eye with 20/20 vision. This is compared

Table 1. Preoperative Ocular Diagnoses in the Operated Eye.

	Number of Eyes (%)
History of trauma	42 (53%)
Open globe injury	36 (46%; 86% of traumatized eyes)
Recurrent retinal detachment[a]	24 (30%)
PVR	19 (24%; 80% of eyes with recurrent RD)
Glaucoma	18 (23%)
Prior endophthalmitis	6 (8%)
Choroidal hemorrhage	5 (6%)
Complicated cataract surgery[b]	3 (4%)
Retinopathy of prematurity	3 (4%)

Abbreviations: PVR, proliferative vitreoretinopathy; RD, retinal detachment.
[a]At least 1 previous retinal reattachment procedure.
[b]Includes posterior capsular rupture with vitreous prolapse, unplanned aphakia, or anterior chamber intraocular lens.

Table 2. Indications for Corneal Transplantation.[a]

	Number of Eyes (%)
Corneal decompensation	34 (43%)
Failed corneal graft[b]	17 (22%)
Traumatic corneal scar	16 (20%)
Bullous keratopathy	9 (11%)
Corneal edema	7 (9%)
Corneal blood staining	4 (5%)
Corneal neovascularization	2 (3%)
Other[c]	6 (8%)

Abbreviations: PKP, penetrating keratoplasty; DSAEK, Descemet stripping automated endothelial keratoplasty.
[a]Some eyes had more than 1 indication for surgery.
[b]Includes PKP and DSAEK.
[c]One eye each with the following indications: improved visualization for posterior segment surgery, keratitis, congenital anterior segment anomaly, and perforated corneal ulcer.

Table 3. Indications for Vitrectomy.[a]

	Number of Eyes (%)
Retinal detachment	51 (65%)
PVR	24 (30%; 47% of eyes with RD)
Vitreous hemorrhage	11 (14%)
Placement of pars plana tube shunt	9 (11%)
Silicone oil removal	5 (6%)
Serous choroidal detachment	4 (5%)
Other[b]	11 (14%)

Abbreviations: PVR, proliferative vitreoretinopathy; RD, retinal detachment.
[a]Some eyes had more than 1 indication for surgery.
[b]Three or fewer eyes each with the following indications: epiretinal membrane, pars plana lensectomy, removal of intraocular foreign body, examination of retina, subretinal hemorrhage, vitreous tractional band, hypotony, hemorrhagic choroidal detachment, and echographic suspicion of retinal detachment.

to just 3 (4%) eyes that were ≥20/400 prior to PPV-PKP. Twelve (15%) eyes gained ≥2 lines of vision during the follow-up period, whereas 6 eyes (8%) lost ≥2 lines of vision. One eye was NLP at the time of PPV-PKP and 12 eyes were NLP at final follow-up (including 1 eye that was NLP prior to PPV-PKP). There was no significant difference in the final VA of the 37 eyes with no history of trauma (logMAR 2.49) and the 42 eyes with a history of ocular trauma (logMAR 2.46; $P = .83$).

Table 4. Concomitant Ocular Procedures.[a]

	Number of Eyes (%)
Cataract removal	11 (14%)
Placement of glaucoma drainage implant (GDI)	9 (11%)
Intraocular lens (IOL) explantation or exchange	6 (8%)
Revision of glaucoma filtering bleb or GDI	3 (4%)
Sutured IOL	1 (1%)
Ciliary body cryotherapy	1 (1%)

Abbreviations: IOL, intraocular lens; PKP, penetrating keratoplasty; PPV, pars plana vitrectomy.
[a]Some eyes had more than 1 concomitant ocular surgical procedure (in addition to PPV-PKP).

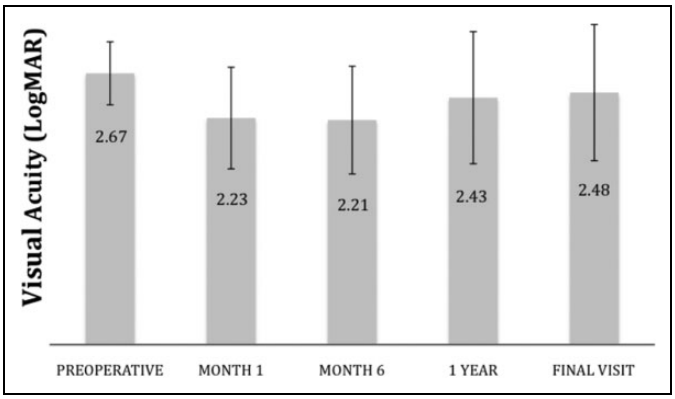

Figure 1. Visual acuity following combined pars plana vitrectomy and penetrating keratoplasty. The preoperative and final visual acuity values were 2.67 (0.31) and 2.48 (0.67) (mean logarithm of the minimum angle of resolution [logMAR] [SD, error bars]; $P = .02$).

At least 1 postoperative pathologic event was identified in 65 (82%) eyes, with an overall incidence of 38% per person-year. The most frequently encountered events were corneal graft failure (40 eyes), recurrent RD (23 eyes), hypotony (20 eyes), PVR (9 eyes, all in association with recurrent RD), and glaucoma (3 eyes without preexisting glaucoma). There were no identified cases of postoperative endophthalmitis or sympathetic ophthalmia. Thirty-one (39%) eyes underwent at least 1 subsequent surgical procedure. Twenty-two eyes underwent at least 1 additional vitrectomy, and 14 of these eyes underwent a second combined PPV-PKP. Three eyes had a third combined PPV-PKP. Five eyes underwent an isolated PKP following the initial PPV-PKP. Five eyes had subsequent placement of a GDI; 2 of these eyes later had removal of an exposed GDI (along with a third eye that had a GDI placed previously). Two eyes underwent a subsequent scleral buckling procedure. Two patients suffered traumatic dehiscence of the corneal graft and open globe injury requiring surgical repair.

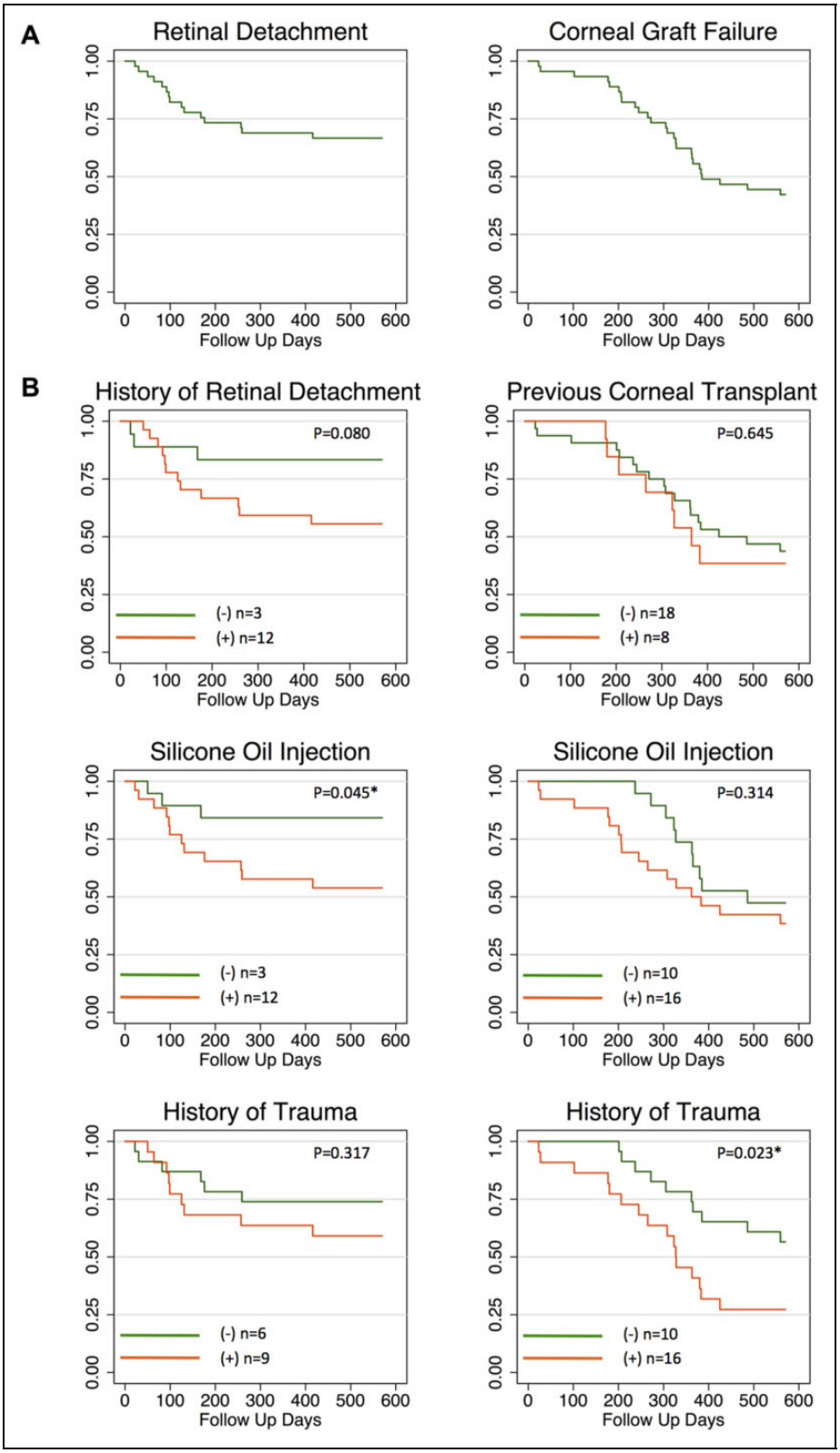

Figure 2. Retinal attachment and corneal graft clarity following combined pars plana vitrectomy and penetrating keratoplasty (PPV-PKP). A, Kaplan-Meier survival functions of retinal attachment and corneal graft clarity following combined PPV-PKP surgery in eyes observed for $\geq$19 months. Fifteen (33%) of 45 developed retinal detachment and 26 (58%) of 45 suffered graft failure. Most retinal detachments occurred during the initial 6 months following PPV-PKP (left). In contrast, the incidence of corneal graft failure increased beginning 6 months after PPV-PKP (right). B, Risk factors for recurrent retinal detachment (left panels) and corneal graft failure (right panels) following PPV-PKP were assessed by comparison of survival functions via log-rank testing for the presence or absence of prior retinal detachment, silicone oil endotamponade, eye trauma, and previous corneal transplantation, respectively. Silicone oil endotamponade was found to be significantly associated with subsequent recurrent retinal detachment, and a history of ocular trauma was significantly associated with the development of corneal graft failure. *$P \leq .05$.

The corneal graft was clear in 44 (56%) eyes at the final examination, with an average follow-up time of 22 months. Durable retinal reattachment was achieved in 43 (55%) eyes at a mean follow-up time of 25 months. Thirty-one (39%) eyes had clear corneal grafts and total retinal attachment at the final follow-up visit. No eyes were enucleated during the study period.

Kaplan-Meier survival curves for the 45 eyes with at least 19 months of follow-up are shown in Figure 2. Fifteen (33%) eyes developed RD and 26 (58%) eyes exhibited corneal graft failure during this interval. Most RDs occurred during the initial 6 months following PPV-PKP. In contrast, the incidence of corneal graft failure increased beginning 6 months after PPV-PKP. Log-rank test results showed that silicone oil endotamponade was significantly associated with subsequent recurrent RD ($P = .045$), and a history of ocular trauma was significantly associated with the development of corneal graft failure ($P = .023$).

Conclusions

Vitreoretinal surgery in combination with corneal transplantation is executed to address severe pathology affecting the anterior and posterior segments. Pars plana vitrectomy and PKP procedures require longer surgical durations in comparison with most vitrectomy procedures, are frequently technically complex, and preexisting anterior and posterior segment pathology often limit postoperative VA, leading some surgeons to question the utility of PPV-PKP procedures.

The results of survival analyses performed in this study indicate that although a majority of eyes achieved durable retinal attachment following PPV-PKP, there was a significant incidence of postoperative ocular morbidity, including corneal graft failure, recurrent RD, PVR, and glaucoma. Combined PPV-PKP surgery achieved stabilization of VA in the majority of eyes. Silicone oil endotamponade was the only significant risk factor associated with recurrent RD, and a history of ocular trauma was the only significant risk factor for corneal graft failure.

The severity of preoperative ocular pathology may account for the limited improvement in VA and observed incidence of recurrent RD in our participants; slightly more than half of study eyes had sustained open globe injury and associated anterior and posterior segment disorders such as PVR and corneal decompensation. Other series of PPV-PKP have reported similar outcomes in VA, classifying most eyes as "stable or improved:" Gelender et al[13] reported 62% of eyes with stable or improved final VA in 1988; Gross et al[6] found 60% of eyes maintained equal or improved VA in 1990; Garcia-Valenzuela et al[5] described 51% of eyes achieved the same result in 1999; Khouri et al[4] described 80% of eyes with stable or improved vision most recently in 2010. We found 67% of eyes had improved or stable vision at the conclusion of the study interval, however, the majority of eyes remained stable, with 15% of eyes gaining $\geq$2 lines of vision in our participants. Eleven (14%) eyes progressed to NLP vision (7% per person-year) in our study; 5 of these eyes had a history of severe trauma and 2 had a history of retinopathy of prematurity (ROP). The incidence of progression to NLP vision is similar to other series, ranging from 0.08% to 32.3%.[4,5,7,13] Although improvement in VA was uncommon, there was stabilization of vision following surgery. All eyes in our series were preserved, and none required enucleation. The status of the fellow eye is an important factor to consider in assessing the utility and potential functional benefit of PPV-PKP; 26% of fellow eyes in our study exhibited VA of CFs or worse at the time of PPV-PKP, with 8 (10%) fellow eyes measuring NLP. Only 1 patient measured NLP in both eyes at final follow-up; this patient was also NLP preoperatively in the setting of prior severe ROP. Stabilization of vision may represent a meaningful goal in which the eye under consideration for PPV-PKP is the better-seeing eye or in the setting of persistent decline in visual function of the fellow eye.

Silicone oil endotamponade was the only significant risk factor associated with recurrent RD following PPV-PKP; in contrast to our assumptions, we did not find an association with prior eye trauma or PVR. The success rates of RD repair in relatively mild cases of trauma or limited PVR likely approximate those of uncomplicated RD; perhaps trauma and PVR of greater severity, prompting the use of silicone oil endotamponade in such cases, represent a subset of complex RD with associated increased risk of recurrence in our study. Corneal grafts remained clear in 56% of eyes. Other retrospective studies have reported prevalence of corneal clarity ranging from 42% to 72%; survival analyses were not reported in previous studies.[3,4,7] We found that corneal graft failure was significantly associated with prior ocular trauma. Although there was a trend toward early graft failure in silicone oil–filled eyes, we found no significant association between graft failure and silicone oil endotamponade or previous corneal transplantation, consistent with the findings of Lee and colleagues.[8]

There are several limitations to our study. Retrospective research methods are prone to the omission of cases from identification and analyses. Another important limitation relating to the retrospective methodology utilized herein is the absence of a matched control group to allow for comparison of the outcome of surgical intervention versus natural history. Ivanisevic[18] reported that the natural course of untreated rhegmatogenous RD led to NLP vision in more than half of eyes. In our series, the incidence of progression to NLP vision was 7% per person-year. This suggests that PPV-PKP may confer better visual outcome compared with observation in patients with RD and significant corneal opacification. The execution of a prospective trial comparing PPV-PKP with observation is unlikely, given that delay in repair of RD, as would be necessary in the observation arm, is associated with irreversible retinal dysfunction. Pars plana vitrectomy and PKP was performed for a diverse array of ocular disorders affecting the posterior and anterior segments in this as well as previous studies. It is possible that outcomes and complications vary widely by disease entity.

In summary, combined PPV-PKP surgery was likely to achieve stabilization of VA, with a minority of eyes achieving modest gains in VA. Common postoperative pathologic occurrences included corneal graft failure, recurrent RD, PVR, and glaucoma. Silicone oil endotamponade was a risk factor for recurrent RD, and ocular trauma was a risk factor for corneal graft failure. These data may affect patient selection and the decision to undergo surgery by providing the surgeon and patient with anticipated visual outcomes, risk factors for postoperative complications, and potential subsequent surgical interventions.

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Declaration of Conflicting Interests

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