

Lens-Sparing Vitrectomy for Stage 4 Retinopathy of Prematurity

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Purpose: To investigate the anatomic results of lens-sparing vitrectomy for tractional stage 4 retinopathy of prematurity (ROP).

Design: Retrospective, noncomparative consecutive case series.

Participants: Thirty-seven eyes (24 patients) with tractional stage 4 ROP.

Intervention: Lens-sparing vitrectomy.

Main Outcome Measure: Anatomic status of the retina.

Results: Twenty-five eyes had stage 4A ROP, and 12 eyes had stage 4B ROP. With a median follow-up of 13 months (range, 6–27), 32 of 37 eyes (86%) had complete reattachment of the retina. Among eyes with 4A ROP, 21 of 25 eyes (84%) had complete retinal reattachment. Among eyes with 4B ROP, 11 of 12 eyes (92%) had complete retinal reattachment. At last follow-up, 29 of 37 eyes (78%) were able to fix and follow.

Conclusions: These results indicate that lens-sparing vitrectomy is effective for achieving retinal reattachment in tractional stage 4 ROP. *Ophthalmology* 2004;111:2274–2277 © 2004 by the American Academy of Ophthalmology.

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Retinal detachments (RDs) associated with retinopathy of prematurity (ROP) have a poor visual and anatomic prognosis.^{1,2} Several operations have been described to treat ROP-associated RDs, including open-sky vitrectomy,^{3,4} scleral buckling,^{5–14} closed vitrectomy and lensectomy with or without scleral buckling,^{15–20} and, more recently, lens-sparing vitrectomy without scleral buckling.^{21–23} Potential advantages of lens-sparing vitrectomy without scleral buckling include the absence of induced anisometropia and avoidance of a second procedure to divide the buckle. In addition, studies reported to date have shown a higher rate of anatomic success for lens-sparing vitrectomy compared with scleral buckling in stage 4A ROP.^{11,23} Potential disadvantages of lens-sparing vitrectomy compared with lensectomy and vitrectomy include less effective relief of anterior traction when the lens is spared. Previous reports of lens-sparing vitrectomy for stage 4 ROP have been promising with respect to anatomic and early visual outcomes. Herein we report the anatomic outcomes and early visual results from our experience with lens-sparing vitrectomy in 37 eyes with stage 4 ROP.

Materials and Methods

After institutional review board approval was obtained, we reviewed the medical records of consecutive patients who underwent lens-sparing vitrectomy for stage 4 ROP. All patients had tractional detachments of the retina that were progressive, threatening the fovea, or involving the fovea. Eyes with significant adhesion between the retina and lens capsule requiring primary lensectomy were not included. All eyes had previously undergone laser ablation of the avascular retina for stage 3 ROP. Every surviving patient was observed for at least 6 months.

All eyes underwent a 2-port, lens-sparing vitrectomy using modifications of the technique developed by Trese.^{21,23} After performing a conjunctival peritomy, 7-0 polyglactac acid sutures were replaced around sclerotomy sites. Nineteen-gauge sclerotomies were made 0.5 to 1.0 mm posterior to the limbus through the pars plicata. The meridian of the sclerotomies varied depending on the location of the traction to be addressed. Small areas of retinotenticular adhesion were divided using a microvitorectinal blade in some cases. The Oculus BIOM wide-angle viewing system (Oculus Inc., Woodinville, WA) was used along with an infusing light pipe and vitreous cutter to perform a core vitrectomy. Sheets and strands of organized vitreous were segmented and removed using a combination of instruments including the vitreous cutter, light-pipe pick, irrigating spatula, and automated vertical scissors. When the dissection was complete, a partial fluid–air exchange was performed to discourage vitreous incarceration in the sclerotomies during closure. No specific positioning was employed postoperatively.

Hospital and clinic charts were reviewed retrospectively, and the following data were collected for each patient: date of birth, gender, gestational age at birth and at surgery, birth weight, preoperative anatomic status of the retina, date of surgery, date of most recent follow-up visit, any postoperative complications, anatomic status at last follow-up, and the presence or absence of fixation behavior at last follow-up. Referring physicians were

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Table 1. Patient Demographic Information and Results of Lens-Sparing Vitrectomy for Stage 4 Retinopathy of Prematurity

	Stage 4A Eyes (n = 25)	Stage 4B Eyes (n = 12)	All (n = 37)
No. of patients	18	8	24
Male gender	13	3	15
Mean birth weight (g)	862	743	817
Mean GA at birth (wks)	26	25	26
Mean GA at 1st vitrectomy (wks)	42	44	43
Eyes requiring 2nd vitrectomy [n (%)]	5 (20)	1 (8.3)	6 (16)
Lensectomy with 2nd vitrectomy [n (%)]	1 (4)	1 (8)	2 (5.4)
Mean GA at 2nd vitrectomy (wks)	47	65	50
Median follow-up (mos)	12	14	13
Postoperative anatomic status			
Complete retinal reattachment [n (%)]	21 (84)	11 (92)	32 (86)
Peripheral TRD [n (%)]	1 (4)	1 (8)	2 (5.4)
Dry macular fold [n (%)]	2 (8)	0	2 (5.4)
Total RD [n (%)]	1 (4)	0	1 (2.7)
Fix and follow [n (%)]	19 (76)	10 (83)	29 (78)

GA = gestational age; RD = retinal detachment; TRD = traction RD.

contacted by telephone for most recent follow-up data on patients being observed outside our institution. Retinas were considered completely attached if there was no fluid under them. Dry retinal folds were classified as being attached if they did not involve the macula. Eyes with a dry fold in the macula were classified as having partial reattachment.

Results

Twenty-seven patients (43 eyes) with stage 4 ROP underwent vitrectomy by one surgeon (GBH) during the study period. One patient (2 eyes) had primary lensectomy with vitrectomy in both eyes because of extensive retinolenticular adhesions and is not included in the series. Two additional patients (4 eyes) were excluded because they died before the 6-month postoperative examination, for a total of 24 patients (37 eyes) that were included in the analysis (Table 1). Twenty-five eyes in 18 infants had stage 4A ROP, and 12 eyes in 8 infants had stage 4B ROP. Mean gestational age at birth was 26 weeks (range, 23–29), and the mean birth weight was 817 g (range, 470–1700). The mean gestational age at surgery was 43 weeks (range, 37–52).

The median follow-up was 13 months (range, 6–27), and at the final follow-up examination, 32 of 37 eyes (86%) had complete reattachment of the retina. Among eyes with 4A ROP, 21 of 25 eyes (84%) had complete retinal reattachment. Of the 4 without complete reattachment, 1 had macular attachment with a nasal traction RD (TRD), 2 had dry macular folds and otherwise attached retinas, and 1 had total detachment. Among eyes with 4B ROP, 11 of 12 (92%) had complete retinal reattachment. The eye without complete reattachment had an inferotemporal TRD that involved the macula. Six of 37 eyes (16%) underwent a second vitrectomy, and 2 of these had lensectomy at the time of the second operation. Among these 6 with repeat surgery, 2 had complete retinal reattachment, 1 progressed to complete detachment, and 3 remained partially detached (1 nasal TRD, 1 inferotemporal TRD, and 1 dry macular fold).

At last follow-up, 29 of 37 eyes (78%) were able to fix and follow. Four eyes with complete retinal reattachment could not fix and follow. Four of the 5 eyes with persistent RD could not fix and follow. One eye with a persistent nasal TRD but an attached macula could fix and follow.

Postoperative complications were observed in 3 patients (4

eyes) and are outlined in Table 2. Three eyes from 2 patients developed postoperative glaucoma. One of these required a cyclodestructive procedure for control of intraocular pressure, whereas the other 2 were successfully managed with topical medications. Two eyes developed retinal breaks in the postoperative period. One was successfully treated with scleral buckle and silicone oil tamponade, and 1 progressed to an inoperable total detachment. No cataracts developed during the follow-up period. Table 3 (available at <http://www.ophsource.com/periodicals/ophtha>) shows the patient characteristics, follow-up duration, and outcome for each patient.

Two patients (4 operated eyes) died before 6 months of follow-up, and their data are not included above; however, short-term follow-up was available for 3 of these eyes. Two of 3 had complete retinal reattachment, and 1 eye had persistent peripheral TRD. No follow-up was available for 1 eye. These 2 patient deaths occurred 3 and 5 months from the last eye surgery and were not considered to be related to lens-sparing vitrectomy.

Discussion

The first goal in the management of severe ROP is to reduce the risk of RD with thorough ablation of the avascular retina using laser or cryotherapy. Some infants, however, develop RDs despite timely and thorough ablation.^{1,2,24} Although several different surgical techniques have been described to approach these RDs, no randomized prospective data are available to guide our management. This study reports an 86% rate of complete retinal reattachment in a consecutive series of stage 4 ROP using modifications of the lens-

Table 2. Complications of Lens-Sparing Vitrectomy for Stage 4 Retinopathy of Prematurity

	All Eyes (n = 37)
Eyes with ≥ 1 complications [n (%)]	4 (11)
Retinal hole [n (%)]	2 (5.4)
Glaucoma [n (%)]	3 (8)

sparing vitrectomy technique developed by Maguire and Trese.²¹ The current series consists of both 4A and 4B eyes and compares favorably to other similar retrospective series. Capone and Trese²³ reported a 90% retinal reattachment rate in a series of 40 eyes undergoing lens-sparing vitrectomy for stage 4A ROP. Recent reports of scleral buckling for stage 4 ROP⁹⁻¹⁴ have reported reattachment rates of 46% to 75%. Studies looking at lensectomy and vitrectomy for stage 4 ROP^{16,18-20} have reported reattachment rates of 64% to 84%. Thus when compared with alternative procedures, lens-sparing vitrectomy seems to be an effective way of achieving retinal reattachment in most eyes with stage 4 ROP.

It should be noted that during the study period one patient (2 eyes) required primary lensectomy with vitrectomy for stage 4 ROP because of extensive retinolenticular adhesions. Data from this patient are not included in the analysis above. In our experience, the great majority of stage 4 ROP cases can be managed with lens-sparing vitrectomy techniques, but there are some eyes for which this approach is not appropriate. Eyes with extensive retinolenticular adhesion and partial RD due to ROP are rare, in our experience, and these eyes should not be considered similar to those reported in the current series.

Aside from the anatomic success rate, lens-sparing vitrectomy offers several other advantages over alternative procedures for stage 4 ROP. Scleral buckling has been shown to induce significant myopia in neonatal eyes and may contribute to amblyopia.²⁵ In addition, infants undergoing scleral buckling require a second procedure to divide or remove the buckle. Vitrectomy with lensectomy also induces significant anisometropia that may contribute to amblyopia when performed unilaterally.

Postoperative complications were encountered in 11% of the eyes in this series. Half of these occurred in one patient with bilateral surgery who developed postoperative glaucoma in both eyes that responded to topical medications. Two additional eyes developed postoperative retinal tears. One of these eyes also had severe glaucoma, ultimately requiring a cyclodestructive procedure once retinal reattachment had been achieved with scleral buckle, repeat vitrectomy, and silicone oil tamponade. After removal of the buckle and oil, this eye has remained attached and has developed fix and follow vision. In general, poor outcomes in this series resulted from progressive tractional changes despite lens-sparing vitrectomy, rather than from complications related to surgery.

Six eyes underwent repeat surgery in this series. One of these was for the retinal hole mentioned above, and the other 5 were for progressive tractional changes. Lens-sparing vitrectomy clearly does not prevent progressive tractional changes in some cases. Vitrectomy removes the scaffolding for fibrous proliferation in the vitreous cavity, but proliferation and subsequent contraction can still occur along the inner surface of the retina. Whether scleral buckling or repeat vitrectomy with lensectomy is beneficial in this subset of cases is unknown. Two of the 6 eyes in our series that underwent a second operation had lensectomy, but despite this, neither of them achieved complete retinal reattachment. It is our impres-

sion that eyes with even mild persistence of vascular dilation and tortuosity at the time of lens-sparing vitrectomy are more likely to have progressive tractional changes postoperatively.

This study has several limitations that should be noted, some of which are inherent in a retrospective series of surgical cases. These include lack of a control group, variable patient follow-up, and variable sizes of the RDs at the time of surgery. Some follow-up visual acuity (VA) data were obtained from referring ophthalmologists, and these VA measurements were not obtained in a systematic fashion. In addition, the follow-up in this series, though complete for at least 6 months, is still relatively short (range, 6-27 months). Early results in a surgical series of ROP detachments have proven unstable in the past,²⁶ and the relatively short-term follow-up in the current series is clearly a limitation.

There are some interesting issues about the management of stage 4 ROP that these data do not address. The long-term efficacy of this procedure is yet to be determined. Additional studies will also be required to determine if scleral buckling is superior to lens-sparing vitrectomy in the setting of mild persistent vascular dilation and tortuosity. Perhaps these eyes are best observed until all vascular activity resolves or best treated with scleral buckle followed by lens-sparing vitrectomy. Data from the current series and the one by Capone and Trese²³ demonstrate, however, that lens-sparing vitrectomy is an effective option for managing tractional stage 4 ROP.

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Table 3. Patient Characteristics, Follow-up Duration, and Outcomes for Each Patient

Patient No., Gender, Gestational Age—Birth (wks)	Birth Weight (g)	Eye	Retinopathy of Prematurity Stage	Gestational Age, Surgery #1 (wks)	Gestational Age, Surgery #2 (wks)	Lensectomy at Second Vitrectomy	Duration of Follow-up (mos)	Complete Retinal Reattachment	Parital Retinal Reattachment	Macular Status	Fix and Follow	Postoperative Retinal Hole	Postoperative Glaucoma
1. M, 23	567	OD	4A	40			16	Yes		Attached	Yes	No	No
		OS	4A	41			16	Yes		Attached	Yes	No	No
2. M, 25	680	OD	4A	37			14	Yes		Attached	Yes	No	No
		OS	4B	38			14	Yes		Attached	Yes	No	No
3. F, 27	830	OS	4A	38			27	Yes		Attached	Yes	No	No
		OD	4A	39			27	Yes		Attached	Yes	No	No
4. F, 28	974	OS	4A	42			24	No	Yes	Folded	No	No	No
5. M, 26	600	OS	4A	42	45	No	22	No	Yes	Folded	No	No	No
6. M, 26	1700	OS	4A	48			13	Yes		Attached	No	No	No
		OD	4A	49			13	Yes		Attached	No	No	No
7. F, 24	470	OS	4B	48			7	Yes		Attached	Yes	No	No
		OD	4B	50			7	Yes		Attached	No	No	No
8. M, 24	625	OS	4A	40	43	Yes	10	No	No	Detached	No	Yes	No
9. M, 24	723	OD	4A	39			11	Yes		Attached	Yes	No	No
		OS	4A	40			11	Yes		Attached	Yes	No	No
10. F, 28	937	OD	4B	45	65	Yes	15	No	Yes	Detached	No	No	No
		OS	4B	48			14	Yes		Attached	Yes	No	No
11. M, 26	800	OD	4A	48			12	Yes		Attached	Yes	No	No
12. M, 27	964	OD	4A	41			16	Yes		Attached	Yes	No	Yes
		OS	4A	43			16	Yes		Attached	Yes	No	Yes
13. F, 26	841	OD	4A	38			14	Yes		Attached	Yes	No	No
14. F, 26	718	OD	4B	42			12	Yes		Attached	Yes	No	No
		OS	4A	42			12	Yes		Attached	Yes	No	No
15. F, 24	593	OS	4B	45			15	Yes		Attached	Yes	No	No
		OD	4B	49			15	Yes		Attached	Yes	No	No
16. M, 24	770	OD	4B	38			17	Yes		Attached	Yes	No	No
		OS	4B	40			16	Yes		Attached	Yes	No	No
17. F, 26	1134	OD	4A	42			8	Yes		Attached	Yes	No	No
18. M, 29	1575	OD	4A	42			6	Yes		Attached	Yes	No	No
19. M, 26	715	OS	4A	44	51	No	7	No	Yes	Attached	Yes	No	No
		OD	4A	45	52	No	7	Yes		Attached	Yes	No	No
20. M, 24	618	OD	4A	41			7	Yes		Attached	Yes	No	No
21. M, 29	1303	OS	4B	38			14	Yes		Attached	Yes	No	No
22. F, 25	680	OS	4B	47			10	Yes		Attached	Yes	No	No
23. M, 26	730	OD	4A	42	46	No	11	Yes		Attached	Yes	Yes	Yes
		OS	4A	52			9	Yes		Attached	Yes	No	No
24. M, 24	539	OS	4A	39			10	Yes		Attached	No	No	No

F = female; M = male; OD = right eye; OS = left eye; ROP = retinopathy of prematurity.