

Adult Retinopathy of Prematurity: Retinal Complications from Cataract Surgery

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• **PURPOSE:** To describe the results and retinal complications of cataract surgery in adults with a history of premature birth from two separate retina services.

• **DESIGN:** Retrospective, noncomparative, interventional, consecutive case series.

• **METHODS:** A retrospective chart review was carried out of two cohorts of patients: Beaumont Hospital and Wills Eye Institute. Eyes of patients were selected who had a birth weight of less than 2200 g or a gestational age of fewer than 32 weeks, were 15 years of age or older at baseline visit, and who underwent cataract surgery in one or both eyes with at least one follow-up examination. A total of 66 eyes from 45 patients were selected and subject to analysis.

• **RESULTS:** Thirty-seven eyes (56%) had minimal cicatricial changes resulting from Retinopathy of Prematurity (ROP). The mean age of cataract surgery was 40.3 years. Twenty-five eyes (38%) had at least a one-line improvement in vision, 20 eyes (30%) had no change in vision, and 21 eyes (32%) had a decline in vision after cataract surgery. A postoperative complication of a retinal tear or retinal detachment developed in 15 (23%) of 66 eyes. The severity of the baseline fundus changes resulting from ROP did not correlate with the likelihood of developing a postcataract surgery complication. Results were similar between the two cohorts.

• **CONCLUSIONS:** In patients with a history of premature birth, cataract surgery tends to be performed at a young age, has a mixed range of visual results, and can be associated with a high rate of retinal complications. (*Am J Ophthalmol* 2008;145:729–735. © 2008 by Elsevier Inc. All rights reserved.)

RETINOPATHY OF PREMATURE (ROP) IS A NEOVASCULAR vitreoretinopathy that develops in 84% of premature infants.^{1–3} With advances in neonatology and the improved survival of extremely low birth weight infants, the incidence of ROP has increased steadily over the past several decades.¹ The increasing survival rate of premature infants over the past 40 years also has increased significantly the number of patients currently living with retinal changes because of ROP. ROP

resolves in most cases (80%) without initial visual loss from the acute changes of ROP.^{2,3} Babies treated via implementation of information from the CRYO-ROP, Early Treatment of ROP (ETROP),⁴ and other studies have significantly improved the treatment of ROP during its initial acute stage. However, these individuals, in whom severe cicatricial ROP or a retinal detachment do not develop during infancy, still have residual ocular changes as a result of being born prematurely.^{5,6} To date, relatively few published reports describe visual and morphologic outcomes as prematurely born infants move through childhood and become adults.^{5–11} There are ranges of residual ophthalmic manifestations that make it important to monitor all premature patients for a lifetime. Suspected complications of ROP that develop in adulthood include early cataract formation, early onset of glaucoma, high myopia, retinal tears, and retinal detachments.^{10,11} This report deals with the surgical removal of cataracts in adults with a history of premature birth.

Clinical impressions suggest that in adults with a history of premature birth, cataracts tend to develop at an earlier age. Prematurely born patients have characteristic retinal and vitreous pathologic features, which places them at an increased risk for developing retinal complications throughout their lives with or without cataract surgery.^{5–14} A previously published report by some of the authors (R.S.K., M.T.T.) using a portion of this data set revealed a high incidence of complex retinal tears and retinal detachments in individuals with a history of premature birth regardless of the fundus changes associated with ROP.⁷ Therefore, it is crucial for ophthalmologists to understand the age of cataract onset and the potential complications that can occur after cataract surgery in individuals born prematurely, regardless of the fundus changes that may or may not be present. Routine follow-up after cataract surgery in adults with a history of premature birth may be inadequate.

To help the ophthalmologist best manage a patient with a history of premature birth and cataracts, we report the results of patients with a birth weight of less than 2200 g or who were born at fewer than 32 weeks gestational age, with and without clinically visible retinal cicatricial changes of ROP, and clinical evaluations after 15 years of age.

METHODS

WE IDENTIFIED PATIENTS EVALUATED FOR ROP AT THE Associated Retinal Consultants at Beaumont Hospital

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TABLE 1. Birth Characteristics for All Patients with a History of Premature Birth

	Beaumont	Wills	Combined
No. of eyes	49	17	66
Birth weight (g)			
Mean	1158	1073	1018
Median	1018	1021 to 1106	1133
Range	746 to 1866	907 to 1361	679 to 1698
Gestational age (wks)			
Mean	26.3	29	27
Median	26	30	26
Range	24 to 30	26 to 30	24 to 30
Age at baseline examination (yrs)			
Mean	36.4	33.7	35.7
Median	36.5	36.5	35
Range	0.25 to 53	23 to 45	0.25 to 53
Follow-up duration			
Mean	8.4 yrs	21.9 yrs	12.0 yrs
Median	7.5 yrs	16.2 yrs	9.9 yrs
Range	One mo to 23.4 yrs	9.3 to 38.1 yrs	One mo to 38.1 yrs
Age at cataract surgery (yrs)			
Mean	38.25	46.12	40.31
Median	38	44	40
Range	7 to 55	38 to 66	Seven to 66

g = grams; mo = month; wks = weeks; yrs = years.

TABLE 2. Birth Characteristics for Patients with a History of Premature Birth in Whom Retinal Complications Developed

	Beaumont	Wills	Combined
No. of eyes	10	Five	15
Birth weight (g)			
Mean	1086	1100	1092
Median	962	1106	1061
Range	962 to 1528	1021 to 1134	962 to 1528
Gestational age (wks)			
Mean	25.5	27	27
Median	25.5	26	26
Range	25 to 26	26 to 30	25 to 30
Age at baseline examination (yrs)			
Mean	40.6	32.6	37.9
Median	39.0	35.0	39
Range	29 to 49	23 to 45	23 to 49
Follow-up duration			
Mean	6.3 yrs	22.6 yrs	11.7 yrs
Median	5.4 yrs	31 yrs	7.9 yrs
Range	One mo to 22.2 yrs	9.3 to 31.8 yrs	One mo to 31.8 yrs
Age at cataract surgery (yrs)			
Mean	40.3	42.8	41.1
Median	38	43	43
Range	25 to 48	38 to 45	25 to 48

g = grams; mo = month; wks = weeks; yrs = years.

TABLE 3. Staging of Cicatricial Changes in All Patients with a History of Premature Birth

Stage 0	No cicatricial changes and no peripheral retinal changes
Stage 1	No cicatricial changes but peripheral retinal changes (lattice-like degeneration or avascular peripheral retina)
Stage 2	Abnormal vessel angle or macular ectopia
Stage 3	Retinal fold
Stage 4	Tractional retinal detachment or retinoschisis
Stage 5	Phthisis or clinical stage 5 by CRYO-ROP standards

TABLE 4. Ophthalmic Fundus Characteristics at Baseline for All Patients with a History of Premature Birth

Stage	No. (%)		
	Beaumont	Wills	Combined
0 (no changes)	12 (25)	0 (0)	12 (18)
1 (peripheral retinal changes)	18 (35)	7 (41)	25 (38)
2 (posterior pole changes)	7 (14)	3 (18)	10 (15)
3 (retinal fold)	11 (22)	3 (18)	14 (21)
4 (TRD or retinoschisis)	1 (2)	4 (24)	5 (8)
5 (phthisis)	0 (0)	0 (0)	0 (0)
Totals	49 (100)	17 (101)	66 (100)

TRD = tractional retinal detachment.

from 1982 through 1998 and patients evaluated for ROP at Wills Eye Institute from 1965 through 1995, both obtained from a registry of diagnostic codes. Eyes of patients were identified that met the following criteria: birth weight less than 2200 g or gestational age of fewer than 32 weeks; all patients who were evaluated at the age of 15 years or older either at or after baseline visit; and all patients who underwent cataract extraction in one or both eyes and had at least one follow-up examination after cataract surgery. A total of 49 eyes of 36 patients from Beaumont and 17 eyes of 9 patients from Wills met the criteria and were subject to analysis. Data collected from the patients' charts included patient gender, birth weight, gestational age, baseline examination age, follow-up duration, and age at cataract surgery (Tables 1 and 2). Any previous treatment for ROP around the time of birth was documented. The reason for the initial presentation to the retinal office was recorded.

Baseline ocular characteristics were recorded from the clinical records. The best visual acuity either with correction, autorefraction, or pinhole examination was documented at baseline and at the patient's final examination. Spherical equivalent refraction also was recorded at baseline for each eye. In addition, data describing the retinal

TABLE 5. Ophthalmic Fundus Characteristics at Baseline for Patients with a History of Premature Birth in Whom Retinal Complications Developed

Stage	No. (%)		
	Beaumont	Wills	Combined
0 (no changes)	2 (20)	0 (0)	2 (13.3)
1 (peripheral retinal changes)	6 (60)	2 (40)	8 (53)
2 (posterior pole changes)	1 (10)	1 (20)	2 (13.3)
3 (retinal fold)	1 (10)	1 (20)	2 (13.3)
4 (TRD or retinoschisis)	0 (0)	1 (20)	1 (7)
5 (phthisis)	0 (0)	0 (0)	0 (0)
Totals	10 (100)	5 (100)	15 (100)

TRD = tractional retinal detachment.

characteristics were noted for each eye based on ophthalmoscopy results. This evaluation documented avascular peripheral retina, lattice-like degeneration, dragging of the posterior pole vasculature, radial or circumferential retinal folds, peripheral retinal schisis secondary to vitreoretinal traction, and total retinal detachment or phthisis.

Most patients were not staged by International Classification of ROP (ICROP) classification because the time of their birth and acute ROP occurred before publication of ICROP criteria. For the purposes of this study, each eye was staged (from stage 0 to stage 5; Table 3) according to the maximum degree of cicatricial retinal changes on initial examination (Tables 4 and 5). For example, if an eye had macular ectopia (a stage 2 change) and a retinal fold (a stage 3 change), then the eye was categorized as stage 3. Eyes with no posterior cicatricial changes from ROP (stage 0 or 1) were evaluated for peripheral lattice-like degeneration or an avascular peripheral retina. Eyes also were categorized according to visual acuity (groups A through E) based on initial visual acuity (Table 6).

All patients subject to this analysis underwent cataract extraction in one or both eyes within days to up to 36 years after initial evaluation. In addition, retinal complications that developed after cataract surgery and the treatments implemented to resolve the retinal complications were noted, including laser treatments, cryotherapy, scleral buckle, vitrectomy, or a combination thereof. Whether multiple treatments were needed and the interval for retreatments also were noted. Finally, the best-corrected visual acuity was recorded from the last examination.

The data abstracted from the patients' charts were collected on standardized data forms and keyed into a computer database. SAS computer software (SAS Institute, Cary, North Carolina, USA) was used to perform customized logical and consistency checking. Identified errors were corrected.

TABLE 6. Visual Acuity at Baseline and Final Examination for All Patients with a History of Premature Birth

Group	Baseline VA, No. (%)			Final VA, No. (%)		
	Beaumont	Wills	Combined	Beaumont	Wills	Combined
A ($\geq 20/60$)	17 (35)	9 (53)	26 (39)	20 (41)	7 (41)	27 (41)
B (20/70 to 20/200)	10 (20)	4 (24)	14 (21)	10 (20)	2 (12)	12 (18)
C (20/400 to 5/200)	9 (18)	4 (24)	13 (20)	9 (18)	5 (29)	14 (21)
D (4/200 to NLP)	7 (14)	0 (0)	7 (11)	4 (8)	3 (18)	7 (11)
E (LP or NLP)	6 (12)	0 (0)	6 (9)	6 (12)	0 (0)	6 (9)
Totals	49 (100)	17 (101)	66 (100)	49 (100)	17 (100)	66 (100)

LP = light perception; NLP = no light perception; VA = visual acuity.

TABLE 7. Reason Patients with a History of Premature Birth Sought Treatment from a Retina Service for Baseline Examination

	No. (%)		
	Beaumont	Wills	Combined
Asymptomatic (general ROP examination)	22 (61)	7 (78)	29 (64)
Symptomatic (decreased vision before or after cataract surgery, flashes or floaters, retinal tear, retinal detachment)	14 (39)	2 (22)	16 (36)
Totals	36 (100) (49 eyes)	9 (100) (17 eyes)	45 (100) (66 eyes)

ROP = retinopathy of prematurity.

RESULTS

• **PATIENT CHARACTERISTICS AND TIME OF CATARACT SURGERY:** A total of 49 eyes from 36 patients from Beaumont and 17 eyes from nine patients from Wills underwent cataract surgery. Characteristics of the patients from Beaumont and Wills individually as well as the combined data set are presented in Tables 1 and 2. The mean birth weight for the combined cohorts was 1018 g (1158 g at Beaumont and 1073 g at Wills Eye), and the mean gestational age for these eyes was 27 weeks. Patient birth weight and gestational age were similar between Wills and Beaumont as well as between patients who experienced retinal complications and those who did not.

Reasons for initial examination at the retina office for the adults with ROP varied for the patients who had cataract surgery (Table 7). Sixty-four percent of patients were asymptomatic on initial retinal evaluation. Thirty-six percent were referred for specific symptoms or ocular problems (decreased vision, symptoms of flashes or floaters, or an evaluation for a retinal tear or retinal detachment) or for an evaluation before or after cataract surgery.

The mean age at which patients underwent cataract surgery was 40.31 years (38.3 years at Beaumont and 46.1 years at Wills Eye), and the median age was 40 years. The range of ages at which patients underwent cataract surgery was from seven to 66 years.

• **REFRACTIVE AND ANATOMIC PRESENTATION:** The mean baseline spherical equivalent refraction of all eyes was -7.0 diopters (D) and the median was -6.1 D. The range was -0.125 to -17.5 D. These values are similar when compared with baseline refraction of eyes in which retinal complications developed after cataract surgery. The subgroup of patients in whom retinal complications developed after cataract surgery had a mean refraction of -6.8 D, a median of -7.0 D, and a range of -2 to -12.75 D.

Baseline fundus categorizations for patients followed up at Beaumont and Wills are presented separately and then in a combined format in Tables 4 and 5. Eighteen percent had stage 0 changes (no peripheral retinal changes). Thirty-eight percent had stage 1 changes (peripheral retinal changes only). Stage 2 changes (posterior pole dragging) were present in 15% of the eyes. Stage 3 changes (retinal fold) were present in 21% of the eyes. Only 8% had a stage 4 changes (TRD or schisis-like peripheral retina). Most of the eyes that underwent cataract surgery had limited cicatricial changes at baseline, with 56% having either stage 0 or stage 1 fundus changes resulting from ROP (no cicatricial ROP changes). A comparison of these baseline fundus characteristics with the subset of patients in whom retinal complications developed after cataract surgery shows them to be similar.

TABLE 8. Patients with a History of Premature Birth in Whom Retinal Complications Developed after Cataract Surgery

Case No.	Initial Complication	Treatment	Interval between Surgery and Retinal Complication (mos)	Complications	Initial Visual Acuity	Final Visual Acuity
Beaumont						
1	Retinal tear	Laser	40	New retinal detachment	20/40	20/25
2	Retinal tear	Laser	3	—	20/400	20/40
3	Retinal tear	Laser	12	—	20/80	20/30
4	Retinal detachment	Scleral buckle	20	Recurrent retinal detachment	20/20	20/30
5	Retinal detachment	Scleral buckle	26	—	20/25	20/60
6	Retinal detachment	Vitrectomy	9	—	20/40	20/40
7	Retinal detachment	Scleral buckle	7	—	20/40	20/70
8	Retinal detachment	Scleral buckle	68	—	20/25	20/25
9	Retinal detachment	Scleral buckle	42	—	20/400	20/50
10	Retinal detachment	Scleral buckle	114	—	1/200	1/200
Wills						
11	Retinal detachment	Vitrectomy	10	New retinal hole	20/50	20/60
12	Retinal detachment	Scleral buckle	23	Recurrent retinal detachment	20/60	Hand movements
13	Retinal detachment	Scleral buckle	76	Recurrent retinal detachment	20/70	Hand movements
14	Tractional retinal detachment	No treatment	136	—	20/120	Hand movements
15	Retinal detachment	Vitrectomy	92	—	20/50	Counting fingers

• **VISUAL RESULTS:** The distributions of visual acuity at baseline and the final examination for patients who had cataract surgery are seen on Table 6. Twenty-six eyes, approximately one-third of the total number of eyes (39%), had baseline vision in group A ($\geq 20/60$), and at the final visit, 27 eyes were in vision group A (41%). More specifically, the visual outcomes of eyes with good vision at baseline ($\geq 20/60$) demonstrates that 21 (81%) of 26 eyes had no change or an improvement in vision by the final examination. Twenty-six eyes had a baseline vision of 20/400 or worse and 23 of those eyes had a final vision of 20/400 or worse. Looking specifically at eyes that had at least two lines of vision change or more from the baseline examination to the final examination, 28 eyes (64%) had a significant improvement in vision and 16 eyes (36%) had a loss of some vision. A total of 12 eyes (1.5%) underwent yttrium–garnet–aluminum capsulotomy after surgery.

• **RETINAL COMPLICATIONS OF CATARACT SURGERY:** After cataract surgery, a postoperative complication of a retinal tear or retinal detachment developed in 15 (23%) of 66 eyes (Table 8). The patients with these complications had a mean birth weight of 1092 g and a median birth weight of 1061 g (Table 2). There was no statistical difference between these values and the mean and median birth weight of the cataract surgery group as a whole. The mean age when these patients underwent cataract surgery was 41.1 years. Baseline clinical refraction of patients with

a postoperative retinal tear or retinal detachment demonstrated a mean spherical equivalent of -6.8 D, with a median of -7.0 D. The mean interval from cataract surgery to development of a retinal complication was 45.2 months, with a median interval of 26 months and a range from three months to 136 months.

Eight of the 15 eyes with a postoperative retinal complications had a decline in visual acuity from baseline to the final examination. Four of the other 15 eyes in which retinal complications developed still had an improvement of visual acuity after cataract surgery and repair of the retinal complication. Finally, three eyes remained with the same final vision compared with baseline after cataract surgery despite the onset of a retinal complications.

The severity of the patient's baseline fundus changes resulting from ROP did not correlate with the likelihood of developing postcataract surgery complications. A tear or detachment developed in eyes that had minimal fundus changes from ROP (stage 0 or stage 1) in 10 of 15 cases. Five of the 15 eyes had more severe fundus changes at baseline and went on to develop postoperative complications.

DISCUSSION

AS NEONATAL CARE CONTINUES TO IMPROVE, THE NUMBER of prematurely born children surviving and reaching

adulthood is expanding. The application of knowledge gained from the CRYO-ROP Study and the ICROP classification of ROP has greatly improved the visual outcomes of children born prematurely.^{15,16} However, all children born early are at risk of developing ophthalmic complications; our study results confirm this notion. This double cohort of patients clearly demonstrates that adults with a history of premature birth are at risk for developing early cataracts. This study reports a median age for cataract surgery in the cohort of premature patients as being 40.31 years of age. This helps confirm data reported in a smaller case series that described cataract extraction in 14 patients with a median age of 38.5 years.¹⁷

The data in this study were compiled from two patient populations at two tertiary care retina referral practices. Each institution probably has a similar referral bias with the increased likelihood of collecting patients with preexisting retinal symptoms (flashes and floaters); however, 29 (64%) of 45 patients who underwent cataract surgery during follow-up in the retina practice were referred to each respective retina service for a general retinal evaluation because of a history of ROP and had none of the ophthalmic symptoms that frequently warrant a retinal evaluation. In 10 of these patients (34%), a retinal tear or detachment developed during the follow-up period. This suggests that asymptomatic patients with a history of premature birth need frequent and regularly scheduled evaluations to monitor for retinal complications before and after cataract surgery.

Visual results after cataract surgery in our patients were mixed, with 38% having at least a one-line improvement in vision, 30% having no change in vision, and 32% having a decline in vision after cataract surgery. Possible explanations for these results include the relatively higher rate of amblyopia in patients with a history of premature birth. In addition, Tasman and Brown reported decreased vision in patients with a history of ROP and macular ectopia resulting from dragged maculas.¹⁸ Ectopic maculae may contribute to the mixed visual results after cataract surgery in some patients. The details of the type of cataract procedure (intracapsular vs extracapsular vs phacoemulsification) were not available to be recorded, which is a significant criticism of our data. The data were compiled from records in two tertiary care retina practices where details regarding surgical technique and specific complications that may have occurred during the procedure were not available. Nonetheless, the results are strikingly similar between the institutions. It seems unlikely that the outcomes generated in these cohorts can be attributed to cataract surgery technique or expertise, given the reproducibility of the outcomes and complications between the two institutions in two separate regions of the United States. Therefore, we believe that the generalized conclusions regarding the complications associated with cataract surgery can be firm based on the reproducibility of the data in this study.

In addition, these cataract procedures were performed over a 30-year span during which cataract surgery techniques drastically changed. In a recent retrospective study published in *Ophthalmology* in 2006 examining patients who underwent cataract extraction from 1980 through 2004, Erie and associates reported that the 20-year incidence of retinal detachment after cataract extraction was 1.79%, which was four times the expected rate when compared with a similar group of patients not undergoing cataract surgery.¹⁹ We can use the results of this study to compare the expected complication rates during cataract surgery in this era of cataract surgery. Our study demonstrates a postoperative retinal complication rate of 23% in patients with a history of premature birth, which is extraordinarily higher than the rates reported by Erie and associates. Therefore, one can conclude that the complications resulting from adult ROP cataract surgery are drastically higher than procedures performed over the past 30 years, thus giving the data reported in this study significant clinical relevance.

The data presented suggest that eyes with minimal or no retinal changes resulting from ROP are at a high risk of developing postoperative retinal tears and detachments. Clinically, this is extremely important, for it may not be obvious to the cataract surgeon before surgery that their patient has a history of premature birth and thus is at higher risk for developing complications as a result of the procedure. Most eyes in which postoperative retinal tears or detachments developed (67%) had peripheral lattice, avascular retina, but no posterior cicatricial ROP changes (stage 0 or stage 1 fundus categorization). Therefore, a patient who is born prematurely and in whom severe retinal cicatricial changes do not develop is still at high risk for developing postoperative retinal complications. Because eyes can be without significant sequelae of ROP, it is important that during an initial consultation for cataract surgery, especially a young patient, a history of prematurity be elicited to determine if the patient is at higher risk of postoperative complications. If a history of premature birth is elicited, more intense retinal follow-up is required for up to four years after surgery.

The eyes in this study tended to be highly myopic. Previously published data on postoperative retinal complications after cataract extraction in highly myopic eyes (without a history of premature birth) demonstrate a postoperative retinal tear and detachment rate from 0.8% up to 12.7%.²⁰⁻²² This study demonstrates a postoperative retinal complication rate of 23% at two different institutions. Thus, the level of myopia in the eyes in this study does not seem to account entirely for the high complication rates we are reporting. This suggests that eyes with a history of prematurity have complex vitreoretinal relationships, which may increase the complication rate after cataract surgery beyond what would be expected for a highly myopic eye with a different birth history.

This retrospective review suggests the following. An asymptomatic patient with a history of prematurity may require cataract surgery at an early age. There is, however, a high likelihood that the eye will retain or improve from its preoperative vision. Overall, the visual results are worse than what is typically expected after cataract surgery. Moreover, the premature patient, with

or without significant posterior fundus changes, is at an increased risk of a retinal detachment or retinal tear during the postoperative period, and these retinal complications can present many months after cataract surgery. Overall, adults with a history of premature birth need to be followed up with life-long, detailed retinal evaluations after cataract surgery.

THE AUTHORS INDICATE NO FINANCIAL SUPPORT OR FINANCIAL CONFLICT OF INTEREST. INVOLVED IN DESIGN OF STUDY (R.S.K.); conduct of study (R.S.K., G.L.F.); collection, management, analysis, and interpretation of the data (R.S.K., G.L.F., W.T., M.T.T.); and preparation, review, or approval of the manuscript (R.S.K., G.L.F., W.T., M.T.T.). Institutional review board (IRB) approval was obtained for this study from the Wills Eye Institute IRB. Health Insurance Portability and Accountability Act compliance was maintained throughout the study.

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Biosketch

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