RISK OF RETINAL DETACHMENT AFTER CATARACT EXTRACTION, 1980-2004: A POPULATION-BASED STUDY

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ABSTRACT

Purpose: To estimate the long-term cumulative risk of retinal detachment (RD) after cataract extraction.

Methods: Using the resources of the Rochester Epidemiology Project, we retrospectively identified all residents of Olmsted County, Minnesota, who had cataract extraction from 1980 through 2004 (10,256 cataract extractions in 7,137 residents) and were diagnosed with RD. The observed probability of RD after cataract extraction was estimated using the Kaplan-Meier method. A cumulative probability ratio of RD after cataract extraction was determined by comparing the observed probability of RD with the expected probability of RD in residents without cataract extraction. Two controls chosen from the primary cataract surgery cohort were matched to each RD case by age, sex, and duration of follow-up. Logistic regression models assessed differences between cases and controls.

Results: Eighty-two cases of RD after cataract extraction were identified. The cumulative probability of RD after extracapsular cataract extraction (ECCE) and phacoemulsification was 0.27%, 0.71%, 1.23%, 1.58%, and 1.79% at 1, 5, 10, 15, and 20 years after surgery. There was no significant difference in the probability of RD after ECCE when compared to phacoemulsification ($P = .13$). The cumulative probability ratio of RD at 20 years after ECCE and phacoemulsification was four times (95% CI, 2.6-5.4) higher than would be expected in a similar group of residents not undergoing cataract extraction ($P < .001$). Males, younger age, myopia, and increased axial length were significantly associated with RD ($P < .001$).

Conclusions: The cumulative risk of RD after ECCE and phacoemulsification is increased for up to 20 years after surgery.

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INTRODUCTION

Cataract extraction is the most common surgical procedure performed in the United States in persons aged 65 years or older. It is estimated that 1.7 million cataract extractions are performed annually on Medicare beneficiaries alone.[1] Increasingly, cataract extraction is performed in younger, non-Medicare patients,[2] and clear lens extraction for correction of refractive errors is gaining popularity.[3]

Retinal detachment (RD) after cataract extraction is a vision-threatening event, with approximately half of patients not recovering better than 20/40 acuity.[4] Previous population-based cohort studies demonstrate an increased risk of RD after extracapsular cataract extraction (ECCE) and phacoemulsification that does not appear to either decrease or level off for up to 5 to 8 years after surgery.[5-10] Data on the risk of RD longer than 5 to 8 years after cataract extraction is lacking. Although pseudophakic RD may be an uncommon complication, the absolute number of RDs is substantial because of the large number of cataract extractions currently performed annually in the United States.[2] Additionally, as the US population ages, the number of pseudophakic Americans is projected to increase by almost 60% to 9.5 million in 2020.[11]

The purpose of this population-based cohort study is to expand on our earlier observations[10] and to report the increased long-term cumulative risk of RD after ECCE and phacoemulsification in the stable, well-defined population of Olmsted County, Minnesota, during the 25-year period from 1980 through 2004.

METHODS

The Institutional Review Board of Mayo Clinic College of Medicine approved the protocol for the study of this cohort.

DATA SOURCE

Data were obtained by using the resources of the Rochester Epidemiology Project (REP), a medical record linkage system established in 1966 to facilitate performance of population-based studies among residents of the city of Rochester and surrounding Olmsted County, Minnesota.[12] Virtually all medical care for this relatively isolated, semi-urban county (2000 total county population = 124,277) is provided by Mayo Clinic, Olmsted Medical Group, and their affiliated hospitals. The REP links Mayo Clinic's extensive medical record system with that of other providers of medical care, including Olmsted Medical Group; the University of Minnesota and the Department of Veterans Affairs Hospitals in Minneapolis, 90 miles north of Rochester; other small hospitals in surrounding counties; and the few independent medical practices in Rochester. Consequently, the REP provides a medical records linkage and retrieval system for virtually all sources of medical care utilized by the Olmsted County population. The usefulness and accuracy of the REP electronic databases for population-based studies of disease cause and outcomes have been well described.[12-14]

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ROCHESTER EPIDEMIOLOGY PROJECT PRIMARY CATARACT SURGERY COHORT

Incident cases of primary cataract extraction performed on all Olmsted County residents in the 25-year period between January 1, 1980, and December 31, 2004, were retrospectively identified using the resources of the REP.[2] The REP cataract surgery cohort included 10,256 cataract extractions performed on 7,137 Olmsted County residents of all ages. Cataract extraction performed by using phacoemulsification, ECCE, intracapsular cataract extraction, lens aspiration, and pars plana lensectomy as a primary procedure or as a combined procedure with penetrating keratoplasty or trabeculectomy was included. Lensectomy combined with a planned pars plana vitrectomy or in the surgical management of ocular trauma was excluded. Manual review of a 5% stratified random sample of the medical records verified the accuracy of coded demographic and clinical data and estimated case over ascertainment at <1%.[2,15]

ROCHESTER EPIDEMIOLOGY PROJECT PSEUDOPHAKIC RETINAL DETACHMENT COHORT

We used Mayo Clinic modifications of *International Classification of Diseases, Ninth Revision, Clinical Modification* (US Dept of Health, 1988) ICD-9 diagnosis codes 361.00, 361.07, 361.31, 361.32, 361.33, 361.6, 361.81, and ICD-9 procedure codes 14.32, 14.34, 14.35, 14.49, 14.52, 14.54, 14.55, 14.74 to retrospectively identify all potential RD-related diagnoses made or procedures performed on subjects in the REP primary cataract surgery cohort between January 1, 1980, and December 31, 2004. RD was defined as any pseudophakic rhegmatogenous retinal elevation in which subretinal fluid extended 3 or more disc diameters from the margin of the break. Nonrhegmatogenous, exudative, and tractional RD was excluded. RD prior to cataract extraction was also excluded. The medical records of all identified patients were reviewed by the authors (M.E.R., J.C.E.) to ensure accuracy of the demographic and clinical data. Olmsted County residence at the time of surgery or diagnosis was verified using previously validated procedures.[12-14]

In the nested case-control study, we compared each incident case of RD after cataract extraction with two control cases from the REP primary cataract surgery cohort who did not have RD. Controls were matched to cases by procedure type, age, sex, and length of follow-up.

DATA COLLECTION AND ANALYSIS

The records of all identified cohort cases were reviewed for gender, date of birth, date and type of cataract extraction, date of RD, extent of RD, treatment of RD, best-corrected visual acuity after RD, and date of last re-registration or date of death. Records in the case-control study were reviewed for axial length, preoperative refraction, subsequent Nd:YAG laser capsulotomy, and posterior capsular tear.

The observed probability of RD after cataract extraction was estimated using life-table analysis, or the Kaplan-Meier method. The duration of follow-up care after cataract extraction was based on the resident's last computer-documented re-registration date for any medical care within the REP or documented death. The expected probability of RD among county residents without prior cataract extraction was estimated using Olmsted County age- and sex-specific incidence rates and was adjusted for length of follow-up.[10] A cumulative probability ratio of RD after cataract extraction was determined by comparing the observed probability of RD after ECCE and phacoemulsification with the expected probability of RD in residents without cataract extraction. This was done to determine whether an increased risk of RD after cataract extraction existed and, if so, for how long. Potential differences between groups were investigated using the log-rank test. The relationship between continuous variables and the cumulative probability of RD was evaluated using Cox proportional hazards models. Differences between cases and controls were evaluated using logistic regression analysis.

RESULTS

Medical record review identified 91 potential cases with a documented RD after cataract extraction. Exclusion of nine nonresidents left 82 incident cases of pseudophakic RD in 79 residents. The mean age at RD diagnosis was 65 ± 15 years (± SD; range, 11 to 93 years), with 40 (49%) of 82 cases in residents less than 65 years of age. Among residents with a pseudophakic RD, the mean age at cataract extraction was 61 ± 16 years, with 49 (60%) of 82 cases in residents less than 65 years of age at the time of cataract surgery. All residents were white. Three (4%) of 79 residents had a bilateral pseudophakic RD. In 1980, 91% of cataract extractions were by ECCE and 0% was by phacoemulsification. In 2000, less than 2% of cataract extractions were by ECCE and 98% were by phacoemlusification. Demographic and clinical data are listed in Table 1.

The cumulative probability of RD at 20 years after cataract extraction was 1.79%. The cumulative probability of RD after ECCE and phacoemulsification increased in a nearly linear manner over the study period and was significantly higher than the probability of RD in county residents who did not have cataract extraction ($P < .001$; Figure 1). There was no significant difference in the probability of RD after ECCE when compared to phacoemulsification when tested to 10 years ($P = .07$) and overall ($P = .13$; Figure 2). At 20 years after ECCE and phacoemulsification, the risk of RD remained four times higher than would be expected in a comparable group of residents who did not have cataract extraction (Table 2).

Forty-eight (59%) of 82 RDs occurred 2 or more years after surgery, and 24 (29%) occurred 5 or more years after surgery. Men were 2.9 times (95% CI, 1.8-4.4) more likely to have a RD than women ($P < .001$, Figure 3). Each 10-year decrease in age resulted in a 1.6-fold (95% CI, 1.4-1.8) increased risk of RD (Figure 4). Residents less than 60 years of age at the time of cataract extraction were six times (95% CI, 3.8-9.5) more likely to have a RD than residents 60 years of age or older.

Forty-six (56%) of 82 cases had a macula-off RD at the time of diagnosis. The extent of the RD was <90° in nine eyes (11%), 90° to 180° in 50 eyes (61%), 181° to 270° in 11 eyes (13%), and >270° in 12 eyes (15%). Sixty-six (80%) of 82 eyes were initially treated with a scleral buckling procedure, 10 eyes (12%) with a scleral buckle combined with a pars plana vitrectomy, three eyes (4%)

with pneumatic retinopexy, one eye (1%) with laser photocoagulation, and two eyes (2%) were untreated. Fourteen (18%) of the 80 treated eyes required two or more retinal surgical procedures. Ultimately, 76 (95%) of the 80 treated eyes achieved anatomical reattachment. At l year after RD repair, the median visual acuity was 20/30 with 51 (64%) of 80 treated eyes seeing 20/40 or better.

TABLE 1. DEMOGRAPHIC CHARACTERISTICS OF THE ROCHESTER EPIDEMIOLOGY PROJECT PRIMARY CATARACT SURGERY AND PSEUDOPHAKIC RETINAL DETACHMENT COHORT, 1980 THOUGH 2004

Variable	Primary Cataract Surgery Cohort No. (%)	Pseudophakic Retinal Detachment Cohort No. (%)
Cataract extraction technique		
Phacoemulsification	6,611 (64.5)	48 (59)
ECCE	3,556 (34.7)	29 (35)
ICCE	65 (0.6)	3 (4)
Aspiration/lensectomy	24 (0.2)	2 (2)
Gender		
Men	3,638 (35)	48 (59)
Women	6,618 (65)	34 (41)
Age at cataract extraction (yr)		
0-9	22 (0.2)	2 (2)
10-19	10 (0.1)	0 (0)
20-29	29 (0.3)	0 (0)
30-39	79 (0.8)	2 (2)
40-49	337 (3.3)	13 (16)
50-59	829 (8.1)	26 (32)
60-69	2,093 (20.4)	18 (22)
70-79	4,023 (39.2)	12 (15)
80-89	2,555 (24.9)	9 (11)
≥90	279 (2.7)	0 (0)
Total	10,256 (100)	82 (100)

ECCE = extracapsular cataract extraction; ICCE = intracapsular cataract extraction.

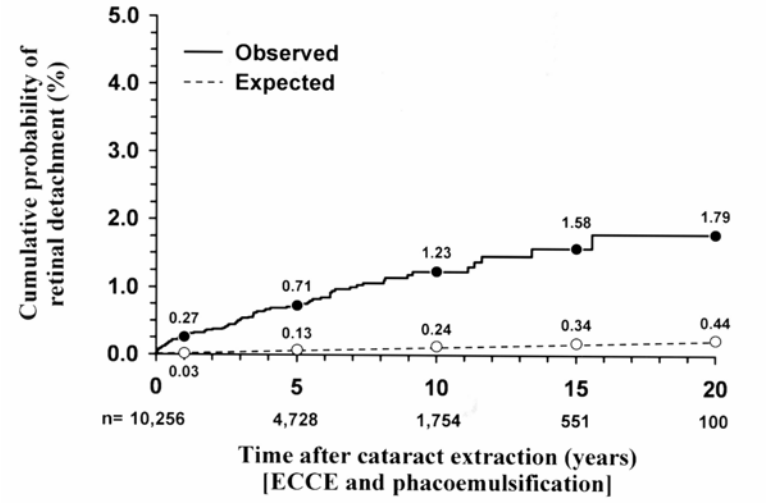

FIGURE 1

Kaplan-Meier analysis of the observed cumulative probability of retinal detachment after extracapsular cataract extraction (ECCE) and phacoemulsification and the expected cumulative probability of retinal detachment in age- and gender-matched Olmsted County residents not undergoing cataract extraction (adjusted for length follow-up). $P < .001$, log-rank test of observed vs expected.

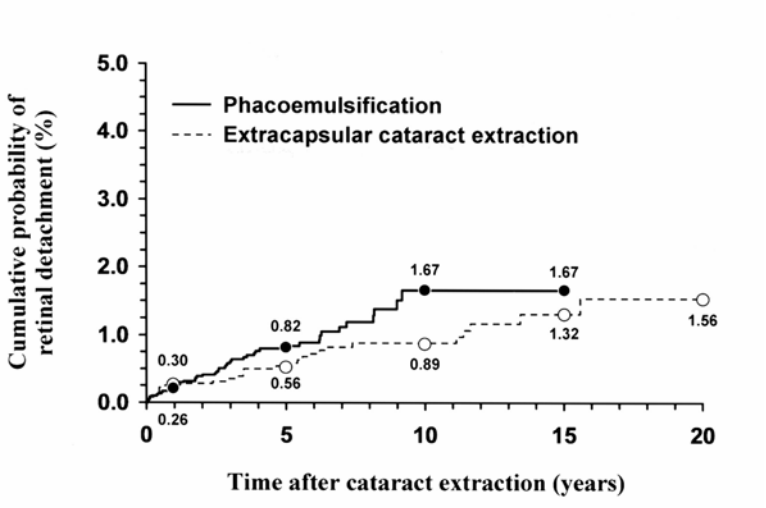

FIGURE 2

The cumulative probability of retinal detachment after extracapsular cataract extraction (ECCE) compared to phacoemulsification. There was no significant difference in the probability of retinal detachment after ECCE when compared to phacoemulsification when tested to 10 years (P = .07, log-rank test) and overall (P = .13, log-rank test).

TABLE 2. CUMULATIVE PROBABILITY RATIO (CPR) COMPARING THE OBSERVED PROBABILITY OF RETINAL DETACHMENT AFTER ECCE AND PHACOEMULSIFICATION TO THE EXPECTED PROBABILITY IN A REFERENCE GROUP NOT UNDERGOING CATARACT EXTRACTION*

TIME AFTER CATARACT EXTRACTION (YR)	CPR AFTER ECCE (95% CI)	CPR AFTER PHACOEMULSIFICATION (95% CI)	CPR AFTER ECCE AND PHACOEMULSIFICATION (95% CI)
1	11.0 (4.2, 17.8)†	8.9 (4.4, 13.3)†	9.7 (5.9, 13.5)†
5	4.5 (2.3, 6.6)†	6.2 (4.1, 8.2)†	5.5 (4.0, 7.0)†
10	3.9 (2.3, 5.5)†	6.9 (4.4, 9.4)†	5.2 (3.9, 6.5)†
15	4.0 (2.3, 5.7)†	4.7 (3.0, 6.5)†	4.7 (3.2, 6.1)†
20	3.6 (1.9, 5.2)†	NA	4.0 (2.6, 5.5)†

CI = confidence interval; ECCE = extracapsular cataract extraction; NA = not available; RD = retinal detachment.

*Using Olmsted County age- and sex-matched incidence rates and adjusted for length of follow-up.

†P < .001, log-rank test when compared to reference group of county residents without prior cataract extraction.

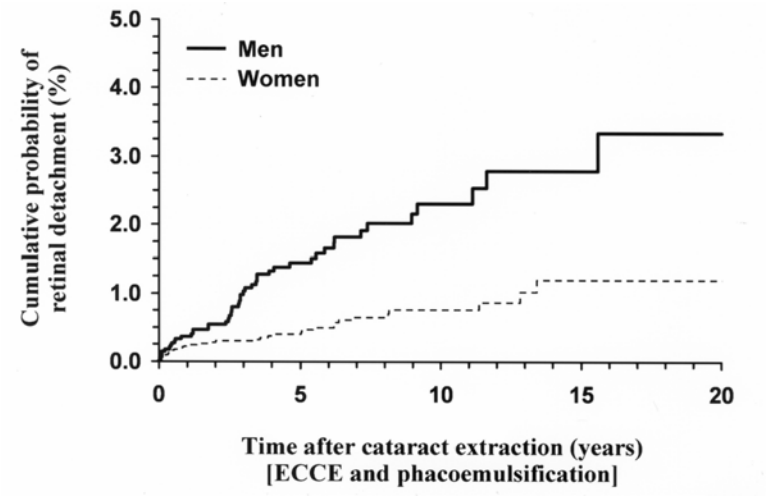

FIGURE 3

The probability of retinal detachment after extracapsular cataract extraction (ECCE) and phacoemulsification in men compared with women in Olmsted County, Minnesota, 1980 through 2004 (P < .001, log-rank test).

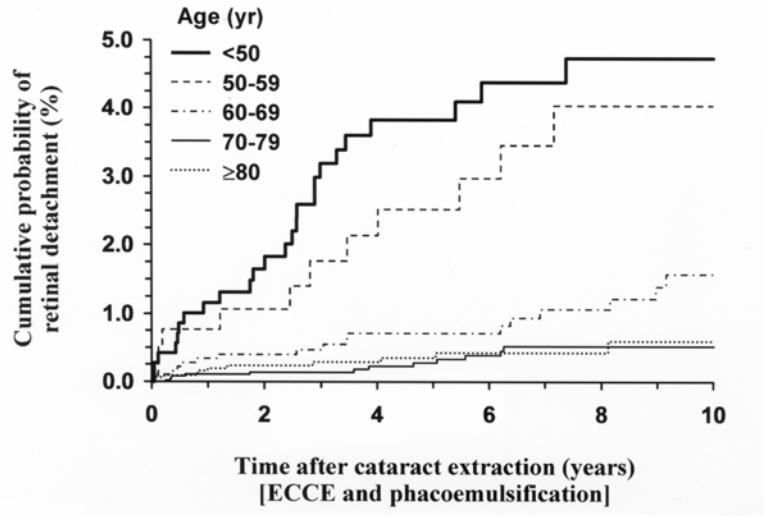

FIGURE 4

The effect of age on the probability of retinal detachment after extracapsular cataract extraction (ECCE) and phacoemulsification in Olmsted County, Minnesota, 1980 through 2004 ($P < .001$, log-rank test). Residents younger than 60 years of age at the time of cataract extraction were six times more likely to have a subsequent retinal detachment than residents 60 years of age or older.

In the case-control portion of the study, 77 cases (45 men, 32 women) with RD after ECCE and phacoemulsification were age- and sex-matched with 154 controls (90 men, 64 women). Univariate associations between selected variables and RD are shown in Table 3. Myopia, increased axial length, and posterior capsular tear at surgery were associated with an increased risk of pseudophakic RD ($P < .009$). Nd:YAG posterior capsulotomy was not associated with an increased risk of RD ($P = .58$). Cataract surgery was complicated by a posterior capsular tear in nine (12%) of the 77 eyes that developed RD after ECCE and phacoemulsification. In six of these nine eyes, the RD occurred within 1 year after cataract extraction.

TABLE 3. UNIVARIATE ASSOCIATION OF SELECTED VARIABLES WITH RETINAL DETACHMENT AFTER EXTRACAPSULAR CATARACT EXTRACTION AND PHACOEMULSIFICATION

VARIABLE	CASES NO. (%)	CONTROLS NO. (%)	ODDS RATIO (95% CI)
Axial length, mm			
< 23	11 (15)	42 (28)	
23 to 25	39 (52)	87 (58)	
> 25	25 (33)	21 (14)	
1-mm increase			1.6 (1.3, 2.0)*
Preoperative spheroequivalent, diopter (D)			
> +2.00	3 (4)	13 (8)	
+2.00 to – 1.00	28 (37)	99 (64)	
–1.00 to – 4.00	24 (32)	32 (21)	
> -4.00	20 (27)	10 (6)	
1 D increase in myopia			1.25 (1.1, 1.4)*
Nd:YAG posterior capsulotomy			
Yes	20 (26)	35 (23)	
No	57 (74)	119 (77)	1.2 (0.6, 2.3)†
Posterior capsular tear at surgery			
Yes	9 (12)	3 (2)	5.1 (1.5, 17.0)‡
No	68 (88)	151 (98)	

CI = confidence interval.
*$P < .001$, logistic regression comparing cases to controls.
† $P = .58$, logistic regression comparing cases to controls.
‡$P = .009$, logistic regression comparing cases to controls.

DISCUSSION

The findings of our population-based cohort study demonstrate that the risk of RD after ECCE and phacoemulsification increased in a nearly linear manner in the 25-year period from 1980 through 2004. We report a cumulative probability of RD that increased from 0.27% at 1 year after cataract extraction to 1.79% at 20 years. At 20 years after ECCE and phacoemulsification, the risk of RD remained four times higher than would be expected in a comparable group of residents who did not have cataract surgery.

There is a lack of population-based data on the risk of RD longer than 5 to 8 years after cataract surgery, despite case series suggesting that late pseudophakic RD is not rare.[3,16-19] Our previous population-based cohort study demonstrated an elevated risk of RD for up to 8 years after cataract extraction.[10] Other US[5,7,20] and non-US [6,8,9] population-based studies demonstrated similar findings. In these studies, the cumulative risk of RD within 3 to 8 years after ECCE and phacoemulsification was 0.8% to 1.3%. Non-US population-based studies from Scandinavia are similar to our study in that they were performed in a complete, rather than sampled, geographically defined population of a relatively broad age range.[6,8,9] The majority of cataract extractions in the Scandanavian population-based studies were performed by ECCE, rather than phacoemulsification, and all surgeries were on people 50 years of age or older. US population-based studies outside of Olmsted County, Minnesota, are limited to 5% random samples of Medicare databases.[5,7,20] One of the potential limitations of using sampled Medicare population data is that the study cohort has a limited age range because patients younger than 65 years are excluded. Younger age is a well-known risk factor for pseudophakic RD.[5-8,10] Medicare databases would have missed 1,924 of the 10,256 subjects (19%) in our primary cataract surgery cohort and 40 of the 82 RD subjects (49%).

The current study demonstrates the importance of length of follow-up in estimating the risk of pseudophakic RD. In our study, the cumulative probability of RD after ECCE and phacoemulsification continued to increase for up to two decades after surgery. At 10 to 20 years after ECCE and phacoemulsification, the risk of RD was still four to five times higher than would be expected in a comparable group not undergoing cataract extraction. Similar to other studies,[8-10,19] late pseudophakic RD was not rare in our community, as 29% of the observed RDs occurred 5 or more years after ECCE and phacoemulsification. On the basis of these findings, future studies that attempt to estimate the probability of RD following various techniques of cataract extraction and IOL insertion may underestimate the true long-term risk of RD if follow-up is limited to less than 5 years.

During the 25-year study period, our cataract extraction technique changed from primarily ECCE in 1980 to nearly exclusively phacoemulsification in 2000. Similar changes in cataract extraction technique were seen nationally during this same time period.[21] The surgical transition to phacoemulsification appears to have had no effect on the long-term cumulative risk of RD, as we found no difference in the risk of RD after phacoemulsificaton when compared to after ECCE. Earlier population-based studies reached a similar conclusion,[9,10,20] although Javitt and coworkers [5] found pseudophakic RD to be higher after phacoemulsification in the years soon after its introduction as a new surgical technique. Currently, no study with follow-up longer than 5 years has proven a difference in RD rates between these two cataract extraction techniques.

Our population-based study confirms the findings of several previous reports that identify male gender and decreasing age as risk factors for RD after cataract extraction.[5-9] Olmsted County residents less than 60 years of age at the time of cataract extraction were six times more likely to have a RD than residents 60 years of age or older. One possible reason for the influence of age on the risk of RD may be the status of the vitreous at the time of cataract extraction. Adjusting for refractive error, the mean age at onset of phakic posterior vitreous detachment (PVD) is 60 years.[22,23] The presence of a PVD in older patients before cataract extraction may protect against subsequent RD by limiting the transmission of forces to the retina that are produced during cataract surgery. Cataract extraction increases the risk of PVD,[24] and pseudophakic eyes have alterations in the vitreous humor structure that are not seen in phakic eyes.[25] Consequently, cataract extraction in younger patients without a previous PVD may subsequently alter the microenvironment of the vitreous and retina, increasing the long-term risk of a retinal break and RD. An alternative explanation is that some younger eyes are abnormal in their tendency to develop cataracts, and this same abnormality predisposes the younger eye to pseudophakic RD. Unfortunately, the status of the vitreous at the time of cataract extraction in our cataract surgery cohort is unknown. The observed strong association between age and pseudophakic RD may have implications when considering clear lens extraction as a refractive procedure in younger patients. If refractive lens exchange becomes more commonly accepted, this procedure may add significantly to the potential RD burden in younger eyes.

In the case-control portion of our study, we found that myopia, increased axial length, and posterior capsular tear at surgery significantly increased the risk of RD. Other nicely designed studies have demonstrated similar findings.[3,6,9,20,26] We note that a posterior capsular tear at surgery also appeared to accelerate the onset of RD. Six of nine cataract extractions complicated by posterior capsular tear had a RD within 1 year of surgery. In contrast, subsequent Nd:YAG laser posterior capsulotomy was not significantly related to RD. Previous studies are conflicting regarding an association between Nd:YAG capsulotomy and RD.[9,20,26,27]

Analysis of population-based studies of disease cause and surgical outcome is useful as it avoids patient inclusion bias, which is a common confounder of non-population-based series. The usefulness of the REP in providing accurate population-based data has been realized previously.[12-15] Any underidentification of patients coming to medical attention is unlikely because the resources of the REP provide access to virtually all medical records of care provided to Olmsted County residents. A previous Medicare data review of cataract surgery indicated that almost all Olmsted County residents 65 years of age and older had surgery at sites for which the REP would have virtually complete data capture.[15] We assume that REP databases have a similar high capture rate for patients undergoing retinal detachment surgery as well.

Although the results of this study indicate an elevated long-term risk of RD after cataract extraction, it is important to note the

limitations of the data. First, we studied a relatively racially homogeneous population of a single geographic area. In 2000, the Olmsted County population was 90% white and largely middle class. Additionally, this locale is not necessarily typical in its supply of medical services, the majority of which are provided by Mayo Clinic. Although the results of previous population-based studies from Rochester and Olmsted County have demonstrated that the data from our present study should be applicable at least to the white population of the United States,[12] we caution the validity of extrapolating our findings more broadly. Second, potential RD cases that were either miscoded as another diagnosis or had surgery at a site outside of the REP databases could result in our incidence estimates being low. Presumably, review of records with related ICD-9 diagnosis codes and ICD-9-CM procedure codes would decrease the likelihood of this occurrence. Third, cases that do not come to medical attention cannot be identified with the resources of the REP. The degree to which this might lower our estimated probability of RD after cataract extraction is unknown, although likely very low.

The authors believe that the findings of this study highlight the need for full preoperative explanation of the long-term risk of pseudophakic RD, especially in the higher-risk subgroups of men, younger age, myopia, and increased axial length.

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PEER DISCUSSION

DR DAVID J. WILSON: Dr. Erie and colleagues have used the resources of the Rochester Epidemiology Project to perform a very useful population-based study of retinal detachment after cataract extraction. The principal findings were: 1) The risk of retinal detachment after cataract extraction is four times the control rate, even 20 years after cataract surgery; 2) There is no significant difference in retinal detachment rate between phacoemulsification and conventional ECCE; 3) Factors associated with a higher risk of retinal detachment are: male sex, young age, increased axial length, and myopia; and 4) YAG laser posterior capsulotomy was not associated with an increased risk of RD.

Of the 10,256 patients undergoing cataract surgery, there were a few that underwent intracapsular surgery, and a few who were under age 19. Few retinal detachments were seen in these patients, but I wondered if they had lens implants.

The authors sought a correlation of several factors with retinal detachment. One factor listed was complication of cataract extraction. Other than posterior capsular tear, what complications of cataract extraction were correlated? Anterior vitrectomy and dislocation of the lens nucleus have been felt to increase the risk of retinal detachment – were these complications included in the posterior capsular tear group?

The authors conclude, I think correctly, that vitreous changes are responsible for the higher incidence of retinal detachment. Our clinical observations of the vitreous are notoriously bad. Sheard provided indirect evidence that the incidence of vitreous detachment increased for 3 years after cataract extraction, then was the same as phakic patients.[1] We also have limited evidence that the proteome of the vitreous changes after lens extraction.[2] Other than in the posterior capsular tear group, was there evidence of a higher incidence of retinal detachment in the first 3 years after cataract extraction, or was there truly a linear rate of retinal detachment which would suggest a metabolic rather than mechanical cause for PVD after cataract extraction?

Male sex, young age, myopia, and increased axial length were all correlated with an increased risk of RD. This sounds like the demographic for clear lens extraction. Can you calculate the cumulative risk of retinal detachment for this type of patient?

The authors are to be congratulated for providing a very useful study that will help in surgical decision making for cataract surgery and for clear lens extraction. I thank them for providing me their manuscript in a very timely fashion.

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DR JERRY SEBAG: Posterior vitreous detachment is the consequence of two concurrent processes – the liquefaction of the gel and dehiscence at the vitreoretinal interface. When both occur in tandem, the PVD is innocuous. When there is liquefaction without sufficient dehiscence at the vitreoretinal interface, an anomalous PVD results. The manifestations of that vary depending upon where the gel is most liquefied and where the cortex is most adherent. In this patient population, it's in the periphery, resulting in retinal detachments. Your observation that it was more frequent in males is due to the fact that PVD is more frequent in females. That probably occurred prior to the cataract surgery in females but not males. Your observation that post-op RD was two-fold more common under 65 years of age, rather than over 65-years of age, is also because they are much less likely to have had a PVD at younger ages prior to cataract surgery. We know that cataract surgery decreases the concentration of hyaluronan, and sets into motion the cascade of events that result in PVD. The factor that I was most interested is the integrity of the posterior capsule, because studies have shown that when the posterior capsule is intact, the biochemical alterations in vitreous are not as extensive as when the posterior capsule is not intact. In your two groups, the control population and the study population, was there a difference in the incidence of posterior capsule integrity, either as a surgical complication or with YAG capsulotomy?

DR JOSE S. PULIDO: Did the patients that were younger have vitrectomies before cataract surgery? Younger patients sometimes might have had vitrectomies because of Type 1 Diabetes and did not have vitreous to begin with. You mention that the risk factors are myopia, axial length, age, and male sex. Axial length and myopia are really linked together, and I wonder whether age also may be linked with myopia. Did you do a multi-variable analysis to see which ones were not particularly important?

DR DOUGLAS D. KOCH: Regarding the incidence of retinal detachment in the phacoemulsification versus the extracapsular groups, I wonder if there might be a confounding factor here. Surgeons transitioning to phacoemulsification more often performed the procedure in younger patients with softer cataracts, and those are the patients who have more axial myopia and are therefore more at risk for developing retinal detachment.

DR HUGH R. TAYLOR. I congratulate the people at Mayo Clinic for setting up the Rochester Epidemiologic Project years ago, particularly in a country like the USA where it is very difficult to get true population-based data across the country. To have a set

epidemiologic cohort like this is tremendously powerful and useful. The mechanism of retinal detachment really falls into two categories. One is that which is related to some ongoing underlying conditions, such as myopia, that will be there lifelong. The other relates to the perioperative events such as capsule rupture, which is an acute perioperative event. It would be very interesting to stratify your data and to run separate life curve analyses or survival analysis on those that have had a perioperative complication, to see if their risk was changed over the long term, or just in the short term. That would also provide more information about the long-term risks in those who did not have complications.

DR TRAVIS A. MEREDITH: As a resident, I was assigned to review 1000 cataract operations performed by Dr. Maumenee in the 1950s and 1960s. At that time, we identified two of the same trends you identified now. The first was that the risk of detachment in younger patients was three times higher than it was in older patients. Second, we were able to see that the continued risk of detachment extended out for many years. Our sampling method was much less sophisticated than your study. Cataract surgeons have been telling us for years that they are doing better operations. However, the risk of retinal detachment is much higher in intracapsular studies than what you have reported here.

DR M. GILBERT GRAND: In an AOS thesis several years ago, I looked at the frequency of retinal detachment in patients who undergo cataract surgery after having previously undergone successful repair of either a retinal tear or a retinal detachment. Among the subgroups in your study, do you have the ability to segregate out those patients who have had either prior retinal tears or prior detachments?

DR DENIS M. O'DAY: What are your thoughts on the implications of your study, in light of the continuing long-term risk following capsule rupture? What might the implications be in the training of surgeons where cataract surgery is the most common procedure and where capsule rupture has a fairly high incidence?

DR JAY C. ERIE: First, we only analyzed rates of retinal detachments after extracapsular cataract extraction and phacoemulsification; we did not specifically study retinal detachments after intracapsular cataract extraction or after lens aspirations in children.

Dr. Wilson and Dr Sebag raised the issue about the status of the vitreous before or after cataract surgery. Dr. Wilson specifically asked that if the incidence of PVD is increased in the first three years after surgery, is the rate of retinal detachment also increased? Late-onset pseudophakic retinal detachment is not uncommon. Thirty percent of retinal detachments in our study occurred five or more years after surgery. However, as Dr Wilson surmised, 50% of retinal detachments occurred in the first three years after surgery, when surgery-induced changes in the vitreous may be occurring.

Dr Wilson also asked, "How is the relative risk of retinal detachment affecting the patients with multiple risk factors?" We identified five risk factors. If one risk factor is present, the risk of pseudophakic retinal detachment increases 1.5-fold. As multiple factors are added, the risk does not increase in a linear fashion. For example, the presence of two risk factors increases the risk of retinal detachment 2.3-fold, and three risk factors increases the risk 3-fold. Finally, in Dr. Wilson's example of a young male who has myopia with increased axial length, or four risk factors, the risk of a pseudophakic retinal detachment increases 5-fold when compared to someone with no risk factors.

With regard to Dr. Sebag and Dr Taylor's comments, we do not have an easy way of exactly determining in our cohort of over 10,000 cataract surgeries who had a posterior capsular tear at surgery. However, a two percent random sample showed that the occurrence of a posterior capsular tear approached one percent in the cataract surgery cohort. In the pseudophakic retinal detachment cohort, 9 (12%) of the 77 cases had a posterior capsular tear at surgery, 7 of the 9 required an anterior vitrectomy, and 6 of the 9 had a retinal detachment within 1 year of cataract surgery.

Dr. Pulido asked if younger patients had vitrectomies prior to cataract surgery and if age was linked to myopia as a risk factor. I can't tell you how many young people had vitrectomies prior to cataract surgery, but I would guess that it is very low. Our analysis of risk factors is limited to univariate analysis because of a limited sample size.

Dr. Koch mentioned that cataract extractions performed by using phacoemulsification may have different demographics than those performed by using ECCE. This is an excellent comment and may be true. Also, phacoemulsification was introduced during the study time period. The natural learning curve associated with phacoemulsification may also have temporarily influenced complication rates.

Dr Grand, we have not analyzed how many patients had a retinal tear or a retinal detachment prior to cataract surgery. However, 3 patients had bilateral pseudophakic retinal detachments.

Dr O'Day, although a posterior capsular tear increases the long-term risk of retinal detachment, I suspect that the intra-operative surgical management of the vitreous influences the subsequent risk of retinal detachment. For residents-in-training, this re-enforces the teaching and practice of safe surgical technique in the practice lab or using surgical simulators prior to the operating room.