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Risk Factors for Vitreous Complications in Resident-Performed Phacoemulsification Surgery

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Abstract

Purpose—To identify risk factors for intraoperative vitreous complications in resident-performed phacoemulsification surgery

Setting—2 urban public county hospitals

Methods—A retrospective review of phacoemulsification cataract surgeries performed by residents between January 4, 2005, and January 8, 2008

Results—Of 2434 cases meeting inclusion criteria there were 92 vitreous complications (3.8%). Significant preoperative risk factors for vitreous complications on univariate analysis included older age (odds ratio [OR], 1.03; 95% confidence interval [CI], 1.01–1.05; P=0.020), worse preoperative best corrected visual acuity (BCVA) (OR, 1.5; 95% CI, 1.1–2.0; P=0.007), left eye (OR, 1.6; 95% CI, 1.0–2.4; P=0.043), history of trauma (OR, 1.8; 95% CI, 1.0–3.4; P=0.045), prior pars plana vitrectomy (OR, 2.3; 95% CI, 1.0–5.0; P=0.034), dementia (OR, 4.4; 95% CI, 1.5–12.9; P=0.020), phacodonesis (OR, 7.1; 95% CI 2.0–26.1; P=0.014), zonular dehiscence (OR, 8.8; 95% CI 4.2–18.5; P<0.0001), posterior polar cataract (OR, 7.7; 95% CI 1.6–37.2; P=0.037), white/mature cataract (OR, 2.0; 95% CI, 1.2–3.5; P=0.005), dense nuclear sclerotic cataract (OR, 2.4; 95% CI, 1.5–4.0; P=0.0006), and poor red reflex (OR, 1.9; 95% CI, 1.2–2.9; P=0.002). Factors that remained significant on multivariate analysis were older age (OR, 1.03; 95% CI, 1.01–1.05), worse preoperative BCVA (OR, 1.52; 95% CI 1.14–2.03), left eye (OR, 1.63; 95% CI, 1.05–2.51), prior pars plana vitrectomy (OR, 1.88; 95% CI 1.01–3.51), dementia (OR, 3.65; 95% CI, 1.20–11.17), and zonular dehiscence (OR, 8.55; 95% CI, 3.92–18.63).

Conclusions—Elements of the preoperative history and exam can identify patients at higher risk for intraoperative complications during resident-performed phacoemulsification surgery.

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Introduction

Intraoperative vitreous complications (including vitreous prolapse, vitreous loss, and dropped nucleus) remain a significant adverse event in cataract surgery. Vitreous loss places patients at higher risk of suboptimal visual result, cystoid macular edema, retinal detachment, and endophthalmitis.¹⁻⁴ The resident learning curve for phacoemulsification surgery has been described, with decreasing vitreous loss rates seen as residents gain experience.⁵⁻⁸ The ability to identify patients preoperatively who are at higher risk for complications would aid in appropriate case selection based on the skill level of the resident surgeon and guide surgeons in their discussion with patients of the potential risks of surgery. To this end, we retrospectively reviewed the preoperative characteristics of resident-performed phacoemulsification surgery cases.

Methods

The study was approved by the Institutional Review Board of the University of Texas Southwestern Medical Center. All cases of resident-performed phacoemulsification surgery performed at one of two urban public county hospital systems, Parkland Health and Hospital System (Dallas) or John Peter Smith Hospital (Fort Worth) between January 4, 2005, and January 8, 2008, were included and retrospectively reviewed. The main outcome was the presence or absence of intraoperative vitreous complication, defined as vitreous prolapse into the anterior chamber, vitreous loss through the wound, or dropped nucleus into the vitreous cavity. Preoperative characteristics reviewed included patient age; gender; race; laterality; presence of diabetes; use of anticoagulants, antiplatelet agents, or tamsulosin; history of ocular trauma, uveitis, glaucoma, or prior ocular surgery (including complicated or uncomplicated cataract surgery in the fellow eye); anxiety; diagnosis of dementia; claustrophobia; ability to lay flat; frontal bossing; sunken globes; best corrected visual acuity (BCVA); dilated pupil diameter; clarity of cornea; anterior chamber depth; type of cataract; density of cataract; adequacy of red reflex; presence of pseudoexfoliation syndrome; phacodonesis; zonular dehiscence; and biometry. Cases with incomplete data were excluded. BCVA was converted to logarithm of the minimum angle of resolution (log MAR) for analysis, and acuities of count fingers and hand motions were converted to log MAR 1.9 and 2.3, respectively.⁹ To grade density of mainly nuclear and posterior subcapsular cataracts, patients with >20/50 vision were classified as mild, 20/50–20/400 as moderate, and <20/400 as dense. Phacoemulsification was performed with the Infiniti Lens Removal System (Alcon Laboratories, Inc.). A single faculty surgeon primarily staffed cases at John Peter Smith Hospital while multiple faculty staffed cases at Parkland. Second year residents only operated at John Peter Smith.

Clinical characteristics were compared between patients with and without intraoperative vitreous complications using Chi-square or Fisher's exact test for categorical variables and two-sample t-test for continuous variables. To evaluate the strength of association, logistic regression analysis was conducted, and odds ratios with 95% confidence intervals were calculated. In multivariate data analysis, stepwise logistic regression analysis was performed to identify significant independent factors associated with vitreous complications. All analyses were performed with SAS 9.2 (SAS Institute Inc., Cary, NC).

Results

2434 cases met inclusion criteria. Surgeries were performed by 39 different residents. There were 92 (3.8%) intraoperative vitreous complications. Significant preoperative risk factors for vitreous complications on univariate analysis included older age, worse preoperative log MAR BCVA, left eye, history of trauma, prior pars plana vitrectomy, dementia,

phacodonesis, zonular dehiscence, type of cataract, and poor red reflex (Tables 1, 2). When compared to mainly nuclear sclerotic cataracts, posterior polar cataracts ($P=0.037$) and white/mature cataracts ($P=0.005$) had significantly higher complication rates. Dense nuclear sclerotic cataracts had significantly higher complication rates than moderately dense nuclear sclerotic cataracts ($P=0.0006$). In addition, cases with prior pars plana vitrectomy were also found to have a significantly higher risk of complications when compared to cases without prior retinal surgery ($P=0.034$). Odds ratios for clinical characteristics are shown in Table 3.

Multivariate data analysis using stepwise logistic regression analysis revealed older age, log MAR BCVA, left eye, prior vitrectomy surgery, dementia, and zonular dehiscence to be significant independent preoperative factors associated with vitreous complications (Table 4).

Discussion

In this retrospective study of 2434 resident-performed phacoemulsification cataract surgeries, six preoperative characteristics were found predictive of intraoperative vitreous complications on multivariate analysis. Older age has also been found to be associated with vitreous complications in other studies. Berler¹⁰ found a threefold increase in complications in phacoemulsification patients over age 88 years, while Kim et al¹¹ found older age predictive in a multivariate analysis of 1730 resident-performed phacoemulsification surgeries. The Cataract National Dataset electronic multicenter audit of 55,567 operations in the United Kingdom also found a significant association of posterior capsule and vitreous loss with increasing age.¹² We also found worse preoperative BCVA independently predictive of intraoperative vitreous complications on multivariate analysis, in contrast to Rutar et al¹³ in their retrospective review of 320 resident-performed phacoemulsification surgeries.

While history of trauma, phacodonesis, and zonular dehiscence were significant on univariate analysis, only zonular dehiscence was significantly associated with vitreous complications on multivariate analysis. Zonular pathology is a common characteristic of all three factors. Traumatic cataracts may be associated with a higher risk of posterior capsule rupture, regardless of zonular integrity.¹⁴ The Swedish Capsule Rupture Study Group¹⁵ found an increased risk of lens capsule complications with previous trauma and phacodonesis. Rutar et al¹³ found an association of major intraoperative complications and zonular pathology, which they defined as antecedent trauma or pseudoexfoliation. The lack of significant association of pseudoexfoliation syndrome and vitreous complications in our study and other recent studies^{11,15–17} deserves comment. While the increased frequency of intraoperative complications during cataract extraction in pseudoexfoliation syndrome is usually due to zonular weakness rather than capsule tears,¹⁸ use of technique modifications and adjunctive devices appear to have decreased the risks of complications.¹⁹

Prior vitrectomy was found to be a significant risk factor for intraoperative vitreous complications on multivariate analysis in this study. Kim et al¹¹ found prior vitrectomy a significant risk factor on univariate logistical regression analysis in their study of resident-performed phacoemulsification, but not on multivariate analysis. Cataract extraction after prior vitrectomy is often challenging and can be complicated by unstable posterior capsules, loose zonules, and posterior capsule plaques.²⁰

To our knowledge, dementia has not been previously identified as an independent risk factor for intraoperative complications in phacoemulsification surgery. Patients with even mild dementia may become disoriented in the unfamiliar confines of the operating room or when

placed under a drape. As a result of these findings, we are now more inclined to recommend general anesthesia to cataract patients with any degree of dementia.

Surprisingly, left eyes were significantly associated with complications on both univariate and multivariate analysis. This has not been found to be the case in previous series of resident-performed phacoemulsification.^{11,13} There were 438 bilateral cases performed in our series (876 eyes), of which vitreous complications occurred in 23 left eyes and 8 right eyes ($P = 0.006$, Fisher's exact test). We can only speculate as to the cause of this finding. The vast majority of our attendings and residents are right-handed and the incisions created are temporal clear corneal. Often the right-handed attending can access the paracentesis incision at the 11 o'clock position (and even the main cataract incision comfortably with the dominant hand) of a patient's right eye without the need to switch chairs when temporal incisions are placed by a right-handed resident. In a left eye under similar circumstances, the paracentesis incision at 5 o'clock is inaccessible from the attending sitting superiorly at the assisting port of the microscope, and the attending must switch positions with the resident in order to intervene. Perhaps attendings are more willing to intervene inside the eye if they do not have to change chairs.

Although we did not find type of cataract to be independent of age and preoperative BCVA on multivariate analysis, several types of cataract have been found to be associated with higher complication rates in previous studies. White and/or brunescant cataracts have been associated with higher rates in previous studies.^{12,13,15,21} Posterior polar cataracts are associated with a 26–40% risk of posterior capsule rupture during phacoemulsification.^{22,23} Small pupils were found to be a risk factor for intraoperative vitreous loss by Kim et al,¹¹ but not in our study or the study by Rutar et al.¹³ With use of iris hooks or pupil expansion devices, residents need no longer fear the small pupil case.

Intraoperative complications decrease the probability of achieving good visual acuity postoperatively.¹¹ By identifying cases at higher risk for complications preoperatively and assigning those surgeries to residents with more experience, hopefully visual outcomes can be optimized in training programs. Muhtaseb et al²⁴ devised a scoring protocol to stratify cataract patients preoperatively based on risk. Similarly, Habib et al²⁵ developed a "potential difficulty score" (PDS). Using data from experienced surgeons, a head to head comparison of the two systems validated both, with the PDS performing slightly better.¹⁴ Najjar and Awwad²⁶ devised a cataract risk score for beginning residents that has recently been validated.²⁷ These scoring systems were built using a combination of literature search and expert opinion. Many factors in these systems may be superfluous, while others may be missing. For example, none list dementia as a possible risk factor for complications, and only 2 of the 3 include advanced age. Najjar and Awwad purposefully excluded traumatic cataracts, congenital cataracts, polar cataracts, dislocated lenses, phacodonesis, and monocular patients from their risk score as they assumed those cases would not be given to beginning surgeons.²⁶ A succinct, simple risk score would be of benefit to attending surgeons assigning cases to residents of differing experience and competency levels.

This study is limited by its retrospective nature. Although all data points were routinely collected during the study period, there were multiple surgeons performing the preoperative examination, with differing examination skills and evaluation bias. In addition, cases were not randomized between residents, so selection bias (assigning easier cases to less experienced residents) almost certainly exists. Second year residents operated only at John Peter Smith with primarily a single faculty surgeon. There was no significant difference found between complication rates between second and third year residents. Cataract cases are usually not as complex at John Peter Smith. In a previous review of 1833 cases,²⁷ the Najjar-Awwad cataract surgery risk score averaged 6.79 at John Peter Smith and 6.99 at

Parkland ($P=0.023$, unpublished data). While there was a trend towards fewer complications in the second half of the third year of residency when compared to the first half, the difference was not statistically significant ($P=0.128$).

In conclusion, we found several preoperative variables significantly predictive of intraoperative vitreous complications on multivariate data analysis using stepwise logistic regression. While older age, worse preoperative BCVA, prior vitrectomy surgery, and zonular dehiscence were somewhat expected from previous studies, dementia is a risk factor previously unreported to our knowledge. Laterality (with left eyes having higher risk) is an unexpected finding and deserves further investigation to see if it is unique to our institutions.

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Synopsis

2434 cases of resident-performed phacoemulsification cataract surgery were reviewed. Older age, worse preoperative vision, prior pars plana vitrectomy, dementia, and zonular dehiscence were associated with vitreous complications on multivariate analysis.

Table 1

Association between vitreous complications and categorical characteristics

Characteristic	No complications (n=2342)	Complications (n=92)	P value
Hospital system			0.668
John Peter Smith	711 (30%)	26 (28%)	
Parkland	1631 (70%)	66 (72%)	
Level of resident surgeon			0.363
Second year	396 (17%)	13 (14%)	
Third year - first half of year	984 (42%)	45 (49%)	
Third year - second half of year	992 (42%)	34 (37%)	
Anesthesia			0.973
General	206 (9%)	8 (9%)	
Injection or topical	2136 (91%)	84 (91%)	
Gender			0.903
Female	1415 (60%)	55 (60%)	
Male	927 (40%)	37 (40%)	
Race			0.097
Black	655 (28%)	25 (27%)	
Latino	878 (37%)	40 (43%)	
White	611 (26%)	15 (16%)	
Other	198 (8%)	12 (13%)	
Diabetes			0.757
No	1235 (53%)	47 (51%)	
Yes	1107 (47%)	45 (49%)	
Anticoagulation			0.580
None	1711 (73%)	71 (77%)	
Aspirin or clopidogrel	566 (24%)	20 (22%)	
Warfarin	57 (2%)	1 (1%)	
Tamsulosin			1.000*
No	2323 (99%)	92 (100%)	
Yes	19 (1%)	0 (0%)	
Operative eye			0.043
Right	1194 (51%)	37 (40%)	
Left	1148 (49%)	55 (60%)	
Hx of trauma in operative eye			0.045
No	2150 (92%)	79 (86%)	
Yes	192 (8%)	13 (14%)	
Hx of uveitis			1.000*
No	2271 (97%)	90 (98%)	
Yes	71 (3%)	2 (2%)	
Hx of glaucoma			0.351
No	2182 (93%)	89 (96%)	

Characteristic	No complications (n=2342)	Complications (n=92)	P value
Yes	160 (7%)	4 (4%)	
Prior ocular surgery			0.115*
None	2134 (91%)	79 (86%)	
Vitrectomy	84 (4%)	7 (8%)	
Retinal laser	67 (3%)	2 (2%)	
Other, including scleral buckle	57 (2%)	4 (4%)	
Previous cataract surgery fellow eye			0.067
No	1497 (64%)	60 (65%)	
Yes (uncomplicated)	763 (32%)	26 (28%)	
Yes (complicated)	82 (4%)	6 (7%)	
Anxiety			0.441
No	2164 (92%)	83 (90%)	
Yes	178 (8%)	9 (10%)	
Claustrophobia			0.752
No	2273 (97%)	89 (97%)	
Yes	69 (3%)	3 (3%)	
Dementia			0.020*
No	2318 (99%)	88 (96%)	
Yes	24 (1%)	4 (4%)	
Can lay flat			0.911
Yes	2121 (91%)	83 (90%)	
No	221 (9%)	9 (10%)	
Frontal bossing			1.000*
No	2307 (99%)	91 (99%)	
Yes	35 (1%)	1 (99%)	
Sunken globe			1.000*
No	2275 (97%)	90 (98%)	
Yes	67 (3%)	2 (2%)	
Cornea			0.752*
Clear	2273 (97%)	89 (97%)	
Cloudy	69 (3%)	3 (3%)	
Anterior chamber			0.768*
Deep	2265 (97%)	90 (98%)	
Shallow	77 (3%)	2 (2%)	
Phacodonesis			0.014
No	2331 (100%)	89 (97%)	
Yes	11 (0%)	3 (3%)	
Zonular dehiscence			<0.0001*
No	2310 (99%)	82 (89%)	
Yes	32 (1%)	10 (11%)	
Cataract type			0.017

Characteristic	No complications (n=2342)	Complications (n=92)	P value
Nuclear sclerosis mainly	1289 (55%)	42 (46%)	0.0006
Anterior subcapsular mainly	16 (1%)	1 (1%)	
Cortical mainly	109 (5%)	6 (7%)	
Posterior polar	8 (0%)	2 (2%)	
Posterior subcapsular mainly	614 (26%)	21 (23%)	
White (mature)	300 (13%)	20 (22%)	0.635
Nuclear sclerosis			
Moderate	1248 (53%)	37 (40%)	
Mild	653 (28%)	23 (25%)	
Dense	441 (19%)	32 (35%)	0.002
Posterior subcapsular			
Moderate	693 (30%)	23 (25%)	
Mild	1322 (56%)	55 (60%)	
Dense	327 (14%)	14 (15%)	0.160*
Red reflex			
Good	1555 (66%)	47 (51%)	
Poor	787 (34%)	45 (49%)	0.160*
Pseudoexfoliation syndrome (either eye)			
No	2325 (99%)	90 (98%)	
Yes	17 (1%)	2 (2%)	

* P value calculated using Fisher's exact test; the other P values calculated using chi-square test

Table 2

Association between vitreous complications and preoperative clinical continuous characteristics

Characteristic	No complications (n=2342)	Complications (n=92)	P value
Age (years)	62.19±11.55	65.03±10.85	0.020
Axial length (mm)	23.54±1.26	23.61±1.14	0.637
Best corrected visual acuity (log MAR)	0.97±0.69	1.21±0.79	0.007
Astigmatism power (D)	1.09±0.93	1.15±0.77	0.444
Average keratometry (D)	43.98±1.69	43.94±1.49	0.809
Pupil diameter (mm)	7.51±1.26	7.63±1.05	0.372

P value calculated using two sample t-test

Table 3

Univariate logistic regression analysis of association between vitreous complications and clinical characteristics

Clinical characteristic	Odds Ratio (95% confidence interval)
Male vs Female	1.0 (0.7–1.6)
Black vs White	1.6 (0.8–3.0)
Latino vs White	1.9 (1.0–3.4)
Other race vs White	2.5 (1.1–5.4)
Diabetes vs Nondiabetic	1.1 (0.7–1.6)
Aspirin or clopidogrel vs None	0.9 (0.5–1.4)
Warfarin vs None	0.4 (0.1–3.1)
Left vs Right eye	1.6 (1.0–2.4)
History of trauma vs None	1.8 (1.0–3.4)
History of uveitis vs None	0.7 (0.2–2.9)
History of glaucoma vs None	0.6 (0.2–1.7)
History of retinal laser vs No prior retinal surgery	0.8 (0.2–3.4)
History of pars plana vitrectomy vs No prior retinal surgery	2.3 (1.0–5.0)
History of scleral buckle vs No prior retinal surgery	1.9 (0.7–5.4)
History of uncomplicated cataract surgery fellow eye vs No surgery	0.8 (0.5–1.3)
History of complicated cataract surgery fellow eye vs No surgery	1.8 (0.8–4.3)
Anxiety vs None	1.3 (0.7–2.7)
Claustrophobia vs None	1.1 (0.3–3.6)
Dementia vs None	4.4 (1.5–12.9)
Frontal bossing vs None	0.7 (0.1–5.3)
Sunken globe vs None	0.8 (0.2–3.1)
Cloudy cornea vs Clear cornea	1.1 (0.3–3.6)
Shallow anterior chamber vs Deep anterior chamber	0.7 (0.2–2.7)
Phacodonesis vs None	7.1 (2.0–26.1)
Zonular dehiscence vs None	8.8 (4.2–18.5)
Mainly anterior subcapsular vs Mainly nuclear sclerotic cataract	1.9 (0.2–14.8)
Mainly cortical vs Mainly nuclear sclerotic cataract	1.7 (0.7–4.1)
Posterior polar vs Mainly nuclear sclerotic cataract	7.7 (1.6–37.2)
Mainly posterior subcapsular vs Mainly nuclear sclerotic cataract	1.0 (0.6–1.8)
White/mature vs Mainly nuclear sclerotic cataract	2.0 (1.2–3.5)
Dense vs Moderate nuclear sclerotic cataract	2.4 (1.5–4.0)
Mild vs Moderate nuclear sclerotic cataract	1.2 (0.7–2.0)
Dense vs Moderate posterior subcapsular cataract	1.0 (0.6–1.9)
Mild vs Moderate posterior subcapsular cataract	0.8 (0.5–1.3)
Poor red reflex vs Good red reflex	1.9 (1.2–2.9)
Exfoliation syndrome vs None	2.0 (0.7–13.4)

Table 4

Independent significant preoperative characteristics for vitreous complications in stepwise logistic regression analysis

Clinical characteristic	Odds Ratio (95% confidence interval)
Older age	1.03 (1.01–1.05)
Worse best corrected visual acuity (log MAR)	1.52 (1.14–2.03)
Left eye	1.63 (1.05–2.51)
Prior pars plana vitrectomy	1.88 (1.01–3.51)
Dementia	3.65 (1.20–11.17)
Zonular dehiscence	8.55 (3.92–18.63)