A 5-Year Audit of Cataract Surgery Outcomes After Posterior Capsule Rupture and Risk Factors Affecting Visual Acuity

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• PURPOSE: To describe the posterior capsule rupture rates and visual outcomes after phacoemulsification, analyze risk factors for poor vision, and compare results of faculty (F) and residents (R).

• DESIGN: Retrospective audit study.

• METHODS: Visual success of all capsule ruptures (2006-2010) was analyzed and compared to uneventful cases. Rupture rates of faculty and residents were compared (χ^2, $P < .05$). Success was defined as % best-corrected visual acuity (BCVA) ≥20/40 at 3 months (excluding poor-prognosis eyes) and studied in relation to age, sex, surgeon type, stage of surgery, vitreous loss, dropped nucleus, and other complications (eg, retinal detachment, corneal decompensation, dislocated intraocular lens [IOL]). Final risk factors were identified using multivariate logistic regression analysis.

• RESULTS: From 2006 to 2010, there were 887 capsule ruptures in 48 377 phacoemulsification cases (rate 1.8%). Uneventful cases had significantly better visual outcomes than capsule ruptures (98.5% vs 93.9%; $P < .01$). Faculty rupture rates were lower (F = 1.4%) than residents' (R = 3.4%; $P < .01$), but visual outcomes were similar (F = 93.8%, R = 93.7%; $P > .05$). Ruptures most frequently occurred during phacoemulsification (59.6%) and irrigation and aspiration (24.8%) stages. Risk factors for poor outcomes included age >65 years, dropped nuclei, and other complications.

• CONCLUSION: The overall capsule rupture rate was 1.8%. Although residents had higher rates, visual success matched faculty's, possibly attributable to case mix and close supervision. Associated risk factors for poor vision included age >65 years, dropped nuclei, and postoperative retinal, corneal, and IOL complications. (Am J Ophthalmol 2014;157:180–185. © 2014 by Elsevier Inc. All rights reserved.)

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DESPITE CURRENT ADVANCES IN CATARACT surgery, which include smaller incisions, femtosecond lasers, improved phacoemulsification machine fluidics, and new intraocular lens (IOL) designs, posterior capsule rupture remains a major risk factor compromising final visual outcome.[1] The incidence of a torn posterior capsule and its sequelae has been shown to be correlated with the learning curve, with the more experienced surgeon generally having lower complication rates.[2,3]

The Singapore National Eye Centre (SNEC) is a large tertiary ophthalmic institution with a fully established residency program and continuously strives to manage the challenges of surgical training while maintaining quality visual outcomes. All cases performed in the Centre are videotaped and posterior capsule rupture rates are reported quarterly.

This paper reports our 5-year audit results on phacoemulsification surgery and posterior capsule rupture. We describe the posterior capsule rupture rates and visual outcome after capsule rupture and compare the outcomes between faculty (F) and residents (R). We also investigate possible risk factors for poor outcomes after posterior capsule rupture.

METHODS

AS PART OF OUR INSTITUTIONAL CLINICAL QUALITY assurance program, it is routine for all surgeons to report the occurrence of a posterior capsule tear at the conclusion of cataract surgery. This is a self-reporting exercise that is audited. This study is a retrospective analysis of our audit data on cases with posterior capsule tears over a 5-year period, from January 1, 2006, to December 31, 2010. Our institutional research board (SingHealth Institution Research Board) waived the need for ethics approval for audit data. The study was conducted in accordance with the Declaration of Helsinki. Data collected included patient demographics, grade of surgeon, stage of posterior capsule rupture, occurrence of vitreous loss, and immediate surgical management. The postoperative outcomes of capsule rupture cases were tracked by our Clinical Audit Service and reported in terms of visual acuity attained and development of additional complications.

Visual outcome after cataract surgery was assessed in terms of a "benchmark" visual acuity (VA) attained,[4] defined as best-corrected Snellen visual acuity (BCVA)

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of 20/40 or better. VA was evaluated between 1 and 3 months postoperatively, and the percentage with benchmark outcomes was calculated after excluding default cases and eyes with significant pre-existing ocular co-pathology such as maculopathy (attributable to diabetes mellitus, myopic degeneration, or other retinal vascular disorders), advanced glaucoma, optic neuropathies, amblyopia, significant corneal disease, and previous corneal or retina surgery that would affect potential VA. The calculation of overall visual success for phacoemulsification surgery was represented by results of a random 10% sample of the total number of cases. Visual outcomes in all capsule rupture cases were captured and were compared to uneventful cases during the study period to ascertain the impact of the torn capsule on visual outcomes. Posterior capsule rupture rates were calculated for the whole cohort, based on the ratio of capsular rent cases over the total number of phacoemulsification surgeries performed during this time period.

Pearson χ^2 test was used to calculate if there were statistically significant differences in posterior capsule rupture rates and visual success rates between faculty and residents.

Risk factors that could influence visual outcome in cases with torn capsules, such as age, sex, surgeon type, vitreous loss, stage of surgery, dropped nucleus, and postoperative complications, were initially examined using univariate logistic regression analysis. Postoperative complications were categorized as major if considered to most likely require further surgery and significantly impact visual outcomes, such as retinal detachment, severe vitreous hemorrhage, endophthalmitis, IOL dislocation, aphakia, retained nuclear fragments, and acute corneal decompensation. Complications associated with torn capsules were considered minor if they were self-limiting in nature and treatable medically and no return to operating theatre was required. This included mild macula pucker, anterior chamber inflammation with or without vitreous strands, raised intraocular pressures, cystoid macula edema, retinal tears treated with retinopexy, and retained (small amounts) soft lens material.

Multivariate logistic regression analysis was performed using the forward LR selection method to identify the risk factors. Interaction terms were checked in the multivariate logistic regression model, and for variables that were not significant in the univariate analysis. The interaction terms were dropped from the final model, which left a main effect–only model. The likelihood ratio test was used to compare the fit of the model and was confirmed with Hosmer-Lemeshow goodness-of-fit test. A significance level of .05 was used and statistical analysis was performed in SPSS 19.0 (SPSS Inc, Chicago, Illinois, USA).

RESULTS

• **OVERVIEW OF DEMOGRAPHICS AND VISUAL OUTCOMES:** From 2006-2010, there were 48 377 cases of phacoemulsification surgery, of which 37 832 (78.2%) were performed by faculty (n = 58) and the rest by residents (n = 105). Demographic data were obtained using a representative 10% random sample (n = 4908) of the total number of phacoemulsification patients performed in the 5 years. The mean age of patients was 67.0 years (SD 10.4), with a slight female preponderance (56.6%), and the racial distribution mirrored the Singaporean population mix, namely, Chinese 84.2%, Malays 7.2%, Indians 5.2%, and minorities 3.4%.

The overall success rate for phacoemulsification surgery (BCVA ≤20/40) was 98.5%. The BCVA ≤20/40 for phacoemulsification cases with no capsule rupture (n = 4278) was also 98.5%, with no significant difference between faculty and residents (F = 98.5%, R = 98.4%; χ^2 = 0.916, $P > .05$).

• **POSTERIOR CAPSULE RUPTURES:** There were 887 posterior capsular rupture cases recorded during the 5-year study period. The posterior capsule rupture rate was 1.83%, with residents contributing 360 cases (40.6%, capsule rupture rate = 3.4%) and faculty 527 cases (rate = 1.4%; 527 of 37 832 cases). This difference in rupture rates between residents and faculty was statistically significant (χ^2 = 187.1, $P < .001$). Of the total 887 torn capsule cases, 843 cases had full follow-up data and 752 eyes with no pre-existing pathology were included in the visual outcome analysis. The percentage of patients with BCVA of 20/40 or better was 93.8%, and this was significantly worse than in the cases with intact capsules (χ^2 = 65.7, $P < .001$). The visual success rate for residents' torn capsule cases was 93.7%, while faculty achieved 93.8%, and this difference was not statistically significant (χ^2 = 0.006, $P > .05$). Data on the type of cataract and case mix differences between residents and faculty were not available.

The frequency of capsular tears according to stage of surgery is as follows (Table 1): phacoemulsification (59.6%), irrigation and aspiration (24.8%), IOL implantation (7.1%), hydrodissection (4.1%), after IOL implantation (2.7%), capsulorrhexis split (1.0%), and fixation of capsular ring device (0.1%).

Vitreous loss (n = 665) was most likely during stages of nuclear disassembly and removal (84.5%; 562 of 665 cases) and occurred in 75.0% of cases (665/887) for both residents and faculty groups. Overall vitreous loss rate was 1.4%. The vitreous loss rate for residents was 2.6% (270/10 545), statistically much worse than the faculty's rate of 1.0% (395/37 832) (χ^2 = 139.9; $P < .001$). In residents' capsule rupture cases with vitreous loss, BCVA 20/40 or better was achieved in 92.8%, not significantly worse than cases with no vitreous loss, which recorded 96.3% (χ^2 = 1.202, $P = .273$). For faculty, BCVA 20/40 or better was recorded in 93.2% vs 95.6% without vitreous loss, and this was not statistically significant (χ^2 = 0.821, $P = .365$). Overall, there was no statistical difference in visual outcomes between cases