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Rate of Posterior Capsule Rupture in Phacoemulsification Cataract Surgery by Residents with Institution of a Wet Laboratory Course

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Abstract

Purpose To determine if a structured surgical wet laboratory curriculum for ophthalmology residents reduced the rate of posterior capsule rupture (PCR) in phacoemulsification cataract surgery.

Setting James A. Haley Veterans' Hospital, Tampa, FL.

Design Retrospective cohort study.

Methods The study assessed resident-performed phacoemulsification cataract cases from 2011 to 2017, after the creation of a wet laboratory course. Primary outcome measure was PCR. If present, timing of complication, dropped lens fragments, and the need for anterior vitrectomies were noted. Self-reported rates of PCR prior to institution of a wet laboratory course (2010–2011) were compared with cases done by residents who completed the course (2011–2017).

Results A total of 3,445 cases were reviewed of which 2.44% (84 cases) noted PCR. Of these, 19% (16) had dropped lens fragments, and 60.7% (51) required anterior vitrectomy. Sixty-nine cases documented timing of PCR with the majority, 58%, occurring during phacoemulsification. When comparing rates of PCR in cases done prior to the presence of a wet laboratory course versus after, there was a significant reduction observed (5.20% before vs. 2.44% after).

Conclusion In the presence of a wet laboratory curriculum, the rate of PCR decreased dramatically. The average rate was lower than those reported at other training programs (2.6–9.9%). Most PCR occurred during phacoemulsification, suggesting need for further focused instruction in this step.

Keywords
- cataract surgery
- posterior capsular rupture
- ophthalmology
- resident
- phacoemulsification
- wet lab

Phacoemulsification cataract surgery is one of the most common surgical procedures performed by ophthalmologists, and ophthalmology residents are expected to be proficient in cataract surgery at the completion of their training. In 2005, the Accreditation Council for Graduate Medical Education mandated all ophthalmology residencies provide

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either wet laboratory or virtual simulators to improve resident trainee surgical skills and patient safety.[1] The strengths and weaknesses of wet laboratory training as compared with surgical simulators have been heavily debated.[2] Simulators do not necessarily require a dedicated laboratory, surgical equipment, or a human instructor. However, a well-structured wet laboratory course may provide additional benefits including familiarity with real-world equipment and tailored feedback from a senior physician.

When attempting to compare training modalities, there are rarely objective metrics that focus on operative performance or patient-related outcomes.[2] There is, therefore, no national standard curriculum which may be due to the fact that there are insufficient studies to indicate the most effective teaching method. A survey published in 2004 in the United Kingdom showed that residents felt that their cataract surgery training was inadequate overall and that they wanted more opportunities to practice.[3] A survey of U.S. ophthalmology residencies showed that 64% of programs had a formal surgical teaching course, and only 37% had mandatory practice time in the form of minimum hours or number of laboratory sessions.[4] A study done at the University of Iowa showed less cataract surgery complications after institution of a surgical curriculum that contained both wet laboratory and simulator experience.[5] However, another article could not find a statistically significant difference in complication rate between residents who trained with a simulator instead of a wet laboratory.[6]

In this study, we explore the complication rates from phacoemulsification cataract surgery performed since the development of a wet laboratory course at our institution. Prior to the institution of a formal wet laboratory curriculum, residents had access to a room with surgical equipment but no formal oversight or instruction. Formal wet laboratory instruction began in 2011 to postgraduate year (PGY)-3 residents in anticipation for PGY-4 cataract surgery. Formal curricula for our PGY-2 and PGY-3 have been included as supplementary materials in ►**Appendices 1** and **2**. In summary, our program utilizes *Basic Principles of Ophthalmic Surgery* and *Basic Techniques of Ophthalmic Surgery* as the primary resources to prepare residents prior to each session. Additional course material is provided in the form of assigned reading from ophthalmic journals and textbooks. PGY-2 residents begin with the basics of suturing and then progress through repairing various wounds pertinent to ophthalmology (simple and complex eyelid lacerations, conjunctival lacerations, corneal lacerations, and scleral lacerations) along with the appropriate terminology and techniques necessary to perform these skills. PGY-3 residents build on this foundation by progressing to various ophthalmologic surgeries such as strabismus resection and recession, installation of Ahmed and Baerveldt tube shunts, trabeculectomies, minimally invasive glaucoma surgery (MIGS), penetrating keratoplasty, and a wide array of cataract extraction techniques with intraocular lens placement. Additionally, there are formal assessments in the form of both practical and written evaluations scheduled throughout the curriculum to allow for continuous assessment of resident progression. The entirety of this instruction has historically been performed by a single board certified ophthalmologist (M.D.) that trained in all of these techniques and spent their career practicing primarily in the fields of glaucoma and refractive cataract surgery. Since the course began, anecdotal evidence has shown resident satisfaction and increased confidence in the operating room (OR). To confirm this, the rates of posterior capsule rupture (PCR), a complication associated with cystoid macular edema, retinal detachment, and endophthalmitis, among other issues, were measured.

Patients and Methods

This retrospective study was approved by the Institutional Review Boards at the University of South Florida and the James A. Haley Veterans Administration Medical Center and was conducted with adherence to the tenets of the Declaration of Helsinki. Operative reports were reviewed from patients who had planned primary phacoemulsification cataract surgery performed by trainees of the University of South Florida residency program from July 1, 2011, to June 30, 2017. Each case was examined for PCR. If present, the surgical step at which PCR occurred, the presence of dropped lens fragments and the need for anterior vitrectomy were noted. Eyes with white cataract or pseudoexfoliation syndrome, and eyes undergoing cataract MIGS were included. The rate of PCR was calculated per residency class as the total number of eyes with PCR divided by the total number of cases examined.

Results

A total of 3,445 cases performed by 24 residents were included in the study. Cases per resident ranged from 90 to 211 cases with an average of 144 cases per resident; 2.44% (84 cases) had documented PCR. Among these, 17% (16) had posterior dislocation of lens fragments and 2% (2) had posterior dislocation of intraocular lenses; 60.7% (51) required anterior vitrectomy, while 1 case was converted to manual extracapsular cataract extraction. Sixty-nine cases had noted the timing of PCR, with the majority of capsule tears occurring during phacoemulsification (59%, including

Table 1 Timing of PCR

Timing of PCR	Number of complications
During hydrodissection	2
During capsulorhexis formation	2
During sculpting	2
During quadrant formation	23
During cortex removal	17
During lens placement	7
Unspecified during phacoemulsification	15
During placement of Malyugin ring	1
Unrecorded	15

Abbreviation: PCR, posterior capsule rupture.

Table 2 Characterization of patients suffering PCR

Type of cataract involved	Number of cases
Conventional	80
White cataract	0
History of pseudoexfoliation syndrome	0
Posterior polar cataract	1
Cataract with presence of rubeosis	1
Preexisting anterior capsular tear	2

Abbreviation: PCR, posterior capsule rupture.

sculpting and quadrant removal) followed by cortical removal (25%). ►**Table 1** shows the number of PCRs by surgical step. The self-reported average rate of PCR prior to initiation of the wet laboratory curriculum was 5.20% and after initiation of the new curriculum, it was 2.44%.

Further subgroup analysis was performed to examine the PCR rate as residents advanced through their surgical years. On average, each resident documented 147 cases from 2011 to 2017. This allowed for a natural division of the first 50 cases, middle 50 cases, and last 50 cases for each resident. There was a clear difference in PCR rates in the first 50 cases as compared with the latter two datasets with 54.8% occurring within the first 50 cases and only 23.8 and 21.40% in each of the latter two datasets, respectively.

►**Table 2** lists the preoperative identifiable risk factors in the cases of PCR. On examination of potential preoperative risk factors, the majority of PCRs occurred independently of any known risk factors. None of the posterior capsule tears occurred in cases with white cataracts, known history of pseudoexfoliation syndrome or use of α-blocker medications (IFIS, Intraoperative Floppy Iris Syndrome). One case had documented the possible presence of a posterior polar cataract. One case noted a dense cataract with rubeosis. Two cases had noted preexisting anterior capsule tears, one from trauma and the other from a laser peripheral iridotomy.

Discussion

At the University of South Florida, residents between 2011 and 2017 performed phacoemulsification cataract surgery as the primary surgeon beginning in their PGY-4 year. Wet laboratory training for these cases took place during the PGY-3 year. On average the residents in this cases series, which is the largest retrospective review of resident cataract surgeries that could be found in the literature, performed 144 cataract surgeries as the primary surgeon (range: 90–211 cases). Our retrospective analysis found that not only did wet laboratory training reduce the rate of PCR from 1 year to the next (5.2% in 2010–2011 vs. 2.27% in 2011–2012) but that it created a lasting change through every year that was included in this study (average PCR rate of 2.44% from 2011 to 2017). A PCR rate of 2.44% is better or comparable to what has been reported by many institutions for resident performed cataract surgery (2.02–9.9%).[7–12] A study performed at The Pennsylvania State University showed a reduction of PCR rate to 1.13% following the implementation of a wet laboratory curriculum, although this was a smaller postcurriculum cohort of 2,044 cases that took place over the course of 3 academic years.[13]

Additionally, not all of the cases of PCR documented vitreous loss. In this study, only 51 cases (1.48%) resulted in vitreous loss. This rate is lower than many of the vitreous loss rates reported at other training centers across the country (1.3–14.7%) and is again noteworthy as it captures nearly twice as many cases as the next closest study.[7–9,12,14–20] The rate of vitreous loss in this study was not only lower than the majority of resident performed cataract cases but it was comparable to published data for nonresident performed cases (0.2–4.4%).[21–33] Our series did note a few cases of PCR associated with predisposing risk factors of PCR. However, there were none reported in cases of white cataracts or in patients with pseudoexfoliation syndrome. This may reflect the surgical population of this residency program. Moreover, this study found that there were only 16 incidents (0.46%) of dislocated lens fragments across our pooled dataset. This represents a comparable or significantly lower rate than what has been published in some other studies (0.4–1.2%).[7,12,19]

There are several limitations to this study. While it is our belief that our postcurriculum cohort offers the largest case log of any available in the literature, our precurriculum data are only derived from a single academic year of four residents. Therefore, this did not allow for power analysis which would have allowed for the establishment of statistical significance. Though this may not be ideal, it does not detract from the ability to compare our postcurriculum data with that offered elsewhere in the literature. Other factors to consider that will apply to any study of this nature individual surgeon dexterity, patient case selection, variable attending oversight while in the OR, and other changes that might affect resident performance such as improvement in operative equipment technology.

Conclusion

While the literature is seemingly replete with studies that elucidate the benefits of a surgical curriculum, whether it be in the form of a wet laboratory or simulator experience, a study published in 2017 reported that nearly one-third of the U.S.-based training programs are still without a formal surgical curriculum.[34] The need for formal surgical training outside the OR has proven even more important as we move away from the coronavirus disease 2019 global pandemic which, based on a global survey published in 2020, reduced ophthalmology residency surgical activity by more than 75% for 74.6% of survey respondents.[35] While resident education should not be necessarily retooled based on generational global events, it appears that a formal surgical curriculum has enough utility to be applied to meet the demands of nearly any scenario that would negatively impact a program's ability to provide their residents with live cataract cases. Further studies are required to examine the barriers to implementing a standard surgical curriculum within residencies and identify areas of improvement for existing programs.

Note

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Disclosures

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Conflict of Interest

None declared.

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