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Wet Lab–Based Cataract Surgery Training Curriculum for the PGY 2/PGY 3 Ophthalmology Resident

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Abstract

Introduction: Studies have shown that structured cataract surgery training curricula are beneficial for resident surgeons-in-training, yet nearly one-third of US training programs do not have one, and public dissemination of said curricula are lacking. **Methods:** We created a microsurgical simulation center and accompanying structured training curriculum. Weekly lectures focused on the steps of cataract surgery, variations on technique, and complications. Each didactic was followed by a 1.5- to 2-hour time block with faculty supervision in the wet lab. Finally, to demonstrate proficiency, residents submitted a recorded video illustrating their competency within 1 week of the lecture. We reviewed videos and provided written feedback via a standardized form. Curriculum effectiveness was evaluated through formative feedback on the course itself and complication rates for resident-performed cataract surgery before and after implementation of the curriculum. **Results:** The course was implemented in 4 consecutive academic years, allowing time for nine junior residents to participate in the course at least once before operating as a senior. The incidence of posterior capsule tears for senior residents decreased from 3.07% in the 4 years preceding curriculum implementation to 1.13% for the senior residents who completed the course at least once as juniors ($p = .0571$). Supervised wet lab sessions and submitted videos allowed faculty to identify surgically struggling residents early. **Discussion:** Implementation of a cataract surgery training curriculum for junior ophthalmology residents provides a safe and effective environment to practice surgical techniques. Such a curriculum may decrease the complication rates of beginner surgeons.

Keywords

Ophthalmology, Cataract Surgery, Wet Lab, Phacoemulsification, Manual Small Incision Cataract Surgery

Educational Objectives

By the end of this activity, PGY 2 and PGY 3 residents will be able to:

1. Identify commonly used instruments and medications associated with phacoemulsification and manual small incision cataract extraction surgery (MSICS) and demonstrate proficiency on the accompanying assessment tool (quiz).
2. Demonstrate proficiency with regard to maneuvers typically encountered during phacoemulsification and MSICS, as measured by a standardized scoring rubric and feedback form.
3. Name common complications associated with each step of phacoemulsification and MSICS.

Introduction

Cataract surgery is the most commonly performed ophthalmic surgical procedure and is thus a cornerstone of residency training in ophthalmology.[1,2] However, there are unique challenges to creating an environment that fosters practice and feedback when teaching ophthalmology residents to perform cataract surgery. First, microsurgery lends itself to only one operating surgeon, leaving no room for the mentee to mimic the mentor in real time. Second, operating inside the eye leaves little room for error, which makes it difficult to demonstrate what not to do. Last, cataract surgery is almost always performed on awake patients. This makes giving constructive real-time feedback extremely difficult. To overcome the above challenges, it has been previously proposed that a structured wet laboratory–based curriculum be used to train beginning surgeons.

Appendices

A. Week 1 - Introduction.pptx
B. Week 1 - Surgical Instruments and Medications.pptx
C. Week 2 - Clear Corneal and Paracentesis Incisions.pptx
D. Week 3 - Capsulorrhexis .pptx
E. Week 4 - Hydrodissection and Nucleus Disassembly .pptx
F. Week 5 - Irrigation Aspiration and Lens Insertion.pptx
G. Week 6 - Manual Small Incision Cataract Surgery .pptx
H. Lab Guide.docx
I. Lab Materials and Equipment List.docx
J. Week 1 - Surgical Instruments Quiz.docx
K. Week 1 - Surgical Instruments Quiz Answer Key.docx
L. Week 2 - Evaluation Sheet .docx
M. Week 3 - Evaluation Sheet .docx
N. Week 4 - Evaluation Sheet .docx
O. Week 5 - Evaluation Sheet .docx
P. Week 6 - Evaluation Sheet .docx
Q. Faculty Feedback Survey .docx
R. Resident Feedback Survey

.docx

All appendices are peer reviewed as integral parts of the Original Publication.

Rogers and colleagues reported on the impact of a structured cataract surgery wet lab curriculum.[3] Implementation at the University of Iowa resulted in a decrease in posterior capsule (PC) tears from 7.17% to 3.77%. Similarly, Belyea, Brown, and Rajjoub reported on 592 resident-performed cataract surgeries, half of which were performed by residents who had previously trained on a simulator. Belyea and colleagues reported reduced phaco time, phaco power, and complication rates from residents with prior simulator experience.[4]

Despite a demonstration in the literature that these structured curricula are beneficial, nearly one-third of US residency training programs do not have one.[5] Even though cataract surgery is taught at every ophthalmology training program in the United States and is the most commonly performed surgery worldwide, only one other electronic resource on the topic has been published in *MedEdPORTAL*.[6] Moreover, all of the prior literature focuses on the tangible benefits wet lab–based practice has on operating room performance; no attention has been paid to feedback and its importance in effective learning.

Training residents to do cataract surgery requires a sound understanding of how surgeons learn so that an environment fostering that method can be created. In their book *How Learning Works: Seven Research-Based Principles for Smart Teaching,* Ambrose and colleagues focus on how to properly structure practice and feedback to foster efficient learning.[7] With regard to practice, the book suggests several strategies, including the following: (1) Be explicit about goals, (2) use a rubric to specify and communicate performance goals, (3) build in multiple opportunities for practice, (4) give examples of model performance, and (5) show students what you do not want. Similarly, the most effective feedback is formative, as opposed to summative (which merely gives final judgment or evaluation of proficiency), and is timely. It is important to note that a combination of both immediate and delayed feedback is likely most beneficial; delayed feedback gives students a chance to fix their own errors so that they have more practice at the corresponding skill. Key strategies for targeted feedback include the following: (1) Focus on a key aspect of the assignment, (2) balance strengths and weaknesses in feedback, (3) design frequent opportunities to give feedback, (4) provide (real-time) feedback at the group level, and (5) incorporate peer feedback. It was with these concepts in mind that this resource was developed.

Methods

We created a microsurgical simulation center in which residents could practice skills reviewed in this resource. Since a main objective was to provide feedback, priority was given to including high-definition video cameras to mount on each of the three operating microscopes, large 49-inch LED TVs to facilitate real-time oversight/feedback by a mentor or a group of trainees, and high-definition video-recording equipment to facilitate off-line review and delayed feedback.

We also designed a 6-week curriculum with the five strategies for encouraging practice mentioned above in mind. The first week included a short introductory didactic (Appendix A) that outlined the goals of the course, the overall structure, and the expectations of the junior (PGY 2 and PGY 3) residents with regard to completing practice sessions, senior (PGY 4) residents with regard to providing some direct supervision in the wet lab, and faculty with regard to returning timely feedback. The first week also included a separate didactic (Appendix B) that reviewed the medications and instrumentation associated with routine phacoemulsification cataract surgery. Each of the subsequent 5 weeks included a 1-hour didactic focusing on one or two important steps of cataract surgery (Table 1) that discussed the mechanics of the technique and included multiple video examples of model performances and what not to do (Appendices C-G). We made these didactics accessible to the residents via a shared network drive. Explicit goals were laid out each week by assigning the residents a video homework assignment, in which they were asked to practice a specific step, which they were given ahead of time (Appendix H). We also created a laboratory manual to assist with proper setup for each of the wet lab–based practice sessions (Appendix I). Multiple opportunities for practice were built in by designating that we, the faculty, be present for no less than 2 hours for each of the five blocks and by separately requiring senior residents to act as resident-teachers for junior residents as they worked on their assignments.

Table 1. Overview of Content Covered and Assessment Tool Used Each Week of the Course

Week	Topic	Didactic	Assessment Tool
1	Introduction	Appendix A	
	Surgical instruments and medications	Appendix B	Quiz: Appendix J; answer key: Appendix K
2	Clear corneal and paracentesis incisions	Appendix C	Feedback form: Appendix L
3	Capsulorrhexis	Appendix D	Feedback form: Appendix M
4	Hydrodissection and nucleus disassembly	Appendix E	Feedback form: Appendix N
5	Irrigation/aspiration and lens insertion	Appendix F	Feedback form: Appendix O
6	Manual small incision cataract surgery	Appendix G	Feedback form: Appendix P

Ambrose and colleagues' strategies for targeted feedback were also incorporated into the curriculum.[7] Assessment of knowledge after the first week was evaluated through completion of a quiz (Appendix J). The current resource also includes an answer key (Appendix K). For subsequent weeks, we provided direct oversight in the wet lab, which allowed for real-time feedback, and separately reviewed the video homework assignments, which allowed for delayed, written feedback. We provided written feedback via a structured feedback form, which was adapted from the International Council of Ophthalmology–Ophthalmology Surgical Competency Assessment Rubrics for phacoemulsification and manual small incision cataract extraction surgery (MSICS; Appendices L-P).[8] Peer feedback was achieved by giving the senior (PGY 4) residents the responsibility of supervising junior residents as they prepared their video assignments.

We first implemented the curriculum in the spring of the 2014-2015 academic year, after the annual Ophthalmic Knowledge Assessment Program (OKAP) in-service exam. The course ran from mid-March to mid-May. As four experienced anterior segment faculty, we co-instructed the course. Residents who completed the course as PGY 2s repeated it in their PGY 3 year. At our institution, there are three residents per class year.

To evaluate the effectiveness of the curriculum, feedback was solicited from both faculty (Appendix Q) and residents (Appendix R) and was used to make iterative changes in subsequent years. The complication rates (PC tears) for PGY 4 residents who completed the curriculum at least once as PGY 2/PGY 3 residents were compared to those from PGY 4 residents who never had the opportunity to complete the curriculum. Even though the course was first implemented in the 2014-2015 academic year, PGY 4 resident outcomes from that year were included in the preimplementation group since those residents never had the opportunity to complete the curriculum previously. A Mann-Whitney test was used to evaluate for statistical significance.

Results

Feedback from residents and faculty was solicited after the 6-week block via an emailed questionnaire. This survey included 5-point Likert scale–style questions (1 = *strongly disagree,* 3 = *neutral,* 5 = *strongly agree*) and an opportunity to provide prose feedback on the strengths and weaknesses of the curriculum. Most notably, 87.5% of respondents strongly agreed with the statement "I am a more competent resident surgeon beginning cataract surgery because of the cataract surgery training curriculum." A majority (87.5%) of the residents either agreed or strongly agreed that the verbal and written feedback was useful and allowed them to advance their skill set. Three out of the four faculty strongly agreed that "video recording of practiced surgical skills gives me the opportunity to accurately evaluate residents' surgical skills and identify those that may struggle in the operating room." Every single faculty mentor independently commented that the video assignments were the most valuable aspect of the curriculum and allowed them to identify baseline technical skill and surgical personality (timid, cavalier, etc.), as well as struggling residents who needed more guidance.

The most commonly reported measure of safety for cataract surgery is the rate of PC tears. The incidence of PC tears before and after implementation is displayed in Table 2. The incidence of PC tears in PGY 4 resident–performed cataract surgery in the 4 academic years preceding curriculum implementation was 3.07% (n = 12 residents). The incidence of PC tears in PGY 4 resident–performed cataract surgery in the 4 academic years after implementation was 1.13% (n = 9 residents; p = .0571). The PGY 4 residents included in the postimplementation analysis completed the curriculum at least once as PGY 2/PGY 3 residents; thus, 4 years after course implementation, data from nine PGY 4 residents were available for analysis. Residents who were exposed to the curriculum performed a small number (<10; 5%) of cataract surgeries in their PGY 2/PGY 3 year, but nearly all of these were performed after completing the curriculum at least once.

Table 2. Incidence of Posterior Capsule Tears in PGY 4 Resident–Performed Cataract Surgery Before and After Curriculum Implementation

Academic Year	Total Cases Performed	Posterior Capsule Tears
Preimplementation		
2011-2012	320	10/320 = 3.12%
2012-2013	245	8/245 = 3.27%
2013-2014	449	20/449 = 4.45%
2014-2015	645	13/645 = 2.01%
All	1,659	51/1,659 = 3.07%
Postimplementation		
2015-2016	654	2/654 = 0.31%
2016-2017	705	9/705 = 1.28%
2017-2018	685	12/685 = 1.75%
All	2,044	23/2,044 = 1.13%

Discussion

We created a comprehensive cataract surgery training curriculum that provides an effective instrument to both disseminate the cognitive knowledge and teach the technical skill expected of beginner cataract surgeons. This is supported by the fact that residents universally (100%) agreed or strongly agreed that the curriculum “improved their knowledge base with regards to the surgical instruments and medications” and “was instructive in demonstrating proper technique.” All residents (100%) also felt that the curriculum “provided an opportunity to practice technical maneuvers,” and 87.5% agreed or strongly agreed that “written feedback from each session was useful.”

Feedback from the residents taught us that the curriculum is likely best implemented after the annual OKAP in-service exam required of ophthalmology residents, as this is when they are most able to focus their attention on the didactics and devote sufficient time to practicing in the wet lab. Moreover, while the course can be delivered in as few as 6 weeks, a more reasonable time line might be 8 weeks, with extra time for practice in the wet lab devoted to the nucleus disassembly and MSICS modules. The residents also recommended that more topics related to cataract surgery be included in future iterations of this resource. Such topics might include intraocular lens power calculations and lens selection, interpretation of corneal topography as part of the cataract evaluation, and femtosecond laser-assisted cataract surgery.

The resource described here is one of the most comprehensive courses published for training junior residents to perform cataract surgery. The strengths of this resource include the incorporation of original high-definition videos within the didactics, video homework assignments, and structured written feedback forms. While some ophthalmology training programs in the United States likely have similar curricula, they are rarely disseminated or shared. It is our hope that by having open access to this resource, other programs might adapt and customize it for their own use.

There are several limitations to this resource. First, full implementation requires construction of a microsurgical simulation center, an environment where residents may practice reviewed techniques. This necessitates a significant commitment of department resources. The simulation center described herein had a start-up cost of approximately $45,000, while simultaneously having the support of two industry sponsors, each of which contributed a phacoemulsification machine. Second, no simulation environment perfectly replicates the operating room experience, and so, the skills learned in the wet lab do not necessarily translate to actually performing cataract surgery.

Since the Pennsylvania State University College of Medicine ophthalmology residency program has only three residents per year, our sample size for assessing the complication rates of resident-performed cataract surgery was small (12 preimplementation, nine postimplementation). Furthermore, one should not necessarily conclude that there is a causative relationship between implementation of the curriculum and a decrease in complication rates, rather only an association. Other naturally occurring changes within the residency program (i.e., upgrade of phacoemulsification equipment in October 2015, expansion of clinician-educator faculty, and secular trends) might have also contributed to the changes.

The laboratory and feedback mechanisms described above may allow clinician-educators to categorize the typology of each resident surgeon (e.g., timid, cavalier, and technically gifted) early and systematically study how to most appropriately coach or remediate each of these typologies. This idea is the foundation for future scholarly activities and products.

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Wright C, Scott IU, Callahan C, Papachristou GC, Khalifa Y, Pantanelli SM. Implementation of a model eye (Kitaro) based cataract surgery training curriculum. Presented at: ARVO Annual Meeting; May 1-5, 2016; Seattle, WA.

Ethical Approval
The Pennsylvania State University College of Medicine Human Subjects Protection Office approved this study.

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