

Reducing Complication Rates: Strategies for Beginning Cataract Surgeons

Building basic skills and learning advanced techniques.

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Cataract extraction is one of the most elegant and rewarding surgeries in all of medicine, but it is also one of the most difficult to learn. We surgeons work in a very tight space that allows little room for error, and we are always aware that our efforts will affect how patients see the world for the rest of their lives. Although we spend years as residents learning the basics of cataract surgery, we master the techniques only through a lifetime of practice.¹ The pearls presented in this article are intended to reduce the rate of complications encountered by beginning cataract surgeons and to help them to build a foundation for their future careers.

UNDERSTANDING BASIC CONCEPTS

Just as beginning drivers need to complete a class before they get behind the wheel of a car, ophthalmic residents need to learn the basics of cataract surgery before they pick up surgical instruments in the OR. A comprehensive educational curriculum should address everything from selecting patients and calculating the power of IOLs to creating incisions and utilizing phaco fluidics. Of particular importance, surgeons should acquire a thorough understanding of how a phaco machine works and the rationale underlying the choice of fluidic and power settings. Simply copying a senior surgeon's settings is not an ideal way to learn how to perform phacoemulsification.

Several excellent books provide beginning cataract surgeons with a step-by-step approach to learning phacoemulsification. One example is *Achieving Excellence in Cataract Surgery: A Step-By-Step Approach* by D. Michael Colvard, MD (video supplement available at <http://eyetube.net/videos/default.asp?fakiru>).

In addition, surgical videos hosted by Eyetube.net and Youtube.com are valuable means of observing how experienced surgeons transform theory into practice, particularly during challenging cases.

Individual interaction is also important for preparing ophthalmologists to perform cataract surgery. For the past 10 years, Dr. Devgan has tested the knowledge of ophthalmic residents at the UCLA Jules Stein Eye Institute in Los Angeles by asking them a series of questions before he clears them to perform cataract surgery (see *Dr. Devgan's Questions for Assessing Surgeons' Readiness*). The questionnaire encourages beginning surgeons to think about the various aspects of surgery and gives them an incentive to prepare before they enter the OR.

SPENDING TIME IN THE WET LAB

The next step in learning how to perform cataract surgery is transforming basic knowledge into practical skills. We recommend that beginning surgeons spend a considerable amount of time (approximately 2 to 4 hours per week) in the surgical wet lab. Acquiring the skills needed to operate under a microscope and to use small-gauge instrumentation requires practice. We recommend that residents concentrate on closing incisions with 10-0 nylon, improving the dexterity of their nondominant hand, and pivoting or floating within the incisions. We have found that beginning surgeons need to tie hundreds of knots with 10-0 nylon before they achieve sufficient proficiency and finesse to place the suture with the right spacing and depth. They also must learn to create a square knot that has the correct amount of tension to ensure the apposition of the wound's edges without inducing astigmatism.

To develop a consistent surgical technique, residents should use the same phaco machines, viscoelastics, and instruments in the wet lab that they would use in the OR. Trainees should always keep in mind, however, that the young porcine eyes used in wet labs are significantly different from the eyes they will treat in senescent humans. We therefore urge residents to proceed with

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Dr. Devgan's Questions for Assessing Surgeons' Readiness

His residents at the UCLA Jules Stein Eye Institute must be able to answer the following questions before they are allowed to perform cataract surgery.

These are the questions that you will be asked in the operating room. If you are unable to answer these questions, you may not get to operate. (You've been warned, so please be prepared.)

General Questions

1. What is your patient's name?
2. Which eye will you be cutting today?
3. Is your patient ready for surgery? Is his history and physical updated? Is the eye dilated?
4. What type of surgery will you be doing today?
5. If this is your first surgery of this type, have you already typed a sample operative report for me to evaluate? If not, get to it.
6. What is the name of your anesthesiologist? Your scrub nurse? Your circulating nurse?
7. What time will your case start? (If you are not in the OR when I arrive, then I will start the case without you.)
8. What other medical problems does your patient have that may have an impact on your surgery (diabetes, Parkinson's, congestive heart failure, schizophrenia, etc.)?
9. Are there any special circumstances for this surgery (status post pars plana vitrectomy, broken/loose zonules, coexisting glaucoma, severe diabetic maculopathy, small pupil, dense white cataract, etc.)?
10. What is the grading of the cataract in this eye? (NS, CS, PSC, polar, etc.)?
11. What is the retina like in this eye?
12. What is the visual potential of this eye?
13. What is the status of the fellow eye?

Anesthesia

14. What type of anesthesia will you be using (systemic and local)?
15. Which anesthetic agents will you inject and why?
16. What is the duration of action of these anesthetic drugs?
17. What is the difference between retrobulbar and peribulbar? How do you perform each type of injection?

18. What anatomical structures will your needle go through?
19. If you are doing topical anesthesia, will you use intracameral anesthesia too? If so, which agent and why?

Refractive Status/IOL Calculations

20. What is the post-op refractive goal for this eye?
21. Is there significant astigmatism? If so, at which axis?
22. How do you perform a limbal relaxing incision (LRI)? Which nomogram will you be using (for senior residents)?
23. Which IOL (both power and brand) will you be putting in the eye? Why?
24. Given this eye, which formula for calculating the IOL power is best?
25. What are the third-generation formulae? How do they differ?
26. Should you be using a theoretical formula or a regression formula? Why?
27. What does the term *A-constant* mean? Is it a true constant, or can it be modified/personalized?
28. Did you perform the Ks, the axial length, and the calculations yourself? Is there any anisometropia among these numbers? If so, did you expect that?
29. How do you load/fold the IOL? Have you studied the videos supplied by the IOL manufacturers?

Setup of Equipment

30. What are the names of all the instruments? And their functions?
31. How do you properly drape the patient? Tape the head? Prep?
32. How do you set up the microscope?
33. What do all of the buttons on the microscope's foot pedal do?
34. How do you increase the red reflex with the microscope?
35. How do you set up the initial focus for the microscope?
36. How do you set up the wrist rest (if you will use one)?

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37. How do you set up your stool and the table height for your comfort?
38. How do you set up the phaco machine? Can you do it by yourself?
39. How do you program the phaco machine with your own settings?
40. What settings do you want to use on the phaco machine for this surgery? (This is a *critical* question that I will likely ask for each and every case.)
41. What is the significance of bottle height? What are the units?
42. What is the significance of vacuum? What are the units?
43. What is the significance of aspiration? What are the units?
44. What is the significance of phaco power? What are the units?
59. When the capsulorhexis starts to radialize, what should you do next?
60. If the capsulorhexis radializes out to the zonules, what should you do next?
61. How do you perform hydrodissection?
62. What size cannula, syringe, and volume of balanced salt solution will you use?
63. Where do you place the cannula to perform hydrodissection?
64. What is hydrodelineation versus hydrodissection? How is it performed and why?
65. How much pressure should you use on the syringe during hydrodissection?

Surgical Techniques

45. What technique of surgery will you use today?
46. How specifically do you plan on making your incision?
47. How large will your incision be (both width and length)?
48. How will your incision affect the astigmatism?
49. What dimensions of the incision are needed in order for it to be self-sealing?
50. Which viscoelastic will you use? Why?
51. What is a dispersive versus a cohesive viscoelastic, and when do you use each?
52. How do you effectively perform a viscoelastic–aqueous exchange in the anterior chamber?
53. What size do you want to make your capsulorhexis?
54. How will you start the capsulorhexis, and which direction will you go?
55. What is shearing versus tearing of the anterior capsule?
56. What are the force vectors needed to tear a continuous round capsulorhexis?
57. How do you pivot in the incision so as not to deflate the anterior chamber?
58. What happens to the capsulorhexis when the anterior chamber flattens?

Nucleus Removal

66. What technique of nucleus removal will you use?
67. What technique of nucleus removal is safest to use with loose zonules?
68. How do you perform bowling of the nucleus?
69. How do you perform divide-and-conquer?
70. How do you perform stop-and-chop (for senior residents)?
71. How do you perform vertical chopping (for senior residents)?
72. How do you perform horizontal chopping (for senior residents)?
73. How do you perform phaco flip (for senior residents)?
74. How do you perform pre-chop (for senior residents)?
75. What is the diameter of the cataractous lens?
76. What is the depth of the cataractous lens at the center versus the periphery?
77. How do you make the grooves in divide-and-conquer? How deep? How wide? How long?
78. How do you crack the nucleus into two halves in divide-and-conquer? Where do you position your instruments?
79. What phaco machine settings will you use for each step of nucleus removal?

Fluidics/Phaco Power

80. What type of vacuum pump does your phaco machine have?
81. What are the advantages/disadvantages of this type of pump?
82. What is "surge"?
83. How do you minimize or prevent surge?
84. When are you most likely to encounter surge?
85. How thick is the lens capsule (anterior vs posterior)?
86. How do you minimize phaco energy? Why do you need to minimize it?
87. What is phaco pulse mode versus phaco burst mode?
88. How do you build up vacuum with the peristaltic phaco machine?
89. What is the most important step needed in order to build up the peristaltic vacuum? (Hint: it's not setting the vacuum to 400 and flooring the pedal.)
90. What is the diameter of the phaco tip? What are the various phaco tips available, and what are the advantages of each?
91. How does the diameter of the phaco needle affect the fluidics?
92. What is the effect of the tiny extra holes on the side of the phaco needle?
93. How much metal should show through the plastic/silicone sleeve? Why?
94. What settings on the phaco machine are needed to engage a quadrant or nuclear piece and bring it upwards out of the capsular bag?
95. How do you bring the quadrant upwards?
96. How can you modulate the ultrasound power with the foot pedal?

I&A/IOL insertion

97. How do you perform I&A (irrigation and aspiration)?
98. How do you perform I&A if you have an irregular or radialized capsulorhexis so as to not extend the tear?
99. How do you grab "sheets" versus "strips" of cortex?

100. How do you remove the subincisional cortex?
101. When do you use "cap vac"? What are the settings?
102. How do you fill up the capsular bag with viscoelastic?
103. What wound size do you need to place your IOL?
104. Is it better to stretch the wound, tear it, or slightly enlarge it?
105. How do you inject/place the IOL into the capsular bag?
106. How do you place the trailing haptic in the capsular bag?
107. How do you rotate the IOL?
108. How do you ensure that both haptics are within the capsular bag?
109. Which lens is suitable for sulcus placement? Which is not?
110. What are the advantages/disadvantages of the various types of IOLs (silicone three-piece, silicone plate, acrylic one-piece, acrylic three-piece, PMMA, etc.)?
111. What is the importance of the edge design of the IOL?
112. How do you remove the viscoelastic at the end of the case?
113. What happens when the viscoelastic is left in the eye? How do you manage this postoperatively?
114. Can you intentionally leave viscoelastic in the eye? When would you want to do this, and which brand is best in this case?

Closing the Incision

115. How do you seal your incisions? How can you verify this on the table?
116. How do you perform hydration of the corneal incision? How much?
117. Will you suture your wound? Which suture and needle will you use?
118. Have you practiced suturing? Can you throw a square knot? (If you have not practiced suturing in the wet lab, please be honest as it will become painfully obvious to both of us if your skills are lacking.)
119. How do you pass the suture? How deep in the tissue? How far from the wound edge?
120. Do you know how to load your own needle? Do you

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have the respect to return the needle to the scrub nurse in the needle holder while saying, "needle back?"

121. How do you close the conjunctiva (if applicable)?

Drugs/Pharmaceuticals

122. What eye medications will you give your patient pre-operatively? Why?

123. Will you use anesthetics, antibiotics, dilating drugs NSAIDs, etc.?

124. Will you use injectable medications? If so, which ones? What concentrations? Where will you inject them?

125. How do you medicate/patch the eye at the end of the case?

126. Will you be using any other drugs during the case? Which ones and why?

127. How specifically do you use trypan blue dye?

128. Which medications are suitable for intracameral use?

129. What is Miochol versus miostat? When do you use them?

130. If the capsule is ruptured versus intact, how do you administer the Miochol?

Complications

131. What factors could cause the anterior chamber to collapse or suddenly shallow?

132. What are the first signs of a broken posterior capsule?

133. When you notice a break in the posterior capsule what are the first steps that you should take right away?

134. How do you minimize vitreous prolapse in these cases?

135. How do you check the wound for vitreous? If you find vitreous at the wound, what do you need to do?

136. How do you prevent further loss of potential capsular support?

137. How do you prevent nuclear pieces from falling into the vitreous?

138. Once a nuclear piece becomes engulfed in vitreous, what is the next step?

139. How do you set up the anterior vitrector? What are the two modes? When would you use each of them?

140. How do you split the vitrector into a bimanual system? When and why would you do this?

141. What settings will you use for the anterior vitrectomy? Why?

142. How do you perform a thorough cleanup of the vitreous?

143. If you will be placing an ACIOL, how do you intend to perform the peripheral iridotomy?

144. How do you perform a peripheral iridotomy with scissors versus the vitrector?

145. How do you insert the ACIOL? How do you determine which size ACIOL to use for your patient? Which sizes do we have available in the OR?

146. How large does your incision need to be for the ACIOL to fit?

147. What is a lens glide? Do you need one?

148. How do you convert from a phacoemulsification to an extracapsular cataract extraction surgery? When would you do this? When is it too late?

And Finally

149. Do you think that any of these questions are unreasonable?

150. If it were your mother's/father's surgery, would you want the surgeon to be able to answer the above questions?

No one is born knowing how to perform ophthalmic surgery. You need to spend a considerable amount of time and effort preparing BEFORE the surgery. There are excellent books and videos, in addition to your extensive knowledge from assisting surgery during your first year of residency.

At any point before or during the case, if you are unprepared for the surgery, the case will be performed by the attending surgeon for the safety of the patient's health and vision.

These are my rules/suggestions, and other attending doctors' rules may differ. E-mail me if you have any questions or concerns.

Note: Miochol-E, Novartis Ophthalmics, Duluth, GA.

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caution in the OR, even after they have become proficient in the wet lab.

USING SURGICAL SIMULATORS

Beginning surgeons can now supplement their experience in the wet lab with devices that simulate the conditions of cataract surgery. Recent evidence suggests that working with a surgical simulator can help surgeons acquire basic skills and improve their ability to execute the different maneuvers used during cataract extraction.²⁻⁴ Educators are still determining the utility of surgical simulators in ophthalmic training, but further study may show that this exciting new technology is an important adjunctive tool for teaching young surgeons how to perform cataract surgery.

SEEKING INTRAOPERATIVE SUPERVISION

Once beginning surgeons are ready to enter the OR, they should choose an appropriate mentor to attend at least their first 100 procedures (Figure 1). This practice continues for the entire 3 years of residents' training in our respective programs. Because every step of cataract surgery depends on the previous ones, it often makes sense for residents to perform the last part of their mentors' surgeries. A poor incision can cause leakage and a radialized capsulorhexis, which can lead to a broken posterior capsule, vitreous loss, and a poor visual outcome. To avoid setting off this cascade of complications, beginning surgeons can start their practical education by closing the incision at the end of the case. Thereafter, they can work their way back through inserting the IOL, aspirating viscoelastic, and the incision's closure. Residents who are ready to perform an entire case by themselves should choose an appropriate patient and reserve enough time in the OR for an unhurried case. Most beginning surgeons find it easiest to begin with phaco techniques such as divide-and-conquer followed by stop-and-chop and finally phaco chop. They should also record and review all of their cases to learn from their mistakes.

We suggest that beginning surgeons watch recordings of every case they perform in real time and critique themselves. This exercise will allow them to identify the best parts of the surgery and to note areas where they need to improve. Since the goal of surgery is to improve patients' vision, postoperative monitoring is as important as the actual procedure. In addition, tracking patients' outcomes allows surgeons-in-training to hone their lens calculations, measure the incision's effect on astigmatism, and examine the level of trauma induced by the surgery.

CONCLUSION

Our advice to beginning surgeons is to stay focused and to be prepared to spend years sharpening their



Figure 1. Close supervision by an experienced surgeon during residents' first 100 cases can help them learn the subtleties of surgery and minimize the risk to patients.

cataract surgical skills. In our experience, performing 100 to 200 cataract surgeries during residency is a good start, but ophthalmic surgeons truly become competent only after they complete an additional 500 to 1,000 cases. Surgical skill, judgment, and confidence should then consistently improve year after year over the course of a long career. ■

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