What is the best way to practice a continuous curvilinear capsulorhexis?

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The capsulorhexis has a reputation for being the most difficult part of phacoemulsification surgery. To make things worse, if the first capsulorhexis is performed on a patient in the operating room, anxiety may prevent the learning surgeon from having a successful outcome. The key to mitigating anxiety is to prepare and practice prior to arriving in the OR. My residents often ask me how to prepare and practice. Here are a few of the teaching points that I give them.

Preparation
Think of the capsulorhexis as a series of repeating steps. Understand each step and what is required to achieve success. For me, those steps are: puncture, scratch, initial tear/flap creation, segmental tearing, and re-grasp. The importance in preparation comes with thinking of each of these as a distinct step, requiring deliberate thought. Often I find that a learning surgeon will hurry through the puncture and scratch steps in order to get to the tearing steps. Unfortunately, if the puncture and scratch are done poorly, the rest of the capsulorhexis becomes more difficult. If on the other hand, the learner thinks of each portion as its own step and practices with that mentality, there is likely to be increased success with each portion and in the capsulorhexis as a whole.

Practice
There are many ways to practice capsulorhexis prior to arrival in the OR. I often recommend a staged progression from non-eye models to animal or cadaver eyes. Though it may seem a bit unusual, my favorite non-eye model is a lightly poached tomato. It works well, as the skin is thin relative to the fruit, and the poaching process creates steam between the fruit and the skin, thus loosening it enough to allow the skin to be torn. Also, the curvature of the tomato can approximate the anterior surface of the lens. To poach, dip a firm but ripe tomato into boiling water, making sure the tomato is fully immersed. After about 10 seconds, remove the tomato and put it in a bowl of cold water to stop the cooking process. When cool, draw an 8-millimeter circle on the tomato (to simulate a dilated pupil) and place two small push pins 3-4 millimeters apart to simulate a corneal tunnel. Practice the capsulorhexis either under the microscope (at work) or with loupes (at home). The advantage of the tomato is that it is readily available, and the vector of force involved in tearing is very similar to that needed in the human eye. The disadvantage is that the tomato skin is thick and requires more course manipulation than with the human. Once the tomato has been mastered (this doesn’t take long), move on to the animal eye that has been microwaved for about 8-10 seconds (to denature and coagulate the lens proteins a bit).

Animal eyes have their advantages and disadvantages. The main advantage is that a real eye will teach the learner to work within the space allotted and to pivot the instruments within the wound. The main disadvantage is that the vector forces required to make a capsulorhexis in the highly elastic animal lens capsule are not the same as the forces required in the human. Cadaver eyes, while better in terms of the lens capsule elasticity, often have very cloudy corneas and are difficult and expensive to obtain.

Though neither the tomato nor animal eye is ideal as a model for capsulorhexis, but the use of both together allows the learner to approximate the steps, force vectors, and space constraints involved in creating an excellent capsulorhexis. Preparation with these models will greatly alleviate the anxiety associated with capsulorhexis and allow greater success intraoperatively.

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As all of us would agree, a flawless curvilinear capsulorhexis is paramount in ensuring an uncomplicated cataract extraction. Unfortunately, it is one of the most difficult aspects of the surgery. One reason for this is the number of variables that exist when performing this part of the procedure, which can include the size of the pupil, globe exposure, red reflex, nature of the capsule texture, and the consistency of the underlying lens (varying from a firm to even liquid state with an intumescent cataract). These variables have historically been difficult to simulate in a practice or laboratory setting. Obtaining competency in perfecting the curvilinear capsulorhexis has been achieved by the use of animal and cadaver eyes, surgical simulators, and to some degree the human patient.

Our teaching methodology...
starts with using a simple sheet of paper and a pair of forceps. This allows us to discuss flap management, where to grasp the flap, and most importantly to review vector forces used at various parts of the capsulorhexis.

We then proceed to the lab, where we practice the curvilinear capsulorhexis on pig and/or synthetic eyes. It is important that the pig eyes are fresh and that the eye chosen for use has a clear cornea. To achieve a more realistic experience when tearing the curvilinear capsulorhexis, we first use a cornea-clearing solution to clear marginal cornea. Second, we use a capsule-staining solution that both stains the capsule and reduces its elasticity. We have also used synthetic eyes purchased from EC Phillips. In our experience, we have found that the pig and synthetic eyes cover the two extremes of capsular texture: The pig eyes have very elastic capsules (much like infant capsules), and the synthetic eyes have more friable capsules (much like you would find in a fragile diabetic or very elderly patient).

There are programs that have utilized surgical simulators. The University of Iowa has purchased a VRmagic simulator (Mannheim, Germany), and the surgical instructors find this of value with helping residents master the mechanics of tearing a curvilinear capsulorhexis. The disadvantage of this solution is the cost of the simulators.

Unfortunately, as much as we prepare the resident for the tearing of a curvilinear capsulorhexis, each patient is unique, and hands-on experience is required. In the OR, we have found the most important aspect is to define a “zone of safety,” outside of which the surgical staff intervenes by returning the rhexis within this zone before turning the case back to the resident. In this way, safety is maintained while providing excellent surgical results.

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In learning continuous tear capsulorhexis, keep three main goals in mind. First, create an opening of adequate size to provide access to the lens during surgery. Second, ensure overlap of the intraocular lens implant all the way around to prevent shifting of the lens and reduce the incidence of posterior capsular opacity. Third, be consistent in size and shape: 5.0 to 5.5 mm, round, and centered within the pupil.

Basic capsulorhexis technique begins with good visualization of the capsule. Early in your practice, select patients who dilate easily in the clinic and who have a good red reflex during clinical examination. Choose moderately dense nuclear sclerotic cataracts to ensure predictable behavior of the capsular tear. Lenses that are too soft or too mature can increase the risk of a radial tear. Despite a large pupil and red reflex, it is useful to use trypan blue for every case until you have refined your technique.

Control of the capsular tear requires a flat anterior surface of the lens during the entire step. Often resident physicians will experience a radial tear in the last quadrant of the capsulorhexis because pressure on the wound allows egress of viscoelastic and rounding of the anterior lens surface. Begin by filling the anterior chamber with adequate dispersive viscoelastic, and reflex as often as needed during the step.

To initiate the capsulorhexis, use a bent needle cystotome to create a radial incision from the center of the lens to the desired radius of the capsulorhexis, then pull down to create a flap. Creating a flap that is too short will result in an opening that is too small. It is important to make a deliberate movement with the cystotome but not press too hard into the cortex of the lens. This will obscure the view of the flap. From here, use capsulorhexis forceps to complete the sub-incisional portion first, as this area is often the most difficult to visualize.

Think of the capsulorhexis as a square rather than a circle. Pull the initial flap down directly toward the wound, then regrasp and turn 90 degrees to the left or right and peel to the desired size, then regrasp and turn 90 degrees again and peel away from the wound, and so on. This concept allows for superior control of the flap and a consistent capsulorhexis size in each case.

References

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