Surgical Pearls for Phacoemulsification and Irrigation/Aspiration

Whether a go-to technique or one used only in difficult cases, there is a plethora of phaco techniques to choose from.

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JORGE L. ALIÓ, MD, PhD

I typically perform cataract surgery through a 1-mm incision. I use the Stellaris Vision Enhancement System (Bausch + Lomb), which incorporates my favored pump for phacoemulsification, and I work through the stages of lens removal with the parameters outlined in Table 1. When an adequate prechop is not achieved (see Performing Seamless Hydrodissection, pg 59), I use the parameters under “Beginning Maneuvers” in Table 1 to eliminate the central hardness of the nucleus. In my bimanual technique, I use a 0.7-mm caliber phaco tip and the Alió Irrigating Stinger, both by MicroSurgical Technology (Figure 1). At the conclusion of the procedure, I use the high power settings to thoroughly aspirate the cortex and the ophthalmic viscosurgical device. The ability to reach 360° of the capsular bag when the instruments change hands is essential for a successful outcome.

Table 1. PROFESSOR ALIÓ’S PHACO PARAMETERS

<table>
<thead>
<tr>
<th></th>
<th>Pump (%)</th>
<th>Irrigation (%)</th>
<th>Vacuum (mm Hg)</th>
<th>Power (%)</th>
<th>BH (cm)</th>
<th>DC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning Maneuvers</td>
<td>100</td>
<td>100</td>
<td>90</td>
<td>4</td>
<td>80</td>
<td>90</td>
</tr>
<tr>
<td>Segment Removal</td>
<td>100</td>
<td>100</td>
<td>350–400</td>
<td>2</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>Cortex Removal</td>
<td>100</td>
<td>100</td>
<td>400</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OVD Removal</td>
<td>0</td>
<td>30</td>
<td>75</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

BH = bottle height; DC = duty cycle; OVD = ophthalmic viscosurgical device.

Figure 1. A surgical case from 2003: Professor Alió used 18-gauge MICS instruments through a 1.2-mm incision (A); separation of fluidics and irrigation/aspiration led to more controlled intraocular maneuvers. Newer 20-gauge instruments can be used through a 1-mm incision (B, C). The irrigating stinger (left hand) assists in intraocular maneuvers and the aspiration cannula (right hand), assisted by the stinger, is able to reach 360° of the capsular bag when the instruments change hands.
of cataract removal, I typically have used less than 3% mean phaco power and less than 3 seconds of effective phaco time, even in hard cataracts.

I often polish the capsule. My technique for this step is described in Capsular Polishing on page 67.

**ROBERTO BELLUCCI, MD**

I always perform microincision cataract surgery (MICS). In my opinion, MICS is more than just incision reduction, it is a better and safer way to do cataract surgery. The key points of my technique are as follows.

**Dual-linear footpedal control of ultrasound and fluidics.** This allows ultrasound activation at any level of aspiration or vacuum and precise control of both. High ultrasound and low fluidics conditions are especially useful with hard and difficult cataracts.

**Micropulse ultrasound regulation.** This improves efficiency and decreases heat generation. I use 4 msec on and 8 msec off; with this setting, I reduce the risk for incision burn by sevenfold.

**Maintenance of some incision leakage during the procedure.** This acts as a fluidics buffer. When employed with low aspiration, it also averts intraocular pressure (IOP) rise and anterior chamber deepening; with high aspiration, reduction of leakage takes place before the anterior chamber shallows.

**BJÖRN JOHANSSON, MD, PhD**

I perform coaxial MICS, and I highly recommend equipment with dual-linear footpedal control. This allows immediate and independent adjustment of vacuum, aspiration, and phaco power levels.

If one is transitioning to dual-linear from a common three-step vertical footpedal control technique, there will be a learning curve. For me, it took about 50 procedures until my operation times returned to normal. Even so, after only 10 to 20 procedures I was scheduling the more complicated cases (eg, hard cataracts, loose zonules, small pupils) with the dual-linear equipment because of the improved control.

With dual-linear footpedal control, there is no longer a great need for various phaco modes. I simply adjust my footwork according to the stage of phacoemulsification; I change the mode or settings on the screen seldomly. It is a bit like driving a car—you use the same motor and transmission for parking as you do for highway driving, only you adjust your footwork.

For many years, I used a divide-and-conquer four-trench technique. A couple of attempts to change to a direct chop technique were not entirely successful, but, after a period with the stop-and-chop technique, I finally got on good terms with direct chop. This technique allows me to handle complicated cases, including eyes with loose zonules and/or small pupils, with better control and safety than I would be able to achieve with the divide-and-conquer technique. Still, I have gained great experience with divide-and-conquer, as this technique gives me excellent knowledge of the three-dimensional anatomy of the lens.

**Adjustments.** In difficult cases, including eyes with extremely hard, dark brown to black cataracts or small pupils, I make a few adjustments to my technique.

**Hard, dark brown to black cataracts.** The maximum ultrasound level is increased from 20% to 40%, and, instead of a chopper with a blunt tip, I use one with a sharp tip. The sharper instrument makes it easier to travel deep into the hard nucleus to perform the chopping maneuver.

**Small pupils.** As Brian C. Little, MA, FRCS, FRCOphth, once said, “You can handle small pupils in a multitude of ways: You can stretch them, hook them, put a ring in them, or just live with them.”

I see a lot of eyes with pseudoexfoliation, and when pupil diameter goes down to 4 mm, my first step is to widen the pupil with a three-prong dilator; if it does not stay dilated, I place iris hooks. Many surgeons today use the Malyugin Ring (MicroSurgical Technology) with good results; however, I prefer iris hooks because I can advance them to the capsulorrhexis opening, thereby stabilizing the capsule when the zonules are loose—a situation that is not uncommon in the presence of pseudoexfoliation.

Small pupils can be a sign of intraoperative floppy iris syndrome (IFIS). In this case, an iris hook can be placed under the phaco tunnel so that the pupil margin can be retracted under the incision to avoid iris prolapse. With a coaxial MICS technique, due to the good control of anterior chamber fluidics and minimal incision leakage, most IFIS cases can be managed without any measures other than adjusting flow with the dual-linear footpedal control.

When moving from phacoemulsification to irrigation/aspiration of cortex, it is common for the surgeon to relax. However, this is when capsular rupture most often occurs. My advice is to stay focused and in control of the procedure.

With MICS, the chamber is always stable and the capsule inflated, so that it is easy to reach for the subincisional cortex with a coaxial I/A handpiece. This location is where I start irrigation/aspiration. A strand of cortex is caught with the I/A tip and moved sideways a few times,
parallel to the rhexis edge. Many times, a sector of cortex comes loose and, with increased vacuum or aspiration, is easily removed. Usually there are cortex strands around the rhexis margin, so that the surgeon can work his or her way around in a similar fashion, sector by sector. Polishing the posterior capsule is a delicate but important step. For maximal safety, a specific polishing setting with low vacuum and aspiration is recommended.

SIMONETTA MORSELLI, MD

I normally use a dual-linear footpedal system for routine phacoemulsification because I can regulate vacuum and ultrasound separately, allowing me to have better surgical control. Depressing the footpedal produces vacuum only, and turning it in the lateral direction delivers ultrasound at any level of vacuum (Figure 2). This can be especially helpful in complicated cases, as only one program is needed to control the procedure. I can use more fluidics or ultrasound as I see fit, without having to switch to a sub-mode to groove or remove the cataract pieces.

For irrigation/aspiration I use a soft single-use I/A tip. The softness of the tip allows me to safely clean the posterior capsule (Figure 3).

THOMAS F. NEUHANN, MD

I do not have a one-and-only phaco technique. Rather, I have a number of variations that I apply according to the individual situation. With this said, I distinguish among three basic technical approaches, which are adapted to three basic levels of nuclear hardness.

**Three basic approaches.** I have separate approaches for very hard, hard, and medium-hard nuclei.

**Very hard nucleus.** I use a basic chop technique. After excavating the nucleus centrally, without insisting too much, the nucleus is engaged with the phaco tip, a relatively high suction limit (ie, holdability) is selected (about 300 mm Hg), and the nucleus is chopped and separated. This maneuver is repeated a minimum of four and a maximum of six times. The wedges are then emulsified with relatively high holding vacuum and low phaco power, so that the wedge is bonded to the tip until it is totally aspirated.

I use a chopper instrument of my own design (Geuder). It allows direct chopping from anterior to posterior and, thus, under direct visual control. This is as opposed to the original chopping technique, which is performed from peripheral to central and can be difficult to control in all aspects, especially with smaller pupils.

**Hard nucleus.** I usually prefer a classic divide-and-conquer technique, using one separation into halves in most cases.

**Routine nucleus.** If the nucleus is too hard to be aspirated but too soft to be well dissected, I perform phacoaspiration in a spiral manner. The mainstays of this technique are an aspiration level that is high enough and a phaco power low enough to keep the nucleus in occlusion continuously. This technique can be seen at www.vjcrs.com/index.asp?id=186&q=medium.

I always use bimanual irrigation/aspiration; I simply cannot find a good reason not to. It gives unlimited accessibility to every part in the circumference, even under the most unfavorable circumstances, at no more expense than creating a second paracentesis, which will be done in many instances anyway.

My technique for capsular polishing is described in Capsular Polishing on page 67.

TOBIAS H. NEUHANN, MD

I almost always favor the quick-chop technique with four quadrants, as it succeeds in nucleus removal if hydrodissection has been perfectly executed. The technique is largely dependent on the second instrument, namely the chopper. I would recommend the Tobias
Neuhann Chopper (Geuder), which is similar to an angled blade with a blunt tip. It enables any lens, whether soft or hard, to be perfectly cut into two, four, or eight sections without damaging the lens capsule.

For irrigation/aspiration, I use only bimanual single-use Titano Irrigation/Aspiration Instruments (Oertli Instrumente). Because complex sterile preparation is not an issue with these disposable instruments, this system offers the best value for the money, and it is also ideal for performing paracenteses with a diamond knife (see Meticulous Incision Construction, pg 39). Aspiration of lens epithelial cells from the anterior capsule is extremely effective with this ergonomically sophisticated system, yet it is atraumatic. This is an important step: With a capsulorrhexis measuring 4 to 4.5 mm, I wish to avoid not only capsular phimosis but also increased postoperative inflammation.

KHIUN F. TJIA, MD

When teaching the traditional cracking technique to residents, I focus on two major points: (1) Start sculpting before the center of the lens, and (2) position the second cracking instrument so that it can push the center part of the nucleus sideways.

Many beginners make the mistake of sculpting down from the center peripherally, leaving a central hump in the posterior part of the nucleus. This makes cracking difficult. Additionally, when the sideport instrument enters the groove from above, it has no efficient impact on the center part. The instrument should, therefore, enter the groove from the bottom center (eyetube.net/?v=lofor and eyetube.net/?v=nurew). Rotating the phaco tip clockwise (for right-handed surgeons) facilitates easy entry of the cracking instrument into the groove.

I prefer bimanual irrigation/aspiration because it makes cortex removal possible in all eyes, including those with small pupils. I strongly recommend devices with a smooth aspiration hole, such as those made with silicone or polymer material. This makes cortex aspiration and posterior capsule polishing much safer. My technique can be viewed at eyetube.net/?v=esasu.
0.9-mm mini-flared bent Kelman tip and sleeve compatible with a 2.2-mm main incision. The most important determinant for a stable anterior chamber is the balance of in- and outflow, which is governed primarily by bottle height (BH) and aspiration flow rate (AFR). Both parameters must be kept in balance. Increasing the AFR may require a proportional increase in the BH, and vice versa.

Using high BH and AFR can increase the speed and efficiency of surgery; however, it may not allow emulsification in the posterior plane, as there is an increased risk of catching the posterior capsule and of associated adverse events on the cornea and in the anterior segment. Using low parameters may increase the duration of surgery, but it allows more controlled posterior plane emulsification.

We conducted a randomized study to assess the effect of high parameters (BH, 110 cm; AFR, 40 cc/min) versus low parameters (BH, 90 cm; AFR, 25 cc/min) on clinical outcomes after cataract surgery (unpublished data). In patients randomized to high parameters, there was significantly more anterior chamber reaction and increased corneal thickness during the first week and month postoperatively.

Furthermore, we compared IOP levels and fluctuations during phacoemulsification with high and low parameters. In the high parameters group, IOP increased to 80 mm Hg with many fluctuations; the maximum IOP in the low parameters group increased to only 60 mm Hg with minimum fluctuations (Figure 4). Because this can have severe implications in eyes with ocular circulation comorbidities, we prefer to use the principles of slow-motion and step-down techniques, which employ low parameters throughout surgery.

In an eye with a small pupil, shallow anterior chamber, and IFIS, we prefer to use even lower parameters than we would otherwise. This allows controlled intraoperative performance with minimal anterior chamber turbulence. Using a high bottle height in such cases can lead to excessive fluid inflow, which, when directed below the iris, can cause iris billowing and worsen the cascade of complications.

Torsional ultrasound energy (Ozil; Alcon) is our preferred mode of ultrasound energy. For optimum performance of fragment removal, it is important to avoid complete coring of the phaco tip into the nuclear material and to perform surface shearing of lens material. Using interrupted energy (ie, burst or pulse mode) also helps to reduce unnecessary waste of ultrasound energy throughout the procedure.

We prefer to use bimanual irrigation/aspiration for cortex removal; there is easy access to the residual cortex in all quadrants—and there is nothing like subincisinal cortex. Furthermore, as less maneuvering is required, there is no risk of wound distortion or enlargement.

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