

Cataract Surgery Techniques and Innovations

a report by

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Cataract surgery and phacoemulsification techniques have advanced dramatically over the past 10 years. The concept was first introduced by Dr Charles Kelman,¹ heralding the era of modern cataract extraction and paving the way for small incision surgery. Since then, the trend has been toward smaller incision surgery with less induced astigmatism and less traumatic surgery by using ultrasound assisted phacoaspiration instead of vacuum-assisted phacoemulsification. Recent refinements in power modulations have led most surgeons to use techniques that utilize less phacoemulsification energy and thus reduce thermal energy delivery and injury to the eye.^{2,3} This is carried out either by using mechanical forces to disassemble the nucleus or by using higher vacuum levels to aspirate the nucleus or a combination of both. This paper will describe QuickChop phacoemulsification and bimanual microincisional phacoemulsification techniques, which attempt to simplify each stage of the operation, in order to minimize trauma and achieve the optimal outcome.

QuickChop Phacoemulsification Technique

There are many challenging scenarios that cataract surgeons can encounter when performing phacoemulsification surgery. It is important when dealing with any challenging case to be aware of what one is confronting and to have a game plan to facilitate the surgery. Although most surgeons are most comfortable when using a certain technique, it is essential to be flexible and able to vary technique depending on the situation. Pre-operative assessment of the patient both in determining the type of cataract and the morphology of the eye—axial length, zonular instability, post-traumatic, post-surgical—will help in determining how to proceed with the case.

Pre-operative treatment with topical medications can make the intra-operative and post-operative course more predictable. Topical non-steroidal anti-inflammatory (NSAID) agents are helpful in maintenance of intra-operative mydriasis. They also assist in control of post-operative inflammation,

thereby reducing the need for long-term topical steroid usage. NSAIDs have also been proven to help in the prevention of chronic macular edema.⁴ Pre-operative NSAIDs can be given four times a day, starting the day prior to surgery and to continuing immediately after surgery for a month. The use of pre-operative antibiotics, such as the fluoroquinolones, may also help prevent post-operative infections. Fluoroquinolones can begin a day prior to surgery and be continued after surgery along with a steroid drop that begins after surgery, for two weeks.

Surgery is performed using a clear cornea temporal approach. Topical tetracaine is usually adequate for satisfactory anesthesia. However, if iris manipulation is to occur or if the patient is particularly sensitive, then intracameral non-preserved 1% lidocaine may be injected at the start of the case. A side port incision is made on the left with a 15-degree metal blade. The anterior chamber is then filled with a cohesive viscoelastic such as Amvisc Plus (Bausch and Lomb), which allows maximum chamber and iris stability. However, if there is any indication of corneal compromise, Arshinoff's soft shell technique⁵ is preferred, utilizing a more dispersive viscoelastic such as Viscoat (Alcon) as an adjunct to help in coating the corneal endothelium. With Arshinoff's technique, the dispersive viscoelastic is injected initially to fill about half of the anterior chamber, followed by a cohesive viscoelastic that will force the dispersive up against the cornea. If the eye has a shallow anterior chamber or the pupil is small then one of the newer viscoadaptive substances (Healon 5, iVisc Phaco) can be used to assist in deepening the anterior chamber and stretching the pupil due to its ability to better retain a given space. Then a clear corneal temporal incision is made.

Continuous curvilinear capsulorhexis is performed using Utrata capsulorhexis forceps while holding on to the eye at the side port using 0.12 forceps. This is followed by Fine's technique of cortical cleavage hydrodissection⁷ by inserting a Gimbel cannula beneath the edge of the capsule, lifting up initially and then injecting a small bolus of fluid. Lens rotation within the capsular bag is always assessed before commencing phacoemulsification.

For phacoemulsification, it is important to understand the fluidics associated with whichever machine one is using, to better predict the progression of the surgery. Phacoemulsification quick-chop technique was first introduced by Nagahara. A 30 degree bevel phaco needle is introduced into the eye with the bevel down. It is important to retract the silicone sleeve exposing more of the metal needle, in order to maximize a deeper purchase when using a chop technique. A Koch chopper (Storz) is then placed just proximal to the center of the nucleus (see *Figure 1*). The phaco tip then deeply impales the central nucleus in a bevel down position utilizing hyperpulse or microburst power modulations. The nucleus is initially impaled using a lower flow and vacuum setting, which is then increased once purchase or hold is achieved. In the same instant, the chop instrument is placed just in front or to the side of the buried phaco needle (see *Figure 1*). The distal tip of the chopper is pressed down and to the left, as the phaco needle is moved slightly up and to the right (see *Figure 2*). The chopper should be directed to the side of the phaco needle so that occlusion of the phaco tip on the nuclear fragment is not broken. The chopper and phaco tip are then spread further apart laterally to allow the cleavage plane to propagate entirely from one end of the nucleus to the other and through the posterior plate, which is a thicker piece of epinucleus that can be found in denser cataracts. It is important to verify that the chop is completely propagated before proceeding to the next step.

The nucleus is then rotated, reimpaled with the bevel turned on its side—to allow for parallel alignment and maximum purchase on the nucleus—and the vertical downward chop repeated. The segment of nucleus that has been chopped is then brought out to the supracapsular space with the phaco needle and high vacuum and flow rates are used, aided by short bursts of phaco power to help in followability of the nuclear material into the phaco tip. This allows the phaco tip to stay central and in a safe zone. It is best to keep the chop instrument or manipulator turned on its side behind the piece of nuclear material being evacuated to protect the posterior capsule. Also, if the initial segment that was chopped is too large then it should be chopped into a smaller segment that is easier to manipulate. As the last bit of segment is being emulsified, the vacuum or flow should be lowered as this allows more control of anterior chamber stability and less effects of surge. This is repeated until the nucleus is completely removed.

After evacuation of the nucleus, the phaco tip under low vacuum or flow settings engages the epinuclear rim. As the epinuclear rim starts to pull away from the capsular bag, the second instrument, either a chopper or

Figure 1: Initial Position for Vertical QuickChop

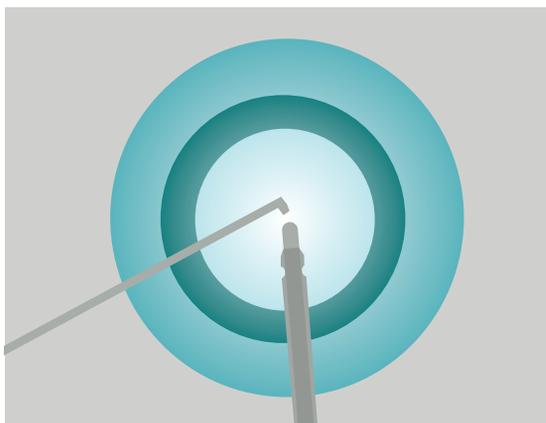
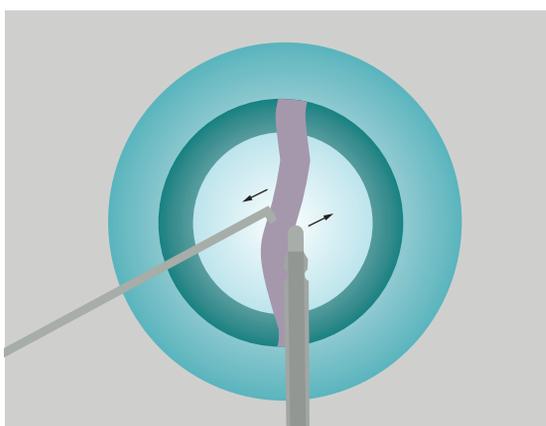


Figure 2: Propagation of Chop through Endonucleus. Arrows Denote Movement of Instruments



manipulator, is used to push on the epinuclear floor in a gentle upward rolling motion to assist in the followability and evacuation of the epinucleus.

If there is remaining cortex, it is removed using a 45° irrigation/aspiration hand piece, using vacuum levels up to 500mm/Hg. If sub-incisional cortex is difficult to remove, it is useful to split irrigation and aspiration and use a bi-manual technique for removal.

The capsular bag is then filled with viscoelastic and an intraocular lens is inserted into the capsular bag. Once the viscoelastic is removed from the eye, the wound is hydrated and checked for integrity and leakage.

Bimanual Microincisional Cataract Surgery

Advances in technology have brought about new and exciting advances in cataract surgery techniques. It is a rapidly evolving field in medicine and surgeons are always looking to perform the least traumatic surgery possible, by decreasing thermal energy delivery to the

eye, decreasing wound size and decreasing trauma to the cornea thereby promoting more rapid visual recovery. Refinements of power modulations² and control have allowed reductions to the total amount of ultrasonic energy delivered into the eye and thus less risk of injury to the corneal endothelium and the incision. Hyperpulse and microburst modes are some of these newer refinements. Owing to the shorter bursts of phaco power followed by quiet intervals in which, essentially, the vacuum is removing the fragment, these modalities definitely promote ultrasound assisted phacoaspiration by minimizing the ultrasound energy into the eye and maximizing the hold on the nuclear fragment.^{8,9}

The most recent movement in phacoemulsification has been toward small-incision bimanual sleeveless (bare needle) phacoemulsification, anticipating the advent of a smaller foldable, rollable or even injectable intraocular lens. Even though currently there is not a lens available that will fit through a small stab incision, there are four significant advantages of lens extraction through two smaller incisions.^{2,7}

- Irrigation through the side-port instrument can assist in moving lens material toward the phacoemulsification needle tip because when irrigation is delivered through the sleeve, the irrigation fluid may potentially create a current which may push the lens material away from the needle tip. Separating the irrigation

from the aspiration should theoretically direct loose pieces toward the aspiration port.

- Nuclear material can be approached from two different incision sites if needed.
- Subincisional cortex can be more easily removed.
- Small stab incisions allow for a tightly closed and stable anterior chamber.

Agarwal¹⁰ has reported his success using the Phacovit method of bimanual lens extraction through a 0.9mm incision with a sleeveless phacoemulsification needle. Recent research¹¹⁻¹³ on the Millennium Microsurgical System (Bausch & Lomb) and the Sovereign (AMO) has shown that microphaco using a bare phaco needle through a relatively small incision could be conducted using specific parameters on each machine.

Conclusion

Being able to refine power and fluidic modulations and use more mechanical forces with techniques such as QuickChop to remove cataracts has allowed for less energy delivery into the eye and ultimately better outcomes for the patients.

Cataract surgery has definitely become an exciting and innovative field. The creativity of cataract surgeons will undoubtedly lead to even more refinements in technique and technology in what is now one of the most successful operations in all of medicine. ■

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