Biaxial Microincision Phacoemulsification for Difficult and Challenging Cases

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Core Message

- The advantages of biaxial microincision phacoemulsification have been elaborated in a variety of papers in the literature [2–10]. This technique is believed to have distinct fluidic advantages.
- The separation of inflow from aspiration and phaco allows the fluid to come in through one side of the eye and exit through the opposite side.
- Competing currents are absent at the phaco tip.
- It is easier to achieve a nearly closed system.
- Cases that are extremely challenging or even impossible with coaxial phaco are easily accomplished by biaxial microincision phaco.

7.1 High Myopia

In highly myopic eyes, a situation in which the anterior chamber is maintained in a completely stable configuration without trampolining the vitreous face can be achieved by keeping the irrigating handpiece in the eye throughout the case. Chopping takes place in the usual manner. With the completion of chopping and mobilization of the segments and the epinucleus, the irrigating chopper should be kept in the eye and the phaco needle should be removed. Then after removing the residual cortex, the viscoelastic Viscoat® (Alcon Laboratories, Fort Worth, Texas) should be infused for the implantation of the intraocular lens (IOL), without shallowing the anterior chamber. It is believed that eventually there may be a documented decreased incidence of retinal detachment in high myopia as a result of nontrampolining of the vitreous face during phaco, and the implantation of IOLs that fill the capsule, such as dual-optic IOLs or IOLs that arch posteriorly, as does the Crystalens.

7.2 Posterior Polar Cataract (Fig. 7.1)

In cases of posterior polar cataracts, 35% have defective posterior capsules [11, 12] and almost all have weakened capsules, and so, it is very important not to overpressurize the eye and perhaps, force nuclear material through the defective posterior capsule. By the same token, it is important not to shallow the chamber and have the nucleus come forward, and possibly open the defect in the posterior capsule. These cases are advantageously done with biaxial microincision phacoemulsification, because of the anterior chamber stability [13].

Hydrodelineation is done without hyrodisection, and then the endonucleus is carefully chopped into...
pie-shaped segments and evacuated from the eye. Once the endonucleus is removed, the epinucleus is viscodissected from its position against the cortex without removing the irrigating chopper. In this way, there is a layer of cortex and Viscoflo® under the epinucleus at the time of evacuation, so that, even if the the capsule opens, it is less likely for the lens material to spill into the vitreous. Once the epinucleus is gone, we leave the irrigation system in the eye, remove the phaco needle, and add Viscoflo®. We viscodissect the cortex up into the plain of the capsulorhexis, in the same way and remove it while having a thick layer of viscoelastic on top of the fragile posterior capsule. We never polish the posterior segment of the capsule prior to the IOL implantation, but would rely on YAG laser if there were visually significant opacities within the visual axis, post-operatively

with irrigation under the nuclear material, there is a system in which there is fluid circulating in a circuitous pattern on top of the Viscoflo® and the chips that are liberated from the mass of the nucleus tend to circulate entirely within the anterior segment and do not get deposited into the vitreous. After the removal of the cataract, a partial anterior vitrectomy is done and a foldable IOL is implanted through a 2.5-mm incision, with the haptics under the iris and the optic on top. This allows the haptics to indent the undersurface of the iris and be easily identifiable. The haptics are then sutured to the iris and the optic is nudged beneath the pupillary margin. There had been a great success with this technique.

7.4 Mature Cataract with Zonular Dialysis (Fig. 7.3)

In cases in which there is a dialysis of the zonular apparatus during phacoemulsification, as in a case of unrecognized pseudoxfoliation in the presence of a dense cataract, the nucleus is held with the phaco tip and the irrigating chopper is removed. The Viscoflo® is then placed under the lens, and then is put the irrigating handpiece without a chopper, under the lens and the lens is again phacoed entirely within the plain of the capsulorhexis. Nuclear material can be mobilized from the posterior chamber with an unsleeved phaco tip because there is no irrigation going along with the phaco tip, as in coaxial phaco, which would force the nuclear material into the vitreous cavity. This is not

7.3 Posterior Subluxed Cataracts (Fig. 7.2)

For posterior subluxed cataracts, which are hinged to a small zone of attached zonules, a pars plana incision is made and the lens is prolapsed in its capsule, up into the anterior chamber, and the Viscoflo® is added under the lens. The lens is then phacoed with biaxial microincision instrumentation using an irrigating cannula in the left hand and a phaco needle in the right, keeping the irrigation on top of the Viscoflo® but below the cataract. Disassembling these cataracts is not attempted, but they are phacoed from the outside, in. In general,
possible with a coaxial phaco tip. In these cases, chips that circulate in the fluid above the Viscoat® which is sitting on top of the vitreous are seen, but chips that move posteriorly are not seen. Once this has been completed, a biaxial microincision partial anterior vitrectomy, or a pars plana 25 gauge transcleral microincision vitrectomy is done, and an anterior chamber lens is implanted or a posterior chamber lens is implanted, and sutured to the iris.

### 7.5 Punctured Posterior Capsule
(Fig. 7.4)

In the case where the capsule is punctured during the course of phacoemulsification, irrigation can be continued high in the anterior chamber and the endolenticular space can be reentered with the unsheathed phaco tip, and the phacoemulsification is completed without further enlarging the puncture in the posterior capsule. The cortex is removed without removing the irrigator, and more Viscoat® is instilled. The lens is then implanted into the capsular bag or into the ciliary sulcus. Residual Viscoat® is removed with a vitrector to avoid the possibility of bringing vitreous to the wound. This procedure would be impossible with a coaxial phaco tip because a continuously changing fluid wave from the phaco sleeve would enlarge, or extend, the capsular tear out to the periphery of the capsule, with the loss of lens material into the vitreous.

### 7.6 Posterior Capsule Rupture
(Figs. 7.5 and 7.6)

In an extensive posterior capsule rupture, the entire endonucleus is brought up into the anterior chamber by holding it with the phaco tip. Very little fluid leaks out of the incision while removing the irrigating chopper. Viscoat® is placed under the nucleus, and the irrigator is placed under the lens. Phacoemulsification is continued in the plain of the capsulorhexis or in the anterior chamber, with the irrigator beneath the nucleus and it is carouselled, or phacoed, from outside in.
Cortical clean-up is continued in a similar manner, or a partial anterior vitrectomy is performed first, either through the pars plana, or through side-port incisions biaxially. Once all the residual cortex has been removed, a posterior chamber lens is implanted into the ciliary sulcus.

7.7 Pseudoexfoliation (Fig. 7.7)

In postfiltration surgery, in the presence of pseudoexfoliation, an endocapsular tension ring that can be introduced through a side-port with an injector is used, following gentle cortical cleaving hydrodissection. The injector doesn’t enter the incision and is just held against the incision, and the forces on the capsule, as the endocapsular tension ring is being inserted, are contained by the use of a Lester hook in the opposite hand (Fig. 7.7). Biaxial microincision horizontal chopping of the lens is then performed so as not to add any downward force on the lens which might stress the residual zonules. Cortical clean-up is facilitated in the presence of an endocapsular tension ring, by performing gentle cortical cleaving hydrodissection prior to the implantation of the ring. The lens is then implanted into the capsular bag through an incision between the two side-port incisions, which is a routine method for IOL implantation in the presence of two 1.1 mm phacoemulsification incisions.

7.8 Rock-Hard Nuclei (Fig. 7.8)

Rock-hard nuclei can be phacoemulsified with the same facility and ease with which biaxial microincision phacoemulsification of softer nuclei is carried out, and usually ends up with an average phaco power under 10% and effective phaco time under 10 seconds, in spite of the density of these nuclei. This is an enormous advantage in terms of corneal endothelial protection because of the great stability of the anterior chamber. A 30° phacoemulsification tip is used with the bevel down. This allows the achievement of vacuum once the tip touches the endonucleus. A bevel-up tip must go deeply into the nucleus before occlusion.
and vacuum are achieved. With a bevel-down tip, all of the energy is directed toward the nucleus and none toward the corneal endothelium or trabecular meshwork. Finally, pie-shaped segments can be mobilized from the level of the capsulorhexis, up, rather than having to go deeply into the endolenticular space to achieve occlusion to mobilize these segments, as with that of a bevel-up configuration.

### 7.9 Switching Hands (Fig. 7.9)

In cases of zonular dialysis, another advantage of biaxial microincision phacoemulsification is that the phaco tip can be used with either hand. After inserting an endocapsular tension ring through one of the microincisions, the lens should be hydroexpressed into the plain of the capsulorhexis and then the phaco tip should be utilized in either the right or left hand, depending on the location of the zonular dialysis. For dialyses that are on the operating surgeon’s right side, the phaco tip should be used in the right hand, drawing material in the anterior chamber toward the area of weakened zonules, rather than away from it, which would stress the intact zonules. For dialyses that are on the left-hand side, the phaco tip should be used in the left hand and the irrigating chopper in the right, to remove the nucleus, thereby closing the zonular dialysis with the activation of flow and vacuum toward the left side.

#### 7.10 Microcornea or Microphthalmos (Fig. 7.10)

For very small eyes, the use of biaxial phacoemulsification is an enormous advantage because the smaller size of the instruments avoids creasing of the cornea, which compromises visualization of intraocular structures. A coaxial tip, which is much larger in size, would indent the cornea while being manipulated and partially obscure the visualization of the intraocular structures. This has turned out to be especially advantageous in cases with a microcornea or a microphthalmic eye, in the presence of an unusually large lens.

#### 7.11 Large Iridodialysis and Zonular Defects (Fig. 7.11)

In cases where there are large iris defects and missing zonules, the area is straddled with the microchopper and the phaco tip and the anterior chamber is fractionated with Healon 5 to keep the vitreous back and proceeded in the usual manner. This has been very efficacious and has not resulted in bringing vitreous out of the posterior segment. This is exemplified in the case of a woman who had 180° of ciliary body and iris, except for the pupillary margin, excised in the management of a choroidal/ciliary body malignant melanoma, resulting additionally in fragile and atrophic sclera and conjunctiva at the tumor site.

![Fig. 7.9 Phacoemulsification tip in the left hand in the presence of zonular dialysis (surgeon’s perspective)](image-url)

![Fig. 7.10 Microinstruments phacoing a large dense nucleus in an eye with micro cornea and iris coloboma)](image-url)
In this case, it was possible to perform biaxial microincision phacoemulsification through two microincisions on each side of the 100° of atrophic sclera and conjunctiva, and missing ciliary body and iris. The advantage here was that with the vitreous face open to the anterior chamber, the material could be drawn toward the area of missing zonules, after sequestering the vitreous in that area with Healon 5 (Advanced Medical Optics, Santa Ana, California). Phacoemulsification performed through an incision in other locations would bring vitreous to the phaco tip and provide a much more challenging situation. The IOL was implanted nasally over the intact zonules to force the lens to push against the capsular fornix in the area of missing zonules, rather than to pull away from the area of missing zonules, if it had been implanted in the temporal periphery.

7.12 Intraoperative Floppy Iris Syndrome (IFIS) (Figs. 7.12–7.16)

Biaxial microincision phacoemulsification is found to be enormously useful in cases of intraoperative floppy iris syndrome (IFIS). If there is adequate dilation in the presence of a floppy iris, gentle cortical cleaving hydrodelineation and hydrodissection will be performed, and then the lens will be hydroexpressed into the plain of the iris. The endonucleus will then be carouselled in the plain of the capsulorhexis with the irrigating cannula held high in the anterior chamber. Holding the irrigator high in the anterior chamber allows for a tamponading of the iris by the fluid which then disallows floppiness, or billowing, of the iris. After removing the endonucleus in the plain of the capsulorhexis, a fully intact epinuclear shell is seen, which had been sitting on top of the iris, helping to hold it back. This is an extremely advantageous technique for nuclei of less hard densities that can be carouselled and phacoed in the anterior chamber without threatening the corneal endothelium.
For harder cataracts, and in the presence of pupils that will not dilate well, the pupil is dilated with Healon 5, and a rather large capsulorhexis is done followed by an endolenticular chop. The irrigating chopper high is kept in the anterior chamber and with the unsleeved phaco tip, nuclear material is brought up to the chopper held high in the anterior chamber for further disassembly. This allows, once again, a tamponading of the iris and prevention of billowing or floppiness. The phaco needle is kept occluded and in foot position two or three, but with a clearance of occlusion, foot position one is reached in order to minimize evacuation of Healon 5, which is holding the pupil open.

After removing the endonucleus in this way, the epinucleus is removed. Since it is harder to keep the tip occluded with epinuclear trimming and flipping, there tends to be evacuation of Healon 5 and a reduction of the size of the pupil, although because of the irrigator held high in the anterior chamber, it does not billow. Healon 5 is then re-instilled to expand the bag and redilate the pupil prior to cortical clean-up. Then, once again, holding the irrigator high in the anterior chamber, the aspirating microincision handpiece is kept occluded by going circumferentially around the capsulorhexis, with the port facing the capsule fornix, removing the cortical material from only the fornix of the capsule, letting it sit as a cluster in the central portion of the capsule. After all of the cortex has been mobilized from the capsular fornix, the residual cortex is removed from the eye. In this way, Healon 5 is kept in the eye and miosis of the pupil is disallowed until the case is complete.

In some cases, the pupil is intractably small and won’t respond to Healon 5 expansion. In these cases, a pupil expander ring (Morcher Pupil Expander Ring, Type SS, FCI Ophthalmics, Marshfield Hills, MA; or a Malyugin Ring, Catalog #MAL-0001, MicroSurgical Technology, Redmond, WA) is used. These are implanted through a 2.5-mm clear corneal incision to enlarge the pupil (Fig. 7.14), after which biaxial phacoemulsification is performed through the two side-port incisions, and the larger incision remains sealed during the operation because of its self-sealing construction and architecture. The pupil expander rings are advantageous because the pupil can be moved away from the incisions just by pushing on the ring.

With the ring in place (Fig. 7.15), it was found in some cases that it is not possible to adequately perform hydrodissection or hydrodelineation. When it is not possible to perform the hydrosteps because of the tendency of the pupil to extrude, a bevel-down phaco tip is used to bowl out the center of the cataract, and then an inside-out hydrodelineation is done, as described by Abhay Vasavada [14]. The residual endonucleus is then chopped in the usual fashion, and then the epinucleus is removed.

In some cases, subincisional cortical removal may be performed by using a coaxial irrigation handpiece in the 2.5 mm incision to hold the iris back, while going to a distal location through a microincision with a 0.2-mm port aspirator to remove the subincisional cortex (Fig. 7.16). This has been very efficacious.
7.13 Every Small Pupil Must Be Viewed as a Potential IFIS

Every small pupil must be viewed as a potential floppy iris case because multiple drugs and nutraceuticals that have antialpha-1A properties which create an intraoperative floppy iris syndrome, have been identified. Small pupils are not stretched because if they become IFIS cases, the floppiness would get exacerbated by the disruption of the only portion of the iris (the pupil) which retains structural integrity. The only exceptions to that are the pupils that are bound down by inflammatory pupillary membranes, or that have a long history of exposure to miotic drops, and a clear absence of medications that might produce a floppy iris.
**7.14 Iris Bombé (Figs. 7.17–7.20)**

For pupils that are completely bound down by a pupillary membrane, biaxial phacoemulsification is used. It is commenced with a small iridotomy peripherally, close to one of the microincisions (Fig. 7.17). Viscoat® is used to elevate the iris and its cannula to sweep the pupillary membrane from the anterior lens capsule. The pupillary membrane is then stretched in one direction and the iris is stretched just distal to the pupillary membrane in the opposite direction in the same meridian (Fig. 7.18). This results in a lysing of the pupillary membrane for several clock hours from the pupil itself, and allows the surgeon to go back and, using tangential forces with a microincision capsulorhexis forceps, strip the pupillary membrane from the pupil (Figs. 7.19 and 7.20). Following this, Healon 5 allows for maximum dilation of the pupil and the process is proceeded with in the usual manner.

**7.15 Very Shallow Anterior Chambers (Fig. 7.21)**

For very shallow anterior chambers biaxial phacoemulsification is also a great advantage because the instruments are indeed smaller and fit more readily in the eye; however, if the anterior chambers are too shallow (Fig. 7.21), a 25-gauge transcleral pars plana vitrectomy is performed, before proceeding with biaxial phacoemulsification. It is very important to use these microvitrectors in order to use a finger of the nondominant hand to maintain tactile contact with the eye, so that the eye is not over-softened. These vitrectors are capable of, between 1,200 and 1,500 cuts/min. In spite of their small gauge, unless care is taken, the eye could be excessively softened, retroplating the lens and creating new difficulties and challenges.

**7.16 Refractive Lens Exchange (Figs. 7.22–7.25)**

Refractive lens exchange can be done very easily, and safely, with biaxial microincision phacoemulsification. Cortical cleaving hydrodissection is performed instead of hydrodelineation. The lens is then hydroexpressed into the plain of the capsulorhexis, and caroused, without any phacoemulsification energy for soft lenses, usually encountered in refractive lens exchange (Figs. 7.22 and 7.23). An entirely fluidic-based extraction is done and then, because of cortical cleaving hydrodissection, the cortex is evacuated by just tilting the phaco tip back into the posterior chamber where it jumps into the phaco tip as a single piece (Figs. 7.24 and 7.25).
7.17 Refractive Lens Exchange in Post Radial Keratotomy (RK) (Fig. 7.26)

In cases where previous radial keratotomy (RK) has been performed, biaxial microincision clear lens or cataract removal is done by going between two previously placed radials, making it much less likely that the radial incisions are ruptured during the course of the lens extraction. An incision is then made between two microincisions for implantation of the IOL, but in the presence of previous RK, it is made through the posterior limbus for the implantation of the IOL.
7.18 Intraocular Cautery (Fig. 7.27)

It has been found that biaxial microincision instruments allow intraocular cautery by using an irrigating cannula in one of the microincisions and a microincision bipolar cautery in the other. Pinching of the irrigation tubing leads to bleeding, clearly identifying the point source because the eye softens and the bleeding points start to ooze. They are precisely cauterized with the bipolar cautery, and therefore trauma to intraocular structures is minimized by avoiding more cautery than is necessary [15].

7.19 Biaxial Microincision Instruments (Figs. 7.28 and 7.29)

There are a number of other instruments that have been developed for use through 1.1 mm microincisions. Iris reconstruction is very much easier utilizing intraocular forceps that stabilize the iris for suturing. New intraocular needle holders are also usable through a 1.0-mm incision. In this way, very fragile and atrophic irides can be sutured without putting excessive stress on the iris tissue. The knots are tied with a Seipser external tying mechanism [16] and the knots are cut with an intraocular microincision scissors, that is also admissible through a 1.0-mm incision.

For late reopening of capsular bags to recenter IOLs, a capsulorrhesis is enlarged in the late postoperative period by nicking the rhexis with a microincision intraocular scissors, and then tearing a larger opening with a microincision capsulorrhesis forceps. Viscodissection of the lens [17] within the capsular bag, can be accomplished through microincisions which also allow for repositioning of IOLs without the need to make larger incisions to manipulate them intraocularly. There are currently additional microincision instruments under a state of development, including microincision Collibri forceps, microincision iris graspers, and microincision IOL holders and cutters.
**Take Home Pearls**

- Bixial microincision phacoemulsification is believed to be a technique that has a very short learning curve, is highly atraumatic, and is unquestionably the technique of the future. For those who are willing to go through the short learning curve now, it represents the best and the safest technique at present, for the management of certain difficult and challenging cases.

- The separation of infusion from aspiration and ultrasound energy allows the use of incoming fluid wave as a unique instrument to hold back floppy irides.

- The anterior segment can be sequestered from the posterior segment in cases of ruptured capsules and zonular dialyses.

- It is especially useful in situations in which the smaller instrumentation of bixial phacoemulsification are required, such as in high hyperopia, small eyes, and crowded anterior chambers.

- It has unique advantages in high myopia and posterior polar cataracts.

- New instrumentation facilitates:
  - Repositioning decentered lenses in fibrosed capsules
  - Control of bleeding pre-, intra- and postoperatively
  - Intraocular suturing, especially following iris trauma

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**References**


