Hydrodissection of the nucleus in cataract surgery has traditionally been perceived as the injection of fluid into the cortical layer of the lens under the lens capsule to separate the lens nucleus from the cortex and capsule. With increased use of continuous curvilinear capsulorhexis and phacoemulsification in cataract surgery, hydrodissection became a very important step to mobilize the nucleus within the capsule for disassembly and removal. Following nuclear removal, cortical cleanup proceeded as a separate step, using an irrigation and aspiration handpiece.

Fine first described cortical cleaving hydrodissection, which is a hydrodissection technique designed to cleave the cortex from the lens capsule and thus leave the cortex attached to the epinucleus. Cortical cleaving hydrodissection often eliminates the need for cortical cleanup as a separate step in cataract surgery, thereby eliminating the risk of capsular rupture during cortical cleanup.

**Step-by-Step Approach to Hydrodissection**

Step 1. **Lift the Anterior Capsule Slightly With the Cannula.** A small capsulorhexis, 5 to 5.5 mm, optimizes the procedure. The large anterior capsular flap makes this type of hydrodissection easier to perform. The anterior capsular flap is elevated away from the cortical material with a 26-gauge blunt cannula (eg, No. K7-5150, Katena, Denville, NJ) prior to hydrodissection. The cannula maintains the anterior capsule in a tented-up position at the injection site near the lens equator. Irrigation prior to elevation of the anterior capsule should be avoided because it will result in transmission of a fluid wave circumferentially within the cortical layer, hydrating the cortex and creating a path of least resistance that will disallow later cortical cleaving hydrodissection.

Step 2. **Inject Balanced Salt Solution (BSS).** Once the cannula is properly placed and the anterior capsule is elevated, gentle, continuous irrigation results in a fluid wave that passes circumferentially in the zone just under the capsule, cleaving the cortex from the posterior capsule in most locations (Figure 4-1).

Step 3. **Allow the Nucleus to Rise, Then Gently Tap It Down.** When the BSS wave has passed around the posterior aspect of the lens, the entire lens will tend to bulge forward. This is because the
fluid is trapped by the firm equatorial cortical-capsular connections. The procedure creates, in effect, a temporary intraoperative version of capsular block syndrome as seen by enlargement of the diameter of the capsulorrhexis (Figure 4-2). At this point, if fluid injection is continued, a portion of the lens prolapses through the capsulorrhexis. However, if prior to prolapse the capsule is decompressed by depressing the central portion of the lens with the side of the cannula in a way that forces fluid to come around the lens equator from behind, the cortical-capsular connections in the capsular fornix and under the anterior capsular flap are cleaved. The cleavage of cortex from the capsule equatorially and anteriorly allows fluid to exit from the capsular bag via the capsulorrhexis, which constricts to its original size (Figure 4-3), and mobilizes the lens in such a way that it can spin freely within the capsular bag.

Step 4. Repeat Injection of BSS at the Opposite Distal Quadrant. Repeating the hydrodissection and capsular decompression at the opposite distal quadrant may be helpful. Adequate hydrodissection at this point is demonstrable by the ease with which the nuclear-cortical complex can be rotated by the cannula.

**Hydrodelineation**

*Hydrodelineation* is a term first used by Anis to describe the act of separating an outer epinuclear shell or multiple shells from the central compact mass of inner nuclear material, the endonucleus, by the forceful irrigation of fluid (BSS) into the mass of the nucleus.7

**Step-by-Step Approach to Hydrodelineation**

Step 1. Use the Cannula to Locate the Endonucleus. A 26-gauge cannula is placed in the nucleus, off center to either side, and directed at an angle downward and forward toward the central plane of the nucleus. When the nucleus starts to move, the endonucleus has been reached. It is not penetrated by the cannula. At this point, the cannula is directed tangentially to the endonucleus, and a to-and-fro movement of the cannula is used to create a tract within the nucleus.
Step 2. **Inject BSS to Create a Cleave Plane.** The cannula is backed out of the tract approximately halfway, and a gentle but steady pressure on the syringe allows fluid to enter the distal tract without resistance. Driven by the hydraulic force of the syringe, the fluid will find the path of least resistance, which is the junction between the endonucleus and the epinucleus, and flow circumferentially in this contour. Most frequently, a circumferential golden ring will be seen outlining the cleavage between the epinucleus and the endonucleus (Figure 4-4). Sometimes the ring will appear as a dark circle rather than a golden ring. Occasionally, an arc will result and surround approximately one quadrant of the endonucleus. In this instance, creating another tract the same depth as the first but ending at one end of the arc, and injecting into the middle of the second tract, will extend that arc (usually another full quadrant). This procedure can be repeated until a golden or dark ring verifies circumferential division of the nucleus.

**Additional Tips**

For very soft nuclei, the placement of the cannula allows creation of an epinuclear shell of any thickness. The cannula may pass through the entire nucleus if it is soft enough, so the placement of the tract and the location of the injection allow an epinuclear shell to be fashioned as desired. In very firm nuclei, one appears to be injecting into the cortex on the anterior surface of the nucleus, and the golden ring will not be seen. However, a thin, hard epinuclear shell is achieved even in the most brunescent nuclei. That shell will offer the same protection as a thicker epinucleus in a softer cataract.

Hydrodelineation circumferentially divides the nucleus and has many advantages. Circumferential division reduces the volume of the central portion of nucleus removed by phacoemulsification by up to 50%. This allows less deep and less peripheral grooving and smaller, more easily mobilized quadrants after cracking or chopping. The epinucleus acts as a protective cushion within which all of the chopping, cracking, and phacoemulsification forces can be confined. In addition, the epinucleus keeps the bag on stretch throughout the procedure, making it unlikely that a knuckle of capsule will come forward, occlude the phaco tip, and rupture.

Cortical cleanup is dramatically facilitated by cortical cleaving hydrodissection. After evacuation of all endonuclear material, the epinuclear rim is trimmed in each of the three quadrants, mobilizing cortex as well in the following way. As each quadrant of the epinuclear rim is rotated to the distal position in the capsule and trimmed, the cortex in the adjacent capsular fornix flows over the floor of the epinucleus and into the phaco tip (Figure 4-5). Then the floor is pushed back to keep the bag on stretch until three of the four quadrants of the epinuclear rim and fornical cortex have been evacuated. It is important not to allow the epinucleus to flip too early, thus avoiding a large amount of residual cortex remaining after evacuation of the epinucleus.

The epinuclear rim of the fourth quadrant is then used as a handle to flip the epinucleus. As the remaining portion of the epinuclear floor and rim is evacuated from the eye, 70% of the time the entire cortex is evacuated with it. Downsized phaco tips with their increased resistance to flow are less capable of mobilizing the cortex because of the decreased minisurge accompanying the clearance of the tip when going from foot position 2 to foot position 3 in trimming of the epinucleus.

After the intraocular lens (IOL) is inserted, these strands and any residual viscoelastic material are removed using the irrigation-aspiration tip, leaving a clean capsular bag.

If there is cortex still remaining following removal of all the nucleus and epinucleus (Figure 4-6), there are
three options. The phacoemulsification handpiece can be left high in the anterior chamber while the second handpiece strokes the cortex-filled capsular fornices. Often, this results in floating up of the cortical shell as a single piece and its exit through the phacoemulsification tip (in foot position two) because cortical cleaving hydrodissection has cleaved most of the cortical capsular adhesions.

Alternatively, if the surgeon wishes to complete cortical cleanup with the irrigation-aspiration handpiece before lens implantation, the residual cortex can almost always be mobilized as a separate and discrete shell (reminiscent of the epinucleus) and removed without ever turning the aspiration port down to face the posterior capsule.

The third option is to viscodissect the residual cortex by injecting the viscoelastic through the posterior cortex onto the posterior capsule (Figure 4-7). We prefer the hyaluronate dispersive viscoelastic device. The viscoelastic material spreads horizontally, elevating the posterior cortex and draping it over the anterior capsular flap (Figure 4-8). The peripheral cortex is forced into the capsular fornix at the same time. The posterior capsule is then deepened with a cohesive viscoelastic device (eg, Healon [AMO, Santa Ana, CA]) and the IOL is implanted through the capsulorrhexis, leaving the anterior extension of the residual cortex anterior to the IOL (Figure 4-9).

Removal of residual viscoelastic material accompanies mobilization and aspiration of residual cortex anterior to the IOL, which protects the posterior capsule, leaving a clean capsular bag.

**SUMMARY**

The lens can be divided into an epinuclear zone with most of the cortex attached and a more compact central nuclear mass. The central portion of the cataract can be removed by any endolenticular technique, after which the protective epinucleus is removed with all or most of the cortex attached. In most cases, irrigation and aspiration of the cortex as a separate step are not required, thereby eliminating that portion of the surgical procedure and its attendant risk of capsular disruption. Residual cortical cleanup may be accomplished in the presence of a posterior chamber IOL, which protects the posterior capsule by holding it remote from the aspiration port.
Hydrodissection and Hydrodelineation

REFERENCES


Figure 4-8. Posterior cortex fully draped on top of capsule and iris (arrows=edges of posterior cortex are elevated by viscoelastic).

Figure 4-9. Posterior cortex now draped back on top of the plate haptic IOL ready for mobilization.