 0896-1549/95 $0.00 + .20

THE CHIP AND FLIP PHACOEMULSIFICATION TECHNIQUE

I. Howard Fine, MD

The "chip and flip" phacoemulsification technique was initially described at the video festival of the American Academy of Ophthalmology meeting in Las Vegas, Nevada, 1989, and presented at the American Society of Cataract and Refractive Surgery symposium in Los Angeles, California, 1990. It was subsequently published in the Journal of Cataract and Refractive Surgery[6] and this article updates that publication.

The continuous curvilinear capsulorhexis (CCC) with a wide anterior capsular flap has definite advantages,[9,10,12] which include avoiding extensions of anterior capsular tears to the posterior capsule and insuring in-the-bag placement and centration of posterior chamber implants.

A CCC with a wide anterior capsular rim, however, presented new challenges to phacoemulsification surgeons, the most important of which was an inability to easily dislocate the superior pole of the nucleus for pupillary plane phacoemulsification. As a result, most phaco surgeons turned to endolenticular techniques in which the nucleus is removed from inside out rather than outside in.[1-3,8,11]

Adapted from Fine IH: The chip and flip phacoemulsification technique. Journal of Cataract and Refractive Surgery (Society of Cataract and Refractive Surgery). The original version of this article was published in the May 1991 issue (vol 17, number 3, pages 366-371); with permission.

The chip and flip technique uses circumferential division of the nucleus into a hard central mass, the endonucleus, and an epinuclear shell. The volume of the central mass of the nucleus to be emulsified is thus reduced by as much as 50%. As a result, sculpting is less deep and less peripheral. The epinucleus is a protective element within which phacoemulsification and other mechanical forces can be contained. The epinuclear shell provides an additional advantage by keeping the bag on stretch and thus making it less likely that a portion of the capsule would come forward, occlude the phaco tip, and rupture. The epinuclear shell minimizes potential injury to the posterior capsule, capsular fornices, and peripheral corneal endothelium. In this technique, there is added safety and control because the surgery takes place almost entirely within the center of the lens capsule and thus one is never working deeply near the posterior capsule nor in the capsular fornix nor under the iris. On the contrary, one is always working in the center of the pupil, the deepest part of the capsular bag, and in the presence of an easily recognizable anatomic landmark, the hydrodelineation cleavage ring or "golden" ring.

Initially, the chip and flip technique was used for nuclei of all densities, but because of the efficiency of cracking techniques,[8,11] I now use it only for soft nuclei.

From the Department of Ophthalmology, Oregon Health Sciences University, Portland, Oregon

SURGICAL TECHNIQUE

The versatility of the chip and flip phacoemulsification technique is such that it can be safely and reliably performed through any properly performed phaco incision in any location. Because my current personal preference is to use a temporally located, clear cornea incision (see also Dr. Howard Fine's article, "Clear Corneal Cataract Incisions" elsewhere in this issue), I will now describe chip and flip accordingly.

Operating from the temporal side, a side port is made to the left with a 1-mm trifaceted diamond knife (KOI), and viscoelastic is infused through the side port into the distal anterior chamber angle to replace aqueous humor. The globe is fixated with a Fine-Thornton ring (Mastel Surgical Instruments, Rapid City, South Dakota) and a 2.6-mm (Diamatrix, The Woodlands, Texas) or 3-mm (Huco, Hauterville, Switzerland) diamond keratome is used to make a temporal clear corneal beveled incision beginning at the anterior edge of the corneal vascular arcade.[4] A Kershner forceps (Rhein Medical, Tampa, Florida) is used to make a 5-mm round CCC. Cortical cleaving hydrodissection[5] is performed followed by hydrodelineation[7] resulting in an epinuclear shell with cortex attached surrounding the denser endonucleus (Fig. 1). The phacoemulsification procedure then takes place through the small curvilinear capsulorhexis, using personalized parameters for each phacoemulsification manufacturer (Fig. 2). Sculpting is accomplished in the usual manner using a shaving technique or an occlusion technique at zero to very low vacuum settings. A Bechert nucleus rotator (Katena, Denville, New Jersey) or a Knolle malleable spatula (Katena) is introduced through the side port incision and the nucleus is pushed toward the phacoemulsification incision with the spatula under the tip of the phaco handpiece. The endonucleus is sculpted at a depth of approximately one half the endonuclear thickness from the center of the pupil directly up to the golden ring delineating endonucleus from epinucleus (Fig. 3). The nucleus is rotated clockwise, and another segment is removed out to the golden ring (Figs. 4 and 5). There is usually a clear-cut golden ring, or dark circle, demarcating the endonucleus from the soft epinuclear shell. The displacement of the nucleus toward the incision while the emulsification is taking place in the periphery protects the capsule because the part of the nucleus being emulsified is brought away from the capsular fornix and out from under the iris, even in the presence of a small pupil. Emulsification takes place just under the anterior capsular rim and close to the center of the deepest place in the anterior chamber.

Once the anterior half of the endonucleus has been removed, the second handpiece can be brought into the golden ring or demarkation circle at the left side of the peripheral

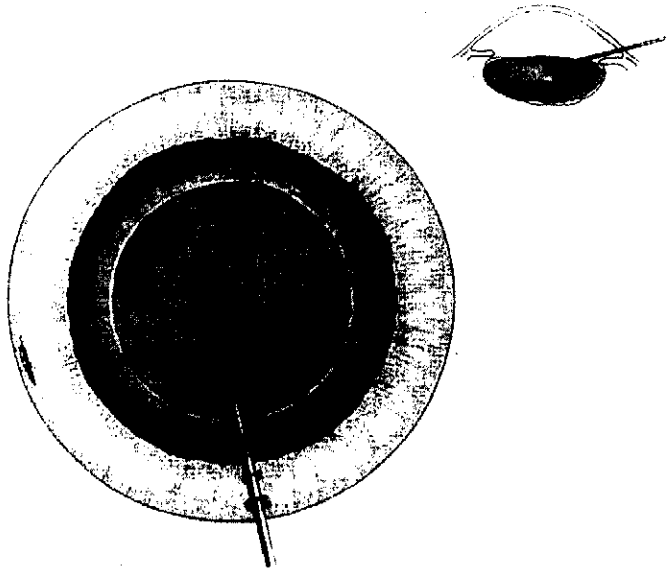

Figure 1. Hydrodelineation of the nucleus.

	PHACO SETTINGS				I/A CONTROL	
	SCULPT	CHIP/QUAD	TRIM	FLIP	CORTICAL CLEAN-UP	VISCOAT REMOVAL
ALCON 10,000 MASTER (See Note)						
Power	80	70	60	60	Surg Vac Control	
Aspiration	16	20	20	20	30	30
Vacuum	1	100	80	80	400	400
Mode	Cont	Pulse 10/sec	Pulse 10/sec	Pulse 10/sec	I/A Mode	I/A Mode
ALCON 20,000 LEGACY with Kelman Tip						
	U/S Mem 1	Pulse Mem 1	Pulse Mem 2	Pulse Mem 3		
Power	80	70	70	70	Surg Vac Control	
Aspiration	16	16	16	16	16	30
Vacuum	0-6	*80/100/120	100	50	500	500
Mode	Cont	Pulse 8/sec	Pulse 8/sec	Pulse 8/sec	I/A Mode	I/A Mode
AMO PRESTIGE (See Note)						
Power	80	80	50	50	Surg Vac Control	
Aspiration	16	16	16	16	30	30
Vacuum	0-6	400	80	80	500	500
Mode	Cont	Pulse 10/sec	Pulse 10/sec	Pulse 10/sec	I/A Mode	I/A Mode
STORZ PREMIERE with Microseal Handpiece						
Power	36%	36%	36%	36%	Surg Vac Control	
Vacuum	30	60	60	60	400	400
Mode	Cont	Pulse 8/sec	Pulse 8/sec	Pulse 8/sec	I/A Mode	I/A Mode
MENTOR ODYSSEY (See Note)						
Power	**40%/55%	**40%/50%	**40%/50%	**40%/50%	Surg Vac Control	
Aspiration	16	16	16	16	18	22
Vacuum	Low 25	**Low 130/165	Low 130	Low 130	High	High
Mode	Cont	Pulse 10/sec	Pulse 10/sec	Pulse 10/sec	I/A Mode	I/A Mode
SURGICAL DESIGN OCUSYSTEM II "ART"						
Power	50%	50%	50%	50%	Surg Vac Control	
Aspiration	6	6	6	6	8-12	8-12
Vacuum	0	120	90	90	175-500	175-500
Mode	Cont	Pulse 6/sec	Pulse 6/sec	Pulse 6/sec	I/A Mode	I/A Mode
OMS DIPLOMAX	Un-occl/Occl Thresh/Limit	Un-occl/Occl Thresh/Limit	Un-occl/Occl Thresh/Limit	Un-occl/Occl Thresh/Limit		
Power	100/100	80/80	60/60	60/60	Surg Asp Control	
Aspiration	16/4	16/32	16/24	16/24	10	10
Vacuum	10/50	20/80	20/70	20/70	500	500
Mode	Auto	Pulse 50%	Pulse 50%	Pulse 50%	I/A Mode	I/A Mode
CHIRON PHACOTRON GOLD PLUS with Ultratip System						
Power	50%	50%	50%	50%	Surg Vac Control	
Aspiration	16	16	16	16	30	30
Vacuum	0	100	80	50	500	500
Mode	Linear	Pulse 10/sec	Pulse 10/sec	Pulse 10/sec	I/A Mode	I/A Mode

Figure 2. Fine phacoemulsification parameters. Thirty-degree tip is used for 1-2+ nuclei; 45-degree tip is used for 3-4+ nuclei.
*Nucleus 1-2+ ≠ 3+ ≠ 4+
**Nucleus 1-3+ ≠ 4+

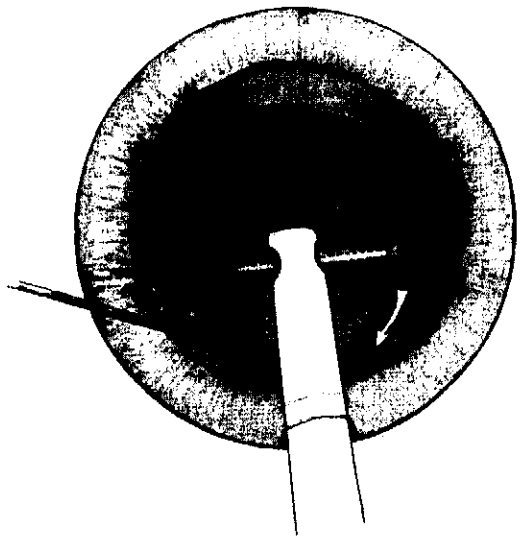

Figure 3. Sculpting of the endonucleus up to the golden ring.

portion of the ring and swept under the chip (the residual endonucleus) elevating it into the center of the capsular bag (Fig. 6). This maneuver may be facilitated by first pushing down on the chip with the phaco handpiece and drawing the nuclear complex toward the incision. This spreads the cleavage ring peripherally and allows easier access to the spatula. As the spatula enters the cleavage ring peripherally to the left and moves under the chip, the phaco handpiece can help push the chip up onto the spatula, facilitating its dislocation and positioning its superior edge near the middle of the capsular bag. Using the second handpiece to control the nuclear chip, the chip can be quickly and safely removed (Fig. 7). Pulsed

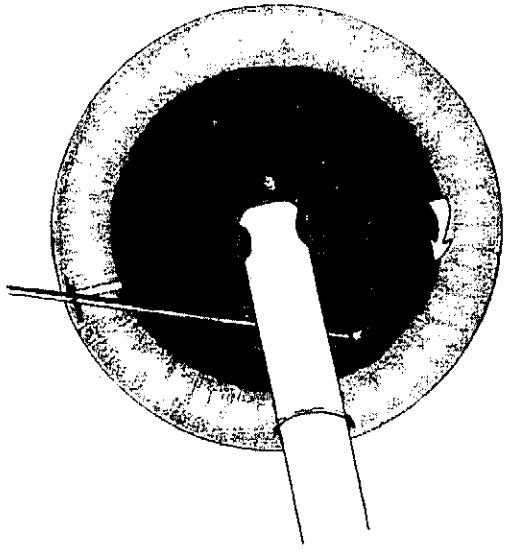

Figure 4. Rotation of the nuclear complex with segmental removal of the rim of the endonucleus.

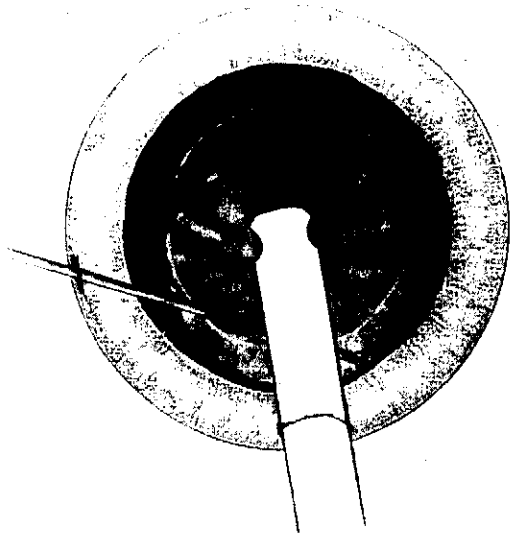

Figure 5. Last segment of endonuclear rim being removed.

phacoemulsification dramatically reduces "chattering" of the chip.

Removal of the epinuclear shell requires equal attention to detail. The surgeon uses the phaco handpiece to engage by occlusion the distal rim of the epinucleus in foot position 2 and to pull the rim toward the center of the capsule at the capsulorhexis level (Fig. 8).

The rim of the distal portion of the epinucleus is removed primarily with aspiration, augmented at times with low powers of phacoemulsification, and the epinucleus is then allowed to fall back completely within the capsular bag. With successful cortical cleaving hydrodissection, one can usually see as the rim of the epinucleus is being trimmed and the

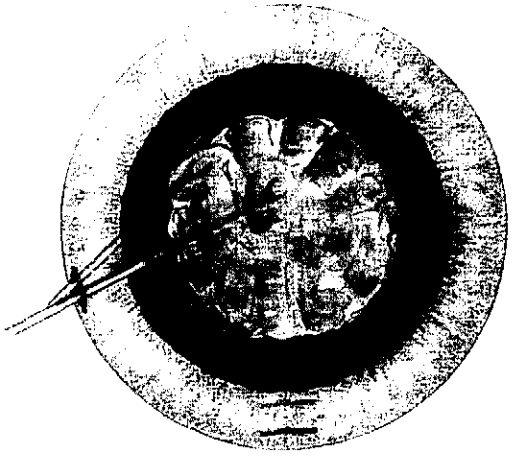

Figure 6. Elevation of the chip into the center of the capsular bag.

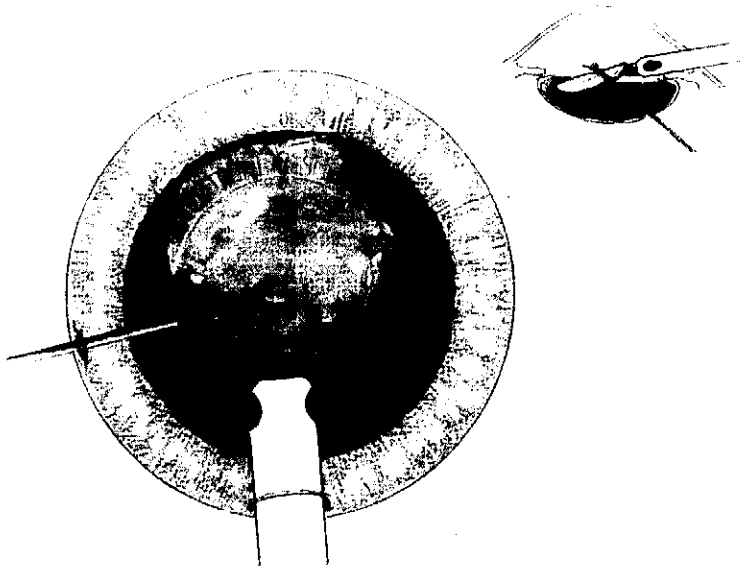

Figure 7. Control of the endonuclear chip with the second handpiece during removal of the chip.

cortex is flowing over the epinuclear shell and into the phaco handpiece. The epinucleus is then rotated and an additional quadrant of epinuclear rim and cortex is removed in the same manner; this is repeated and a third quadrant is treated in exactly the same manner leading to a residual quadrant of the rim of the epinucleus which is then rotated into the distal position. This is now purchased by the phacoemulsification tip in foot position 2 (aspiration) and pulled toward the incision while the nucleus rotation is placed in the bottom of the remaining portion of the epinucleus, at the center of the epinucleus, and the epinuclear

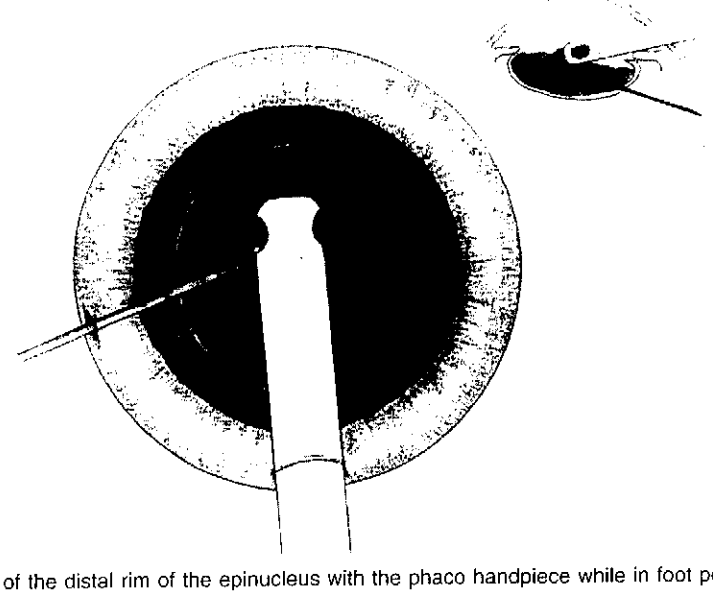

Figure 8. Purchase of the distal rim of the epinucleus with the phaco handpiece while in foot position 2.

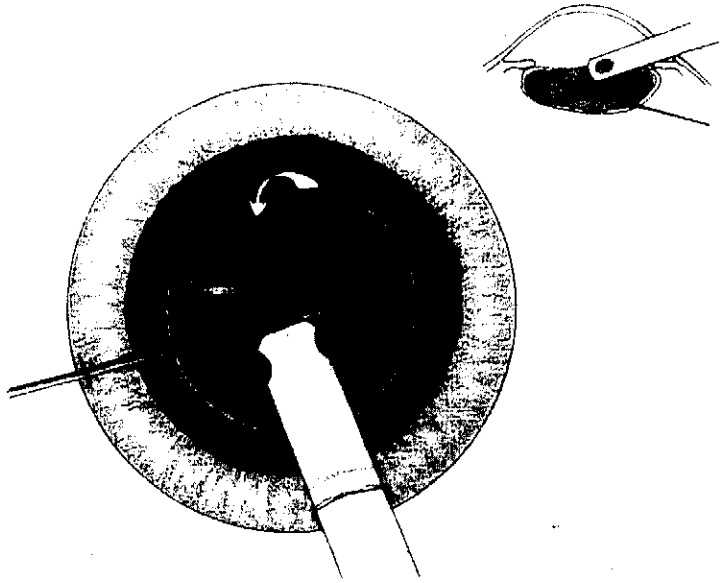

Figure 9. Beginning of the epinuclear flip maneuver.

floor is simultaneously pushed with the second hand toward the distal portion of the capsular bag (Fig. 9). This creates antiparallel forces and results in a flipping of the epinucleus, removing it from its proximity to the posterior capsule (Figs. 10 and 11).

In its flipped position it is removed by aspiration or low powers of phacoemulsification (Figs. 12 and 13). In general, if cortical cleaving hydrodissection has been performed properly, the epinucleus, cortex, and all is removed in this manner. Any residual cortex is removed

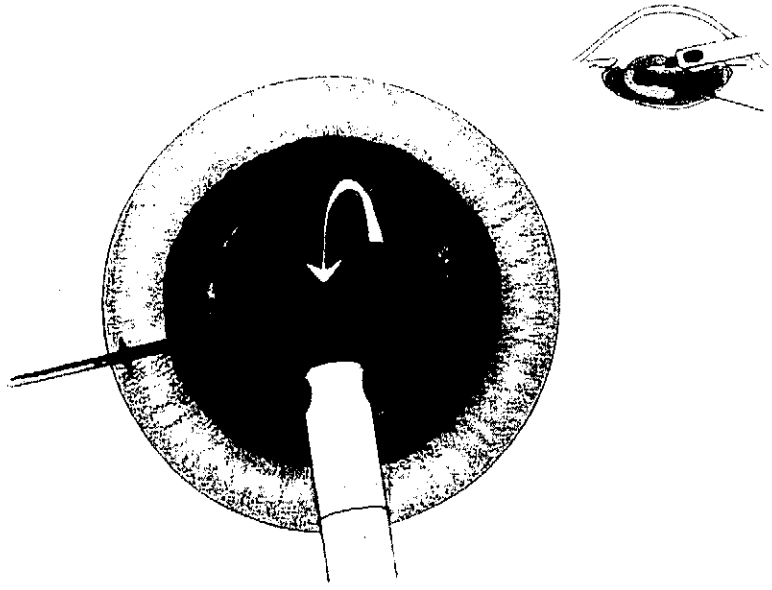

Figure 10. Epinuclear flip continuing.

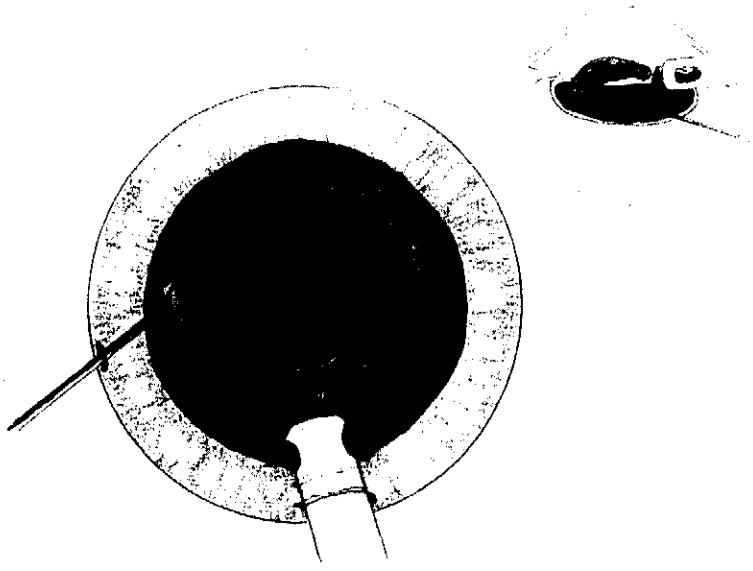

Figure 11. Completely everted residual epinucleus.

after the intraocular lens has been implanted as described in previous publications.[3]

SUMMARY

This technique, which I have used in approximately 1500 surgeries, is as easy to learn as any of the currently available endolenticular technique. It is especially appropriate for soft nuclei and for surgeons making the transition to capsulorhexis and endolenticular phacoemulsification. This technique involves dividing the nucleus circumferentially, removing the hard central portion in the presence of a protective epinuclear shell, and then trimming

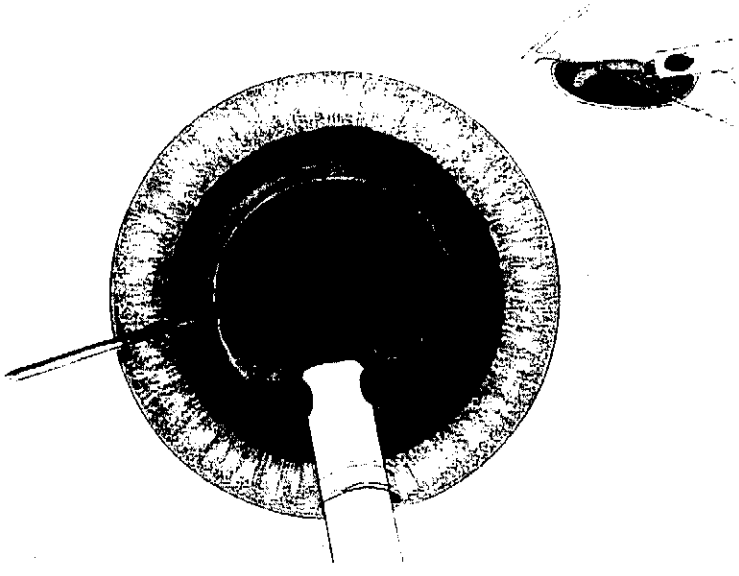

Figure 12. Removal of the everted epinuclear shell.

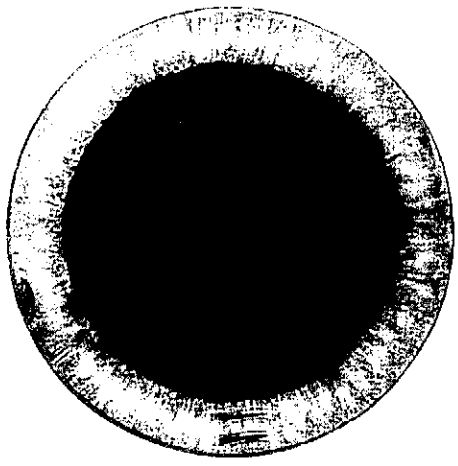

Figure 13. Phacoemulsification is completed.

and tumbling the shell to displace it from its proximity to the posterior capsule before removing it.

References

1. Arnold PN: One-handed method of posterior chamber phacoemulsification. J Cataract Refract Surg 16:646–648, 1990
2. Davison JA: Bimodal capsular bag phacoemulsification: A serial cutting and suction ultrasonic nuclear dissection technique. J Cataract Refract Surg 15:272–282, 1989
3. Davison JA: Hybrid nuclear dissection technique for capsular bag phacoemulsification. J Cataract Refract Surg 16:441–450, 1990
4. Fine IH: Corneal tunnel incision with a temporal approach. *In* Fine IH, Fichman RA, Grabow HB (eds): Clear Corneal Cataract Surgery and Topical Anesthesia, Thorofare, NJ, Slack, 1993, pp 8–12
5. Fine IH: Cortical cleaving hydrodissection. J Cataract Refract Surg 18:508–512, 1992
6. Fine IH: The chip and flip phacoemulsification technique. J Cataract Refract Surg 17:366–371, 1991
7. Fine IH, Maloney WF, Dillman DM: Crack and flip phacoemulsification technique. J Cataract Refract Surg 19:797–802, 1993
8. Gimbel HV: Divide and conquer nucleofractis phacoemulsification: Development and variations. J Cataract Refract Surg 17:281–291, 1991
9. Gimble HV: Capsulotomy method eases in-the-bag PCL. Ocular Surgery News, pp 20–21, July 1985
10. Gimbel HV, Neuhann T: Development, advantages and methods of the continuous circular capsulorhexis technique. J Cataract Refract Surg 16:31–37, 1990
11. Shepherd JR: In situ fracture. J Cataract Refract Surg 16:436–440, 1990
12. Neuhann T: Theorie und Operationstechnik der Kapsulorhexis. Klin Monatsbl Augenheilkd 190:542–545, 1987

Address reprint requests to

I. Howard Fine, MD
1550 Oak Street, Suite 5
Eugene, OR 97401