The Choo-Choo Chop and Flip Phacoemulsification Technique

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The choo-choo chop and flip phacoemulsification is a chopping technique that uses power modulations and high vacuum along with specific maneuvers to minimize the amount of ultrasound energy in the eye and maximize safety and control.

This technique is designed to take maximum advantage of various new technologies available through the Alcon 20,000 Legacy[1] (Alcon Surgical Inc, Ft Worth, TX) and the AMO Diplomax[2] (Allergan Medical Optics, Irvine, CA) Phacoemulsification Systems. These technologies include high-vacuum cassettes and tubing, multiple programmable features on both systems, as well as the Mackool Microtip (Alcon Surgical Inc) with the Legacy and burst mode and occlusion mode capabilities with the Diplomax (Table 1). The result is enhanced efficiency, control, and safety. The procedure is done as follows:

A side-port incision is made to the left with a 1-mm trifaceted diamond knife, after which the anterior chamber is irrigated with 0.5 mL preservative-free xylocaine. Using the soft-shell technique described by Steve Arshinoff, Viscoat (Alcon Surgical Inc) is placed into the anterior chamber angle distal to the side port, through the side-port incision. It fills the anterior chamber but allows the eye to remain relatively soft. Provisc (Alcon Surgical Inc) is instilled on top of the center of the lens capsule under the Viscoat. Provisc forces the Viscoat up against the cornea, creating a soft shell, which helps stabilize the anterior chamber and protect the endothelium. Additionally, Provisc, which is a cohesive viscoelastic, decreases any tendency for iris prolapse during the hydro steps. After clear corneal incision, cortical cleaving hydrodissection is performed in the two distal quadrants followed by hydrodelineation. After the two hydro steps, the nucleus should rotate easily within the capsular bag. The Mackool/Kelman microtip on the Legacy is introduced bevel down to aspirate the epinucleus uncovered by the capsulorhexis, and is then turned bevel up. With a Diplomax system, a 30° standard bevel-down tip is used throughout endonuclear removal. The Fine/Nagahara chopper (Rhein Medical, Tampa, FL) is placed in the golden ring and is used to stabilize the nucleus by lifting and pulling toward the incision slightly (Fig 1), after which the phaco tip lollipops the nucleus in either pulse mode at 2 pulses/second (Legacy) or 80-msec burst mode (Diplomax). With the energy set in this way, we minimize ultrasound energy into the eye and maximize our hold on the nucleus as the vacuum builds between pulses or bursts. Because of the decrease in cavitational energy around the tip at this low pulse rate or in burst mode, the tunnel in the nucleus in which the tip is embedded fits the needle very tightly and gives us an excellent hold on the nucleus, thus maximizing control of the nucleus as we score and chop it (Fig 2) in foot position 2.

The Fine/Nagahara chop instrument is grooved on the horizontal arm close to the vertical "chop" element with the groove parallel to the direction of the sharp edge of the vertical element. In scoring the nucleus, the instrument is always moved in the direction the sharp edge of the wedge-shaped vertical element is facing (as indicated by the groove on the instrument), thus facilitating scoring. The nucleus is scored by bringing the chop instrument to the side of the phaco needle. It is chopped in half by pulling the chopper to the left and slightly down while moving the phaco needle, still in foot position 2, to the right and slightly up. Then the nuclear complex is rotated. The chop instrument is again brought into the golden ring (Fig 3), and the nucleus is again lollipopped, scored, and chopped, with the resulting pie-shaped segment now lollipopped on the phaco tip (Fig 4). The segment is then evacuated, using high vacuum and short bursts or pulse mode phaco at 2 pulses/second (Fig 5). The nucleus is continually rotated so that pie-shaped segments can be scored, chopped, and removed essentially by the high vacuum assisted by short bursts or pulses of phaco. The short bursts or pulses of ultrasound energy continuously reshape the pie-shaped segments that are kept at the tip, allowing for occlusion and extraction by the vacuum. The size of the pie-shaped segments is customized to the density of the nucleus, with smaller segments for denser nuclei. Phaco in burst mode or at this low pulse rate sounds like "choo-choo-choo-choo"; ergo the name of this technique. With burst mode or the low pulse rate, the nuclear material tends to stay at the tip rather than chatter as vacuum holds between pulses. The chop instrument is used to stuff the segment into the tip or keep it down in the nuclear shell.

After evacuation of the first hemi-nucleus, the second hemi-nucleus is rotated to the distal portion of the bag, and the chop instrument stabilizes it while it is lollipopped. It is then scored (Fig 6) and chopped. The pie-shaped segments can be chopped a second time to reduce their size (Fig 7) if they appear too large to easily evacuate.

There is little tendency for nuclear material to come up into the anterior chamber with this technique. Usually it stays down within the epinuclear shell, but the position of the endonuclear material can be controlled by the chop instrument. After evacuation of all endonuclear material (the Diplomax tip is turned bevel up) (Fig 8), 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 trimmed, the cortex in the adjacent capsular fornix flows over the floor of the epinucleus and into the phaco tip. Then

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TABLE 1. Fine Phacoemulsification

Alcon Legacy					
MacKool System Hi-Vac "Choo-choo Chop and Flip"				I & A	
Memory Mode	Chop Mem 1 Pulse	Trim Mem 2 Pulse	Flip Mem 3 Pulp	Cortical Mem 1-3	Viscoat Mem 4
Power (%)	50	35	35	Surg vac	Surg as
Asp (mL/min)	28/33	20/18	22	38	60
Vac (mm Hg)	350	180	180	500+	500+
Mode	Pulse 2/sec	Pulse 7/sec	Pulse 7/sec	Cont irrig	Cont irrig
Bottle height (cm)	78	72	72	70	70
Fine AMO Diplomax					
Hi-Vac/Chop and Flip "Choo-choo Chop and Flip"				I & A Control Surg Vac Control	
	Chop Phaco 1	Trim Phaco 2	Flip Phaco 3	Cortical Clean-up	Viscoat Removal
Power (%)	60%	60	60		
Aspiration cont flow (mL/min)	26/30	32/26	32/16	10	30
Vacuum (mmHg)	50/250	40/90	70/150	500	500
Mode	Cont burst	Cont burst	Cont burst	Cont irrig	Cont irrig
Bottle height (in.)	32	32	32	28	28

the floor is pushed back to keep the bag on stretch until three of the four quadrants of epinuclear rim and forniceal 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 (Fig 9). As the remaining portion of the epinuclear floor and rim is evacuated from the eye, 80% to 90% of the time all of the cortex is evacuated with it (Fig 10). Continuing with the soft-shell technique, the capsular bag is filled with Provisc, and Viscoat is injected into the center of the capsular bag to help stabilize the anterior chamber and to blunt the movement of the foldable IOL as it is implanted into the eye. If the cortex was incompletely mobilized during epinuclear removal, Viscoat (rather than Provisc) is instilled first to viscodissect the cortex into the capsular fornix and drape some of it on top of the capsulorhexis (Figs 11 and 12). Provisc is then injected into the bottom of the bag, forcing the Viscoat anteriorly. The foldable intraocular lense (IOL) is then implanted.

Residual cortex is evacuated with residual viscoelastic, the posterior capsule being protected by the optic of the IOL. Mobilization of Viscoat is greatly facilitated because it is encased within the much more highly cohesive Provisc and less time is necessary to evacuate residual viscoelastic.

The choo-choo chop and flip technique uses the same hydro

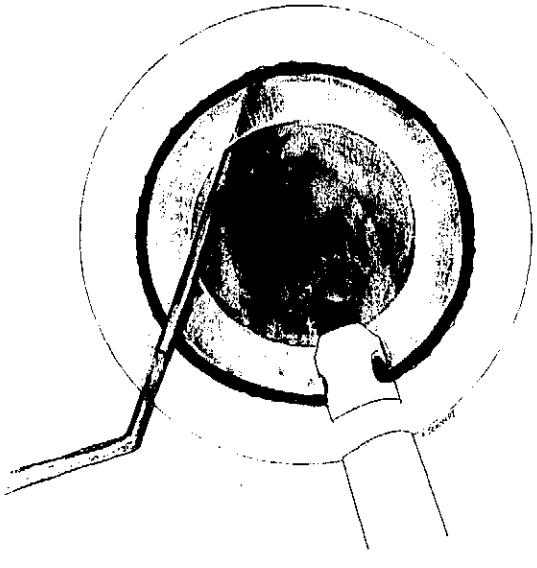

Figure 1. Stabilization of the nucleus during lollipopping for the initial chop.

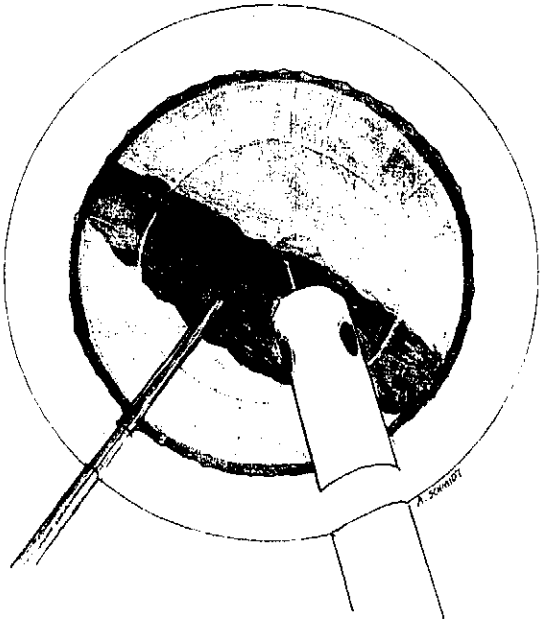

Figure 2. Completion of the initial chop.

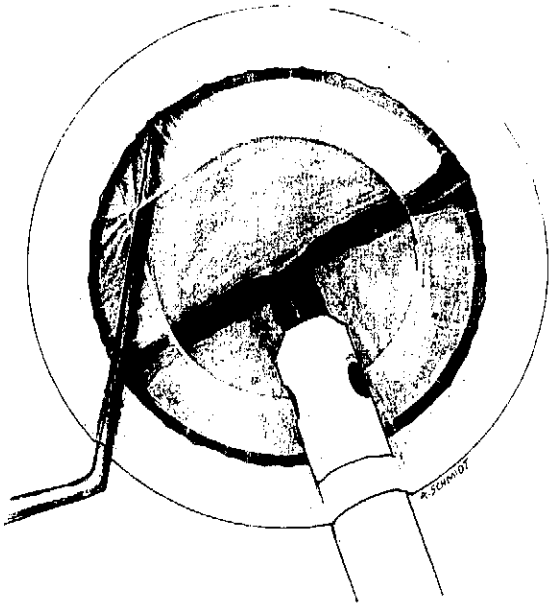

Figure 3. Stabilization of the nucleus before commencing the second chop.

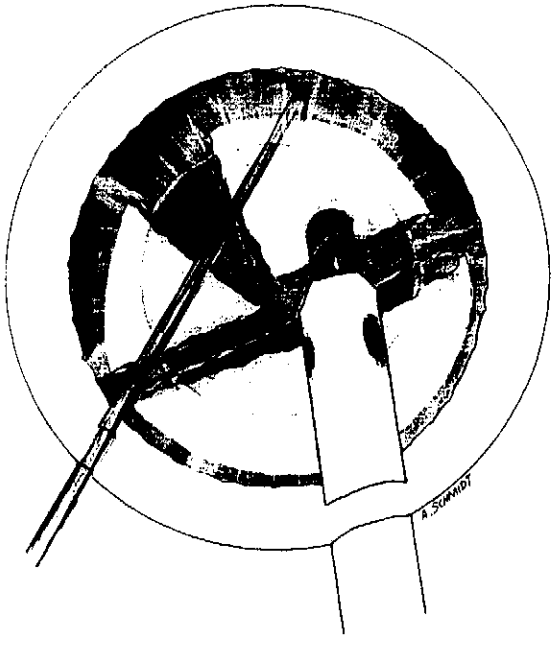

Figure 5. Mobilization of the first pie-shaped segment.

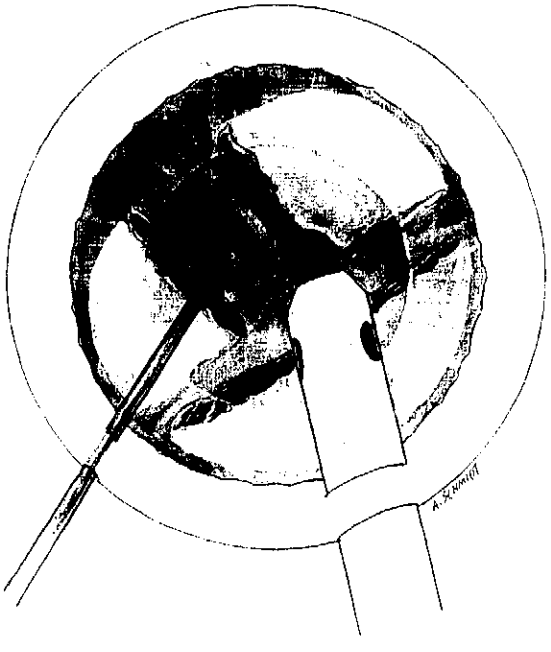

Figure 4. Pie-shaped segment adherent to the phaco tip after completion of the second chop.

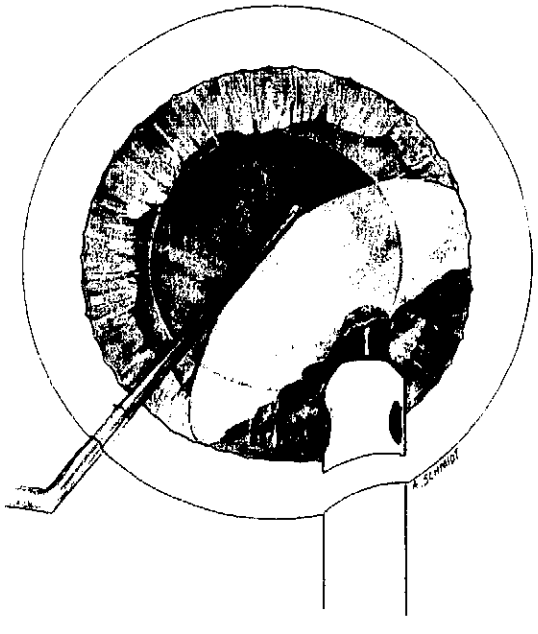

Figure 6. Scoring of the second hemi-nucleus.

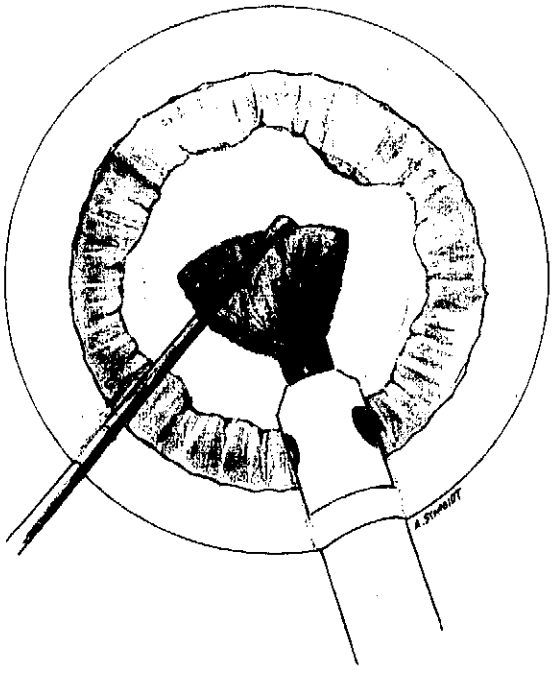

Figure 7. Mobilizing the final quadrant.

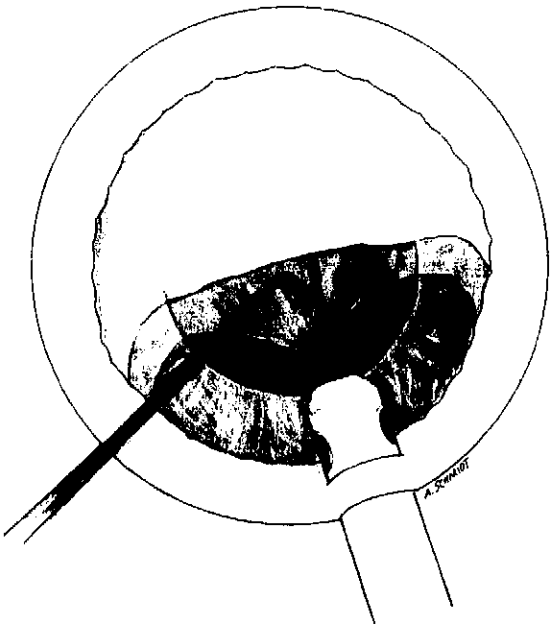

Figure 9. Flipping of the epinucleus.

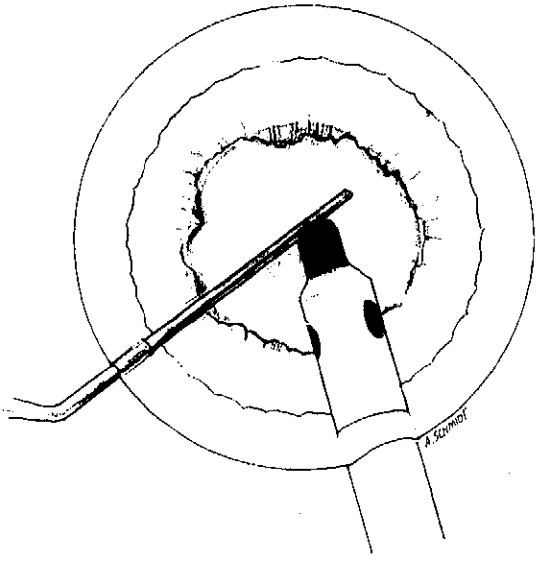

Figure 8. The epinuclear shell being rotated for trimming.

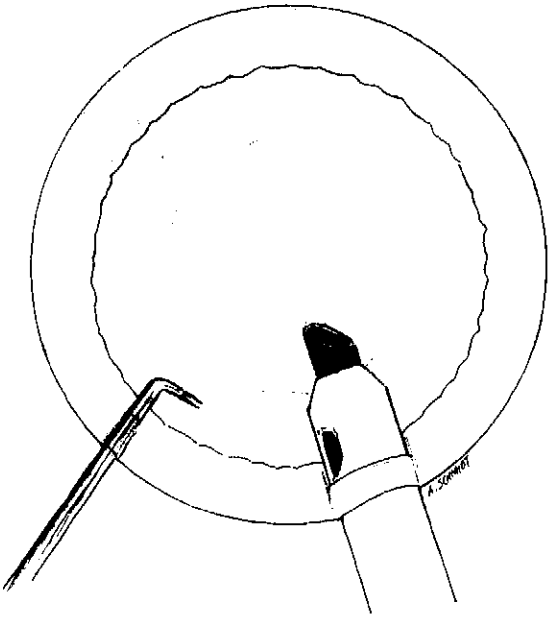

Figure 10. Empty capsular bag after flipping of the epinucleus.

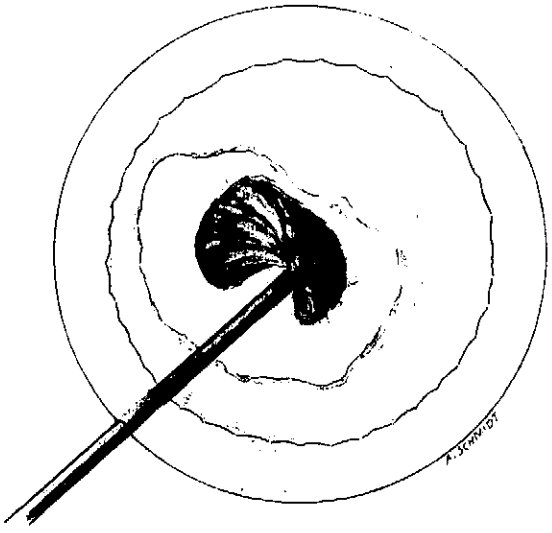

Figure 11. Viscodissection of residual cortex before IOL implantation.

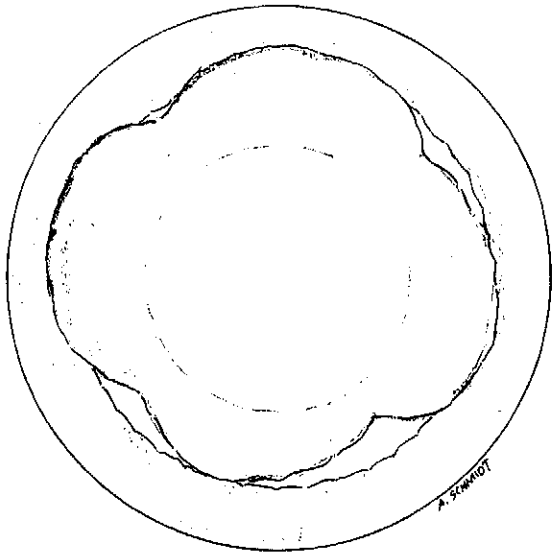

Figure 12. Viscodissection of residual cortex before IOL implantation.

forces to disassemble the nucleus but substitutes mechanical forces (chopping) for ultrasound energy (grooving) to further disassemble the nucleus. High vacuum is used as an extractive technique to remove nuclear material rather than using ultrasound energy to convert the nucleus to an emulsate that is evacuated by aspiration. This technique maximizes safety and control as well as efficiency in all cases, and allows for phaco of harder nuclei in the presence of a compromised endothelium. This technique facilitates the achievement of two goals: minimally invasive cataract surgery and maximally rapid visual rehabilitation.

References

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2. Masket S, Thorlakson R: The OMS Diplomax in endolenticular phacoemulsification, in Fine IH (ed): Phacoemulsification: New Technology & Clinical Application. Thorofare, NJ, Slack, 1996, pp 67-80