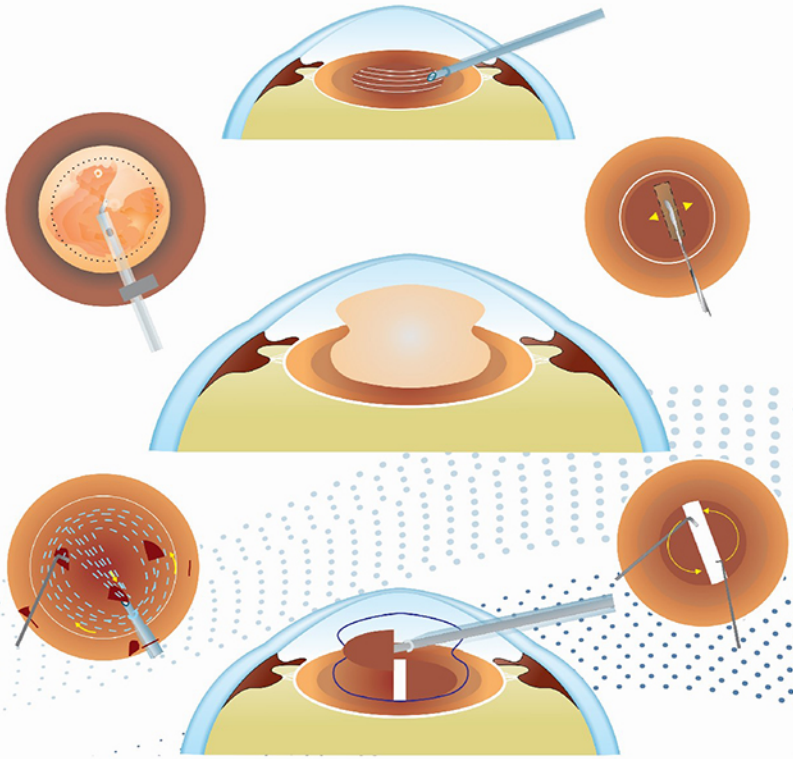
2nd Edition

Simplified Phacoemulsification



Navneet Toshniwal

Forewords
SH Lee
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CHAPTER

Removal of Small Pieces of Nucleus

INTRODUCTION

Although this is a simple step in nucleus management, complications such as posterior capsule rupture (PCR), injury to anterior capsule, iris trauma, and postoperative hazy cornea are common. So, to avoid this, surgeons should know specific area or safe zone to remove small pieces. One should know specific parameters and factors or instruments which are having the real role in removal of nucleus pieces.

INSTRUMENTS (FIG. 1)

Following are the instruments used in removal of small pieces:

- Chopper
- Phaco tip
- Viscoelastic and viscocannula

PRINCIPLE

Aspiration flow rate: It is one of the most important parameters to bring the nuclear pieces toward phaco tip.

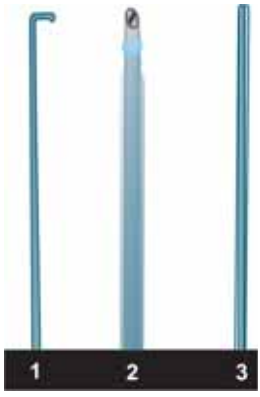
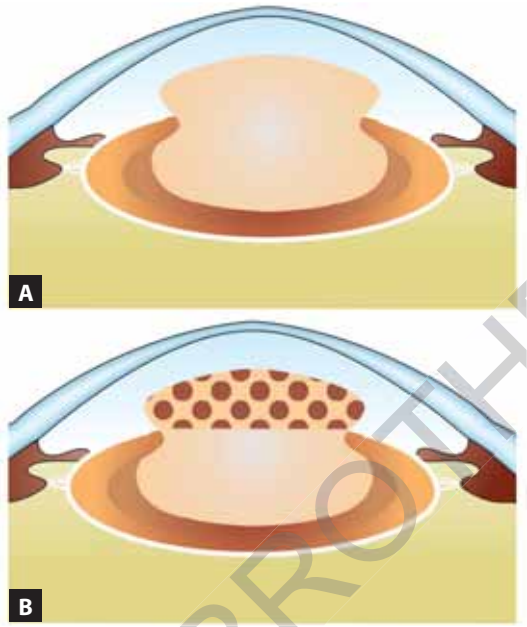


Fig. 1: Instruments: (1) Chopper; (2) Phaco tip; (3) Viscocannula.



Figs. 2A and B: Ideal site to remove small pieces: (A) Safe zone for phaco surgery—central safe zone (CSZ) and (B) Safe zone to remove small pieces of nucleus.

Energy: Once the piece is in opposition, use minimum energy to engage the nucleus or sometimes, use energy to bring the nucleus in opposition and engage. Energy is used to emulsify the nuclear pieces.

Vacuum: It builds up once nucleus is engaged. Then start using adequate or minimum energy for emulsifying the pieces.

IDEAL SITE TO REMOVE SMALL PIECES (FIGS. 2A AND B)

In **Figures 2A and B**, safe zone for phaco surgery is demarcated. Part which is out of bag of that area (posterior aspect of anterior chamber) is most ideal and safe site to remove small pieces.

PARAMETERS (TABLE 1—PHACO III)

See **Table 1**.

TABLE 1: Parameters for removal of small pieces.

Energy	*Vacuum*	*Aspiration flow rate*
20–40% According to the density of nucleus	200–300 mm Hg	24–30 cc/min
Traditional pulse or hyperpulse	Linear or panel	Linear or panel

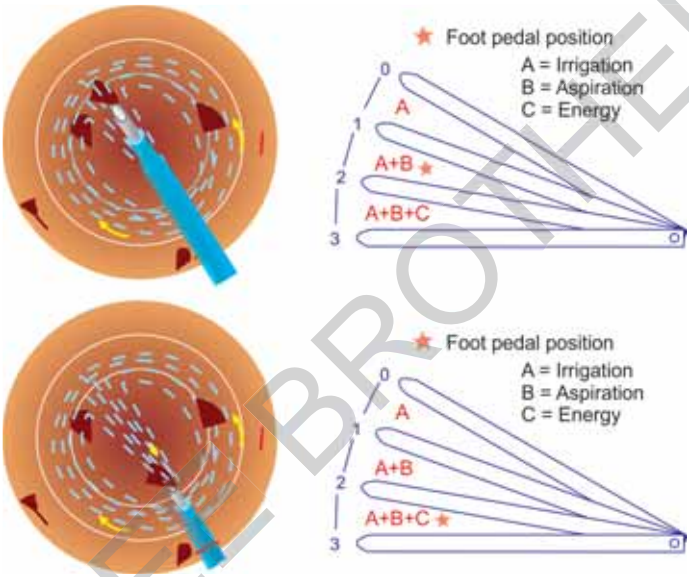


Fig. 3: Correlation of foot pedal with parameter.

CORRELATION OF FOOT PEDAL WITH PARAMETER—MOST IMPORTANT (FIG. 3)

Foot pedal positions 2 and 3 play a significant role in this step.

Foot pedal position 2 brings the piece toward tip and then foot pedal position 3 emulsifies it.

ROLE OF ENERGY, VACUUM, AND FLOW RATE

Energy

- Pulse or hyperpulse
- Minimum or adequate, i.e., 20–40%
- To engage the piece

- Once engaged, to emulsify the pieces
- Energy should be used according to the different zones of nucleus; hard part of nucleus needs relatively more energy, and soft part needs relatively less energy.
- Energy used in the central zone can be more, but it should be less than adequate as tip is moving toward periphery and toward cornea or posterior capsule.
- Sometimes, energy is needed to hold and chop nucleus pieces during removal of small pieces.
- Sometimes when epinucleus is coming along with nucleus, energy may be needed to remove epinucleus also.
- Energy should be cut down for last pieces removal.

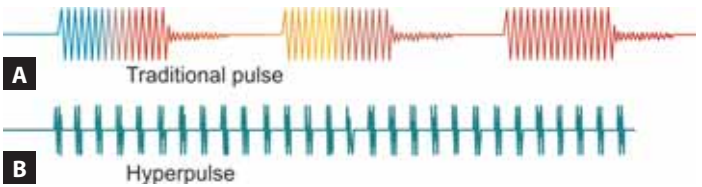
Modes of Energy (Figs. 4A and B)

- Traditional pulse mode
- *Hyperpulse mode:* May be in the form of continuous hyperpulse or pulse hyperpulse (new definition by author)
- *How these parameters work:*
  - Energy cuts
  - Gap holds
- *Pulse energy:* Cut-hold-cut-hold
  - So that pulse mode is more controlled and safer
- Setting is four to six pulses per second

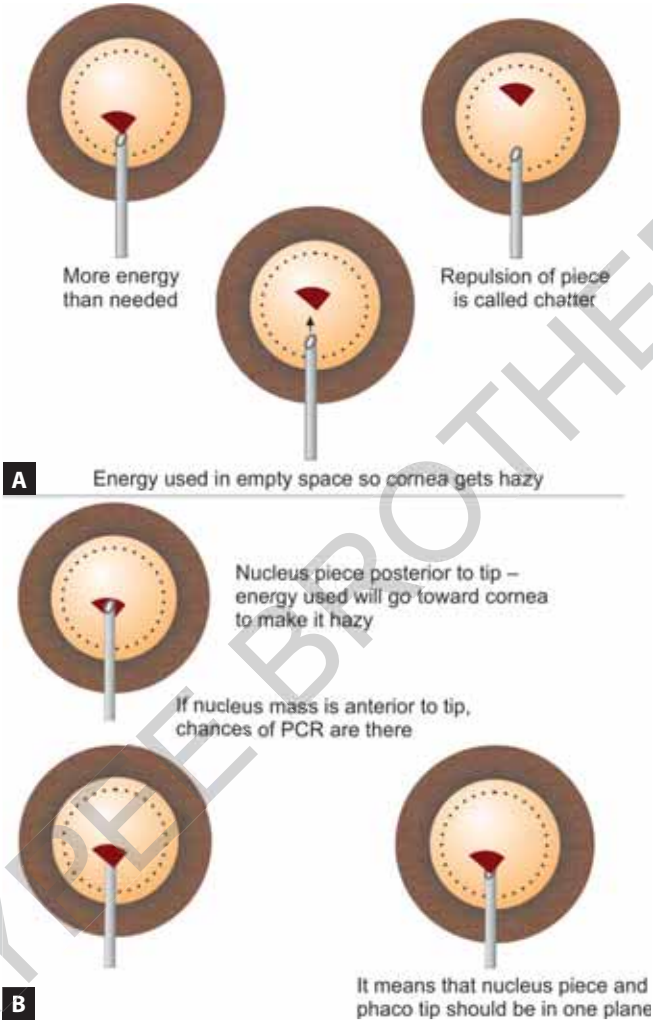
Energy Used in Wrong Way

Some illustrations are as follows (Figs. 5A and B):

- Energy used is more than needed, so repulsion of piece is called chatter.
- Energy used in empty space, so cornea gets hazy



Figs. 4A and B: Modes of energy: (A) Traditional pulse and (B) Hyperpulse.



Figs. 5A and B: Energy used in wrong way.

- Energy used in the vicinity of nucleus piece but without engaging to it, which is also responsible for postoperative hazy cornea
- *Nucleus piece posterior to tip:* Energy used will go toward cornea to make it hazy.
- If nucleus mass is anterior to tip, chances of PCR are there.

It means that nucleus piece and phaco tip should be in one plane.

Vacuum

- Once nucleus engaged, vacuum builds up to keep the piece in engaged position or to keep the piece in opposition of tip—this is nothing but hold. Emulsification of nucleus after this hold will make procedure more effective and very safe.
- Adequate vacuum is needed for this procedure.
- It ranges from 150 to 300 mm Hg for routine cases and should be more, i.e., 300–400 mm Hg in hard cataract.
- It can be in linear or panel mode.
- Vacuum is to hold; maintain the hold before use of energy.
- Sometimes with vacuum, surgeon can emulsify soft nucleus.

Vacuum used in wrong way: Misconception about vacuum is that when pieces are not coming toward the phaco tip, surgeons are increasing the vacuum which has no specific role for that purpose.

If a surgeon fails to remove pieces, then out of frustration surgeon increases vacuum.

Aspiration Flow Rate

- Understanding of phaco fluidics in this step means understanding of flow rate which plays a vital role in emulsification of small pieces.
- By definition, flow rate means the followability of the tissue, which means pieces which are moving toward the phaco tip are due to flow rate.
- It should be adequate, i.e., 24–30 cc/min.
- It should be usually linear; panel can be used for faster work.

Factors which are assisting the flow rate:

- Horizontal position of globe
- Water current of irrigation fluid
- If phaco tip is in bevel-up or near to bevel-up, water currents move in horizontal fashion to facilitate bringing nucleus pieces toward tip.
- More number of leakages or more number of instruments decreases flow rate.

Some facts related to flow rate: Depends on water current **(Figs. 6A and B)**, if two instruments phaco tip and chopper (through two openings) are placed in anterior chamber, water current diverts due to leakage, so flow rate decreases.

If only one instrument, phaco tip (through one opening), is placed in the anterior chamber, there is no leakage, so effectivity of flow rate is nearly equal to preset parameter (near to 100%).

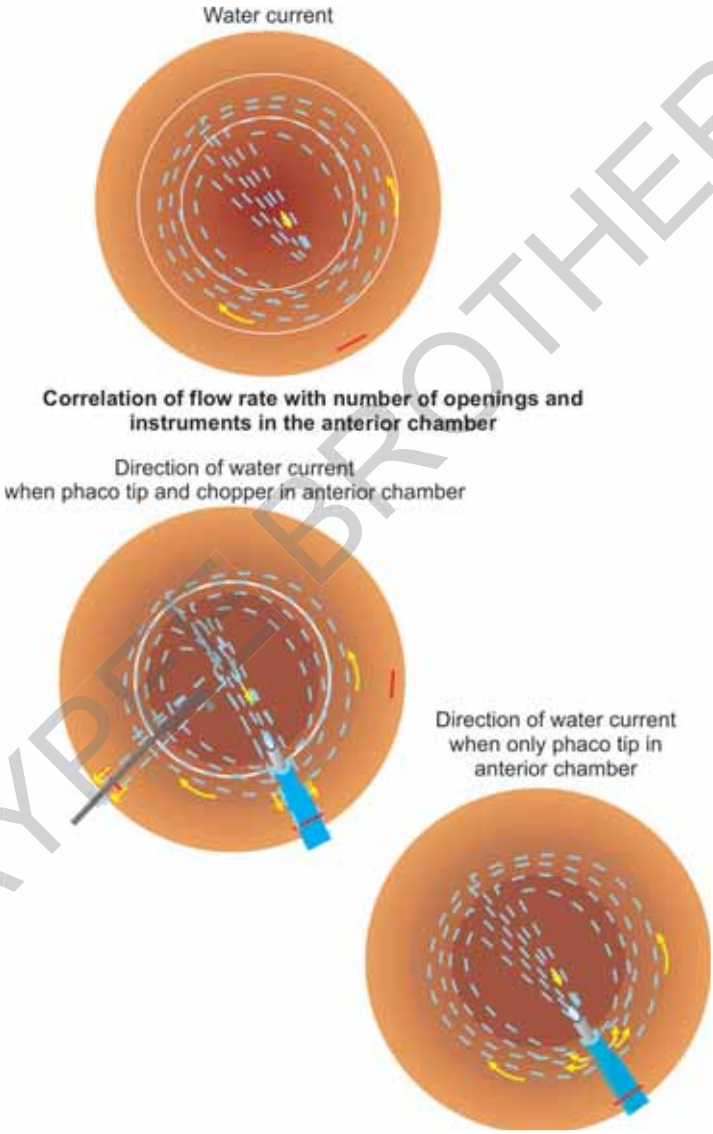


Fig. 6A

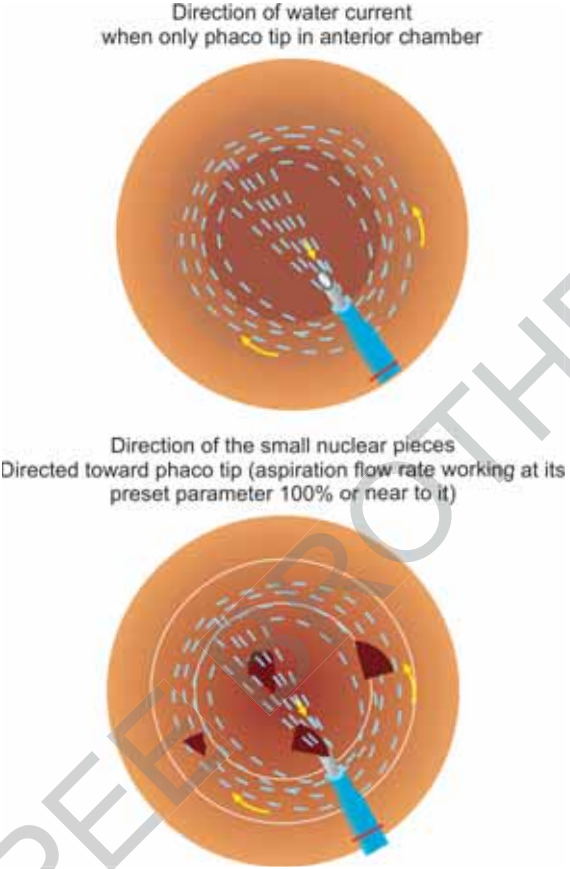


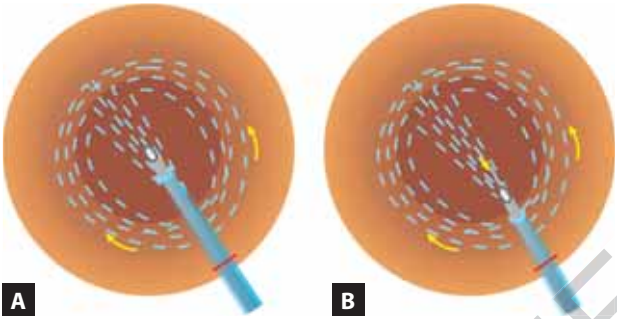
Fig. 6B

Figs. 6A and B: Water current.

Sometimes, surgeons increase flow rate for fast removal of pieces, but caution should be taken as chances of catching of iris and PCR increases.

PHACO TIP

- *Placement of phaco tip inside the chamber* **(Figs. 7A and B)**:
  - Placement of phaco tip should be in central safe zone, i.e., in the center or just behind it.
  - Phaco tip moves toward the periphery to engage nucleus piece and brings toward center for further emulsification.



Figs. 7A and B: Ideal placement of phaco tip during removal of small pieces: (A) Placement of phaco tip should be in the center and (B) Just behind the center.

During this maneuver, press the foot pedal partially to decrease the parameter.

- Phaco tip should be in bevel-up or bevel lateral position during emulsification of nuclear pieces.
- Direction of phaco tip may be bevel-up, sideway, or down to give 0° effect to engage nucleus.

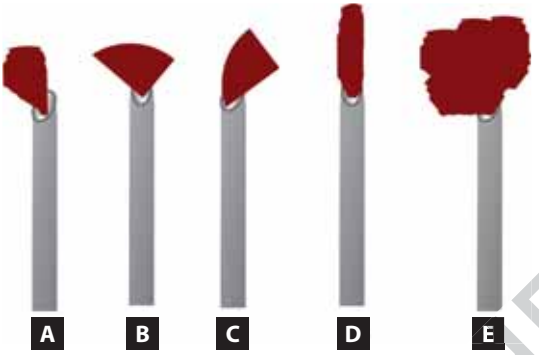
- *Movement of phaco tip during this step should be very slow for following reasons:*
  - Complication rate decreases
  - There is no turbulence of water current
  - Correlation of foot pedal with phaco tip is better.

Orientation of nucleus pieces with phaco tip is most crucial factor for effective and safe procedure **(Figs. 8A to E)**.

- Try to catch the long axis of pieces for larger working distance for better efficiency of energy and it is always safe.
- Try to get the apex of the piece.
- Try to catch the edge of nucleus piece.
- Try to catch the bulk of nucleus.
- Avoid catching from round surface of nucleus piece.

ROLE OF CHOPPER (FIGS. 9A AND B)

- Placement of chopper should be in horizontal position.
- For easy maneuvering of position of eyeball or fixation of eyeball
- To chop the big nucleus pieces and partial chopping or teasing of nucleus



Figs. 8A to E: Orientation of nucleus pieces with phaco tip: (A and B) Catch at apex of nucleus piece; (C) Catch at the edge and apex of nucleus piece; (D) Catch at the long axis of nucleus piece; and (E) Catch the bulk of nucleus mass.

Fig. 9A

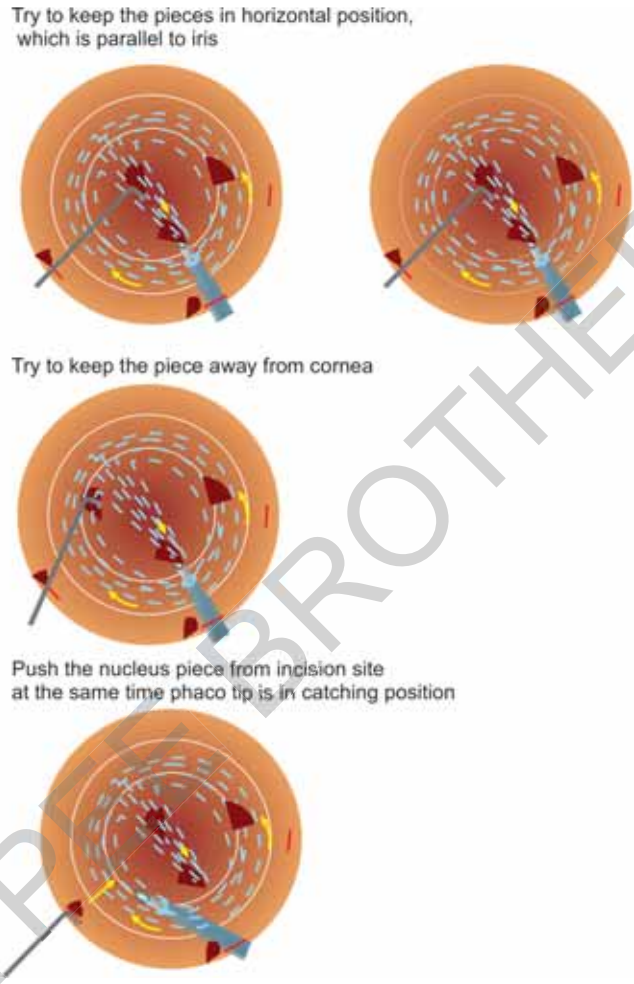


Fig. 9B

Figs. 9A and B: (A) Role of chopper for reorientation of nucleus pieces and (B) Role of chopper in removal of small pieces.

- Reorientation or guiding of nucleus pieces toward phaco tip by disengaging the nucleus or by pushing nucleus piece away from phaco tip
- Keep horizontal plane of nucleus pieces which are wandering in the anterior chamber.

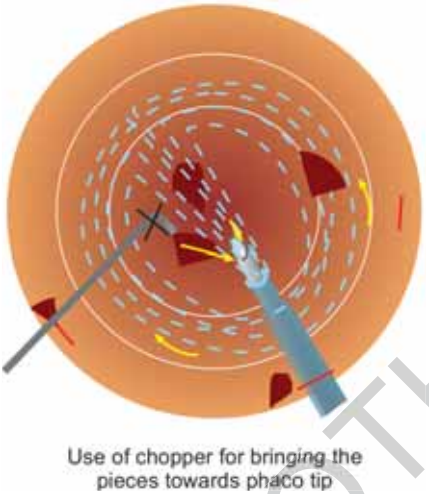


Fig. 10: Misuse of chopper.

- To keep or maintain same plane of phaco tip and nucleus piece
- Try to keep nucleus pieces away from cornea.
- To push the pieces of nucleus which got stuck at side port incision
- Minimum use of chopper for removal of small pieces is more effective.

MISUSE OF CHOPPER (FIG. 10)

To bring nucleus pieces toward phaco tip.

Disadvantage of Chopper

Water current diverts toward side port, so effectivity of flow rate decreases.

VISCOELASTICS AND VISCOCANNULA

- To inflate the anterior chamber and bag
- Keep the pieces away from cornea and posterior capsule.
- Try to bring the pieces toward the safe zone.
- Try to push the pieces in the center, which get stuck at incision sites.
- If tubings get blocked by nucleus pieces and phaco stops working—at this movement, phaco tip should move out of

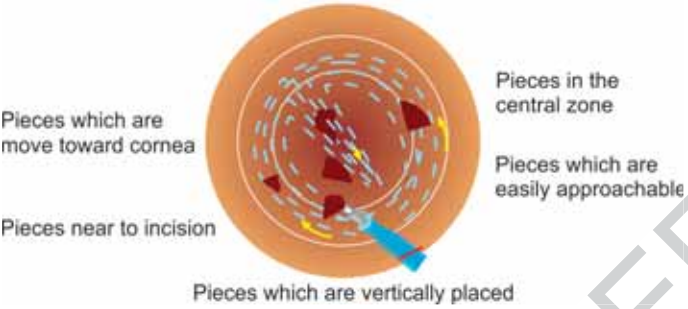


Fig. 11: Which piece to remove first.

anterior chamber and it should be inflated by putting viscoelastics through side port.

- Small pieces of nucleus can be removed by viscoelastics.

Which Pieces to Remove First (Fig. 11)

- This is not in the surgeon's hand as nucleus pieces are wandering here and there due to water current. Still, some points concerned with this will be helpful for this procedure.
- Nucleus pieces in central safe zone can be removed easily.
- Piece which moves toward cornea
- Pieces which are easily approachable to phaco tip
- If two pieces are there, the piece which is near to main incision should be removed first.
- If hard part of particular nucleus piece touching endothelium
- Big piece wandering in the anterior chamber should be tackled first.

Which Piece to Remove Last

- Nucleus piece which is near to posterior capsule
- Piece wandering in the bag
- Pieces which are awkwardly approachable to phaco tip.

COMPLICATIONS

As in other steps, these steps are also having some complications. Two most important complications are as follows:

1. *Hazy cornea:*
   - Mechanical touching of phaco tip, chopper, viscocannula, and nucleus pieces
   - Sudden collapse of chamber due to surge during procedure
   - If nucleus pieces stay longer near cornea
   - If phaco tip is over the nucleus piece during removal
   - If preexisting shallow anterior chamber
   - Unnecessary use of energy in empty space of anterior chamber
   - Use of energy without opposition of nucleus or without engaging the nucleus
   - Use of energy near cornea
   - Sudden removal of phaco tip out of eye due to any reason collapses anterior chamber and nucleus pieces can hit the cornea.
2. *Posterior capsule rupture:*
   - Mechanical injury by phaco tip, chopper, and viscocannula
   - Use of wrong parameters near posterior capsule
   - Use of parameters without engaging nucleus pieces
   - Wrong placement of phaco tip with respect to nucleus pieces
   - Emulsification of pieces in the bag

KEY POINTS

Chances of PCR are very common in this step, so to understand all principles related to phaco fluidics and associated factors is mandatory.

LIVE SURGERY PHOTOGRAPHS (FIGS. 12A TO Z)

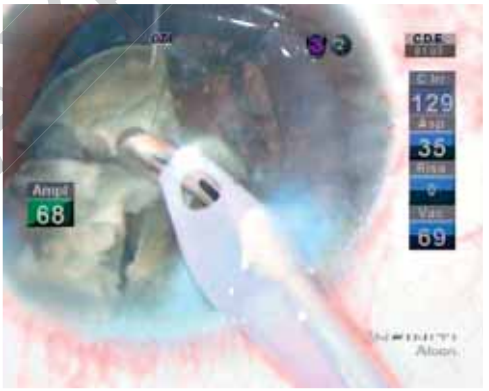


Fig. 12A: In torsional technology with Kelman tip, horizontal placement of tip, parallel to the nucleus mass is important for the removal of small pieces.

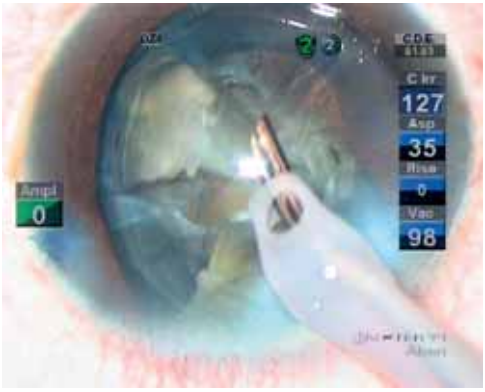


Fig. 12B: Bevel sideways to catch the apex of the nuclear mass.

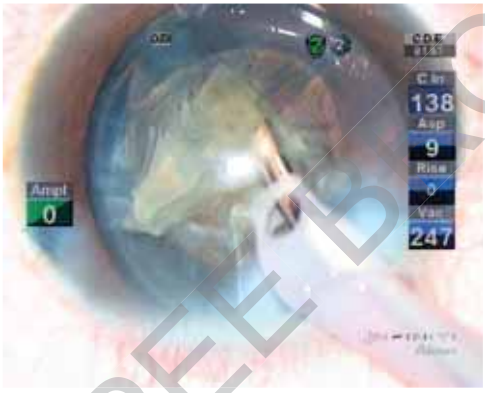


Fig. 12C: Placement of the phaco tip to round edge of the nucleus mass helps in speedy removal of nucleus mass which is opposite to longitudinal phaco.

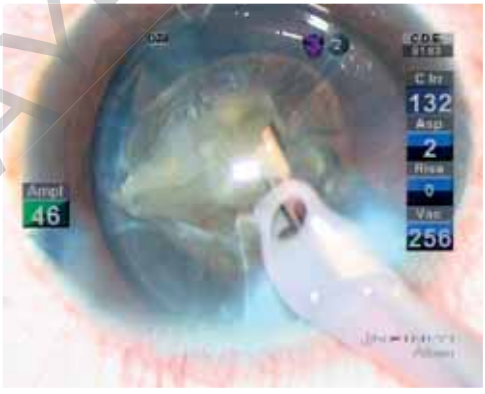


Fig. 12D: Torsional phaco energy started with adequate vacuum.

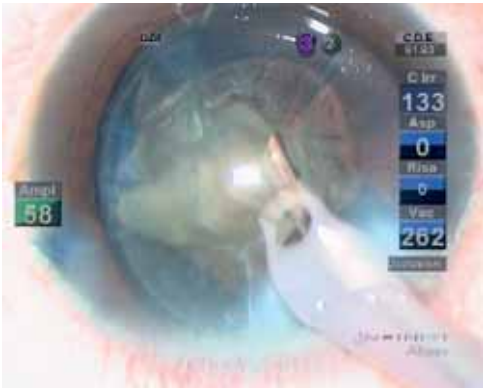


Fig. 12E: Nucleus is removed at the level of capsulorhexis or just anterior to it.

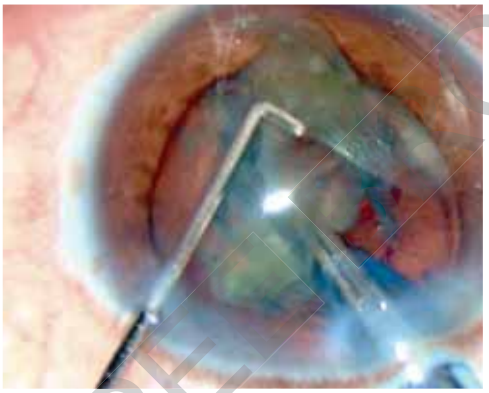


Fig. 12F: For hard nuclear mass, chopper assisting for chopping, teasing (partial chopping), reverse chopping, or release the piece for proper reorientation of nucleus mass for better emulsification.

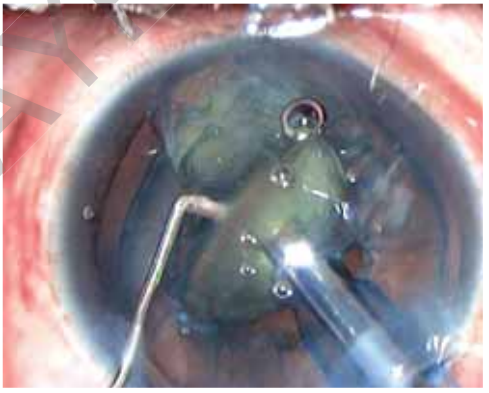


Fig. 12G: During emulsification, if bulk is big, chop first and then emulsify the piece.

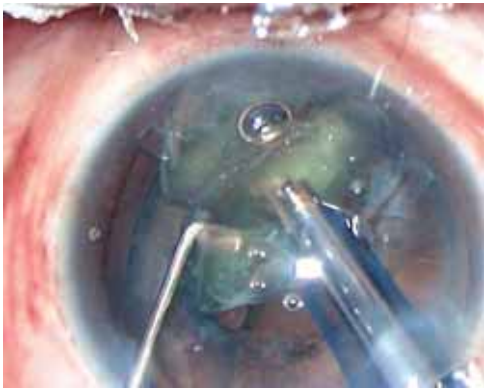


Fig. 12H: Chopping of the big piece is done.

Fig. 12I: Emulsification of piece usually at the central safe zone (CSZ).

Fig. 12J: Plane of nucleus mass and phaco tip should be usually at one level.

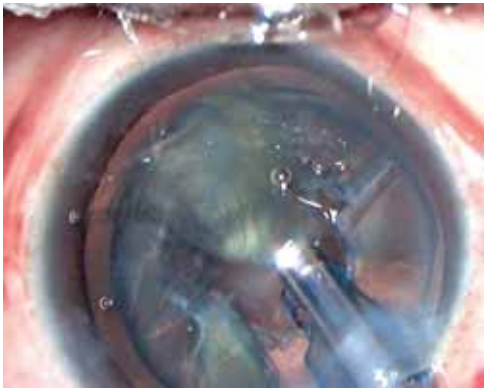


Fig. 12K: Only phaco tip without chopper in the eye for better followability of the tissue which hastens the nucleus emulsification.

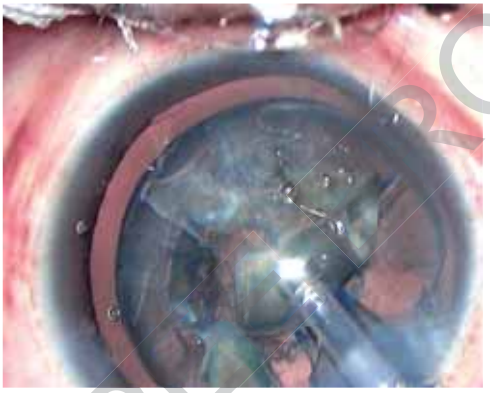


Fig. 12L: Direction of phaco tip toward nucleus mass; bevel-up position of phaco tip for emulsification of nucleus mass is having advantage of better visualization and better fluidics.

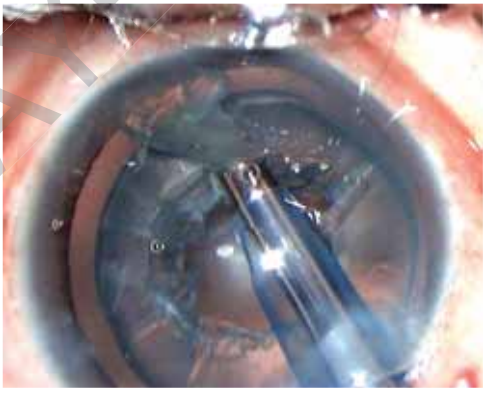


Fig. 12M: The peripheral piece brought at the central safe zone before emulsification.

Simplified Phacoemulsification

Salient Features

- Contains concepts of phaco in a very precise but simplified way
- Gives an idea of technical details of the steps of phaco
- Provides important information which is helpful to all ophthalmic surgeons, paramedical staff like technical people related to phaco machine, nursing staff, mainly operation theater assistants
- Presents the author's views, ideas and concepts related to phaco, that he gathered in the form of notes in a concise way, which is concerned mainly with technical details and experienced views related to phaco.

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