Systematic Transition to Phaco-Chop

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ABSTRACT

Phaco surgeons initially train in a four quadrant divide and conquer technique. Subsequently, several surgeons transition to chopping techniques due to the perceived advantages of phaco-chop that include lower ultrasound energy and lesser zonular stress. Stop and chop has conventionally been the technique of choice for making this transition. However, the surgeon has to execute a full-fledged chop after the creation of two hemi-segments by the classical trenching and cracking skills already acquired in divide and conquer techniques. Here we describe a set of intermediate steps during four quadrant divide and conquer that breaks down the skills required for chopping and enables the surgeon to sequentially imbibe the required skill sets to make the transition to chop safer and smoother.

KEY WORDS: Chop, divide and conquer, phacoemulsification, transition

INTRODUCTION

Divide and conquer and various chopping techniques are among the popular methods to create nuclear segments during phacoemulsification. Divide and conquer is the technique most phaco surgeons master initially. Several surgeons transition to chopping techniques due to the perceived advantages of phaco-chop that include lesser zonular stress, ultrasound energy and endothelial damage. Stop and chop has conventionally been the technique of choice for making this transition. However, after the creation of two hemi-segments by the classical trenching and cracking skills already acquired in divide and conquer techniques, the surgeon has to execute a full-fledged chop to further fragment a hemi-nucleus. We describe a set of intermediate steps during four quadrant divide and conquer to breakdown the skills required for chopping into its constituent components and enable the surgeon to sequentially imbibe the required skill set to make the transition to chop smoother.

SURGICAL TECHNIQUE

The surgery starts with the main and side port incisions, a 5-5.5 mm diameter capsulorhexis under an appropriate ocular viscoelastic device, followed by hydrodissection and hydrodelineation to achieve a mobile nucleus. A proximal down-slope trench is performed starting from the proximal sub-incisional area just within the capsulorhexis margin and...
extending till the midpoint of nucleus. A 45° Kelman tip allows the surgeon to perform deep proximal down slope sculpting with minimal corneal folds.

During trenching, one is working in the center of the pupil in the deepest part of the capsular bag and within the confines of the “golden” hydrodelineation cleavage ring. Trenching is continued till a deep trench is achieved that is characterized by only linear striations visible on the floor of the trench that run parallel to the long axis of the trench. The surgeon will be able to appreciate the posterior embryonal “Y” suture where the linear striations on the floor of the trench meet at the midpoint of a well centered trench (Figure 1). This lens morphology-based clinical indicator is exploited to determine the end point for trenching.

**Classical divide**

The phaco tip and the preferred second instrument are placed distally and deep in the floor of a deep trench. The foot pedal remains in position one only. The phaco tip is held steady against one side wall of the trench while the second instrument exerts a lateral separating force against the opposite wall of the trench to achieve a classical divide that extends beyond the mid-point of the posterior plate (Figure 2). Sequential repetition in all the trenches completes segment creation.

**Modified divide**

The phaco tip is impaled in the side wall of the trench by a short burst of power (foot position 3), and then the nucleus is held stable with high vacuum (foot position 2). The surgeon focuses on phaco tip and foot pedal position and control as these are the new and unfamiliar steps to execute (Figure 3). The lateral separating force by the second instrument against

![Figure 1: Adequacy of trenching is determined by the presence of linear fibers along the entire floor of the trench that run parallel to the long axis of the trench and which meet at the posterior embryonal “Y” suture.](image1)

![Figure 2: During classical divide, the phaco tip and the second instrument are placed distally and deep in the floor of a deep trench. With irrigation on, the phaco tip is held steady against one side wall of the trench while the second instrument exerts a lateral pressure against the opposite wall of the trench to achieve a classical divide that extends beyond the mid-point of the posterior plate. Sequential repetition in all the trenches completes segment creation.](image2)

![Figure 3: In a modified divide, the phaco tip is impaled in the side wall of the trench by a short burst of power (foot position 3) and then the nucleus is held stable with high vacuum (foot position 2). A lateral separating force by the second instrument against the opposite wall of the trench splits the nucleus.](image3)
the opposite wall of the trench to split the nucleus is executed autonomously as it is already a well-practiced maneuver during classical divide.

**Modified chop**

Once the surgeon achieves a measure of comfort in impaling and holding the nucleus, the next stage of training of the non-dominant hand occurs during a modified chop. The surgeon concentrates on the new step of performing a chop to split the trench. Minimal force and control are required to create the segment, as the chop is executed in the distal end of a trench, where the trench itself further weakens the naturally existing fault lines created by the radial arrangement of the lens fibers (Figure 4). If unsuccessful in creating a segment by chopping the trench, the surgeon can always create segments as in a classic divide and conquer phacoemulsification.

The modified chop can be either a horizontal or a vertical chop. Attention is paid to positioning the second instrument at the equator of the endonucleus and generating opposing forces without torque when performing a modified horizontal chop. In a modified vertical chop, the second instrument vertically splits the region of the nucleus between the distal end of the trench and the equator of the endonucleus.

**CLASSICAL CHOP**

Once the surgeon has mastered the mechanics of the individual skill-sets and is able to perform them autonomously, the surgeon can easily combine all the individual components in a classical chop technique to perform either stop and chop or primary chop method of phacoemulsification (Figure 5). The phaco tip is embedded in the center of the nucleus in x, y and z dimensions. The second instrument is drawn from the equator of the endonucleus to execute a horizontal chop or vertically cleaves the lens fibers during a vertical chop.

**DISCUSSION**

In classic in situ fracture of the nucleus, a groove was created using shallow sculpting motions or proximal downslope sculpting. The nucleus was rotated one-quarter turn with the second instrument, and another groove was created perpendicular to the first one. After the nucleus was trenched to the extent of a “deep trench” as judged by the linear lens fiber orientation in the floor of the trench and the posterior Y suture at the midpoint of a well-centered cruciate trench, the posterior plate of the nucleus was fractured by applying lateral separating pressure on the side walls of the trench. This process was repeated by rotating the nucleus within the capsular bag until four free-floating nuclear quadrants were created. Each quadrant was then emulsified.

![Figure 4](image_url): The surgeon performs either a horizontal or a vertical chop to split the trench in modified chopping. Minimal force and control are required to create the segment as the chop is executed to exploit the naturally existing fault lines created by the radial arrangement of the lens fibers in a trench.

![Figure 5](image_url): Classical chop: Once the surgeon has mastered the mechanics of the individual skill-sets and is able to perform them autonomously, the surgeon can easily combine all the individual components in a classical chop technique.
During either vertical or horizontal chopping, the surgeon had to impale the nucleus with the phaco-tip and use appropriate vacuum to stabilize it, while the second instrument exploited the radially oriented fracture lines created by the lens fibers to cleave the nucleus into fragments.\cite{15}

Stop and chop had conventionally been the technique of choice for making the transition to chop.\cite{12} A surgeon skilled in divide and conquer phacoemulsification had the necessary trenching and cracking skills to create two hemi-segments. Then the surgeon had to chop each hemi-segment into quadrants or smaller fragments depending on the nuclear hardness. This chop was made easier by the ability of the surgeon to visualize the thickness of the hemi-nucleus and impale the phaco-tip in the center of the nucleus in three dimensions. However, the surgeon had limited opportunities to practice the requisite phaco-tip, the second instrument and the foot pedal coordination outside the wet-lab.

The skills set required for classic in situ fracture and classic chopping were broken down to the constituent components (Table 1). From the comfort level of the surgeon skilled in classical divide and conquer, a step by step approach was used to initially train the dominant hand to impale the nucleus with the appropriate foot pedal control while performing a modified divide. Once the surgeon achieved a measure of comfort in impaling and stabilizing the nucleus, modified chopping either horizontal or vertical helped to train the non-dominant hand. Finally, all the individual components could be combined in a classical chop technique.

Dreyfus’ theory of experiential learning\cite{16} proposes that any surgical skill requires a combination of “techne” or craft that is the explicit knowledge related to procedural or scientific knowledge and “phronesis” or practical wisdom that is the reasoned practice developed through experiential learning, where the surgeon is continually improving her or his practice. Our technique embraces Dreyfus’ theory by analyzing the skills sets required for chopping and breaking them down to the constituent components from the point of view of both the “techne” as well as the “phronesis.” This method also embraces Fitts and Posner’s 3-stage theory of motor skill acquisition.\cite{17} Initially, in the cognitive stage, the learner intellectualizes the task to understand the mechanics of the skill. In the integrative stage, knowledge is translated into appropriate motor behavior and the execution is fluid. Finally, in the autonomous stage, the learner no longer needs to think about how to execute that particular task and can concentrate on other aspects of the procedure.

The surgeon through Dreyfus’ theory of experiential learning, moves from classical divide to modified divide, modified chop and finally masters classical chop after having reached the autonomous stage of Fitts and Posner’s 3-stage theory of motor skill acquisition at each step. The surgical technique described here thus gives a graded enhancement of the skill sets for chopping and would make the transition to chopping easier for surgeons comfortable with divide and conquer phacoemulsification.

### REFERENCES

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