BRIEF REPORT

Rotary Chop: A New Technique for Teaching Chop and Tackling Mature Cataracts

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ABSTRACT

Introduction: Here we describe a new cataract chop technique that is most valuable for two groups of ophthalmologists: (1) experienced surgeons encountering challenging nuclear fragmentation due to mature cataracts or zonulopathies, and (2) inexperienced surgeons wishing to develop skills necessary for chopping techniques.

Methods: We have termed this new method “rotary chop,” since the partial thickness pilot holes created by the phacoemulsification

(phaco) tip around the periphery of the nucleus produce a rotary phone dial appearance on the surface of the cataract. By creating these pilot holes, the surgeon is able to easily place the chopper deep into the body of the nucleus, avoiding the need to apply vertical piercing force to the nucleus.

Results: The patient in the technical video had a 4+ nuclear sclerosis cataract. The preoperative vision in this eye was counting fingers at 2 feet with no improvement with refraction. On postoperative day 1, visual acuity had improved to 20/80. By postoperative week 1, best-corrected visual acuity was 20/20 (20/25-2 uncorrected).

Conclusion: This method avoids unnecessary zonular stress. Additionally, inexperienced surgeons using this technique during routine cataract surgery are able to quickly master the movements necessary for both vertical and horizontal chop in a safer environment.

Keywords: Cataract surgery; Chop; Complex cataract; FLACS; MSICS; Phacoemulsification; Resident; SICS; Teaching phaco; Training

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Key Summary Points

Dense cataracts increase the difficulty of phacoemulsification and lead to higher rates of complications, even by experienced surgeons.

The chop technique is a difficult skill to master by surgeons in training.

We have designed a chop technique that allows for safer nuclear disassembly in dense cataracts by experienced surgeons, and improved teaching of chop techniques to surgeons in training.

We have termed this new method “rotary chop,” since the partial-thickness pilot holes created by the phacoemulsification tip around the periphery of the nucleus produce a rotary phone dial appearance on the surface of the cataract.

INTRODUCTION

Cataracts are the leading cause of preventable blindness worldwide [1], and surgery remains the only intervention available to restore vision in advanced cases. Multiple techniques have been described for cataract removal [2]. Phaco remains the standard of care for surgery in the developed world. Unfortunately, phaco of dense cataractous lenses can lead to increased surgical time and complications [3]. Alternatives and adjuvants to phaco include femtosecond laser-assisted cataract surgery (FLACS) and small-incision cataract surgery (SICS). Studies have shown that FLACS for dense cataracts can be complicated by incomplete capsulotomy, inconsistent nucleus disassembly, and posterior capsule rupture [4, 5]. Besides added cost, FLACS can add a significant amount of time to cataract surgery [6]. Because of the difficulties that dense cataracts present to traditional phaco and FLACS, SICS is a cheaper and faster alternative [7]. However, most surgeons in

the developed world are inexperienced in SICS. This limited utilization of SICS in the developed world has driven the authors to develop a safe and efficient method of phaco-dependent nuclear disassembly, especially for particularly dense cataracts.

Prior publications have shown a fourfold decrease in phaco energy, lower power, and less operative time using the chop techniques compared with divide and conquer [8, 9]. This discrepancy between phaco energies widens with increasing densities of the lens [10]. In addition to lower energy, chop techniques have a presumed decrease in stress on the capsular zonules, but this has not been quantified or measured. In spite of these differences, studies show that there is a similar best-corrected visual acuity and amount of endothelial cell loss at 12 months between the two techniques [11]. However, these study patients were not randomized, and cataract density was not taken into consideration.

There are many techniques that fall under chop, including stop and chop, vertical chop, and horizontal chop. The standard maneuvers among the different varieties of chop remain the same, as do the overall benefits. All forms rely on the natural fault lines within the crystalline lens. Kunihiro Nagahara presented the first chop technique in 1993; this initial technique was later coined “horizontal chop,” as the chopper slides around the equator of the lens and then meets the phaco tip in the horizontal plane to create a crack. In the vertical chop technique, the phaco tip is impaled into the lens and lifted as the chopper is depressed to propagate the crack. Finally, stop and chop uses a central groove to create space to subsequently horizontal-chop the heminucleus [12].

A separate problem altogether is teaching inexperienced surgeons to safely master multiple nuclear disassembly techniques prior to graduating from a residency training program. Certain steps in cataract surgery are more difficult to master than others. Sen et al. looked at a trainees’ first ten cases of phaco. Upon completion of the case, the trainees perceived nucleus disassembly and phaco as the hardest steps, with the lowest stepwise completion rate [13]. This is often taught initially in a divide-

and-conquer fashion. A recent survey of program directors showed that 56.6% of residents initially learn divide and conquer. The next most common was stop and chop, with 25.4% of residents [14]. There is no data on which phaco technique is easier to learn. However, a UK survey of educators showed that 72.9% of respondents preferred to teach divide and conquer to trainees, but only 49.7% preferred divide and conquer as their personal operating technique [15]. Hesitation to teach the chop technique is likely due to the difficulty of the chop maneuvers. One of the frequent pitfalls of chop is the depth of the second instrument, with incomplete cracking occurring when the chopper is too shallow in the nucleus. Another pitfall is breaking the occlusion of the vacuum during the chop maneuver, which also leads to an inability to propagate a complete crack.

Here, we describe a new technique that can aid the experienced phaco surgeon during challenging cases of dense nuclear cataracts or zonulopathies, and help an inexperienced surgeon master the movements necessary for chop. We have termed this new method “rotary chop,” since the partial-thickness pilot holes created by the phaco tip around the periphery of the nucleus produce a rotary phone dial appearance on the surface of the cataract (Fig. 1).

Fig. 1 A cartoon illustration of a rotary phone. Accessed 12/30/2019 <https://www.kisscc0.com/clipart/mobile-phones-telephone-call-rotary-dial-cartoon-p-r57tsp/>

METHODS

This single patient case report contains no unique identifiers, is HIPAA compliant, and qualifies for exemption from the Colorado Multiple Institutional Review Board. All necessary surgical consent was obtained from the patient.

No additional equipment is required for this technique compared with traditional phaco beyond an adequate chopper. The most important characteristic of the chopper is to have enough tip length and angulation at the neck to allow the chopper tip to enter the pilot hole deeply and easily. Our video example uses the Nichamin Quick Chopper II (Rhein Medical, St. Petersburg, FL, USA).

Traditional chop phaco settings can be used with no adjustments needed. Our video example uses a Centurion Vision System (Alcon, Fort Worth, TX, USA) with the following parameters: longitudinal phaco at 30% power in burst mode, 60 mmHg intraocular pressure (IOP), 525 mmHg of vacuum, and 33 cc/min of aspiration flow.

Steps

A limbal paracentesis is created. Preservative-free intracameral lidocaine 1% is instilled into the anterior chamber followed by a dispersive ophthalmic viscosurgical device (OVD). A 2.4 mm tri-beveled clear corneal incision is made temporally 85°–90° away from the paracentesis. A continuous curvilinear capsulotomy is created and hydrodissection is performed. Mobility of the lens is important; ensure adequate nuclear rotation prior to initiating chop. The sleeve on the phaco tip is exposed to a greater degree than typical depending on how dense the lens is (more tip exposure for denser cataracts, usually 3–4 mm). The phaco tip is introduced through the main wound, and anterior cortical material is removed inside the area of the capsulotomy. The chopper is introduced inside the eye. With either bevel-down or bevel-up phaco technique, the phaco tip is angled steeply posterior in the mid-periphery of the nucleus, next to the capsulotomy edge

Fig. 2 Proper positioning of the phaco instrument prior to creation of the first pilot hole. Note that the cortex and epinucleus have been removed in the area of the capsulorhexis, exposing the anterior surface of the nucleus

Fig. 3 Creation of the first pilot hole. Once the phaco tip is impaled to the level of the instrument sleeve, the surgeon should discontinue phaco energy and aspiration by returning to position 1 on the foot pedal. This allows the phaco tip to be removed from the nucleus

(Fig. 2). Using the chop ultrasound setting described above, the phaco tip should be burrowed into the nucleus until the instrument sleeve reaches the lens surface (Fig. 3). Once this is achieved, return to foot position 1 (irrigation) and remove the tip from the nucleus. Rotate the lens 180° so that the initial pilot hole is opposite the main wound (Fig. 4). Once again, angle the phaco tip steeply posteriorly in the mid-periphery of the nucleus next to the capsulotomy edge, and burrow into the nucleus until the instrument sleeve reaches the lens surface. Next, return to foot position 2 (vacuum) and discontinue any phaco energy (as is typical in a routine chop technique). Place your chopper tip deeply into the original pilot hole (Fig. 5). Bring

Fig. 4 The lens is spun 180° away from the main incision so that the original pilot hole is now across from the phaco tip

Fig. 5 Once again, the phaco tip is advanced into the cataract as is done with a vertical chop technique. This time, vacuum is held, and the chopper tip is placed into the pilot hole across from the phaco tip. The chopper and phaco tip are brought together in order to create and propagate the nuclear crack, separating the two heminuclei

Fig. 6 Example of multiple pilot holes in the nucleus prior to nuclear cracking

the chopper and phaco tip together to initiate a crack, then use both instruments to separate the two heminuclei and propagate the crack.

An alternative to this method is to create more than one pilot hole to aid in cracking the lens into quadrants (Fig. 6). Regardless of the number of pilot holes made, these holes should be completed prior to the first chop sequence and segmentation to ensure adequate stability and decreased movement of the nucleus during pilot hole creation.

Once segmented, quadrant/segment removal may continue as usual.

RESULTS

The patient in the above technical video had a 4+ nuclear sclerosis cataract (based on the World Health Organization's simplified cataract grading system) with brunescence, poor red reflex, and no view to the posterior pole on clinical exam. The preoperative vision in this eye was counting fingers at 2 feet with no improvement with refraction. Using the rotary chop technique for nuclear disassembly, the cumulative dissipated energy at the conclusion of the case was 14.26. On postoperative day 1, visual acuity had improved to 20/80+. By postoperative week 1, best-corrected visual acuity was 20/20 (20/25-2 uncorrected).

DISCUSSION

This new rotary chop technique is favorable for multiple reasons. First, it easily lends itself to the teaching of chop techniques. Whether the ultimate goal is to master horizontal chop or vertical chop, rotary chop is a stepping stone to all chopping techniques.

For horizontal chop, many inexperienced surgeons have difficulty placing the horizontal chopper underneath the anterior capsule and out along the lens equator. Poor visibility and unfamiliar maneuvers during chopper placement in the periphery create an uncomfortable environment for the surgeon. This uncertainty leads to hesitation and improper superficial chopper placement, culminating in a horizontal chop maneuver that is unable to create a full crack in the nucleus. Rotary chop

allows beginners to become comfortable with the horizontal chop maneuver inside the well-visualized safety zone of the capsulotomy. By becoming comfortable with tilting the chopper into the pilot hole, surgeons can gain experience with this maneuver before moving on to a true horizontal chop.

For vertical chop, a strong purchase on the nucleus is needed to provide counter traction for the vertical chopper. Many inexperienced surgeons run into the problem of displacing the nuclear fragment from the phaco tip. This breaks the vacuum force and prevents an adequate crack from propagating through the nucleus. Rotary chop allows beginners to place the vertical chopper inside the pilot hole and conduct the maneuver necessary to create and propagate a nuclear crack in the same fashion as vertical chop. Once a surgeon masters this movement, it is possible to easily transition to the full vertical chop sequence.

A second reason that rotary chop is favorable is that it lends itself well to dense cataracts or lenses with zonulopathy. By creating deep pilot holes inside the mature nucleus, the surgeon creates a cleft that is deep enough to propagate cracks even in very dense lenses. Multiple pilot holes can be created in order to repeat the process more than once. In the authors' experience, this process has been shown to significantly decrease the cumulative dissipated energy. Furthermore, dense lenses in patients with pseudoexfoliation or other zonulopathies create a precarious situation in which undue stress on the zonules during chop maneuvers can lead to intraoperative complications. Using rotary chop to create pilot holes alleviates the force placed on the nucleus (and thus zonules) during nuclear manipulation in vertical chop.

CONCLUSION

In summary, we describe a new technique coined "rotary chop" that facilitates learning of the chop technique and also allows for easier disassembly of mature or complex cataracts. Similar techniques have not been described in the literature outside of a traditional central

groove being created by consecutive drilling with the phaco tip [16]. We hope that this new technique enhances our ability to train the next generation of phaco surgeons and allows experienced surgeons to more safely tackle mature cataracts.

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Compliance with Ethics Guidelines. This single patient case report contains no unique identifiers, is HIPAA compliant, and qualifies for exemption from the Colorado Multiple Institutional Review Board. All necessary surgical consent was obtained from the patient.

Data Availability. Data sharing is not applicable to this article, as no datasets were generated or analyzed during the current study.

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