Zero Phaco: A new technique for dealing with soft cataracts

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Phacoemulsification in soft cataracts can be challenging due to the lack of rigid cleavage planes and the inability to crack. We describe a new phacoemulsification technique for dealing with soft cataracts using high vacuum and zero energy. Following capsulorhexis and hydrodissection, we introduced the phacoemulsification probe, keeping the torsional and longitudinal power at zero. A central groove was created in sculpting mode. We held the nucleus with adequate vacuum in chop mode and divided the nucleus. Then, we rotated and chopped the nucleus similarly into small pieces without using any power. For emulsification, we increased the vacuum to 600 mmHg and then shredded and stuffed the pieces into the phaco probe by the chopper. A newer generation phaco machine with active fluidic system and monitored pressurized infusion helps the surgeon control the intraocular pressure (IOP) and hold the nucleus with vacuum alone, allowing chopping and emulsifying of the pieces without any energy.

Key words: High Vacuum, phacoemulsification, soft cataract, zero energy

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Any intraocular surgical procedure involves varying amount of endothelial cell loss. Corneal endothelial cell loss is a significant side effect of phacoemulsification surgery resulting from heat and free radical formation by ultrasound waves during the surgery.[1] The extent of the damage depends on many factors like the technique employed, the surgeon's experience, preoperative status of the endothelium, density of the nucleus, intraoperative complications, and so on.[2] Studies have shown that phacoemulsification is safer and more feasible if the corneal endothelial cells are exposed to minimal ultrasound energy.[3] Increased infusion volume is also associated with higher endothelial cell loss. The higher volume of balanced salt solution (BSS) used during phacoemulsification is also associated with a higher endothelial cell loss.[4] Excessive surgical manipulation and repetitive movements in the anterior chamber may also increase the risk of endothelial cell loss.

Surgeons, technologists, and manufacturers are trying their best to bring down the damage caused by ultrasound energy on endothelial cells. Application of endocapsular phaco, femtosecond laser pretreatment, and dispersive Ophthalmic Viscosurgical Devices (OVD) are few steps toward minimizing the damage caused by ultrasound on the corneal endothelium.[5]

The Centurion Vision System (Alcon Laboratories, Fort Worth, TX, USA), the new-generation phacoemulsification system, came to the market with many new features. The most remarkable changes are introduction of active fluidics and dual-segment pump technology.[6] The active fluidic system does away with the age-old gravity-driven irrigation system. With the help of sophisticated sensors, it allows the surgeon to work at a preset intraocular pressure (IOP) during all the stages of the surgery.[7] Phacoemulsification at low bottle height ensures less fluid turbulence and less fluid use as the IOP inside the eye remains stable in preset parameters during the procedure. The dual-segment pump technology is even more unique. There is only one peristaltic pump in other phacoemulsification systems (Infiniti and Laureate; Alcon Laboratories, USA). When the pump in these machines touches the membrane, it produces a single fluid wave with attendant peaks and troughs.[8] In a dual-segment pump, the peaks and troughs of each fluid wave neutralize the troughs and peaks of the other [Fig. 1]. This results in a smoother fluid wave when the pump works in the tubing. We have developed a cornea-friendly phacoemulsification technique for soft cataracts, where ultrasound energy is not used, taking advantage of the active fluidics and dual-segment pump technology. Phacoemulsification in soft cataracts has always been challenging even for experienced surgeons also. Many authors have tried and described many techniques for soft cataract management with reasonable success. The divide-and-conquer,[9] stop-and-chop,[10] phaco

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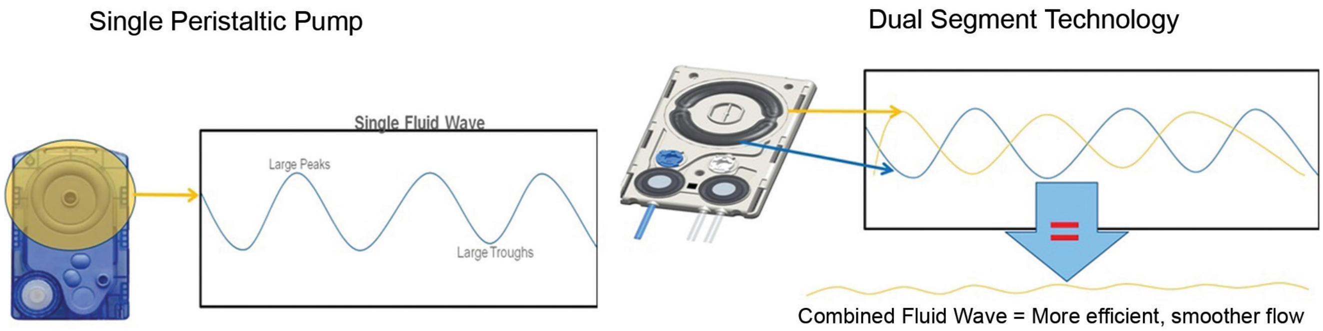

Figure 1: Schematic diagram showing the dual-segment pump of the Centurion Vision System

rolling,[11] visco-fracture,[12] bowl-and-snail,[13] and Rotation Alignment Placement Impaling Devouring (RAPID) technique for soft cataract phacoemulsification, or other methods have been used to remove a soft nucleus.[14]

Surgical Technique

The study approval was obtained from the institutional review board (IRB/CPEH/01-19-45), and it adhered to the Declaration of Helsinki. Informed written consent was collected from all the patients. The study period was from January 2019 to December 2019. The study included patients with visually significant immature cataract up to grade 2 scheduled for phacoemulsification surgery. Patients with ocular comorbidities such as glaucoma, uveitis, corneal opacity, pseudoexfoliation syndrome, Fuch's endothelial dystrophy, complicated cataract, subluxated cataract, and traumatic cataract were excluded from the study. Preoperative evaluation included uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), slit-lamp biomicroscopy, Goldman applanation tonometer (GAT), specular microscopy, and dilated fundus examination. Biometry was performed using IOL Master 700 (Zeiss, Berlin, Germany). A single experienced observer (SS) graded the nucleus using Lens Opacities Classification III.

All the surgeries were performed with the Centurion Vision System (Alcon Surgical, Inc.) using active fluidics under topical anesthesia through a 2.2 mm temporal limbal incision [Video 1]. A single experienced surgeon (NB) using an Intrepid balanced mini tip with an Ozil handpiece performed the surgeries. A 5–5.5 mm continuous curvilinear capsulorhexis was made with a 30-gauze needle cystotome under irrigation.[15] Cortical cleavage hydrodissection was performed, and the nuclear rotation was confirmed. After the initial removal of loose cortex in sculpting mode with vacuum set at 100 mmHg, the aspiration flow rate at 20 ml/min, and both torsional and longitudinal ultrasound at zero, a small groove was created at the center of the nucleus [Fig. 2a]. Parameters were now changed to IOP at 60 mmHg, vacuum at 400 mmHg, aspiration flow settings – linear at 30 ml/min, and the phacoemulsification power settings at zero in both torsional and longitudinal modes. At this set up, the phaco probe was placed at the created groove and the nucleus was held with 400 mmHg vacuum [Fig. 2b] and chopped into two heminuclei using a blunt chopper [Fig. 2c]. Since no power was used, the nucleus remained firmly held without cutting through. The nuclear fragments were then rotated, and the two hemispheres were chopped into smaller pieces [Fig. 2d–f]. Now the vacuum was increased to 600 mmHg and the pieces were aspirated out one by one. The pieces were held at the upper portion, with the bevel of the probe facing sideways. The fragment was then pulled down to the center in such a manner that the posterior surface of the fragment faced the corneal endothelium. The posterior surface composed of cortex and epinucleus was easily aspirated out, leaving behind a smaller, harder nuclear portion. This nuclear portion was then shredded and stuffed into the probe with the second instrument and taken out easily [Fig. 3a–d]. As the phaco tip remains stationary in zero power, shredding and stuffing with the second instrument do not damage the tip. The remaining cortex was then aspirated by bimanual irrigation and aspiration (I/A). A foldable, single-piece, hydrophobic, acrylic intraocular lens (IOL) was put in the capsular bag. Intracameral preservative-free 0.5% moxifloxacin (Vigamox, Alcon Laboratories, Inc) was injected. Stromal hydration was done to seal the main and side port

Table 1: Summary of the patients

Parameters	Zero Phaco
No. of patients	92
Age (Mean±SD), years	58.5±5.41
Sex (male/female)	55/37
Cataract grade (LOCSIII)	
Grade I	26 (28.26%)
Grade II	66 (71.73%)
Mean±SD	1.59±0.71
ACD (mm)	3.32±0.24
AL (mm)	22.28±0.16
Pre-op CDVA (LogMAR)	0.295±0.80
Pre-op ECD (cells/mm^2)	2558.23±175.39
Pre-op IOP	14.80±3.13
CDVA (LogMAR) at 3 months postoperatively	0.01±0.02
ECD (cells/mm^2) at 3 months postoperatively	2466±177.31
Cell loss (cells/mm^2) at 3 months postoperatively	77.07±13.77 (3.04%)

ACD=anterior chamber depth, AL=axial length, CDVA=corrected distance visual acuity, ECD=endothelial cell density, IOP=intraocular pressure, LogMAR=logarithm of the minimum angle of resolution, SD=standard deviation

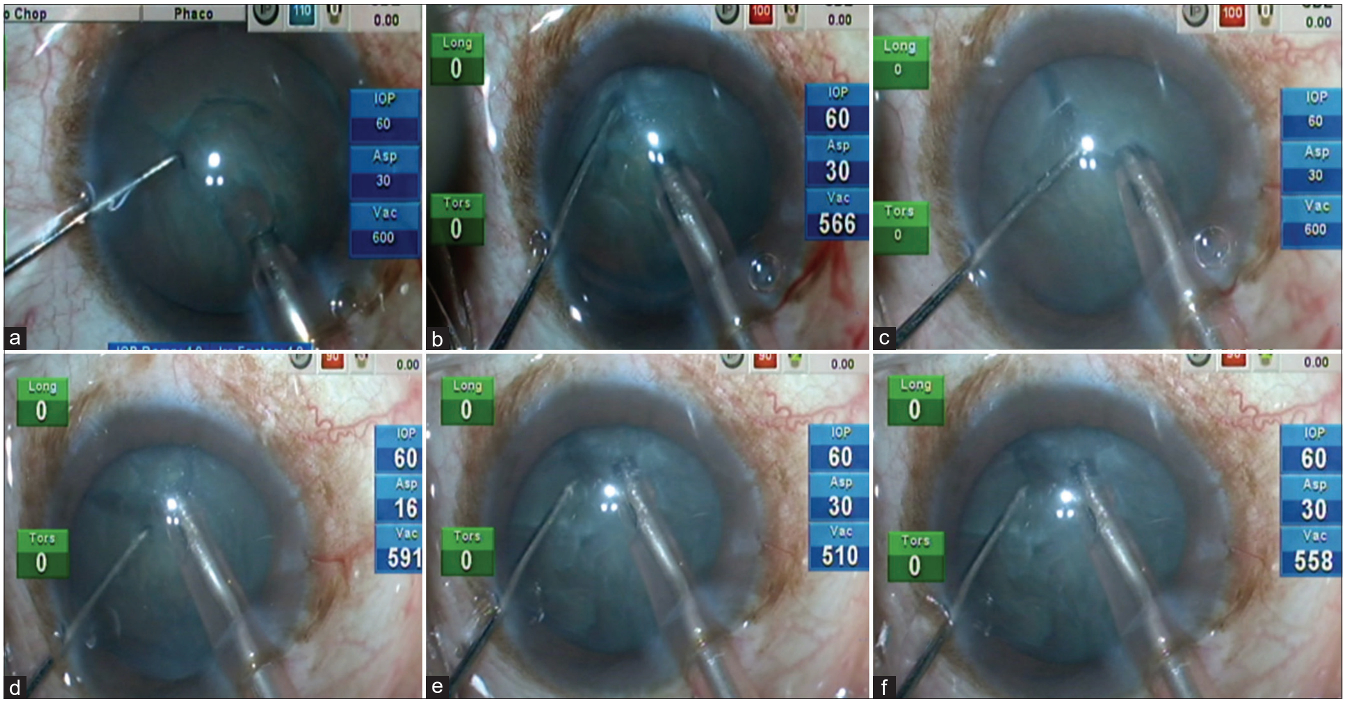

Figure 2: (a) A small groove is created at the center of the nucleus with the phaco probe. (b) The phaco probe is placed at the created groove and the nucleus is held with 400 mmHg vacuum. (c) The nucleus is chopped into two heminuclei using a vertical chopping method. (d) The nucleus is rotated and the two heminuclei are further divided into fragments (e and f). The fragments are further chopped into smaller pieces

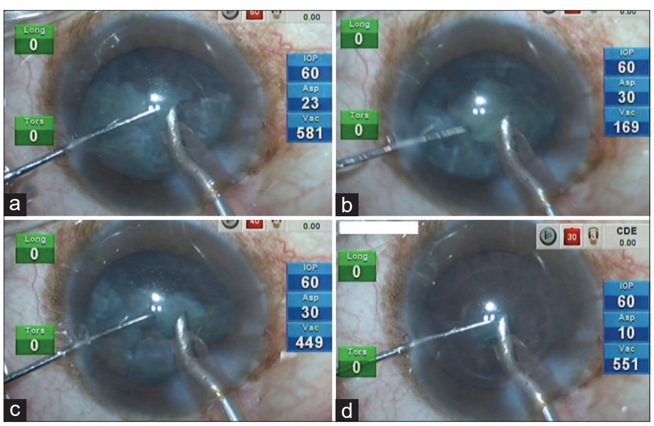

Figure 3: (a–d) The nuclear fragments are slowly aspirated with a high vacuum and with the help of a second-hand instrument

incisions. Standard postoperative medication was prescribed to all the patients.

Results

The study included 92 eyes of 92 patients. The mean age of the patients was 58.5 ± 5.41 years [Table 1]. Out of these 92 patients, 55 (59.78%) were males and 37 (40.21%) were females. The mean cataract grade was 1.59 ± 0.71. The mean CDVA improved from 0.295 ± 0.22 logarithm of the minimum angle of resolution (LogMAR) to 0.01 ± 0.02 LogMAR at 3 months postoperatively. The mean endothelial cell loss was found to be 77.07 ± 13.77 cells/mm^2 (3.04%) at 3 months postoperatively. There were no intraoperative complications like posterior capsular rupture (PCR), iris trauma, sudden anterior chamber shallowing, vitreous loss, and zonular dialysis.

Discussion

Soft cataracts are characterized by a minimally dense nucleus and an abundant sticky cortex.[16] They occur in pediatric or young adults, mostly as posterior polar or subcapsular opacities. Most common etiologies include diabetes, intraocular inflammation, steroid usage, or blunt trauma.[17] Soft lenses are also encountered in the setting of lenticonus or refractive lens exchange for presbyopia.[18] They are frequented by a cataract surgeon nowadays due to the increasing patient awareness and early presentation to the clinic.[14] These patients have high expectations on the visual outcome as they are young and the preoperative vision is fair. While phacoemulsification of hard cataracts has received much consideration and most surgeons routinely perform the divide-and-conquer or the phaco chop technique, softer cataracts are not conducive to these techniques.

Soft cataracts often challenge many of the standard techniques for phacoemulsification because of lacking rigid cleavage planes and their inability to crack. They tend to be sticky and resist nuclear rotation as the dialing instruments tend to pass through them without exerting any torque. Standard divide-and-conquer technique may impose a higher risk of capsular tear during sculpting as there is a risk of the phaco tip going rapidly through the soft nucleus and eventually through the posterior capsule.[9] Supracapsular phaco techniques improve capsular safety, but may be challenging in small pupil or small capsulorhexis situation.[19] They place the corneal endothelium and trabecular meshwork at greater risk of damage from ultrasound energy. Soft nuclei post difficulties to the traditional chopping techniques.[20] Using a higher vacuum to impale the nucleus for chopping results in the soft lens material aspirated into the phaco tip with a loss of holding power. The chopper tends to cheese wire through the nucleus during the separation. The higher vacuum causes the nucleus to jump into the phaco tip and create a "Swiss chess" or hole in the lens. Trying to impale and extract each quadrant can result in repeated loss of lens holding, ultimately creating a bowl of nuclear material. Further attempts can convert this bowl into a plate, increasing the difficulty in its removal. In torsional phaco technologies, adequate lens purchase may be suboptimal and lead to inefficient chopping. Thus, mobilizing and fragmenting them can be surprisingly challenging, especially for novice surgeons.

The advantages of our technique include no use of phaco power at any step of the surgery, thus protecting the corneal endothelium and intracameral structures and leading to less chance of complications. The Centurion Vision System achieves this with dual pump and active fluidics, which monitors pressurized infusion. It enables the surgeon to maintain the IOP and anterior chamber stability more effectively with improved surgical efficiency. Higher vacuum in the gravity fluid system causes aspiration of the soft nuclei, resulting in post-occlusion surge and PCR.[21] To overcome this situation, we need to increase the bottle height, which inevitably increases the IOP inside the eye and predisposes to further complications. The active fluidics system applies pressure directly to the irrigation bag. The older-generation phaco machines like the Infiniti and Laureate use the gravity-based fluidic system, which is more vulnerable to the IOP changes. The Centurion vision system can produce more stable anterior chamber (AC) by adjusting these fluctuations. This system has enabled us to develop this technique of holding the nucleus with a vacuum alone, chopping and emulsifying the pieces without using any energy.

In a gravity fluid-dependent phacoemulsification system, the optimum vacuum needed to hold the soft nucleus will eventually break the occlusion and aspirate the soft nucleus, besides increasing the chances of posterior capsular rupture. The active fluidic system with the high vacuum settings allows us to control the IOP, hold the nucleus with vacuum alone, and emulsify the pieces without any energy.

Conclusion

Newer generation phaco machine with active fluidic system and monitored pressurized infusion helps the surgeon control the intraocular pressure (IOP) and hold the nucleus with vacuum alone, allowing chopping and emulsifying of the pieces without any energy.

Informed consent

Informed consent for publication of clinical details and images was obtained from all individual participants included in the study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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