Longitudinal Versus Torsional Phacoemulsification: Analysis of Perioperative Parameters

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Abstract

Aim: To compare the safety and efficacy of torsional and longitudinal modalities of phacoemulsification.

Methods: This was a prospective, randomized study including 200 patients. Group I (longitudinal, n=100) and group II (torsional, n=100). Grade two cataracts with well-dilated pupil were included. The same surgeon performed all surgeries by phaco chop technique with the same phaco machine. Minimum follow-up was 3 months. Two-sample t-test and multivariate regression analysis were used to analyse the data.

Results: All patients achieved 6/6 with no intraoperative complications. Total phaco time in group I was 47.75 ± 12.67 sec & in group II 30.88 ± 9.98 sec (p<0.01). Cumulative dissipated energy (CDE) in group I & II was 12.37 ± 3.82 & 9.02 ± 3.01 (p<0.01). Intraoperative fluid used in group I & II was 56.51 ± 15.5 & 38.54 ± 8.01 ml (p<0.01). Corneal endothelial cell loss at 3 months in group I & II was 180.5 & 172.2(p=0.1). Increase in central corneal thickness at 3 months in group I & II was 3.7 & 4.2µ (p=0.1).

Conclusion: Torsional phaco group had statistically significant lower mean phaco time, CDE & fluid usage than longitudinal phaco group making torsional mode a safe and efficient modality of phacoemulsification.

Introduction

Since Sir Charles Kelman’s development of ultrasound phacoemulsification, there has been constant exploration into the mechanism of phacoemulsification. It is well reported that the nucleus is broken down by the ultrasonic effects of the ultrasound tip, in which the phenomenon of cavitation plays a role and the power of the jackhammer effect; or both forces. Over the last decade, there have been many advances in surgical techniques and instrumentation, including developments in instrument power modes and movement.

The classically described phaco tip movement was longitudinal where the phaco tip moves forward and backward with high frequency. However, this mode can produce a repulsion effect because the phaco tip pushes the nucleus away with each stroke as it moves forward. Thus, the ultrasonde is interrupted and the efficiency of phacoemulsification is compromised. Mikhail Boukhney developed torsional phacoemulsification for the Infiniti Vision System in January 2006 (Alcon Laboratories, Inc., Fort Worth, TX). The OZIL torsional portion is a hardware and software upgrade of the machine and includes a dedicated handpiece that produces rotary oscillations of the phacoemulsification tip. The rotary side-to-side action of the torsional tip increases surgical efficiency by increasing followability, producing less chattering, and decreasing tip movement. This technology allows for ultrasonic oscillations of the system’s bent phaco tip, which shears nuclear material and removes it without the repulsive force (jack hammer effect) of longitudinal phacoemulsification. This brilliant innovation moves away from high vacuum to a system of both lower energy and reduced vacuum.

But to decide whether this new technology was comparable or better that the time tested longitudinal mode phacoemulsification, we decided to undertake a study to compare the safety and efficacy of torsional mode phacoemulsification with the conventional longitudinal mode.

Aim

To analyse the perioperative parameters of torsional and longitudinal mode phacoemulsification assessing the perioperative safety and efficacy along with the immediate post operative results.

Materials and methods

The Prospective randomized comparative study was conducted at Chaithanya Eye hospital, Trivandrum. 200 patients we divided into two groups; Group I (longitudinal, n=100) and group II (torsional, n=100). Grade two cataracts with well-dilated pupil were included. Patients were excluded if they had other eye or general disorders affecting their vision; eg, diabetic retinopathy, glaucoma, age related macular degeneration, uveitis, or previous intraocular surgery. All patients underwent complete slitlamp examination, best corrected visual acuity, fundus examination, endothelial cell count and central corneal thickness by non contact specular microscopy (SP-2000 P, Topcon). All surgeries were performed by the same surgeon who was well experienced with longitudinal and torsional modes of phacoemulsification by the phaco-chop technique using the same phaco machine (Infiniti Vision System). The MicroTip 0.9 mm ABS (aspiration bypass system) phaco tip (45 degrees) was used for both groups. For group I, ultrasound hyperpulse mode with a maximum power of 60%, pulse frequency of 60 pulses per second, and 60% duty cycle were selected. For group II, the torsional continuous mode with 100% amplitude was selected. All patients received topical anesthesia with proparacaine hydrochloride 0.5% eyedrops before surgery.
A 2.2 mm self-sealing clear corneal incision was made on the temporal side. Viscoelastic was injected into the anterior chamber before a 5.5 to 6.0 mm continuous curvilinear capsulorhexis was performed with a bent 26-gauge needle. After hydroprocedures and completion of the nucleus emulsification by the chopping technique and the same phaco chopper, and cortical cleanup, an acrylic intraocular lens was inserted with the injector system through the 2.2 mm incision into the capsular bag. The main preoperative outcome parameters were mean total Phaco ultrasound time (UST) and mean cumulative dissipated energy (CDE) and the total fluid used during the procedure. The values were automatically calculated by the device and displayed on the monitor of the phaco system. The UST represents how many seconds the foot pedal remained in the third position. The mean CDE power indicates the mean percentage of power spent during the UST. During post operative evaluation the examiner was not informed about the group to which the patient was randomized. Patients were seen 1, 7, 21 and 90 days postoperatively with a minimum follow up of at least 3 months for all patients. The postoperative best corrected visual acuity (BCVA), central corneal thickness and endothelial cell count were measured on postoperative 7, 21 and 90 days. Two-sample t-test and multivariate regression analysis were used to analyse the data.

Results

All patients achieved 6/6 with no intraoperative complications. Total phaco time in group I was 47.75 ± 12.67 sec & in group II 30.88 ± 9.98 sec (p<0.01). Cumulative dissipated energy (CDE) in group I & II was 12.37 ± 3.82 & 9.02 ± 3.01 (p<0.01). Intraoperative fluid used in group I & II was 56.51 ± 15.5 & 38.54 ± 8.01 ml (p<0.01) (Table 1).

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<td>Mean ultrasound time (UST in sees)</td>
<td>47.75 ± 12.67</td>
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<td>(p&lt;0.01)</td>
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<td>(p&lt;0.01)</td>
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<td>Mean intraoperative fluid usage (ml)</td>
<td>56.51 ± 15.5</td>
<td>38.54 ± 8.01</td>
<td>(p&lt;0.01)</td>
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No postoperative complications such as fibrin formation, severe corneal oedema, deposits on the IOL optic or endophthalmitis were observed in any patient in the 3 month follow up period.

Increase in central corneal thickness (CCT) at 3 months in group I & II was 3.7 & 4.2µ (p=0.1) (Figure 1). Corneal endothelial cell loss at 3 months in group I & II was 180.5 & 172.2(p=0.1) (Figure 2).

Discussion

Randomization ensures the prognostic factors at baseline were comparable between the 2 study groups. The validity of the study was increased by all surgery being performed by the same surgeon using the same phacoemulsification machine and technique, except the mode, and the blind observation of the postoperative outcomes. Since the introduction of phacoemulsification endothelial cell loss, which is associated with the dissipated ultrasound energy, has been a major concern. Technological developments to reduce ultrasound energy include nonultrasonic energy such as sonic frequencies, NeoSoniX-generated tip rotation, and pulse water-jet technology (Aqualase). Energy delivery as pulses or bursts and millisecond-level microburst and micro pulses, tip design and specific chopping technique also reduce the ultrasound energy used inside the eye. Reducing the phaco energy and phaco time are the main objectives of future phacoemulsification development.

Currently, most machines operate at a frequency between 35,000 cycles per sec and 45,000 cps. Lower frequencies appear to be less efficient and higher frequencies create excess heat. The OZil, torsional portion is a hardware and software upgrade of the machine and includes a dedicated handpiece that produces rotary oscillations of the phacoemulsification tip (Figure 3). OZil torsional technology
is a modality involving high-frequency oscillatory movement. The frequency is 32 kHz so oscillations alone have enough energy to cut. The frequency is lower than the 40 kHz of conventional ultrasound, which results in a 20% energy saving. The stroke length of the phaco tip in torsional is half (40 µ) that of the stroke length in conventional ultrasound mode. The emulsification action is believed to involve mechanical cutting and cavitation. The phaco tip in the torsional mode moves from side to side and can produce an effective phaco cut in both sides in transverse direction, which can improve phaco efficiency. It also removes the lens by shearing and not by a jackhammer effect as in the conventional ultrasound mode. In the traditional phaco mode, the phaco tip moves backward and forward longitudinally (Figure 4) The phaco tip can push the nucleus away as the tip moves forward, so it works best in the first half of the stroke, and typically less in the latter half of the stroke as it moves backward. In the torsional mode, the tip moves from side to side and cannot produce repulsion.

**Figure 3**

**Torsional Oscillations On**

**Figure 4**

**Traditional Ultrasound On**

In our study, the intraoperative values of total ultrasound time, Cumulative dissipated energy and intraoperative fluid used were significantly lower in the torsional group than in the longitudinal group (p<0.001). The corneal injury after phacoemulsification may be attributed to several factors like mechanical damage such as with surgical instruments, lens fragments touching the endothelium, ultrasound trauma by the energy delivered close to the endothelium, and the irrigating solution and its turbulence in the anterior chamber. In our study all surgeries were performed by the same experienced surgeon on the same grade of cataract, using the same chopping technique, the same 0.9 mm ABS tip, the same FMS and the same vacuum and aspiration flow setting, and the same IOL types and implantation techniques. So the variations due to surgical techniques were minimized.

**Conclusion**

This study clearly shows that torsional mode phacoemulsification significantly reduces the ultrasound energy used inside the eye and uses considerably lesser amount of fluid to complete the procedure making it a safer and more efficient modality. The difference in endothelial cell loss and increase in CCT were not significant between the two groups which can be attributed to the fact that only grade 2 nucleus sclerosis cases were included in this study. The impact on the corneal damage will be more significant in harder cataracts where more energy and time are required to complete the emulsification of the nucleus.

**References**


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A growing super specialty hospital urgently requires an Ophthalmic Surgeon Proficient in Phaco Surgery. Candidates may mail their C.V’s immediately.

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