The Comparison between Torsional and Conventional Mode Phacoemulsification in Different Cataracts Densities

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Abstract: Purpose: To compare various outcome measures using torsional mode and longitudinal mode in the phacoemulsification of cataract with different nuclear densities. Materials and Methods: Twenty patients were assigned for phacoemusification by combined torsional and longitudinal mode using the Infiniti Vision System (Alcon Laboratories).Cataracts were subdivided into moderate and hard, according to the Lens Opacities Classification System III grading of nucleus opalescence (NO).All eyes received AcrySof® single piece intraocular lens (Alcon Surgical, Fort Worth, TX). The primary outcome measures were ultrasound time (UST), cumulative dissipated energy (CDE), and surgical complications. Postoperative outcome measures were the degree of corneal edema on the first postoperative day and final best corrected visual acuity (BCVA) and CCT (central corneal thickness). **Results**: 20 eyes of 20 patients divided randomly into two groups were evaluated. Preoperative BCVA and mean grading of NO showed no difference in both groups. Preoperative endothelial cell count and central corneal thickness also showed no significant difference in both groups. In the moderate cataract group, the CDE, UST, were significantly lower in the torsional mode than the longitudinal mode, but they did not show any difference in the hard cataract group. Torsional group showed less endothelial cell loss and central corneal thickening at postoperative day seven in moderate cataracts but showed no significant differences, as compared with the longitudinal group, by postoperative day 30. No complications were recorded among both groups. **Conclusions:** The torsional mode provides an effective and safe method for cataract removal with lower energy usage as compared to longitudinal traditional phacoemulsification. However, the final visual outcome was similar for both study groups.

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1.Introduction

In January 2006, Alcon Surgical incorporated OZil torsional into the Infiniti Vision System. The OZil torsional portion is a hardware and software upgrade of the machine and includes a dedicated hand-piece that produces rotary oscillations of the phacoemulsification tip with a frequency of 32 KHz. It is suggested that the OZil torsional oscillation effect and the incorporated improvements reduce the amount of phacoemulsification energy and increase the efficiency required to remove the cataractous nucleus because it does not produce repulsion and breaks up cataract by shearing and not by conventional jackhammer effect(1,2).

In longitudinal phaco, the needle tip uses an in-and-out motion to break up the lens material, while this was wonderful technology at the time, the jackhammer effect sometimes works against you. The material is only broken up when the tip goes forward. When it moves backward, it is not cutting anything, just generating more energy—and more heat (3,4).

In contrast to repulsing the lens material in a back-and-forth fashion, newer transversal technology cuts the material in an elliptical lateral motion, and torsional technology cuts the lens material through circular oscillations.

"The logic is that when the needle is going side to side, it is not repulsing the lens material and is actually maintaining longer contact with it. This makes these technologies faster and more efficient because they require less phaco energy (5,6).

Traditional longitudinal phacoemulsification operates by a physical jackhammer effect on the nucleus. It is important to note that it ison the backstroke of the tip when voids or cavitational bubbles are formed. The collapse of these bubbles occurs when pressure increases as the tip starts to move backtoward the lenticular material(7).

We designed a study to compare the intraoperative and postoperative clinical performances between torsional and conventional phacoemulsification to verify the efficiency of torsional phacoemulsification in moderate and hard cataracts.

2.Patients and Methods

Patients aged 55 years or older, with the diagnosis of age-related cataract, have been included in the study. Patients who had other ocular or systemic disorders

affecting vision were excluded. These included patients with diabetic retinopathy, glaucoma, age-related macular degeneration, uveitis, corneal endothelial disease or previous intraocular surgery**.**

The patients were randomly assigned into two groups ; group A in which torsional phacoemulsification was used and group B in which conventional longitudinal phacoemulsification was used.

The grading of cataracts was determined according to the Lens Opacities Classification System III(8). Cataracts ranging from NO4/NC4 to NO5/NC5 were included .

All surgeries were performed using the Infiniti Vision System (Alcon Laboratories), and the same US and fluidic settings were used by a single experienced surgeon. First, patients are enrolled and informed consent is obtained from them. All patients received periocular anesthesia and surgeries were performed by the same surgeon. A 3.2 mm self sealing clear corneal incision was made at 12 O'clock and a paracentesis using 15° blades performed at about 60° from the main incision. Sodium hyaluronate 3.0%-chondroitin sulfate 4.0% (Viscoat, Alcon Surgical, Fort Worth, TX) was used to reform and stabilize the surgical planes and protect the corneal endothelium. A 5.5 to 6.0 mm continuous curvilinear capsulorhexis was performed with a bent 27-gauge needle.

A routine phaco-chop technique was used either with the US pulse mode (60 p/sec) or torsional continual mode. The microtip 0.9 mm angled Aspiration Bypass System phaco tip (15 degrees) was used with a standard setting. For the torsional mode in group A , 100% amplitude was selected. The US pulse mode, a maximum power of 60% and pulse frequency of 60 pulses per second were selected. The vacuum limit was 400 mmHg, and the aspiration flow rate was 40 mL/min.An intraocular lens was inserted with the injector through the main incision wound into the capsular bag and the posterior chamber. No sutures were performed on the clear corneal wound.

The main outcome parameters were mean UST and mean cumulative dissipated energy (CDE). The UST represents the number of seconds the foot pedal remained in the third position. The mean CDE power indicates the mean percentage of power spent during the UST. (CDE = mean US power × UST) The UST and CDE values in torsional and phaco modes were automatically calculated by the device and displayed on the monitor of the phaco machine.

The patients were seen one day, seven days and 30 days postoperatively. The postoperative best corrected visual acuity (BCVA), degree of corneal edema and intra and post-operative complications were all documented. Corneal edema was graded as trace; where there was minimal corneal clouding and thickening in relation to incision sites, mild - corneal clouding and thickening affecting less than 25% of the cornea with no Descemet's folds and clear iris details, moderate-corneal clouding and thickening affecting more than 25% of the cornea with few Descemet's folds and hazy iris details and severe-corneal clouding and thickening affecting more than 50% of the cornea with more Descemet's folds and no view of iris details.

Statistical analysis was performed between the two groups using independent *t*-test or Mann-Whitney test, while analysis of preoperative and postoperative changes in same group were performed using Wilcoxon test. A $p < 0.05$ was considered statistically significant.

3. Results

A total of 20 eyes (20 patients), 10 in the US conventional group and 10 in the torsional group were enrolled in the study. The mean age of all patients was 66.0 ± 9.8 years (standard deviation, SD). Seven patients were male and 13 were female. The nuclear opalescence grades are shown in Table 1. There were no differences of mean grade in nuclear opacity in both groups (moderate cataract, p= 0.248; hard cataract, p = 0.744). Preoperative BCVA, central endothelial cell count, and central corneal thickness were not significantly different between the conventional and torsional groups (Table 2).

Table 1. Nuclear opalescence grading distribution and mean nuclear opalescence (NO) grading of all patients

	Conventional group (n)	Torsional group (n)	*p*-value
The mean grade of NO in moderate cataract	2.63±0.20 (7)	2.50±0.31 6)	0.248
The mean grade of NO in hard cataract	4.33±0.26 (3)	4.37±0.28 (4)	0.744

In moderate cataract, the mean UST (39.1 ± 9.1 in the torsional group, 61.3 ± 10.0 in the conventional group; p = 0.023), CDE (2.40 ± 0.64 in the torsional group, 5.30 ± 1.65 in the conventional group; p = 0.014).

Table 2.Preoperative best corrected visual acuity, endothelial cell status, and central corneal thickness

	Conventional group (n)	Torsional group (n)	*p*-value
Moderate cataract* Best corrected visual acuity (logMAR	0.49±0.21 (34)	0.61±0.29 (33)	0.11
Endothelial cell count (cells/mm2)	2,560±656	2,595±449	0.443
Central corneal thickness (μm)	514±28	530±39	0.324
Hard cataract†Best corrected visual acuity (logMAR)	0.89±0.29 (17)	0.74±0.28 (18)	0.969
Endothelial cell count (cells/mm2)	2,686±366	2,690±457	0.747
Central corneal thickness (μm)	513±26	512±36	0.383

logMAR=logarithm of the minimum angle of resolution.
*Independent *t*-test; †Mann-Whitney *U*-test

Table 3. Cumulative dissipated energy (CDE), ultrasound time (UST), in the two groups during surgery

	Conventional group (n)	Torsional group (n)	*p*-value
Moderate cataract† CDE	5.30±1.65 (7)	2.40±0.64 (6)	0.014*
UST (sec)	61.3±10.0	39.1±9.1	0.023*
Hard cataract‡CDE	30.2±5.1 (9)	27.9±9.0 (8)	0.324
UST (sec)	189.0±13.0	148.3±40.1	0.249

In moderate cataracts, endothelial cell count (ECC) loss (5.8 ± 4.47% in the torsional group, 11.18 ± 9.25% in the conventional group; $p = 0.036$) and central corneal thickness (CCT; 548 ± 41 in the torsional group, 561 ± 49 in the conventional group; $p = 0.026$) at the one week postoperative exam were significantly lower in the torsional group than in the conventional group, which turned out to be not significantly different by one month after operation. Meanwhile, in hard cataracts, ECC loss and CCT showed no differences between the two groups until one month after operation. No intraoperative or postoperative complications were noted in either group.

4.Discussion

Traditional longitudinal phacoemulsificationis inefficient in two ways. First, it constantly pushes the nuclear material away by the jackhammer effect into the lenticular material. Second, it performs effectively only half of the time, because it emulsifies material just on the forward stroke. On the backward stroke, the tip only pulls away from the nuclear material. Torsional phacoemulsification greatly reduces the repulsion of nuclear material from the phaco tip. Less repulsion at the tip means that the lenticular material stays on the tip and the tip therefore is kept in an occluded or nearly occluded state. This greater occlusion in turn decreases turbulence in the anterior chamber and increases the efficiency of the lens' removal(9,10).

Traditional phacoemulsification is not only inefficient, but it also can generate a significant buildup of thermal energy at the incision. Torsional ultrasound therefore produces half the movement of traditional phacoemulsification within the incision and also oscillates at a lower frequency than traditional longitudinal (32 versus 40kHz). The total effect of this lower frequency is that the amount of frictional movement against the cornea per second (and therefore of heat generation) is roughly one-third that of longitudinal phacoemulsification(11).

In this study we compared the safety and efficacy of torsional mode with longitudinal phacoemulsification in moderate and hard cataract. Our results demonstrate that torsional phacoemulsification produces a safe and efficient mode of phacoemulsification than longitudinal mode with reduced mean UST and CDE in all grades of nucleus densities. Our results are supported by results obtained by Yizhi Liu *et al*(12). Energy saving (as determined by CDE) was significant in nucleus Grade-3 and Grade-4 following torsional phacoemulsification. This was reflected in the absence or traces of corneal edema in most patients on the first day and only a few patients with mild or moderate corneal edema that resolved within one week of adequate treatment following torsional phacoemulsification.The differences in central corneal thickness in both groups were not statistically significant(13). Lund berg et al reported that the degree of permanent corneal endothelial damage is related to the degree of early post operative corneal swelling(14).

As mentioned before, torsional phacoemulsification causes less repulsion of nuclear materials than conventional phacoemulsification, so lens materials stays at the tip most of the time(15). As a consequence, in our study less vacuum level was used with torsional mode compared to the longitudinal mode, this counteracts surge and the outcome is a safer surgery.

The mean BCVA at day one was significantly better in the torsional group which was attributable to less corneal edema secondary to less UST and CDE. However, at 30 days postoperative, the mean BCVA was nearly the same in both groups with no statistically significant differences. This emphasize that torsional phacoemulsification has better visual outcomes in the early postoperative period.

In conclusion torsional phacoemulsificationcan be used for all grades of cataract, even very dense ones. The densest cataracts respond best to a combination of torsional and longitudinal ultrasound(16), a pairing that works as smoothly as torsional phacoemulsification alone.

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