Efficacy of Balanced Torsional Phacoemulsification Tip for Cataract Surgery

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Abstract

Purpose: To compare the efficacy of the Intrepid® Balanced torsional phacoemulsification tip to that of the 30° Ozil® and 45° Kelman® tips using Centurion Vision System.

Methods: This study included 150 eyes that underwent torsional phacoemulsification surgery using 30° Ozil® tip (Group 1, 48 eyes), Intrepid® Balanced tip (Group 2, 52 eyes), or 45° Kelman® tip (Group 3, 50 eyes). Ultrasound time (UST), cumulative dissipated energy (CDE), average phaco power, average torsional amplitude, balanced salt solution volume, aspiration and operation time, and preoperative, postoperative corrected distance visual acuity, central corneal thickness were recorded.

Results: The mean UST, CDE, average phaco power, average torsional amplitude were 49.9 ± 15.7 s, 10.8 ± 4.5%‑s, 23.9 ± 4.6%, and 51.4 ± 5.7% in the Ozil® group and 47.5 ± 10.6 s, 5.3 ± 2.2%‑s, 12.5 ± 5.3%, and 28.9 ± 7.2% in the Intrepid® Balanced group, and 48.1 ± 12.7 s, 6.9 ± 3.3%‑s, 18.9 ± 5.9%, and 39.2 ± 7.9% in the Kelman® group, respectively. The CDE, average phaco power, and average torsional amplitude of the Intrepid® Balanced group were significantly lower than other groups (P < 0.05). There was no statistically significant difference between the three groups in terms of UST and operation time (P > 0.05).

Conclusion: Intrepid® Balanced tip, by means of its distinctive “double bent” design and balanced energy distribution, offers more effective phacoemulsification compared to conventional 30° Ozil® and 45° Kelman® tips.

Keywords: Intrepid balanced phaco tip, Kelman phaco tip, Ozil phaco tip, Phaco tip, Torsional phacoemulsification

INTRODUCTION

Globally, cataract is the common cause of vision loss, and cataract removal is the most frequently performed eye surgery, with an estimated 19.5 million procedures performed in 2011.¹ Today, in the industrialized world, phacoemulsification is the gold-standard technique for cataract extraction.² Phacoemulsification devices have adapted to consume less ultrasound energy by incorporating new energy delivery techniques such as torsional ultrasound and optimizing tip designs for increased hold and cutting performance.³ Unlike forward and backward movements in longitudinal phacoemulsification, the torsional handpiece optimizes cumulative dissipated energy (CDE) by its horizontal swing motion. Torsional phacoemulsification can only be done with bent phaco tips. Therefore, different tips were designed with different bents and aperture angulation. The higher the bent and aperture angle of the tip, the better the torsional phacoemulsification efficiency.⁴,⁵

The Intrepid® Balanced phaco tip has a different (double bent) design than the conventional 30° Ozil® and 45° Kelman® tips. The studies comparing this innovative tip with other conventional phaco tips are
limited in the literature. Herein, we aimed to compare the results of Intrepid® Balanced tip with conventional Ozil® and Kelman® tips regarding phacoemulsification efficiency using Centurion Vision System.

**METHODS**

Medical records of 200 patients who underwent cataract surgery due to a senile cataract with different phaco tips in the hospital system were reviewed retrospectively. Any cases of complicated cataracts, traumatic cataracts, mature-Morgagnian cataracts, presenile cataracts, and patients who had previously undergone an intracocular surgery with another eye disease were excluded from the study. One hundred and fifty patients met the study’s inclusion criteria and were enrolled. The local Ethics Committee of Izmir Bakircay University waived ethical approval, and the Declaration of Helsinki principles were followed. Each patient signed an informed consent form.

A comprehensive ophthalmic examination including corrected distance visual acuity (CDVA), biomicroscopy, intraocular pressure measurement, fundoscopy, biometry, and central corneal thickness (CCT) was performed before surgery. The Aladdin optical biometer (Topcon, Japan) was used for biometry measurements, and in cases where optical biometry could not be performed, ultrasound biometry was used. CCT measurements were performed using TX-20P noncontact tonometer and pachymeter (Canon, Japan.) device. The cataracts were graded by The Lens Opacification Classification System III (LOCS III).

All surgeries were done with topical anesthesia (proparacaine hydrochloride 0.5%). After 2.2 mm main and side port incisions were made, a cohesive viscoelastic material was used to fill the anterior chamber. A continuous curvilinear capsulorhexis was made with Utrata capsulorhexis forceps. A hydrophobic acrylic lens was inserted in the capsular bag using an injector system. Finally, after removing viscoelastic material from the anterior chamber, the main and side port incisions were sealed.

Phacoemulsification was carried out using Centurion® (Alcon Laboratories, USA) device and gravity-fed infusion system with the Ozil Intelligent Phaco (IP) technology. A quick chop or divide and conquer technique was used according to the following parameters: continuous phacoemulsification mode with a maximum 80% torsional power and 10% longitudinal power (only when IP is active), a maximum vacuum of 500 mmHg, an aspiration flow rate of 32 cc/mmHg, and irrigation bottle height of 110 cm. A 0.9 mm 30° mini-flared 12° bent tip (Ozil®), 0.9 mm 45° mini-flared 22° bent tip (Kelman®), or 0.9 mm mini-flared 45° Intrepid® Balanced tip was used for each phacoemulsification. These three tips were different in configuration but had similar outer and inner diameters of 0.9 mm and 0.8 mm, respectively. The configurations of the tips are shown in Figure 1.

One hundred and fifty eyes of 150 patients with similar cataract grades who underwent a torsional phacoemulsification surgery and met the inclusion criteria were included in the study. Patients were operated on using the available phaco tip in the operating room, and three groups were created according to phaco tip used as 30° Ozil® tip (Group 1, 48 eyes), 45° Intrepid® Balanced tip (Group 2, 52 eyes), or 45° Kelman® tip (Group 3, 50 eyes).

The following recorded data from the phaco machine was used: ultrasound time (UST), CDE, average phaco power, average torsional amplitude, the balanced salt solution (BSS) volume, aspiration time, and operation time for each group.

Topical antibiotics and corticosteroids were implemented on all patients four times a day for 1 month. Routine ophthalmic controls were carried out on postoperative 1-day, 1-week, and 1-month. CDVA and CCT measurements were performed on postoperative 1 week and 1 month.

**Statistical analysis**

The SPSS software (version 25, SPSS Statistics; IBM, Armonk, NY, USA) program was used to analyze the data. Mean, standard deviation, median, minimum, maximum, frequency, and ratio values were used for descriptive statistics. The distribution of variables was checked by the Shapiro–Wilk test. Analysis of variance (with post hoc Tukey test), Kruskal–Wallis, and Mann–Whitney U-test were used to analyze quantitative independent data. In the analysis of dependent quantitative data, paired-sample t-test, and Wilcoxon test were used. The analysis of qualitative independent data was carried out with Pearson Chi-square test.

**Results**

Preoperative data is given in Table 1. No statistically significant difference was found between the Ozil®, Intrepid® Balanced, and Kelman® groups regarding age, gender, preoperative CDVA, CCT, and cataract grades.
The CDE, average phaco power, and average torsional amplitude of the Intrepid® Balanced group were significantly lower than other groups ($P < 0.05$). The highest values of these parameters were determined in the Ozil® group, whereas the lowest values belonged to the Intrepid® Balanced group [Table 2 and Figure 2]. There was no statistically significant difference between the three groups in terms of UST and operation time ($P > 0.05$) [Table 2 and Figure 3]. In the Ozil® group, the volume of BSS was significantly higher than the Kelman® group ($P < 0.05$), whereas the volume of the BSS Intrepid® Balanced group did not differ from the other two groups ($P > 0.05$) [Table 2 and Figure 2].

Aspiration time (second) was significantly higher in the Ozil® group than the Kelman® group ($P < 0.05$) while this time in the Intrepid® Balanced group did not differ from the other two groups ($P > 0.05$) [Table 2 and Figure 3].

CDVA parameters on postoperative 1 week and 1 month were comparable between all groups, and there was no statistically significant difference ($P > 0.05$) [Table 3]. CCT parameter on the postoperative 1st week in the Ozil® group was significantly higher than the other two groups ($P < 0.05$). Moreover, this parameter on the postoperative 1st week in the Intrepid® Balanced group was higher than the Kelman® group without any statistical significance ($P > 0.05$) [Table 3]. CCT parameters of all groups were comparable on postoperative 1st month ($P > 0.05$).

**Discussion**

Today’s phacoemulsification systems combine a variety of advanced technology and innovative design elements that make cataract surgery safer, faster, and less challenging for the surgeon. Centurion® (Alcon, USA) was the first device to utilize a dual peristaltic pump. The system’s innovations, such as dual-segment pump technology and a seven-roller pump mechanism, have been used to achieve rapid and stable liquid flow and vacuum rise while minimizing pulsations. In addition, the pump system’s rotational valve mechanism was developed to minimize fluid leakage. Another advancement made possible by the pump system is the aspiration tubing system, which features a small diameter and caliber (inner diameter: 0.048 mm) but retains flexibility. This small-scale flexible system has the advantage of high resistance and low compliance, which helps minimize the risk of surge during surgery.11

Another innovation that comes with the Centurion® (Alcon, USA) device is the Intrepid® Balanced phaco tip. This innovative phaco tip, with its “double bent” feature, acts as an alternative flat tip, providing a balanced energy distribution throughout the shaft. In addition, by improving the torsional motion in the distal tip, the stroke amplitude of the Intrepid® Balanced (192 µm) tip has been increased with respect to the Kelman® (130 µm) tip, and the risk of burns has been minimized by reducing the shaft movement in the incision site compared to the Kelman® tip.12 Chen et al.12 revealed that CDE was significantly lower in the Centurion® system with an Intrepid® Balanced phaco tip than in the Infiniti® system with a Kelman® phaco tip.

The intraoperative metric preferred as the basis for conclusions is CDE, which is assessed in percent seconds. CDE represents the total ultrasound energy in foot pedal position 3 (both longitudinal and torsional) and calculated as (longitudinal time × average longitudinal power) + (torsional time × average torsional amplitude × 0.4).11 Regardless of the cataract grade and type of the phaco tip, the longer the foot pedal stays in position 3 and the torsional

**Table 1: Preoperative characteristics of the patients grouped with different phaco tips**

|                     | Mean±SD/n (%) | P       |
|---------------------|---------------|---------|
|                     | Ozil          | Balanced| Kelman  |
| Age (median)        | 66.3±6.7 (66.5) | 68.3±6.5 (70.5) | 68.9±8.4 (70.0) | 0.124<sup>A</sup> |
| Gender              |               |         |         |         |
| Female              | 20 (42)       | 22 (42) | 23 (46) | 0.829<sup>B</sup> |
| Male                | 28 (58)       | 30 (58) | 27 (54) |         |
| CDVA (logMAR)       | 0.435±0.146   | 0.442±0.147 | 0.455±0.159 | 0.556<sup>A</sup> |
| CCT (µm)            | 526.1±18.2    | 523.4±17.6 | 524.8±19.3 | 0.34<sup>A</sup> |
| LOCS III score      | 3.63±0.72     | 3.65±0.64 | 3.78±0.81 | 0.25<sup>A</sup> |
<sup>A</sup>Analysis of variance (Tukey test); <sup>B</sup>Chi-square test.

**Table 2: Comparison of intraoperative parameters of patients grouped with different phaco tips**

|                     | Mean±SD (median) | P       |
|---------------------|-----------------|---------|
|                     | Ozil            | Balanced| Kelman  |
| Ultrasound time (s) | 49.9±15.7 (50.2) | 47.5±10.6 (46.1) | 48.1±12.7 (46.6) | 0.318<sup>A</sup> |
| Cumulative dissipated energy (%s) | 10.8±4.5 (10.3) | 5.3±2.2 (4.9) | 6.9±3.3 (5.7) | 0.000<sup>A</sup> |
| Average phaco power (%) | 23.9±4.6 (22.7) | 12.5±3.3 (11.9) | 18.9±5.9 (17.3) | 0.000<sup>A</sup> |
| Average torsional amplitude (%) | 51.4±5.7 (51.8) | 28.9±7.2 (30.1) | 39.2±7.9 (40.7) | 0.000<sup>A</sup> |
| Operation time (s)  | 594±145 (587)   | 576±101 (564) | 596±98 (585) | 0.759<sup>A</sup> |
| Volume of balanced salt solution (cc) | 56.1±9.1 (53.5) | 52.3±8.2 (50.0) | 51.0±7.9* (51.5) | 0.019<sup>A</sup> |
| Aspiration time (s) | 159±20 (166)    | 150±25 (151) | 140±33* (136) | 0.016<sup>A</sup> |
<sup>A</sup>Analysis of variance (Tukey test), <sup>B</sup>Kruskal-Wallis (Mann-Whitney U test), <sup>C</sup>Compared with Ozil Group. SD: Standard deviation
power is adjusted linearly, the more energy and amount of fluid are going to be used. If the IP mode is on, longitudinal power is activated in case of occlusion and results in an increase of CDE. Furthermore, CDE is affected by the surgeon difference, phaco technique, and whether the surgical site is hospital based or mobile.\textsuperscript{12}

Effective and safe phacoemulsification requires low energy and fluid usage. In our study, lower CDE values, average phaco power, and average torsional amplitude were obtained with Intrepid\textsuperscript{®} Balanced tip and Centurion\textsuperscript{®} system compared with the Kelman\textsuperscript{®} and Ozil\textsuperscript{®} tips. Inconsistent with our findings, in a study, Khochar \textit{et al.}\textsuperscript{7} revealed a lower CDE, total UST, torsional amplitude, aspiration time, and fluid usage by the Intrepid\textsuperscript{®} Balanced tip compared to Kelman\textsuperscript{®} tip using Centurion\textsuperscript{®} vision system. However, unlike us, they used an active fluidics system instead of a gravity-fed system, which provides better fluidics control.

In torsional phacoemulsification, the phaco tip anatomy is of great importance in terms of emulsification efficiency. Studies have shown that as the bent and aperture angle increase, emulsification efficiency increases. Helvacioglu \textit{et al.}\textsuperscript{4,5} found...
that more effective emulsification was achieved by the tips with a bent angle of 22° since the stroke length increases compared to those with 12°, and by the tips with an aperture angle of 45° since the cutting effect increased compared to tips with 30°. In our study, we found that the Kelman® tip with a 22° bent angle and a 45° aperture angle had lower CDE values than the Ozil® tip with a 12° bent angle and a 30° aperture angle.

In another study, Demircan et al."6 compared Kelman® and Intrepid® Balanced tips in the Infiniti® System and showed that Intrepid® Balanced tip uses less energy by achieving lower CDE values, average phaco power, and average torsional amplitude."6 According to the literature and our consideration, whether used with the active fluidics or gravity-based system or with Infiniti® or Centurion® device, the Intrepid® Balanced tip is more effective and safer than other tips.

There are several limitations of our study. First, our study was conducted retrospectively. Second, endothelial cell count could not be measured, and patients with different degrees of cataracts were not included in this study. Since the effectiveness of tips may differ in high-grade cataracts, this evaluation can be considered in future.

We concluded that the Intrepid® Balanced tip provides more effective phacoemulsification than conventional 30° Ozil® and 45° Kelman® tips due to its distinctive “double bent” design and balanced energy distribution. More studies are needed to determine the efficacy of tips in patients with higher grade cataracts.

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Conflicts of interest
There are no conflicts of interest.

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