Original Article

Efficacy of Balanced Torsional Phacoemulsification Tip for Cataract Surgery

Huri Sabur[1], Sayime Aydin Eroglu[2], Salih Sertac Azarsiz[2]

[1]Department of Ophthalmology, Bergama Necla-Mithat Oztüre State Hospital, Izmir, Turkey, [2]Deparment of Ophthalmology, Izmir Bakircay University Cigli Training and Research Hospital, Izmir, Turkey

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

Address for correspondence: Huri Sabur, Department of Ophthalmology, Dıskapı Training and Research Hospital, 06110, Altındag/Ankara, Turkey.
E-mail: dr_hurisabur@hotmail.com
Submitted: 03-Apr-2021; **Revised:** 28-Aug-2021; **Accepted:** 27-Sep-2021; **Published:** 16-Apr-2022

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 phaco tips. The studies comparing this innovative tip with other conventional phaco tips are

Access this article online

Quick Response Code:

Website: www.jcurrophthalmol.org

DOI: 10.4103/joco.joco_105_21

How to cite this article: Sabur H, Eroglu SA, Azarsiz SS. Efficacy of balanced torsional phacoemulsification tip for cataract surgery. J Curr Ophthalmol 2022;34:74-9.

limited in the literature.[6-9] 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 intraocular 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 Bakırcay 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).[10]

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.

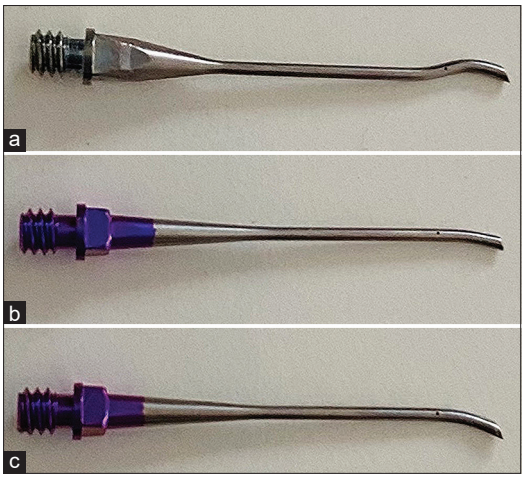

Figure 1: Configuration of phaco tips: (a) Intrepid® Balanced phaco tip, (b) Ozil® phaco tip, (c) Kelman® phaco tip

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 4].

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 ($P > 0.05$).

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[A]
Gender				
Female	20 (42)	22 (42)	23 (46)	0.829[χ2]
Male	28 (58)	30 (58)	27 (54)	
CDVA (logMAR)	0.435±0.146	0.442±0.147	0.455±0.159	0.556[A]
CCT (µm)	526.1±18.2	523.4±17.6	524.8±19.3	0.34[A]
LOCS III score	3.63±0.72	3.65±0.64	3.78±0.81	0.25[A]

[A]Analysis of variance (Tukey test)/χ^2: Chi-square test. SD: Standard deviation, CDVA: Corrected distance visual acuity, CCT: Central corneal thickness, LOCS III: Lens opacification classification system III

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*.[9] 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 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[A]
Cumulative dissipated energy (%-s)	10.8±4.5 (10.3)	5.3±2.2 (4.9)	6.9±3.3 (5.7)	0.000[K]
Average phaco power (%)	23.9±4.6 (22.7)	12.5±5.3 (11.9)	18.9±5.9 (17.3)	0.000[A]
Average torsional amplitude (%)	51.4±5.7 (51.8)	28.9±7.2 (30.1)	39.2±7.9 (40.7)	0.000[A]
Operation time (s)	594±145 (587)	576±101 (564)	596±98 (585)	0.759[A]
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[A]
Aspiration time (s)	159±20 (166)	150±25 (151)	140±33* (136)	0.016[A]

[A]Analysis of variance (Tukey test), [K]Kruskal-Wallis (Mann-Whitney U test), *Compared with Ozil Group. SD: Standard deviation

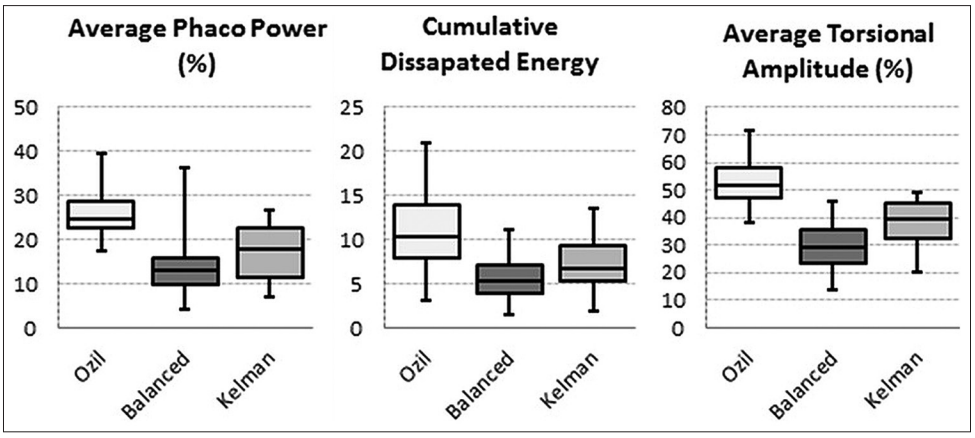

Figure 2: Box plot analysis of the cumulative dissipated energy, average phaco power, and average torsional amplitude between phaco tip groups

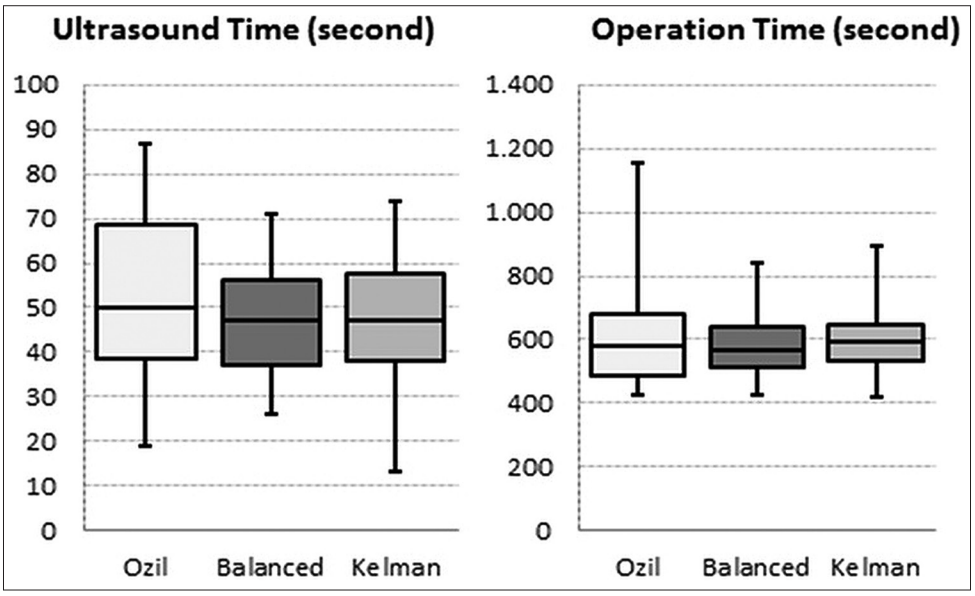

Figure 3: Box plot analysis of the ultrasound and operation time (s) between phaco tip groups

Table 3: Comparison of postoperative corrected distance visual acuity and central corneal thickness changes in patients grouped with different phaco tips

	Mean±SD			*P*
	Ozil	Balanced	Kelman	
CDVA preoperative	0.435±146	0.442±147	0.455±159	0.556[A]
1 week	0.07±0.55	0.08±0.66	0.08±0.69	0.86[A]
1 month	0.01±1.25	0.01±1.23	0.01±1.32	1.00[A]
CCT preoperative	526.1±18.2	523.4±17.6	524.8±19.3	0.34[A]
1 week	570.2±17.4	563.6±14.8	560.2±17.3	0.02*[,A]
1 month	532.3±12.1	531.1±13.4	533.4±16.8	0.27[A]

*Statistically significant. [A]Analysis of variance (Tukey test). SD: Standard deviation, CDVA: Corrected distance visual acuity, CCT: Central corneal thickness

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.[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® Balanced tip and Centurion® system compared with the Kelman® and Ozil® tips. Inconsistent with our findings, in a study, Khochar *et al*.[7] revealed a lower CDE, total UST, torsional amplitude, aspiration time, and fluid usage by the Intrepid® Balanced tip compared to Kelman® tip using Centurion® 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. Helvacıoglu *et al*.[4,5] found

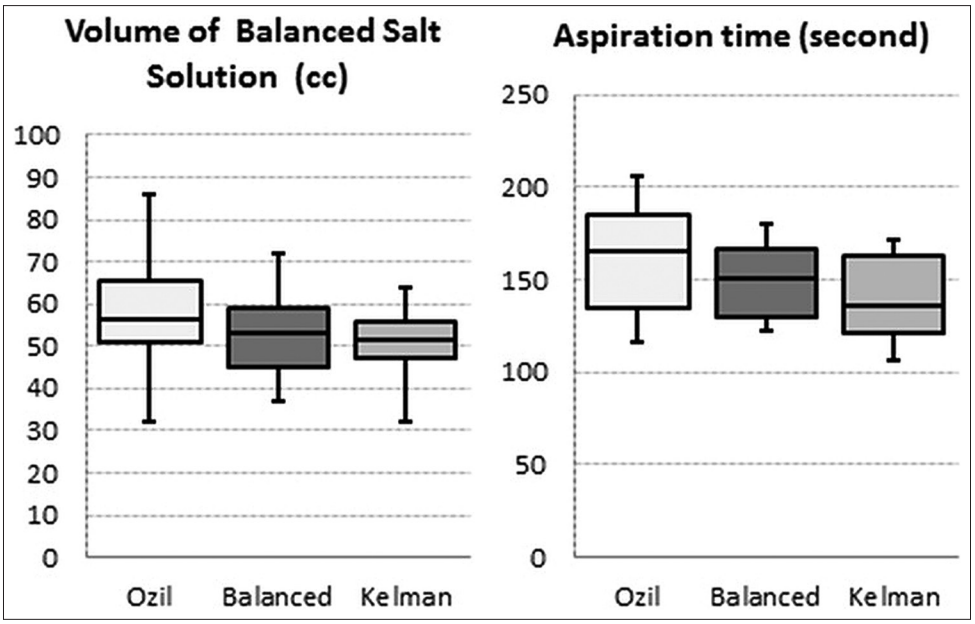

Figure 4: Box plot analysis of the volume of balanced salt solution used and aspiration time between phaco tip groups

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.

Acknowledgment

We would like to thank Mr. Muhammed Ilyas, Ph.D., provided assistance with figures and English language editing.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Day AC, Gore DM, Bunce C, Evans JR. Laser-assisted cataract surgery versus standard ultrasound phacoemulsification cataract surgery. Cochrane Database Syst Rev 2016;7:CD010735.
2. de Silva SR, Riaz Y, Evans JR. Phacoemulsification with posterior chamber intraocular lens versus extracapsular cataract extraction (ECCE) with posterior chamber intraocular lens for age-related cataract. Cochrane Database Syst Rev 2014;(1):CD008812.
3. Helvacıoğlu F, Şencan S, Tunç Z, Yeter C. Torsional phacoemulsification and tip selection. Turk J Ophthalmol 2014;44:392-5.
4. Helvacioglu F, Yeter C, Tunc Z, Sencan S. Outcomes of torsional microcoaxial phacoemulsification performed by 12-degree and 22-degree bent tips. J Cataract Refract Surg 2013;39:1219-25.
5. Helvacioglu F, Sencan S, Yeter C, Tunc Z, Uyar OM. Outcomes of torsional microcoaxial phacoemulsification using tips with 30-degree and 45-degree aperture angles. J Cataract Refract Surg 2014;40:362-8.
6. Demircan S, Ataş M, Göktaş E, Başkan B. Comparison of 45-degree Kelman and 45-degree balanced phaco tip designs in torsional microcoaxial phacoemulsification. Int J Ophthalmol 2015;8:1168-72.
7. Khokhar S, Aron N, Sen S, Pillay G, Agarwal E. Effect of balanced phacoemulsification tip on the outcomes of torsional phacoemulsification using an active-fluidics system. J Cataract Refract Surg 2017;43:22-8.
8. Vetter JM, Wirbelauer C. Improvement of phaco tip geometry during torsional phacoemulsification. Klin Monbl Augenheilkd 2018;235:611-5.
9. Chen M, Anderson E, Hill G, Chen JJ, Patrianakos T. Comparison of cumulative dissipated energy between the ınfiniti and centurion phacoemulsification systems. Clin Ophthalmol

2015;9:1367-72.
10. Chylack LT Jr., Wolfe JK, Singer DM, Leske MC, Bullimore MA, Bailey IL, *et al.* The lens opacities classification system III. The longitudinal study of cataract study group. Arch Ophthalmol 1993;111:831-6.
11. Malik PK, Dewan T, Patidar AK, Sain E. Effect of IOP based infusion system with and without balanced phaco tip on cumulative dissipated energy and estimated fluid usage in comparison to gravity fed infusion in torsional phacoemulsification. Eye Vis (Lond) 2017;4:22.
12. Chen M, Sweeney HW, Luke B, Chen M, Brown M. A retrospective randomized study to compare the energy delivered using CDE with different techniques and OZil settings by different surgeons in phacoemulsification. Clin Ophthalmol 2009;3:401-3.