EJMI

DOI: 10.14744/ejmi.2021.25231
EJMI 2021;5(3):309–312

Research Article

Comparison of Phacoemulsification Parameters Using Active-Fluidic Pressure Control System versus Gravity-Fluidic System

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Abstract

Objectives: This study aimed to compare the mean surgical time, cumulative dissipated energy (CDE), aspiration time and estimated aspiration fluid parameters in phacoemulsification surgery using an active-fluidic pressure control system (AFPCS) in comparison with gravity-fluidic system (GFS).

Methods: The study analysed 202 eyes of 202 patients diagnosed with senile nuclear cataract and admitted to our clinic. Phacoemulsification surgery was performed by an experienced surgeon using the Centurion Vision System device and the Infiniti Vision System device. After each case, the mean surgical time, CDE, aspiration time and estimated aspiration fluid parameters were recorded. Complicated cases were excluded from the study.

Results: In the AFPCS group, the mean age of the patients was 64.15±3.83 years, with the following results: mean surgical time, 11.88±5.44 min; CDE, 11.63±9.37; aspiration time, 3.91±1.49 min; estimated aspiration fluid, 71.89±27.56 ml. In the GFS group, the mean age of the patients was 64.99±3.80 years, and the following results were obtained: mean surgical time, 14.35±3.93 min; CDE, 13.60±7.61; aspiration time, 5.56±1.8 min; estimated aspiration fluid, 101.23±15.62 ml.

Conclusion: AFPCS was found to be more successful than GFS, with low-energy consumption, shorter surgical time and better postoperative outcomes.

Keywords: Active-fluidic system, gravity-fluidic system, phacoemulsification, cataract

Cite This Article: *Bulut A. Comparison of Phacoemulsification Parameters Using Active-Fluidic Pressure Control System versus Gravity-Fluidic System. EJMI 2021;5(3):309–312.*

The main purpose of cataract surgery with phacoemulsification is to surgically remove the lens that develops cataract and thus to achieve the best visual acuity and to maintain visual function with an artificial intraocular lens (IOL).[1] The main goal in modern cataract surgery is to minimise iatrogenic effects on ocular structures such as the cornea, which are particularly vulnerable to significant risks.[2] Cataract surgery has become one of the most frequently performed surgical procedures worldwide owing to the increase in life expectancy and quality of life.[3] The expectation of an increased visual quality with technological developments has accelerated research in this direction and increased the use of IOL of different structures such as toric, bifocal, or trifocal lens.[4] Rapid developments in phacoemulsification devices, shortening of the surgical time, rapid recovery with the reduction of corneal incisions and use of toric or multifocal forms of intraocular foldable lenses according to the needs of an individual have made the phacoemulsification method the first choice in cataract surgery worldwide.[5] New-generation phacoemulsification devices provide better surgical outcomes and improve surgical safety.

Careless use of intraocular ultrasound energy can sometimes damage the corneal endothelium and cause varying

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Submitted Date: June 26, 2021 **Accepted Date:** July 28, 2021 **Available Online Date:** September 22, 2021

degrees of corneal oedema and even corneal burns in some cases.[6] In addition, fluid leakage from corneal incisions and inconsistent work in the irrigation/aspiration (I/A) system cause anterior chamber collapse (surge) and increase the risk of complications. Thus, successful phacoemulsification surgery depends on an experienced surgeon and an effective cataract device.

Recently, the Centurion® Vision System (Alcon Laboratories, Inc., Fort Worth, TX, USA) phacoemulsification device with active-fluidic pressure control system (AFPCS) technology, which can maintain anterior chamber stability even at high I/A and vacuum speeds, was introduced.[7] The Centurion® Vision System phacoemulsification device is equipped with active-fluidic pressure control technology software and balanced-type phaco tip in addition to its previous version Infiniti® Vision System (Novartis Laboratory Basel, Switzerland) with gravity-fed infusion-based unit. AFPCS prevents fluctuations in the anterior chamber with minimal intraocular pressure (IOP). Moreover, AFPCS prevents anterior chamber surges that may occur in case of occlusion, which helps surgeons reach an effective phacoemulsification time under high-vacuum condition.

In the literature, many studies have compared the safety and efficacy of using different phaco tips, fluid dynamics with gravity- or active-fluidic pressure control, dual or multiple devices and torsional and longitudinal power modes.[8-10]

This study aimed to compare the perioperative mean surgical time, cumulative dissipated energy (CDE), aspiration time and estimated aspiration fluid parameters of cataract surgery performed with conventional methods using the Alcon Centurion® Vision System phacoemulsification device providing AFPCS and the Infiniti® Vision System providing gravity-fluidic system (GFS).

Methods

This single-centre prospective study was conducted in the Ophthalmology Department of Istanbul Medipol University Sefakoy Hospital. This study adhered to the principles of the Declaration of Helsinki. Informed consent was obtained from each patient. Ethics Committee approval was obtained from Istanbul Medipol University Ethics Committee (20/05/2021, Document No. E-10840098-772.02-2488).

This study included 202 eyes of 202 patients diagnosed with senile nuclear cataract and admitted to our clinic. Phacoemulsification surgery was performed by an experienced surgeon using the Centurion Vision System device and the Infiniti Vision System device. In this study, 45° classical Kelman-type phaco lead and 45° balanced-type phaco lead were used in cases with Centurion Vision System device and Infiniti Vision System device, respectively. The mean surgical time, CDE, aspiration time and estimated aspiration fluid parameters, which are the criteria in the user interface of the cataract device, were recorded for each case. Collected data were statistically analysed with IBM SPSS version 22.0 (IBM Corp., Armonk, NY, USA).

All patients underwent a comprehensive ophthalmic examination before surgery. Visual acuity, best-corrected visual acuity, biomicroscopic examination of the evaluated cornea, cataract grade and IOP were measured and recorded by non-contact tonometry.

Patients who developed congenital cataract, traumatic cataract, complicated cataract or cataract from any cause were excluded from the study. Patients with corneal dystrophy such as postoperative uveitis, corneal opacity, subluxed IOL, angle-closure glaucoma, pseudoexfoliation and Fuchs endothelial dystrophy detected in control examinations were excluded from the study.

Surgical Technique

All surgical procedures were performed by the same surgeon (AB) using the Centurion Vision System and the Infiniti Vision System phacoemulsification devices. Procedures were performed under topical anaesthesia. During phacoemulsification, device parameters were set with 40 mmHg of IOP, 500 mmHg vacuum and 35 cc/min aspiration flow rate. Following surgical site cleaning, the main incision in the cornea was made with a 2.8-mm blade from the 135° axis, and two side port entrances were made from the 0°–180° axis. A viscoelastic substance containing 1.6% sodium hyaluronate was applied to the anterior chamber. A 5- to 5.5-mm capsulorhexis was performed using a viscoelastic substance. After the phacoemulsification, the cortex material was cleaned with the help of I/A. A foldable IOL under viscoelastic substance containing 1.4% sodium hyaluronate was placed in the bag. Then, 0.05 cc of moxifloxacin was administered to the anterior chamber. The procedure was terminated after the corneal incisions were inflated with fluid, and there was no fluid leakage.

All patients were planned to be treated with moxafiloxacin drops 4 × 1, dexamethasone drops 4×1 and nepafenac drops 3×1 in the postoperative period. Patients were followed up on day 1, week 1 and month 1.

Results

In the AFPCS group, the mean age of the patients who underwent surgery was 64.15±3.83 years. The mean surgical time was 11.88±5.44 min, the CDE was 11.63±9.37, the aspiration time was 3.91±1.49 min and the estimated aspiration fluid was 71.89±27.56 ml. In the GFS group, the mean age of the patients was 64.99±3.80 years. The mean surgical time was 14.35±3.93 min, the CDE was 13.60±7.61, the aspiration time was 5.56±1.8 minutes and the estimated

aspiration fluid was 101.23±15.62 ml (Fig. 1). Successful phacoemulsification was performed in all eyes analysed. No intraoperative complications developed. Demographic characteristics and perioperative surgical data of the patients are summarised in Table 1.

Discussion

In recent years, phacoemulsification has become the standard surgical procedure in the treatment of cataracts. With technological development, phacoemulsification devices have progressed towards the reduction of phaco energy to achieve the goal of minimal corneal damage after surgery as well as improvements in phacodynamics and fluid parameters. Various methods have been applied to reduce endothelial damage, including viscosurgery, torsional phacoemulsification versus linear mode and modification of tip design to increase efficiency.[8,11] In this study, we compared the mean surgical time, CDE, aspiration time and estimated aspiration fluid, which are important intraoperative factors leading to postoperative endothelial cell loss, of the Alcon Centurion Vision System phacoemulsification device providing AFPCS and the Infiniti Vision System phacoemulsification device providing GFS.

Many comparative studies have focused on cataract surgery. Most of these studies compared surgical parameters or data obtained using different modes of phacoemulsification machines. In the present study, the mean surgical time, aspiration time and estimated aspiration fluid were significantly lower in the AFPCS group than in the GFS group (p<0.001). Although the CDE was not significantly lower in the AFPCS group than in the GFS group (p=0.103), it numerical value was lower.

Gonzalez-Salinas et al. found that the mean surgical time, CDE, aspiration time and estimated aspiration fluid were significantly lower in the Centurion device than in the Infiniti device (p<0.001). However, the preoperative corneal endothelial cell density was not different with either device.[12]

With the use of Centurion Vision System and AFPCS technology in cataract surgery, the efficiency of phacoemulsification has increased and minimal fluctuations in IOP during surgery have contributed to maintaining a stable anterior chamber. The combined use of AFPCS and balanced-type phaco tip made it possible to consume minimum fluid by reducing the surgical time, as it prevents anterior chamber fluctuation that may occur due to abrupt opening after occlusion and provides effective phacoemulsification with maximum vacuum.[7] The AFPCS also allows the use of less energy during phacoemulsification surgery by using a redesigned balanced tip compared with the classical 45° Kelman tip (Fig. 2).[9] The balanced tip leads to an increased emulsification effect. This reduced movement at the main incision site generates minimal heat in the wound, minimise corneal stromal changes at the wound site and reduce complications such as wound leaks and astigmatic shifts.[13] The higher phacoemulsification efficiency with the Centurion Vision System is attributed to the use of the balanced-type tip and better fluid dynamics.

Khokhar et al. investigated the effectiveness of the balanced-type in torsional phaco using AFPCS. Particularly, in denser cataracts, the balanced-type phaco tip has been reported to provide significantly less CDE, total ultrasound (US) time, torsion amplitude, aspiration time and

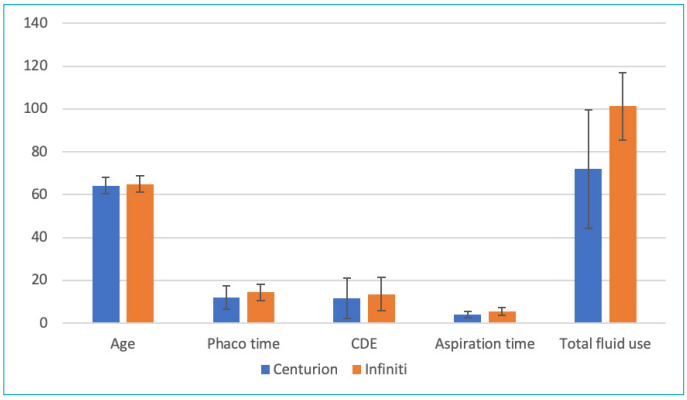

Figure 1. Comparison of the intraoperative parameters between Active-Fluidic Pressure Control System versus Gravity-Fluidic System.

Table 1. Demographic characteristics of patients and perioperative surgery data

	Centurion	Infiniti	p
Age	64.15±3.83	64.99±3.80	0.119
Female/male	52/49	54/47	0.778
Phaco time	11.88±5.44	14.35±3.93	<0.001
CDE	11.63±9.37	13.60±7.61	0.103
Aspiration time	3.91±1.49	5.56±1.8	<0.001
Total fluid use	71.89±27.56	101.23±15.62	<0.001

CDE: Cumulative Dissipated Energy.

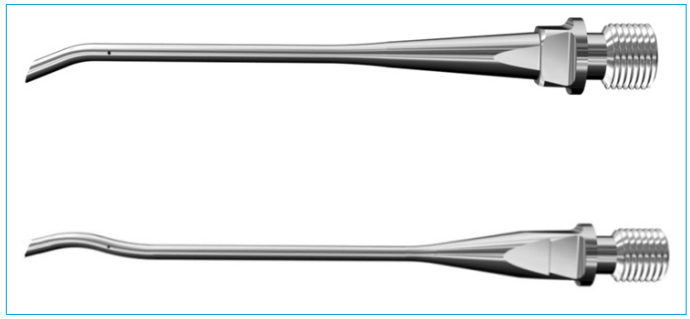

Figure 2. 45° classical kelman type phaco lead (top), 45° balanced type phaco lead (bottom).

fluid use than the conventional tip.[8] Studies have shown that one of the most important intraoperative parameters that cause endothelial cell loss is CDE.[9,14] The CDE is a theoretically derived mathematical model of torsional amplitude transmitted to the eye that correlates roughly with tip motions and reflects only the actual US energy delivered by a particular tip.

Despite the lower CDE, Demircan et al. found that the endothelial cell loss was greater with the balanced-type tip. This was due to the higher amplitude of the balanced tip (192 mm) than with the maximum amplitude of the Kelman tip (130 mm).[17] Khokhar et al. compared CDE, total US time, torsion amplitude, aspiration time, fluid use and endothelial cell loss in patients with and without diabetes who underwent cataract surgery and reported that these parameters were significantly higher in patients with diabetes.[16]

Conclusion

In conclusion, the effectiveness of phacoemulsification appears to be enhanced by the AFPCS and the redesigned balanced-type phaco tip. The new balanced-type phaco tip can help reduce short- and long-term corneal damage associated with phacoemulsification. The Alcon Centurion® Vision System phacoemulsification device, which provides AFPCS, offers more successful surgical efficiency with both lower energy use and shorter surgical time than the Infiniti® Vision System, which improves postoperative outcomes.

Disclosures

Ethics Committee Approval: Istanbul Medipol University Ethics Committee, The study adhered to the principles of the Helsinki Declaration of Human Rights and received ethics committee approval(20/05/2021, Document No. E-10840098-772.02-2488).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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