ARTICLE

Differences in energy expenditure for conventional and femtosecond-assisted cataract surgery using 2 different phacoemulsification systems

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Purpose: To compare the mean cumulative dissipated energy (CDE) in patients having femtosecond laser–assisted or conventional phacoemulsification cataract surgery using 2 different phacoemulsification platforms.

Setting: Bascom Palmer Eye Institute, Miami, Florida, USA.

Design: Prospective comparative nonrandomized clinical study.

Methods: Consecutive patients were scheduled to have femtosecond laser–assisted cataract surgery with the Lensx laser or conventional phacoemulsification using an active-fluidics torsional platform (Centurion) or torsional platform (Infiniti). The mean CDE and cataract grade were recorded.

Results: The study comprised 570 eyes (570 patients). There was no statistically significant difference in mean age ($P = .41$, femtosecond group; $P = .33$, conventional group) or cataract grade ($P = .78$ and $P = .45$, respectively) between the active-fluidics and gravity-fluidics platforms. In femtosecond cases (145 eyes), the mean CDE (percent-seconds) was 5.18 $\pm$ 4.58 (SD) with active fluidics and 7.00 $\pm$ 6.85 with gravity fluidics; in conventional cases (425 eyes), the mean CDE was 7.77 $\pm$ 6.97 and 11.43 $\pm$ 9.12, respectively. In both femtosecond cases and conventional cases, the CDE was lower with the active-fluidics platform than with the gravity-fluidics platform ($P = .029$, femtosecond group; $P < .001$ conventional group). With both fluidics platforms, the mean CDE was significantly lower in the femtosecond group than in the conventional group (both $P < .001$).

Conclusions: The active-fluidics phacoemulsification platform achieved lower CDE values than the gravity-fluidics platform for conventional cataract extraction. Femtosecond laser pretreatment with the active-fluidics platform further reduced CDE.

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Cataract surgery is the most commonly performed ophthalmic procedures, and phacoemulsification is the most commonly used technique for cataract removal.[1] The continued development of technology related to phacoemulsification machines and handpiece tips and the recent addition of femtosecond lasers have provided ophthalmologists with tools to advance their capabilities as cataract surgeons.[2]

After receiving U.S. Food and Drug Administration approval, several femtosecond lasers for cataract surgery became available in the United States. These lasers can be used during cataract surgery to create the anterior capsulotomy, perform lens fragmentation, and create corneal incisions. Studies[3–8] report several advantages of femtosecond laser–assisted cataract surgery over conventional phacoemulsification, including evidence that lens fragmentation with the femtosecond laser can decrease the ultrasound (US) energy used during phacoemulsification, which might be associated with a significant reduction in postoperative corneal edema and corneal endothelial cell loss and thus potentially resulting in improved visual outcomes and faster recovery. However, to our knowledge, no previous studies have compared the difference between various phacoemulsification machines in conjunction with femtosecond laser platforms with respect to a reduction in cumulative dissipated energy (CDE), which is a

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platform-based estimation of the US energy (percent-seconds) used during phacoemulsification.

In this prospective study, we compared the mean CDE in patients having cataract surgery using a gravity-fluidics torsional or an active-fluidics torsional phacoemulsification platform in femtosecond laser–assisted cataract surgery or conventional cataract surgery.

PATIENTS AND METHODS

This prospective comparative nonrandomized study included consecutive eyes of patients scheduled to have cataract surgery with femtosecond laser–assisted cataract surgery or conventional phacoemulsification at the Bascom Palmer Eye Institute, Miami, Florida, USA, between November 2013 and May 2015. Before the study, institutional review board approval was obtained. The study adhered to the tenets of the Declaration of Helsinki.

Inclusion and Exclusion Criteria

The patients included in the study had grade 1 to 4 nuclear sclerosis according to the Lens Opacities Classification System III[9,10] (LOCS III) by LOCS-certified surgeons (S.Y., K.D.). Patients with a history of ocular surgery, serious coexisting ocular disease, active ocular inflammation, corneal opacities, pseudoexfoliation syndrome, uncontrolled glaucoma, congenital cataract, traumatic cataract, chronic use of topical or systemic steroids or nonsteroidal antiinflammatory drugs (NSAIDs) (except daily aspirin), or poor pupil dilation (<5.0 mm) and patients who had intraoperative complications were excluded from the study.

Table 1. Lens fragmentation settings used by the 2 surgeons for femtosecond laser–assisted cataract surgery.

Setting	Surgeon	
	S.Y.	K.D.
Lens method	Chop and cylinder	Chop and cylinder
Diameter (mm)	4.60 and 4.00	4.80 and 4.00
Anterior capsule depth (μm)	3986.00	3986.00
Posterior capsule depth (μm)	7772.00	7772.00
Lens anterior offset (μm)	500.00	500.00
Lens posterior offset (μm)	800.00	800.00
Zone 1 energy (μJ)	6.00	6.00
Zone 2 energy (μJ)	6.00	6.00
Zone 3 energy (μJ)	6.00	6.00
Zone 4 energy (μJ)	6.00	7.00
Zone 5 energy (μJ)	6.00	7.00
Anterior lens curvature (mm)	9.00	9.00
Posterior lens curvature (mm)	5.90	5.90
Cuts (n)	2.00	3.00
Cylinder (n)	3.00	2.00
Spot separation (μm)	12.00	12.00
Layer separation (μm)	10.00	10.00
Primary incision angle offset (°)	4.00	4.00

Surgical Technique

All procedures were performed under topical anesthesia. Femtosecond laser–assisted cataract surgery pretreatment was performed with the Lensx femtosecond laser platform (Alcon Laboratories, Inc.) and included both capsulotomy and lens fragmentation (pattern: concentric cylinders and segment cuts) by 1 of 2 experienced surgeons (S.Y., K.D.) using slightly different settings (Table 1) followed by conventional phacoemulsification performed using an Infiniti gravity-fluidics torsional phaco machine (with mini-flared 45-degree Kelman tip and ultra-infusion sleeve) or using a Centurion active-fluidics torsional phaco machine (with Intrepid balanced ultrasonic tip with a very small sleeve/microincision) (both Alcon Laboratories, Inc.). Both surgeons used a phacochop technique. Tables 2 and 3 show gravity-fluidics platform and active-fluidics platform settings used by the 2 surgeons. All clear

Table 2. Settings used by surgeon S.Y. for the 2 phacoemulsification platforms.

Setting	Platform	
	Gravity-Fluidics	Active-Fluidics
Sculpt		
Irrigation (cm H_2O)	95	88
Aspiration rate (cc/min)	25	28
Vacuum (mm Hg)	90	135
Torsional amplitude (%)	100	60
Longitudinal amplitude (%)	—	0
Chop		
Irrigation (cm H_2O)	105	88
Aspiration rate (cc/min)	41	35
Vacuum (mm Hg)	380	575
Torsional amplitude (%)	95	0
Longitudinal amplitude (%)	—	50
Quad		
Irrigation (cm H_2O)	105	88
Aspiration rate (cc/min)	38	38
Vacuum (mm Hg)	400	525
Torsional amplitude (%)	100	60
Longitudinal amplitude (%)	—	0
Epi		
Irrigation (cm H_2O)	95	88
Aspiration rate (cc/min)	30	35
Vacuum (mm Hg)	230	425
Torsional amplitude (%)	60	25
Longitudinal amplitude (%)	—	0
Cortex		
Irrigation (cm H_2O)	110	82
Aspiration rate (cc/min)	45	42
Vacuum (mm Hg)	650	600

Epi = epinucleus; H_2O = water; Quad = quadrant