Translenticular hydrodissection, lens fragmentation, and influence on ultrasound power in femtosecond laser–assisted cataract surgery and refractive lens exchange

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PURPOSE: To compare ultrasound time (UST) during femtosecond laser–assisted and conventional cataract surgery or refractive lens exchange and evaluate UST during femtosecond laser surgery with and without a new technique, translenticular hydrodissection.

SETTING: Centre for Sight, East Grinstead, West Sussex, United Kingdom.

DESIGN: Comparative case series.

METHOD: This single-surgeon study compared consecutive femtosecond laser–assisted surgery (with and without translenticular hydrodissection to assist lens mobilization) and consecutive conventional surgery performed immediately before adoption of femtosecond laser technology. The mean US power, UST, and effective phacoemulsification time (EPT) in the 2 groups were compared. Further analysis of the femtosecond group compared translenticular hydrodissection and no translenticular hydrodissection.

RESULTS: The mean US power, UST, and EPT were significantly longer in the conventional group (n = 108) than in the femtosecond group (n = 108) as follows: 7.30% ± 2.56% (SD) versus 5.32% ± 2.48% (P=.000); 9.89 ± 5.32 seconds versus 8.58 ± 4.66 seconds (P=.044); 0.87 ± 0.85 seconds versus 0.57 ± 0.51 seconds (P=.002), respectively. In the femtosecond group, parameters were significantly higher in eyes without translenticular hydrodissection (n = 27) than in eyes with translenticular hydrodissection (n = 81) as follows: 5.78% ± 2.23% versus 5.16% ± 2.56% (P=.046); 10.95 ± 4.66 seconds versus 7.78 ± 4.41 seconds (P=.046); 0.72 ± 0.26 seconds versus 0.52 ± 0.53 seconds (P=.002), respectively.

CONCLUSION: Femtosecond laser capsulotomy and lens fragmentation statistically significantly reduced UST over conventional surgery. Translenticular hydrodissection further reduced UST.

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Online Video

Femtosecond lasers have been successfully used for several corneal procedures, including creation of a flap in laser in situ keratomileusis, arcuate incisions,[1] and tunnels for intrastromal corneal ring segments[2] as well as for penetrating and deep anterior lamellar keratoplasty.[3–5] More recently, in combination with advanced techniques of anterior segment imaging, femtosecond laser models have been developed to perform surgery in the anterior segment. The laser is being used in conjunction with cataract surgery to create corneal incisions and capsulotomies and to perform lens fragmentation.[6–8] There have been several studies of the advantages of the use of the femtosecond laser in cataract surgery, including the accuracy and circularity of the capsulorhexis,[9–12] increased anterior edge capsule strength,[10] and decreased phacoemulsification fragmentation times.[9,13,14]

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The technique of lens removal after femtosecond preparation requires deviation from conventional practice because the process of capsulotomy includes the anterior cortex and conventional hydrodissection is difficult to perform reproducibly. Many femtosecond laser surgeons have elected to avoid hydrodissection for fear of producing capsular block syndrome (CBS) with consequent anterior capsule tears and posterior capsule rupture.[15,16]

To avoid these problems, we evaluated a new technique—translenticular hydrodissection—specifically for use in femtosecond laser lens fragmentation. We also describe our initial experience with the Victus femtosecond laser (Bausch & Lomb, Technolas Perfect Vision) for capsulotomy and lens fragmentation.

PATIENTS AND METHODS

This study prospectively audited the first femtosecond laser (Victus) cataract or refractive lens exchange (RLE) surgery cases at a specialty ambulatory surgical center. For the purposes of comparison, consecutive cases of conventional cataract surgery or RLE performed immediately before transition to femtosecond laser–assisted surgery were retrospectively audited. Approval to perform the review and study was obtained from the medical board of the institution.

Before surgery, all patients had a detailed ophthalmic evaluation that included slitlamp biomicroscopy; tonometry; pachymetry; measurement of uncorrected and corrected distance visual acuities; uncorrected visual acuities at 40 cm, 60 cm, and 80 cm; manifest refraction; and a dilated fundus examination. Other examinations included biometry (IOLMaster, Carl Zeiss Meditec AG) and corneal topography and aberrometry (KR1-W, Topcon Corp.). To avoid damage from elevated pressure from the laser suction ring, patients with established glaucoma and visual field abnormalities were excluded from femtosecond laser–assisted cataract or RLE surgery.

Surgical Technique

All procedures were performed using topical anesthesia. Dilation preoperatively was achieved by instillation of tropicamide 0.28 mg–phenylephrine hydrochloride 5.4 mg (Mydriasert) or phenylephrine 0.25% and tropicamide 1.0% drops 1 hour preoperatively. All patients also received preoperative diclofenac drops (Voltarol Ophtha) and chloramphenicol minims 1 hour before surgery.

The patients had capsulotomy and lens fragmentation with the femtosecond laser located in the operating room. A small-diameter interface (9.5 mm) was used; thus, corneal and limbal relaxing incisions could not be performed. A suction ring was placed on the eye under direct observation through an operating microscope attached to the laser. Once correctly positioned, automated suction was commenced on the laser. Nine drops of a balanced salt solution were instilled on the eye within the well of the suction ring, and the laser bed was rotated under the laser. The ring was then docked onto the curved interface attached to the laser. Pressure sensors were used to ensure that docking onto the cornea was light in pressure and centered. Once docked, the dilated pupil was identified on the interface software by marking 3 points at the pupil margin. The capsulotomy overlay on the eye was confirmed as centered on the dilated pupil and adjusted if required. The lens anterior capsule margin in the 90-degree meridian was identified on high-resolution optical coherence tomography (OCT) and demarcated at 3 points, 1 centrally and 2 peripherally in the 90-degree meridian. The same was performed for the posterior capsule. Next, the integrated OCT device was altered to visualize the anterior segment in the 180-degree axis and a similar process performed. The posterior margin of safety of ablation from the posterior capsule was preset at 700 μm. A ring OCT (Figure 1) imaged the anterior capsule at the diameter of the intended anterior capsulotomy for 360 degrees. The position and overall band of laser ablation to accomplish complete anterior capsulotomy was adjusted to encompass the capsule in all meridians (Figure 1). This ensured that femtosecond laser disruption involved the entire anterior capsule for 360 degrees. In all cases, the capsule size was set at 5.2 mm and a quadrant cut of 4 radial cuts combined with a quadrant of rings was used as a fragmentation pattern (Figure 2).

After the femtosecond laser portion of the procedure, the patients (except 3 cases) walked 3 to 4 steps to the operating table. In 3 cases, the complete procedure, including cataract removal, was performed on the laser bed. All cases had coaxial microincision surgery with a 1.8 mm incision using the Stellaris phacoemulsifier (Bausch & Lomb) and the vacuum-based pump option rather than peristaltic. After the main incision and 2 side-port incisions were created, an ophthalmic viscosurgical device (OVD) was injected into the eye. The anterior capsule was removed with a Calladine-Inamura capsulorhexis forceps (Duckworth & Kent Ltd.). Conventional hydrodissection was attempted in the first 9 cases and then abandoned. The following 19 cases were performed without hydrodissection, and the subsequent 80 cases were performed using translenticular hydrodissection. After removal of the lens nucleus, cortical irrigation/aspiration (I/A) was performed using a bimanual technique. An intraocular lens (IOL) was implanted in the capsular bag. After I/A of the OVD, intracameral cefuroxime (1 mg in 0.1 mL) was injected into the anterior chamber.

Postoperatively, patients were treated with neomycin, polymyxin B sulfates, and dexamethasone eyedrops (Maxitrol) 4 times daily, taped over 4 weeks, and ketorolac trometamol 5 mg/mL (Acular) 3 times daily for 4 weeks.

Translenticular Hydrodissection Technique

The translenticular hydrodissection technique was discovered when the surgeon (S.M.D.), using a hydrodissection cannula (Daya 25-gauge, Hurricane Medical) (Figure 3) to dismantle the lens through 1 of the radial incisions,

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