Anterior Segment OCT Imaging After Femtosecond Laser Cataract Surgery

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ABSTRACT

PURPOSE: To report the anterior segment imaging characteristics after femtosecond laser assisted cataract surgery.

METHODS: Cataract surgery was performed with the LenSx femtosecond laser (Alcon-LenSx Inc., Aliso Viejo, CA) in 40 eyes of 40 patients. The laser was programmed to perform a 4.5-mm capsulorhexis, a cross-pattern fragmentation of the nucleus, a 2.8-mm main incision, and a 1.0-mm side-port incision. The anterior segment was then analyzed using the Visante OCT anterior segment program (Zeiss-Meditec AG, Jena, Germany).

RESULTS: The preoperatively set treatment parameters correlated well with the achieved results. For the capsulorhexis, the femtosecond laser cut was programmed to start 350 µm behind the anterior lens capsule and OCT measured 377 ± 55.3 µm. Nucleus fragmentation was programmed to start 750 µm in front of the posterior capsule and end 550 µm behind the anterior capsule, and OCT measured 794 ± 111 and 568 ± 147 µm, respectively. The diameter of the capsulorhexis measured by OCT was 4.54 ± 0.2 mm, compared to the 4.5 mm programmed.

CONCLUSIONS: Anterior segment OCT imaging was able to detect the tissue changes within the lens after femtosecond laser capsulorhexis and nucleus fragmentation. The measured values correlated well with the planned treatment parameters.

was used to generate a 4.5-mm capsulotomy, nucleus fragmentation in a cross-pattern with a diameter of 4.5 mm, and two corneal incisions (a 2.8-mm two-plane main incision and a 1.0-mm single-plane side port incision). The capsulotomy laser-cut was programmed to start 350 μm below the anterior lens capsule and end 100 μm above the anterior capsule. The nucleus fragmentation was programmed to start 750 μm in front of the posterior capsule and to end 550 μm behind the anterior capsule.

In all treated eyes, anterior segment imaging was performed using optical coherence tomography (OCT) (Visante OCT; Zeiss Meditec AG, Jena, Germany) immediately after the femtosecond laser procedure. Anterior segment single and high-resolution corneal programs were used for imaging the anterior segment, including the anterior capsule, lens material, and cornea. The Visante software was used to measure the dimensions of the laser-treated area behind the anterior capsule for the capsulorhexis creations, and the distances of the nucleus fragmentation from the anterior and posterior capsule during nucleus fragmentation. The shape and position of the corneal laser incisions were also analyzed.

**RESULTS**

An intact, round, and complete capsulorhexis was achieved in all eyes. During capsulorhexis creation, carbon dioxide bubbles appeared in the anterior chamber (Figure 1). The laser pulses started at a distance of 377 ± 55 μm behind the anterior capsule, as measured with the Visante OCT (Figure 2). The diameter of capsulorhexis was 4.54 ± 0.2 mm after femtosecond laser treatment (Figure 3).

In all eyes, the cross-pattern fragmentation lines within the lens nucleus were visible in the OCT image. The laser pulses created two vertical planes within the lens, which were perpendicular to each other. In 22 eyes (45%), an additional horizontal plane was formed within the lens (Figure 4). This horizontal layer was most likely caused by the carbon dioxide bubbles formed within the nucleus during the laser treatment. The femtosecond laser fragmentation planes extended between 568 ± 147 μm behind the anterior capsule and 794 ± 111 μm from the posterior capsule.

The two corneal incisions (2.8-mm main incision and 1.0-mm side port) were both programmed to be 1.8 mm in length. The measured values (OCT) were simi-
lar at 1.84 ± 0.12 mm (Figure 5). The planned width of the incisions was 2.8 mm, whereas the postoperative value was 2.71 ± 0.11 mm.

**DISCUSSION**

To our knowledge, this is the first report on anterior segment imaging immediately after femtosecond laser application for cataract surgery. Femtosecond lasers were first used to produce anterior circular capsulorhexis and phacofragmentation procedures in porcine eyes by Nagy et al.⁵

Initial results demonstrated a higher precision of the laser capsulotomy than a manual capsulorhexis both in porcine eyes⁵ and clinically.⁶,⁷

The femtosecond laser system used in our study uses a built-in OCT to measure the dimensions of the anterior segment, namely the cornea, the anterior and posterior lens capsule, and the nucleus. The laser treatment is planned and performed based on these measurements. In this study, we evaluated the actual treatment location using another anterior segment OCT system immediately after laser treatment and compared the measured values to the planned values. We found that the preoperatively set laser treatment parameters correlated well with the achieved results. This indicates that the built-in OCT system is reliable in measuring the anterior segment and in guiding the laser treatment in laser refractive cataract surgery.

**AUTHOR CONTRIBUTIONS**

Study concept and design (JLA, ED, TJ, KK, ZZN); data collection (JLA, TF, ZZN, AIT); analysis and interpretation of data (JLA, TF, MCK, ZZN); drafting of the manuscript (JLA, ZZN); critical revision of the manuscript (JLA, ED, TF, KK, MCK, AIT); statistical expertise (JLA); administrative, technical, or material support (TF, AIT); supervision (JLA, KK)

**REFERENCES**