CORRESPONDENCE

Corneal etching in femtosecond laser-assisted cataract surgery

Femtosecond laser technology can be used in cataract surgery to perform the capsulotomy, lens fragmentation, and corneal incisions. Compared to traditional cataract surgery, femtosecond laser-assisted cataract surgery (FLACS) can offer potential advantages such as enhanced intraocular lens centration[1,2] and decreased phacoemulsification power.[3,4] However, the potential for increased utility and safety over conventional techniques has not been definitively established.[5,6] Though FLACS is generally a safe procedure, complications can include suction loss, anterior capsule tears or tags, posterior capsule rupture, dropped nuclei, or vitreous loss.[5,7–10] We present a case in which a partial lens fragmentation pattern was found etched onto a patient's cornea after FLACS, despite the absence of any apparent intraoperative complications.

Case Report

An 86-year-old Caucasian male patient was found to have bilateral visually significant cataracts. He had no significant ocular history or prior ocular surgeries. Preoperatively, best corrected distance visual acuity (BCVA) was 20/60 OU. Intraocular pressure (IOP) was 17 mm Hg in the right eye and 18 mm Hg in the left eye. The corneas were clear bilaterally, and the lens opacities in both eyes were classified grade 3 according to the Lens Opacification Classification System III scale. The patient elected to have routine FLACS in the left eye using the LensAR femtosecond laser system (LensAR, Inc, Orlando, Fla.).

At the time of surgery, the patient was placed supine with head and eyes in primary gaze. A disposable fluid-interface suction ring was applied to the sclera of the left eye with good centration. A lid speculum was not required, as the suction ring was rolled under the upper and lower lids. The suction ring was filled with a balanced salt solution to facilitate tight seal. Vacuum suction was initiated without complication. The laser platform was docked to the suction ring in close apposition to the corneal apex. After alignment was achieved the docking system was locked into place.

The built-in LensAR proprietary software recapitulated anterior segment structures and automatically determined patient-specific treatment parameters for anterior capsulotomy and lens fragmentation. Clear corneal incisions were not performed, as per the surgeon's preference. After final review and confirmation of the customized treatment plan, the surgeon initiated the treatment. The laser performed an anterior capsulotomy centred on the pupil centre (5.2-mm diameter, 1.0-mm edge height, 600-μm incision depth, 7-μJ pulse energy), followed by lens fragmentation (10-μJ pulse energy, 80-kHz repetition rate). The fragmentation pattern consisted of a combination of 2 concentric cylindrical cuts (5-mm outer diameter, 2-mm inner diameter) and 6 intersecting linear chops traversing the cylinders, creating a radial pattern of discrete "pie slice" divisions (Fig. 1A). The progress of the treatment sequence was monitored during the procedure. The system display did not indicate that any corneal incisions were made or that any other errors or malfunctions occurred. Throughout the procedure the patient remained still without perceptible head, eye, or body movement. There was no disengagement of the laser system at the patient interface, and excellent vacuum suction was maintained. The manual portion of the surgery was then performed without complication. The patient tolerated both the laser and manual procedures well and expressed no complaints during or after surgery.

On the first postoperative day, the operated left eye had a BCVA of 20/60 and IOP of 18 mm Hg. Slit-lamp examination of the left eye revealed a faint etching in a "pie" configuration on the superotemporal mid-peripheral corneal stroma (Fig. 1B). This circular pattern containing discrete radial divisions resembled the inner portion of the template utilized by the femtosecond laser during lens fragmentation (Fig. 1C). Stromal edema of the left cornea was additionally noted. The patient denied excessive discomfort or disability.

Two weeks after surgery, BCVA was 20/30 OS. The laser pattern had significantly faded, and the corneal edema had resolved. At 8 weeks postoperative, the corneal etching was no longer visible, and BCVA was 20/25 OS. The patient was pleased with the final postoperative result.

Discussion

Though femtosecond-laser technology offers many features for enhanced precision over conventional cataract surgery techniques, it is not devoid of complications.[5,7–10] Two prior reports have documented the finding of a laser pattern delivered to the peripheral cornea after suction loss or abrupt patient head movement during FLACS.[7,8]

The present case serves as a warning that corneal etching can occur even in the absence of suction loss, patient head movement, or other apparent intraoperative complications. Such a phenomenon has not been previously reported. The lack of overt, identifiable intraoperative complications that preceded inadvertent laser targeting of the cornea may be of significant concern to surgeons.

The corneal etching in this case may be a result of aberrant laser misfiring despite adequate suction and absence of patient movement. This is surprising, as the LensAR system is equipped with multiple features and safety controls to ensure that the laser is directed to the appropriate plane, including software algorithms that guide laser pulses to the proper depths for photodisruption while removing image artefacts that could disrupt laser placement.[11] Further, the amount of vacuum suction at the patient interface is under continuous computer

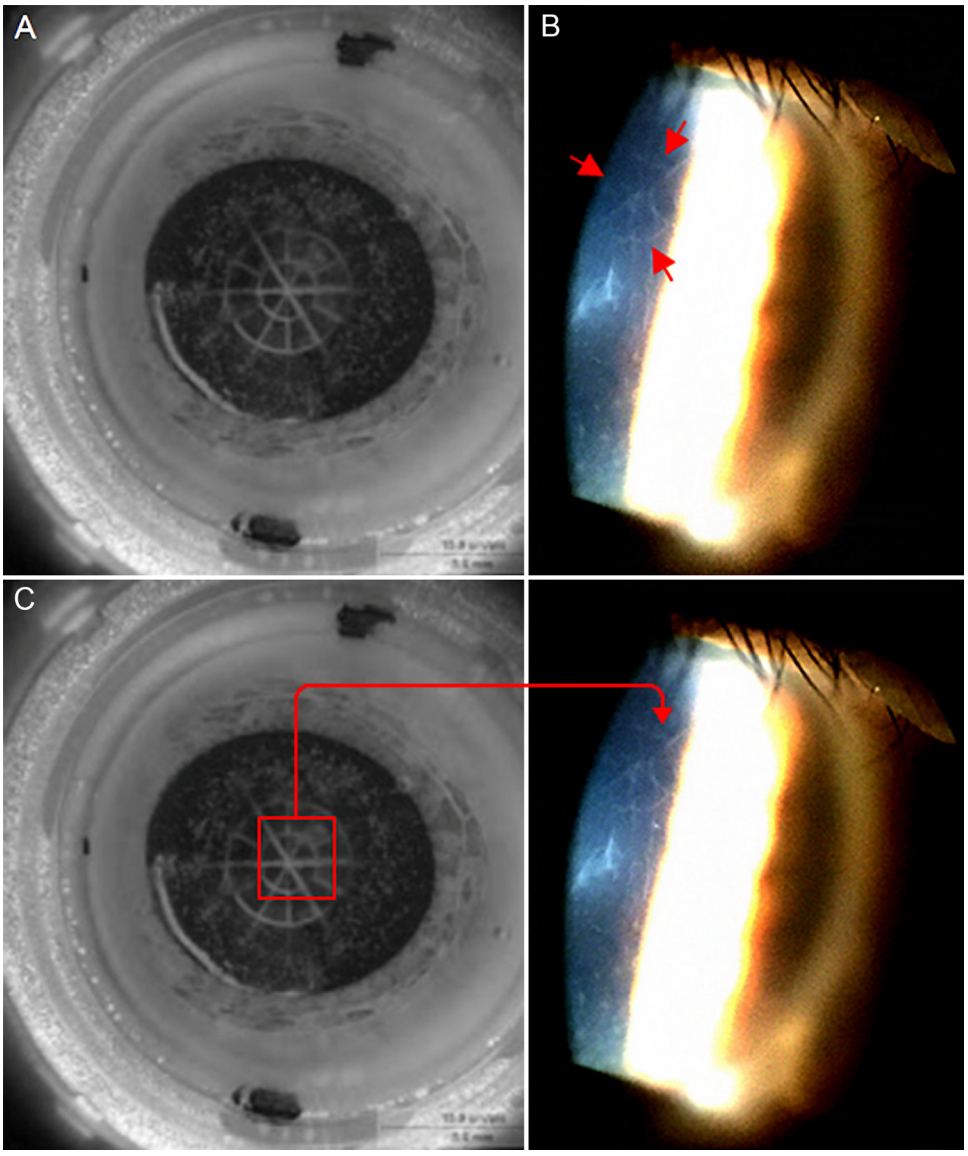

Fig. 1—Femtosecond laser pattern delivered to the cornea. (A) Photograph of lens fragmentation pattern utilized by the LensAR femtosecond laser system during the patient's cataract surgery. The configuration consists of a combination of 2 concentric cylindrical cuts and 6 intersecting division planes traversing the cylinders, creating a radial pattern of "pie slice" divisions. (B) Slit-lamp photograph of the patient's left eye taken on postoperative day one, 20 hours after surgery. A faint etching (outlined by *red arrows*) is visible in the superotemporal midperipheral corneal stroma, resembling a portion of the inner cylinder and radial divisions of the laser template. Moderate stromal edema is additionally present. (C) Diagrammatic representation illustrating the potential mechanism by which the etching was delivered to the cornea. A portion of the inner cylinder and radial cuts (*left*, outlined by *red box*) is presumed to have engaged (*red curvilinear arrow*) the patient's cornea (*right*).

monitoring, and the system is programmed to automatically abort the procedure should any leakage occur.[11] As no automatic termination occurred in the present case, it is unlikely that vacuum suction was lost.

In spite of such precise safety features associated with LensAR and other systems, femtosecond laser misfiring has nonetheless been noted in various situations. For example, misdirected laser firing has been associated with changes in plane of the anterior capsule that may occur during capsulotomy, though these misfirings are localized to the anterior capsule.[12,13] In addition, the presence of microcavitation bubbles anterior to the laser target may result in laser scatter.[14,15] During FLACS, treating the anterior capsule first may promote formation of gas bubbles anterior to the lens that could potentially cause laser scatter during lens fragmentation. It is unclear if this was a factor in the present case, as the position of smaller gas bubbles may be difficult to appreciate during treatment.

The 2 prior cases of documented corneal etching were observed using the Catalys Precision Laser System (Optimedica Corp, Santa Clara, Calif.).[7,8] The potential for inadvertent laser delivery to the cornea therefore may not be restricted to a particular brand of femtosecond technology. Despite the absence of any error notification or

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