Anterior chamber gas bubbles during femtosecond laser flap creation

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We report 12 cases (14 eyes) in which anterior chamber gas bubbles were produced by the Wave-light FS-200 femtosecond laser during laser in situ keratomileusis. The parameters for femtosecond laser flap creation, number of bubbles, and management in each eye before excimer ablations of the stromal bed were retrospectively reviewed. One day postoperatively, the uncorrected distance visual acuity (UDVA) was 20/20 in 8 eyes, 20/25 in 4 eyes, 20/32 in 1 eye, and 20/40 in 2 eyes. At 3 months, the UDVA was 20/16 in 4 eyes, 20/20 in 4 eyes, and 20/25 in 2 eyes. Although the femtosecond laser can produce anterior chamber gas bubbles, in our cases this had no effect on the UDVA after 3 months.

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The femtosecond laser photodisrupts the corneal stroma to generate plasma, displacing the surrounding tissue, which results in the formation of cavitation gas bubbles comprising carbon dioxide and water vapor.1 Cavitation gas bubbles can appear under the flap, in the pocket behind the hinge, in the episclera, or in the subepithelial space.2 Gas bubbles in the anterior chamber are an infrequent complication during flap creation with a femtosecond laser.3–11 However, they may interfere with recognition of the pupil and iris by automated tracking systems and may complicate wavefront excimer laser treatment.

We evaluated the management as well as the refractive outcomes of 12 patients (14 eyes) in whom anterior chamber gas bubbles were produced by the Wave-light FS-200 femtosecond laser (ALCON) during laser in situ keratomileusis (LASIK) performed in 377 patients (750 eyes) at Chiang Mai University LASIK Center between January 2013 and October 2014.

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The baseline characteristics of the 12 patients are shown in Table 1.

The parameters for the femtosecond laser flap creation were as follows: flap diameter 9.0 mm flap, flap thickness 100 to 120 μm, flap bed energy 0.81 to 0.85 μJ, side-cut energy 0.85 to 0.89 μJ (side-cut angle 70 degrees), and canal length 0.3 to 0.9 mm. The hinge was superior with an angle of 50 degrees, and a pocket (width 0.4 mm, length 3.8 mm, spot/line separation 7.5 μm) was performed in all cases. During flap creation, gas bubbles were noted in the anterior chamber prior to photoablation. The number of bubbles and the management in each eye before excimer ablation of the stromal bed are shown in Table 2. In 8 eyes, the ablation was performed using the autotracking system after the bubbles had partially resolved; in 4 eyes, the ablation was performed uneventfully without eye tracking (Figure 1).
On the first postoperative day, no gas bubbles were noted in the anterior chamber in any eye. Postoperative examination included uncorrected distance visual acuity (UDVA), corrected distance visual acuity, manifest refraction, keratometry, tonometry, and corneal topography. The postoperative UDVA at 1 day and the UDVA and manifest refraction at 1 week, 3 months, and 6 months are shown in Table 3. At 1 day, the UDVA was 20/20 in 8 eyes, 20/25 in 3 eyes, 20/32 in 1 eye, and 20/40 in 2 eyes. At 3 months, it was 20/16 in 4 eyes, 20/20 in 4 eyes, and 20/25 in 2 eyes. There were no correlations between the UDVA and the parameters used for femtosecond laser flap creation, number of bubbles, or management in each eye.

**DISCUSSION**

Various mechanisms for anterior chamber gas bubbles have been proposed. There have been some reports with the Intralase FS, but only a few reports with the Wavelight FS-200. The management in each case differed based on the number and size of the gas bubbles. In our cases, even though the incidence of gas bubbles (1.6%) was higher than in a previous report (0.14%), satisfactory refractive outcomes were achieved without further complications in all eyes. However, the gas bubbles caused frustration intraoperatively and prolonged the procedures. One report found a predilection for anterior chamber gas formation with the femtosecond laser and a 9.0 mm flap diameter in Asian patients. We also used a 9.0 mm flap diameter, and all the patients were Asian. We postulate that Asian eyes may have smaller white-to-white (WTW) diameters than average white eyes. The mean WTW diameter in Asian eyes is usually less than 12.0 mm. In these eyes, a flap diameter of 9.0 mm may be too large relative to the canal length of the hinge; ie, if the canal length is too long in an eye with a small WTW, the canal may be close to the limbus if the flap diameter is large. As a result, we recommend reducing the flap diameter to less than 9.0 mm in Asian eyes when using the femtosecond laser.

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**Table 1.** The baseline characteristics of the patients.

| Patient* | Age (Y) | Sex | Laterality | Manifest Refraction (D) |
|----------|---------|-----|------------|-------------------------|
|          |         |     | LE         | Sphere | Cylinder |
| 1        | 43      | Male | LE         | -3.00  | -        |
| 2        | 23      | Male | RE         | -0.75  | -0.5    |
| 3        | 32      | Male | RE         | -2.50  | -2.00   |
| 4        | 49      | Female | LE         | -4.75  | -       |
| 5        | 22      | Male | LE         | -5.50  | -0.75   |
| 6        | 32      | Male | RE         | -5.50  | -0.25   |
| 7        | 19      | Male | LE         | -2.75  | -0.25   |
| 8        | 20      | Female | LE         | -6.50  | -1.25   |
| 9        | 27      | Female | RE         | -6.25  | -0.50   |
| 10       | 56      | Female | LE         | -6.50  | -0.50   |
| 11       | 31      | Female | LE         | -5.25  | -0.50   |
| 12       | 33      | Female | LE         | -3.25  | -1.50   |

*Patients 1, 2, and 3 were lost to follow-up after 1 month.

**Table 2.** The flap parameters, number of bubbles, and management in each eyes.

| Flap Parameters | Suction Time (sec) | Temp (°C) | Number of Bubbles | Management |
|-----------------|--------------------|-----------|-------------------|------------|
| Thickness (μm)  | Canal Length (mm)  | Bed Energy (μJ) | Side-Cut Energy (μJ) | |
| 1               | 110                | 0.8       | 0.82              | 0.89       | 63         | 26     | 5   | Waiting and autotracking |
| 2               | RE                 | 110       | 0.7               | 0.82       | 0.85       | 49     | 27   | 1   | Waiting and autotracking |
|                 | LE                 | 110       | 0.6               | 0.82       | 0.85       | 62     | 28   | 3   | Waiting and autotracking |
| 3               | 120                | 0.8       | 0.82              | 0.85       | 77         | 30     | 2   | Waiting and autotracking |
| 4               | 100                | 0.9       | 0.82              | 0.86       | 138        | 30     | 5   | Manual tracking         |
| 5               | 110                | 0.3       | 0.84              | 0.87       | 101        | 27     | 1   | Waiting and autotracking |
| 6               | 110                | 0.8       | 0.85              | 0.89       | 52         | 28     | 3   | Manual tracking         |
| 7               | 110                | 0.7       | 0.84              | 0.88       | 56         | 28     | 3   | Manual tracking         |
| 8               | 110                | 0.6       | 0.84              | 0.87       | 72         | 28     | 1   | Waiting and autotracking |
| 9               | RE                 | 110       | 0.8               | 0.83       | 0.87       | 65     | 26   | 4   | Waiting and autotracking |
|                 | LE                 | 110       | 0.3               | 0.83       | 0.87       | 55     | 27   | 10  | Manual tracking         |
| 10              | 120                | 0.9       | 0.84              | 0.88       | 63         | 28     | 6   | Manual tracking         |
| 11              | 120                | 0.6       | 0.81              | 0.89       | 83         | 26     | 4   | Waiting and autotracking |
| 12              | 110                | 0.6       | 0.82              | 0.85       | 75         | 27     | 3   | Manual tracking         |

LE = left eye; RE = right eye
*Patients 1, 2, and 3 were lost to follow-up after 1 month.
Figure 1. Air bubbles in the anterior chamber after flap creation with the femtosecond laser: A = patient 1, B = patient 2 (right eye), C = patient 2 (left eye), D = patient 3, E = patient 4, F = patient 5, G = patient 6, H = patient 7, I = patient 8, J = patient 9 (right eye), K = patient 9 (left eye), L = patient 10. (There are no photographs of patients 11 and 12.)

| Patient* | 1 Day UDVA | 1 Week UDVA | Manifest Refraction (D) | 1 Month UDVA | Manifest Refraction (D) | 3 Months UDVA | Manifest Refraction (D) |
|----------|------------|-------------|-------------------------|--------------|-------------------------|---------------|-------------------------|
|          | Sphere    | Cylinder    | Sphere | Cylinder | Sphere    | Cylinder | Sphere | Cylinder | Sphere | Cylinder | Sphere | Cylinder |
| 1        | 20/20     | 0           | 0      | 20/16     | 0          | 0        | 20/16    | 0        | 0        | 20/16    | 0        | 0        |
| 2        | 20/20     | 0           | 0      | 20/16     | 0          | 0        | 20/16    | 0        | 0        | 20/16    | 0        | 0        |
| LE       | 20/20     | 0           | 0      | 20/16     | 0          | 0        | 20/16    | 0        | 0        | 20/16    | 0        | 0        |
| 3        | 20/25     | 0           | 0      | 20/16     | 0          | 0        | 20/16    | 0        | 0        | 20/16    | 0        | 0        |
| 4        | 20/20     | 0           | 0      | 20/20     | 0          | 0        | 20/20    | 0        | 0        | 20/20    | 0        | 0        |
| 5        | 20/25     | 0.25        | 0.50   | 20/20     | 0          | 0        | 20/20    | 0.25     | 0.50     | 20/20    | 0.25     | 0.50     |
| 6        | 20/20     | 0           | 0      | 20/20     | 0          | 0        | 20/20    | 0        | 0        | 20/16    | 0        | 0        |
| 7        | 20/20     | 0           | 0      | 20/16     | 0          | 0        | 20/20    | 0        | 0        | 20/25    | 0        | 0.50     |
| 8        | 20/20     | 0           | 0      | 20/20     | 0          | 0        | 20/20    | 0        | 0        | 20/20    | 0        | 0        |
| 9        | 20/20     | 0           | 0      | 20/16     | 0          | 0        | 20/16    | 0        | 0        | 20/16    | 0        | 0        |
| RE       | 20/20     | 0           | 0      | 20/16     | 0          | 0        | 20/16    | 0        | 0        | 20/16    | 0        | 0        |
| LE       | 20/20     | 0           | 0      | 20/16     | 0          | 0        | 20/16    | 0        | 0        | 20/16    | 0        | 0        |
| 10       | 20/25     | 0           | 0      | 20/25     | 0          | 0        | 20/25    | 0        | 0        | 20/25    | 0        | 0        |
| 11       | 20/40     | 0           | 0      | 20/20     | 0          | 0        | 20/16    | 0        | 0        | 20/16    | 0        | 0        |
| 12       | 20/40     | 0           | 0      | 20/20     | 0          | 0        | 20/16    | 0        | 0        | 20/16    | 0        | 0        |

LE = left eye; RE = right eye; UDVA = uncorrected distance visual acuity

*Patients 1, 2, and 3 were lost to follow-up after 1 month.
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