

Transient light sensitivity after femtosecond laser flap creation: Clinical findings and management

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PURPOSE: To describe the constellation of subjective and objective findings associated with unusual occurrences of photosensitivity after laser in situ keratomileusis (LASIK) with femtosecond flap creation and identify optimal management strategies.

METHODS: Demographic data, laser settings, subjective complaints, clinical findings, treatment, and response to treatment were recorded for suspected cases of transient postoperative photosensitivity from 3 surgeons operating at 3 different sites. All cases were estimated for the period covering the suspected cases at each site to assess incidence. Additional cases were solicited from IntraLase users via a survey.

RESULTS: For the 3 sites, 63 eyes from 33 patients were reported of a total estimated case log of 5667 (incidence, 1.1%). Average age was 41 years, and 51.7% of patients were women. Onset of symptoms ranged from 2 to 6 weeks after uneventful LASIK. All patients were treated with prednisolone acetate drops, whereas 1 surgeon also used Restasis (cyclosporine ophthalmic solution 0.05%). Patients noted improvement of symptoms within 1 week of treatment. When the raster and side-cut energy settings were lowered (by an average of 24% and 33%, respectively), significant reductions in incidence were noted. Similar findings were reported by 3 additional surgeons reporting 17 cases in the survey of IntraLase users.

CONCLUSIONS: This report describes a new complication of LASIK performed with a femtosecond laser keratome that may be related to the pulse energy used for flap creation. Although there is no loss of uncorrected visual acuity, symptoms can be prolonged, especially without prompt steroid therapy. Technical advances that reduced pulse energies appear to decrease the incidence.

J Cataract Refract Surg 2006; 32:91-94 © 2006 ASCRS and ESCRS

The mechanism of femtosecond laser flap creation with the IntraLase FS (IntraLase Corp.) has been described extensively.¹⁻⁵ Briefly, the system produces short-duration (600 to 800 femtosecond) light pulses at 1053 nm infrared wavelength. Multiple pulses are focused to an approximately 3 µm spot diameter at a preset depth, leading to photodisruption and creation of a corneal resection plane. Once the bed of the flap has been created, the device creates a side cut from the level of the resection plane, moving anteriorly through the epithelium. Cavitation bubbles created during photodisruption generally remain in the resection plane; however, they may migrate anteriorly, posteriorly, or peripherally in the cornea.

Initial experience in the United States with the IntraLase FS laser began in May 2000 and showed excellent results with no postoperative complications.^{3,4} To date, several studies have documented improved flap predictability and refractive outcomes compared with that of the mechanical microkeratome.^{6,8} Use of the technology has

been reported to reduce or eliminate many of the minor and severe complications associated with flap creation.⁴⁻⁸

More recently, sporadic cases of unusual photosensitivity that does not affect visual acuity have been reported (B. Will, MD, "Success with IntraLase: It's Not Just Point and Shoot"; K. Stonecipher, MD, "A Comparative Study: Moria, Hansatome, and IntraLase"; both presented at the ASCRS Symposium on Cataract, IOL and Refractive Surgery, San Diego, California, USA, May 2004). The term *transient light sensitivity syndrome* (TLSS) has been coined to describe this condition. A multicenter case series is reported to describe the constellation of subjective and objective findings as well as clinical outcomes seen with this entity.

PATIENTS AND METHODS

Suspected postoperative photosensitivity cases were divided into 3 groups according to the surgeon reporting them (Table 1). For each group, demographic data, reported symptoms, uncorrected visual acuity (UCVA), slitlamp examination, and

Table 1. Summary of suspected postoperative photosensitivity cases grouped according to reporting surgeon.

Group	No. of Patients	Time Frame
1	6*	2001
2	16	2003–2004
3	11	2003–2004

*Although only 6 cases were reported with clinical data, approximately 20 cases were suspected in retrospect before recognition of the entity.

response to interventions were recorded from clinical records. Raster and side-cut energy used for femtosecond laser flap creation were also recorded. Estimates of incidence rates were made based on the number of procedures performed during the relevant time interval at each respective clinical site.

Additional cases were collected from a survey distributed to all IntraLase users, which solicited data on suspected TLSS cases including patient symptoms, clinical findings, demographics, laser energy settings, and treatment; responses were received between August and November 2004.

RESULTS

Individual Group Findings

Group 1

Eleven eyes of 6 patients were identified from a cohort of 783 cases followed up prospectively in 2001. Approximately 14 additional patients may have experienced similar symptoms but were not specifically identified, so their data were not available for review. The mean age of affected patients was 43 years (range 37 to 47 years), and 50% were women. Patients presented with complaints of extreme sensitivity to indoor lights and computer screens. The onset of symptoms ranged between 3 and 6 weeks after uneventful laser in situ keratomileusis (LASIK). The mean laser bed (raster) energy was $3.75 \mu\text{J} \pm 1.3$ (SD), and the mean side-cut energy was $8.75 \pm 0.12 \mu\text{J}$. The mean UCVA (decimal) at the time of reported symptoms was of 0.95 ± 0.1 (range

Accepted for publication April 8, 2005.

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Dr. Stonecipher and Dr. Dishler have received travel and research support from IntraLase. Dr. Binder and Dr. Ignacio are consultants to IntraLase Corp.

No author has a financial or proprietary interest in any material or method mentioned.

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20/20 to 20/30). Slitlamp examination found no internal or external inflammatory reaction and no significant interface findings. Patients were treated with prednisolone acetate 1% (Pred Forte) as frequently as hourly or 4 times per day for 1 to 2 weeks. The Pred Forte was tapered after 1 week or over 1 to 2 months. Symptoms resolved within 1 to 2 weeks of topical steroid therapy, with no change in UCVA.

After the laser bed energy settings were lowered to $2.3 \mu\text{J}$ (39% decrease) and side-cut energy to $3.2 \mu\text{J}$ (64% decrease), no additional similar cases were reported. In addition to these laser setting changes, the postoperative medication regimen was changed from loteprednol 0.5% eyedrops (Lotemax) 4 times a day for 1 week to Pred Forte 4 times a day for 1 week.

Group 2

Thirty-two eyes of 16 patients reporting severe light sensitivity were collected from a cohort of 2994 eyes (incidence of 1.06%) having LASIK between January 2003 and September 2004. The mean patient age was 41 years (range 25 to 57 years) and the mean preoperative spherical equivalent was -4.6 diopters (D) (range -0.9 to -8.75 D) and the mean cylinder, 0.94 D (range 0.0 to 2.5 D). Sixty percent of the patients were women. The iris color was brown in 37.5% (12 of 32), blue in 37.5% (12 of 32), and hazel in 25% (8 of 32). Preoperative UCVA ranged from 20/200 to counting fingers. The mean preoperative best corrected visual acuity (BCVA) was 1.01 ± 0.08 (range 0.8 to 1.33). The mean postoperative UCVA was 1.03 ± 0.19 (range 0.5 to 1.33). One eye of 1 patient with a visual acuity of 20/200 was planned for monovision, with the other 96.5% having 20/25 or better. The mean postoperative BCVA was 1.11 ± 0.16 (range 1.33 to 1.0), with 100% of the population correctable to 20/20 or better. The mean preoperative pachymetry was $542.5 \pm 24.4 \mu\text{m}$. The mean photopic pupil size was 4.63 ± 1.02 mm (range 3.0 to 6.6 mm) and the mean scotopic pupil size, 6.13 ± 0.74 mm (range 5 to 7 mm). There were no perioperative or postoperative complications.

Onset of photophobia occurred between 4 and 6 weeks postoperatively with normal visual acuity at the time of complaint. The mean raster energy used was $3.4 \pm 0.5 \mu\text{J}$ and the mean side-cut energy, $4.3 \pm 0.89 \mu\text{J}$. On slitlamp examination, anterior segments in all patients were normal with no significant detectable interface inflammation or deposits. Patients were given Pred Forte 4 to 6 times a day or Restasis (cyclosporine ophthalmic solution 0.05%) 2 to 4 times per day for the first week or 2 after presentation, and improvement of symptoms was noted after a week of treatment.

Confocal imaging was performed in some eyes and compared with asymptomatic cases (Figure 1). Findings

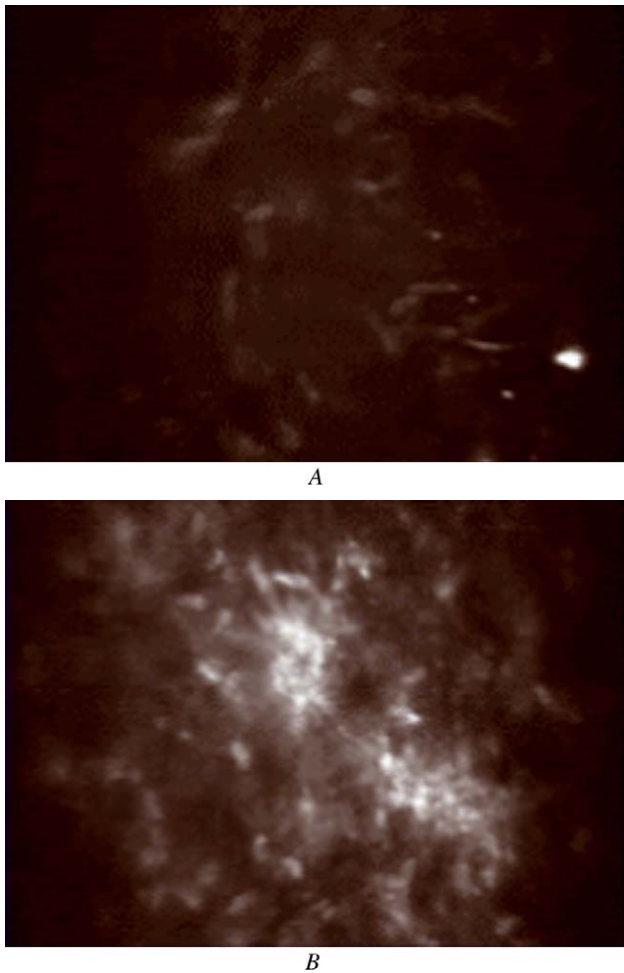


Figure 1. A: Confocal image of a post-LASIK interface of an asymptomatic patient. B: Confocal image of a stromal interface in a patient with TLSS. Probable activated keratocytes are present.

included activated keratocytes at the interface that resolved with the resolution of the patient's subjective complaints. Laser bed energy and side-cut energy were reduced subsequently by 20.5% to 2.7 μJ and 25.7% to 3.2 μJ , respectively. Incidence of TLSS was reduced to 0.17% (3 of 1705) after the decrease in laser energy settings.

Group 3

Twenty eyes of 11 patients were collected from a cohort of 1900 patients having LASIK between August 2003 and August 2004 (incidence 1.05%). The mean age was 39 years (range 26 to 56 years), and 45% of the patients were women. Patients presented 2 to 6 weeks after surgery with sensitivity to room light severe enough to make them unable to watch television or use the computer. The mean laser bed energy was $1.98 \pm 0.17 \mu\text{J}$, and the mean and side-cut energy was 4.0 μJ . The mean UCVA was 0.89 ± 0.27 . Two patients

had planned monovision with 20/200 and 20/300 in each eye. All remaining eyes had acuities of 20/30 or better. On slitlamp examination, no signs of inflammation were noted in any eye. Patients were treated with hourly drops of Pred Forte for 7 days. All patients responded to treatment, and there were no chronic cases seen. Laser side-cut energy setting was lowered subsequently to 3.6 μJ (decreased by 10%). Incidence of this entity was 1% (5 of 500) after the decrease in laser energy settings.

Survey Results

In the survey, an additional 17 eyes of 10 patients were reported by 3 surgeons from different clinical sites. All patients were women with a mean age of 47 years (range 26 to 63 years). Patients' complaints were light sensitivity and glare. The mean raster energy used was $1.97 \pm 0.3 \mu\text{J}$ (range 1.8 to 2.5 μJ), and the mean side-cut energy was $3.42 \pm 0.3 \mu\text{J}$ (range 3 to 3.6 μJ). The mean UCVA was 0.90 ± 0.3 (range 20/20 to 20/80). One eye of 1 patient had an acuity of 20/150 after planned monovision treatment. On slitlamp examination, 4 eyes showed mild interface haze. However, the same interface haze was seen in other patients who did not complain of light sensitivity. Treatment varied according to surgeon preference. Medication regimens included Lotemax 0.5% eyedrops 4 times a day for 2 weeks and prednisolone acetate ophthalmic suspension (Econopred $\frac{1}{8}\%$) twice a day for 2 weeks. Symptoms began to resolve after 1 week of treatment in all cases, and no loss of BCVA was reported in any case.

Laser energy settings used by surgeons and surgeons who participated in the survey are summarized in Table 2.

DISCUSSION

Transient light sensitivity syndrome describes a constellation of symptoms that can occur after LASIK with femtosecond laser flap creation. Patients with TLSS generally present with light sensitivity that is out of the ordinary, good UCVA, and minimal slitlamp findings 2 to 6 weeks after uneventful LASIK. All patients responded to topical steroids, although improvement with Restasis has also been reported by 1 center. Based on collected cases, an incidence of approximately 1% was identified. The highest incidence rates occurred with the highest initial energy settings and with reduction in the number of cases after reductions in laser energy settings by 20% to 60%. In best documented series (group 2), there was an approximately 5-fold reduction in incidence to less than 0.2% after an approximately 20% lowering of surgical energies.

The etiology of this syndrome is unknown, but the identification of activated keratocytes at the interface that in some cases resolve with the resolution of the patient's subjective complaints is noteworthy. However, these cells

Table 2. Summary of laser energy settings used by different surgeons.

Groups	Initial Raster Energy (μJ)	Current Raster Energy (μJ)	Initial Side-Cut Energy (μJ)	Current Side-Cut Energy (μJ)
1	3.75 ± 1.3	2.3	8.75 ± 0.12	3.2
2	3.4 ± 0.5	2.7	4.3 ± 0.89	3.2
3	1.98 ± 0.17	1.9	4.0	3.6
Survey	1.97 ± 0.3	NA	3.42 ± 0.3	NA

NA = not applicable

are also seen in patients with no symptoms. Activated keratocytes are a feature of normal healing after LASIK,^{9,10} and they have been reported to occur after other refractive procedures as well. The reduction in TLSS cases after laser energy settings were lowered supports secondary effects of laser pulse energy, such as shock wave exposure on local keratocytes or corneal nerve endings, as an etiology. Reduction in laser energy reduces the magnitude and range of these transients, thereby possibly reducing their effects on local cell populations. Similar symptoms have been reported more rarely after LASIK performed with a mechanical microkeratome,^{11,12} suggesting that keratocyte activation may occur via different mechanisms as well. Another etiology may be associated with migration of the expelled gases into the peripheral cornea and episclera that could irritate the ciliary body. Because the eyes respond to topical steroids, some irritation of the ciliary body can be suspected.

Although no definite etiologic mechanism has been identified, several management strategies can be recommended based on the summarized clinical experience to reduce incidence and severity of TLSS. These include:

1. The lowest possible surgical energy settings needed to maintain good flap dissection quality should be used, usually combined with reduction in laser spot separations to allow lower energy settings.
2. Patients presenting with photosensitivity should be examined for evidence of true diffuse lamellar keratitis.¹³ If available, confocal microscopy may be considered for additional information directing treatment. Eyes can be treated with prednisolone acetate 1% every 1 to 6 hours tapered over 1 to 4 weeks. Patients should be monitored for evidence of elevated intraocular pressure. Adjunctive use of nonsteroidal antiinflammatory medications can also be considered (Frank Price, MD, personal communication).

Further clinical studies may help identify more specific etiologies and management of TLSS. However, the relatively

low incidence of the entity seen after reduction in laser energy settings may make this impractical. Animal studies may therefore provide additional information regarding this phenomenon. Technical advances in the device that permit even lower energy settings may also help reduce the incidence of TLSS.

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