We present the case of a 43-year-old woman with severe dry eye after laser in situ keratomileusis (LASIK) that was successfully treated with vectored thermal pulsation therapy (Lipiflow). For 4 years after LASIK, despite the aggressive use of lubricants, the Standard Patient Evaluation of Eye Dryness (SPEED) score was 20, the tear breakup time (TBUT) was less than 5 seconds, and the mean lipid layer thickness was 33 nm in the right eye and 31 nm in the left eye with moderate to severe corneal staining. Eighteen months after a single 12-minute treatment with vectored thermal pulsation therapy, the SPEED score was 12 and the lipid layer thickness was 77 nm in the right eye and 70 nm in the left eye; the TBUT was 8 seconds and 14 seconds, respectively. Vectored thermal pulsation therapy successfully treated a case of post-LASIK dry eye that was refractory to conventional treatment.

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Laser in situ keratomileusis (LASIK) is the most common refractive surgical procedure. The efficiency rate is high, with more than 90% of patients achieving 20/25 or better corrected distance visual acuity (CDVA) without glasses. The procedure is documented to be safe, but several post-LASIK complications may occur; dry-eye syndrome is the most frequent. Although 95% of patients may experience dry-eye symptoms immediately after LASIK, approximately 20% develop chronic dry-eye symptoms that persist beyond 6 months. Despite the identification of several risk factors for post-LASIK dry eye and attempts to mitigate some of them, post-LASIK dry eye continues to be a major challenge of LASIK.

Multiple theories about the pathophysiology of post-LASIK dry eye have been proposed. Corneal nerve damage with resultant loss of corneal sensation is probably the most important. Loss of corneal sensation has been associated with reduced blinking rate, leading to evaporative stress and lipid-deficiency dry eye secondary to meibomian gland dysfunction. Additionally, LASIK-induced change in corneal shape may affect the relationship between the eyelids and the ocular surface and lead to abnormal tear distribution during blinking.

The conventional therapy for post-LASIK dry eye is lubricating the ocular surface adequately with artificial tears, preserving tears using punctual plugs, and treating ocular surface inflammation. However, lubricants offer only temporary relief; punctual plugs are not without complications, and long-term use of topical steroids is not sustainable.

Recently, a new treatment device, the Lipiflow vectored thermal pulsation system (Tearscience), has been reported to be safe and effective for treating evaporative dry eye with meibomian gland dysfunction. We describe a case of post-LASIK dry eye with severe symptoms recalcitrant to conventional post-LASIK
dry-eye therapy that was successfully treated using vectored thermal pulsation therapy.

**CASE REPORT**

A 43-year-old woman presented to the author (G.P.) with severe dry-eye symptoms, which she reportedly had developed after bilateral LASIK 4 years earlier. Concomitantly, the patient had Hashimoto thyroiditis. A careful ophthalmic examination was done to look for ocular involvement of Hashimoto thyroiditis: signs of proptosis, soft tissue swelling, decreased eye muscle function, lagophthalmos or upper eyelid retraction; however, the patient had none of these signs. Therefore, post-LASIK dry eye was diagnosed.

The symptoms of dry eye included discomfort, irritation, foreign-body sensation, dryness and severe pain in both eyes. The symptoms negatively affected the patient’s daily activities. Her treatment included instillation of hydroxypropyl methylcellulose (Artelac 3.2 mg/mL, eyedrop solution) every 15 minutes (up to 64 times a day), warm compresses once a day during waking hours, and carbomers 0.2% gel (Artelac nighttime gel) at night. The patient did not report using other therapies during the 4 years prior to seeking treatment.

The CDVA (decimal) was 0.63 in the right eye and 0.8 in the left eye. The ocular surface examination showed a corneal fluorescein staining grade of 2 to 3 in the right eye and 1 in the left eye (National Eye Institute/Industry Workshop scoring system); the tear breakup time (TBUT) was less than 5 seconds in both eyes. Meibomian gland function was evaluated using standardized diagnostic meibomian gland expression across the entire lower eyelid; only 8 meibomian glands in the right lower lid and 10 in the left lower lid yielded liquid secretions. The score of the Standard Patient Evaluation of Eye Dryness (SPEED) questionnaire was 20. The tear-film lipid layer thickness was measured using the ocular surface interferometer. Prior to vectored thermal pulsation therapy, it was 33 nm ± 5 (SD) in the right eye (Figure 1) and 31 ± 5 nm in the left eye.

Each eye was treated once for 12 minutes with vectored thermal pulsation therapy. The key clinical findings for all visits are shown in Table 1. One month after treatment, there was improvement in the number of meibomian glands yielding liquid secretions, the TBUT, the lipid layer thickness, and the SPEED score. At the last follow-up visit (18 months), the lipid layer thickness had increased further in both eyes (Figure 1).

**DISCUSSION**

The treatment of post-LASIK dry eye includes adequate lubrication of the ocular surface with artificial tears and/or cyclosporine eyedrops to treat the inflammatory component of dry eyes. However, despite the...
aggressive use of lubricants (instilled several times an hour) in our case, there was limited improvement in the dry-eye signs and symptoms.

The use of vectored thermal pulsation therapy for meibomian gland dysfunction in this patient was effective in increasing the number of functional meibomian glands, with a corresponding increase in lipid layer thickness, an increase in TBUT time, and a decrease in symptoms. At the 1-month visit, there was improvement in the patient’s symptoms, with a decrease in the pretreatment SPEED score from 20 to 7. Although the SPEED score increased by a couple of points in subsequent follow-up visits, overall the patient was satisfied with the treatment and did not feel the need for retreatment. Continued improvement in the ocular surface health was also apparent from the increased TBUT and absence of corneal staining at 6 and 18 months.

The safety of the vectored thermal pulsation device is well established19–22; however, there may be apprehension regarding flap dislocation with the use of the vectored thermal pulsation device in post-LASIK eyes. It is important to note that the device contains a scleral shell and thus is structured to vault the cornea, resting on the scleral portion of the eye only. The cornea remains untouched by the device even with rotation of the eye; therefore, the risk for flap dislocation with the use of the vectored thermal pulsation device would be minimal to none. However, inserting and removing the device should be done carefully to prevent contact of the device with the cornea.

Laser in situ keratomileusis may be the tipping point for subclinical forms of dry eye that become manifest after LASIK, highlighting the need for a thorough pre-LASIK ocular surface evaluation.23 Contact lens users electing to have LASIK may not present with significant dry eye but may have diagnosable and treatable nonobvious meibomian gland dysfunction.24,25 Because meibomian gland dysfunction is understood to be the leading cause of dry eye,26 detailed evaluation of meibomian gland function and structure during any pre-LASIK workup is arguably advisable. As it is known that aggressive pre-LASIK treatment of dry-eye syndrome reduces the frequency and severity of post-LASIK dry eye,16,27 comprehensive treatment of meibomian gland dysfunction,28 the leading cause of dry eye, should also be considered. Treatment of meibomian gland dysfunction before cataract surgery has been shown to improve ocular comfort after cataract refractive surgery relative to untreated controls.26

The increase in meibomian gland function after treatment was sufficient to reduce dry-eye symptoms, stabilize the tear film, improve visual acuity, and reduce the ocular surface staining to zero in this patient with severe refractory post-LASIK dry eye. The improvement was maintained, and no retreatment was needed up to 18 months after vectored thermal pulsation therapy. Future studies involving a series of patients with post-LASIK dry eye may validate the efficacy of vectored thermal pulsation therapy.

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**Table 1.** Clinical results from the pretreatment visit to the 18-month posttreatment visit.

| Measurement                        | Eye  | Pretreatment | Posttreatment |
|------------------------------------|------|--------------|---------------|
|                                    |      |              | 1 Mo | 6 Mo | 18 Mo |
| Lipid layer thickness (Mean ICU)   | OD   | 33 ± 5       | 50 ± 8 | 40 ± 6 | 77 ± 5 |
|                                    | OS   | 31 ± 5       | 45 ± 4 | 41 ± 4 | 70 ± 2 |
| SPEED score                        | OU   | 20           | 7    | 10    | 12   |
|                                    | OS   | 8            | 13   | 13*   | 12   |
| Number of meibomian glands yielding liquid secretions | OD   | 10           | 14   | 10   | 13   |
|                                    | OS   |              |      |       |      |
| Corneal staining                   | OD   | 2 to 3       | NA   | No staining | No staining |
|                                    | OS   | 1            | NA   | No staining | No staining |
| TBUT (seconds)                     | OD   | <5           | 10   | 10    | 8    |
|                                    | OS   | <5           | 15   | 9     | 14   |
| Visual acuity (decimal)            | OD   | 0.63         | NA   | 0.8   | 1    |
|                                    | OS   | 0.8          | NA   | 0.8   | 1    |
| Mean number of eyedrop instillations per day | OU   | 64 (methylhydroxypropylcellulose) | 5 (preservative-free 30% hyaluronic acid-containing eyedrops) | 2-5 (preservative-free 30% hyaluronic acid-containing eyedrops) | 4-5 (preservative-free 30% hyaluronic acid-containing eyedrops) |

**ICU** = interferometric color units; **NA** = data not recorded; **SPEED** = Standard Patient Evaluation of Eye Dryness; **TBUT** = tear breakup time

*The meibomian gland assessment was not recorded at 6 months; the findings presented were recorded at 12 months.
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