

Pupil Damage After Periorbital Laser Treatment of a Port-wine Stain

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Background: The increase in the number of laser treatments has led to an increase in the number of therapy-related adverse effects. Herein we report a case in which long-term adverse effects occurred after periorbital laser treatment of a treatment-resistant port-wine stain using a long-pulsed alexandrite laser without protective eyewear.

Observations: A 33-year-old woman with a therapy-resistant port-wine stain was treated periorbitally with a 755-nm long-pulsed alexandrite laser after several treatment sessions with the pulsed-dye laser; she was not given protective eye shields. Within a few days of the session,

she reported disorders in the motility of her left pupil and a painful sensitivity to light, which was not completely resolved after 12 months of follow-up.

Conclusions: We recommend that both patients and operators use protective eyewear with every laser procedure. When treatment is administered near the eye, eye shields should be placed behind the eyelid or a safe distance should be maintained between the laser and the eyeball by treating up to the orbital rim only.

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LASER TREATMENTS IN DERMATOLOGY are an important therapeutic option with limited adverse effects in experienced hands. Observing the necessary safety procedures is as important as performing the treatment correctly. The increase in the number of laser treatments has led to an increase in the number of therapy-related adverse effects. We report a case in which long-term adverse effects occurred after periorbital laser treatment of a therapy-resistant port-wine stain using a long-pulsed alexandrite laser without protective eyewear.

REPORT OF A CASE

A 33-year-old woman was born with a port-wine stain on the left side of her face that extended from the left corner of her mouth past the eye (1 cm from the edge of the eyelid) and up to the forehead. She had already undergone 28 sessions with a pulsed-dye laser and 3 sessions with a long-pulsed KTP-Nd:YAG laser (VersaPulse; Coherent, Palo Alto, Calif), but the port-wine stain had not responded to treatment. After an additional session during which a pulsed-dye laser was used on her cheek, a 755-nm long-pulsed alexandrite laser (Apogee 9300; Cynosure, Inc, Chelmsford, Calif)

with cold air cooling (Cryo5; Zimmer Elektromedizin GmbH, Neu-Ulm, Germany) was used on her cheek and in the periorbital area during the same session at a laser treatment center. The fluence of the alexandrite laser was 50 J/cm² with a pulse duration of 20 milliseconds and a beam diameter of 12.5 mm. The periorbital segment of the treatment was conducted while the patient kept her eyes shut. Safety guidelines were ignored, and the patient was not provided with eye shields; the operator wore wavelength-adapted goggles. The pulses were aimed at the edge of the zygomatic bone, the skin was held taut, and the probe was pointed away from the eyeball. The immediate postoperative state began normally with intense swelling and reddening of the eyes. On the third day after the procedure, the patient complained of a painful sensitivity to light and blurred vision. The pupil of her left eye was irregular and did not respond to light.

On the fourth day, an ophthalmologist diagnosed inflammation of the sclera and posterior synechia (**Figure 1**). Further examination revealed a slight reduction of vision and a direct alteration of the pupillary sphincter. The posterior synechia, which showed evidence of a laser-induced intraocular (iritic) inflammation, could not be broken with mydriatic eyedrops. Three months later, the left pu-

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pupil was still irregular (oval) and more dilated than that of the other eye but responded to light (**Figure 2**).

Eleven months after laser treatment, there was a significant increase in pupil motility because of constant topical treatment with diclofenac sodium (Voltaren). However, the increased sensitivity to light persisted and the patient's vision distorted whenever she moved. The pupil remained irregularly, slightly dilated (9 vs 6 mm) and responded to light only nasally and in the superior segment of the eye. The patient was advised to continue topical treatment.

COMMENT

Lasers of different wavelengths are used in treating port-wine stains, depending on the thickness and depth of the vessels in the tissue.¹⁻⁵ The therapeutic principle at work is selective photothermolysis.⁶

The currently preferred method of treatment for port-wine stains is the flashlamp-pumped pulsed-dye laser at wavelengths of 585 to 595 nm and pulse durations of 0.5 to 40 milliseconds.¹⁻⁵ Other strategies include the use of the long-pulsed KTP-Nd:YAG laser (532 nm), intense pulsed-light technology, and the long-pulsed alexandrite laser (755 nm). The alexandrite laser is most commonly used for epilation and treatment of broken vessels in the legs; it is also a useful alternative in cases of bulky malformations and mature port-wine stains.⁴ No et al⁷ reported that the alexandrite laser achieved significant lightening in 3 patients with hypertrophic port-wine stains.

Compared with the pulsed-dye laser (585-595 nm), the alexandrite laser has a wavelength of 755 nm and penetrates the tissue more deeply, regardless of the beam diameter.

In our patient, the light of the laser caused scleritic and episcleritic inflammation and involvement of intraocular structures. In general, the human iris absorbs between 53% and 98% of the infrared light within a spectrum of 750 to 900 nm; the extents of absorption and of any subsequent damage are largely related to the degree of pigmentation.⁸ Our patient's iris was green with a narrow inner rim of brown. Because she did not undergo spectroscopy, we cannot determine the exact extent of absorption; however, even an absorption of about 50% is rather high. In this case, absorption of the laser light by the pupillary sphincter caused hyperthermia and led to temporal atrophy. This induced an inhibited reaction to light and thus a greater sensitivity to light. Furthermore, small atrophies developed in the lower to temporal regions of the iris, resulting in the typical "church window phenomenon."

Posterior synechia developed as a result of posttraumatic intraocular inflammation. In such cases, the risk of a secondary cataract developing is increased.⁸ Despite the fact that the ocular treatment given to our patient resulted in clear improvement from a subjective and an objective perspective, it must be assumed that there will not be complete resolution in the long run. The patient will probably grow accustomed to the increased sensitivity to light over time.

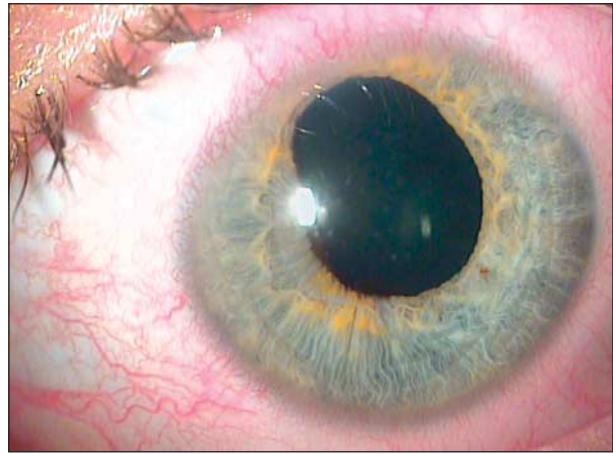


Figure 1. Slitlamp photograph shows that the pupil of the patient's left eye is mid-dilated and does not respond to light. Posterior synechia and an obvious scleral injection and inflammation can be seen.



Figure 2. Slitlamp photograph 3 months later shows that the left pupil is still irregular (oval) and more dilated than that of the right eye but responds to light. The eye is no longer in a state of significant inflammation.

We have found only 2 published reports of intraocular side effects of laser epilation after using diode lasers (800 nm).^{9,10} In both cases, the patient underwent epilation of the upper eyelid region without protective eye shields, with subsequent uveitis and pupillary distortion in one case and iris atrophy and nuclear cataract in the other. Other laser-induced adverse effects involving the eyes occurred for the most part when trained operators failed to protect their eyes adequately.¹¹⁻¹⁶ Most of these were retinal injuries due to accidental exposure to various kinds of lasers. The laser caused bleeding in the retina, the subretinal area, or the vitreous. A macular hole can develop during resorption, which may lead to formation of epiretinal gliosis.¹¹ Lin et al¹² reported a case in which laser treatment with a short-pulsed alexandrite laser at a distance of 25 cm caused a macular hole with a central scotoma. The consequent loss of vision persisted throughout the 7-month follow-up. Ours is the first case, to our knowledge, of an ocular injury involving the alexandrite laser and related damage in the frontal region of the eye.

A study by Pham et al¹⁵ demonstrated the effectiveness of protective eyewear. In that study, the eyes of the

5 patients undergoing treatment with a long-pulsed diode laser (810 nm) for periorbital hypertrichosis were effectively protected by metal eye shields that were placed behind the eyelids. After treatment, no vision changes were detected by electroretinography, slitlamp examination, and fundoscopy.

In their assessment of 29 cases of laser-induced eye injuries, Liu et al¹³ concluded that most of the accidents were preventable. Of 12 medical laser accidents examined by Moseley¹⁴ in 2004, 67% were caused by operator error. Biesman and Zachary¹⁷ criticized the lack of specific standards for the safe use of newer devices in the periorbital region and called for a systematic approach to reporting laser- and light-induced ocular injury.

When performing laser treatments near the eye, we consider the use of protective eyewear and the rigorous observance of general safety measures¹⁸ indispensable. When treatment is administered near the eyes while the patient is wearing external eye shields only, a safe distance should be maintained between the laser and the eyeball by treating up to the orbital rim only, and the laser should be pointed away from the eyeball. Whenever laser energy is used in the immediate vicinity of the eye (eg, when treating eyelids), a stainless steel or lead eye shield should be positioned on the surface of the orbit after the application of a topical ophthalmic local anesthetic. Plastic patient eye shields cannot be expected to withstand the thermal and mechanical effects of pulsed lasers and should never be used.^{19,20}

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REFERENCES

1. Dover JS, Arndt KA. New approaches to the treatment of vascular lesions. *Lasers Surg Med.* 2000;26:158-163.
2. Greve B, Raulin C. Prospective study of port wine stain treatment with dye laser: comparison of two wavelengths (585 nm vs. 595 nm) and two pulse durations (0.5 milliseconds vs. 20 milliseconds). *Lasers Surg Med.* 2004;34:168-173.
3. Lanigan SW. Port-wine stains unresponsive to pulsed dye laser: explanations and solutions. *Br J Dermatol.* 1998;139:173-177.
4. Lanigan SW, Taibjee SM. Recent advances in laser treatment of port-wine stains. *Br J Dermatol.* 2004;151:527-533.
5. Loo WJ, Lanigan SW. Recent advances in laser therapy for the treatment of cutaneous vascular disorders. *Lasers Med Sci.* 2002;17:9-12.
6. Anderson RR, Parrish JA. Selective photothermolysis: precise microsurgery by selective absorption of pulsed radiation. *Science.* 1983;220:524-527.
7. No D, Dierickx C, McClaren M, et al. Pulsed alexandrite treatment of bulky vascular malformation [abstract]. *Lasers Surg Med.* 2003;15(suppl):26.
8. Voke J. Radiation effects on the eye, part 1: infrared radiation effects on ocular tissue. *Optom Today.* 1999;(5):22-28.
9. Lam TT, Tso MO. Retinal injury by neodymium:YAG laser. *Retina.* 1996;16:42-46.
10. Brilakis HS, Holland EJ. Diode-laser-induced cataract and iris atrophy as a complication of eyelid hair removal. *Am J Ophthalmol.* 2004;137:762-763.
11. Wessely D, Lieb W. Ocular complications of diode laser epilation in the face: loss of pupillary symmetry and pigment layer defect as well as coagulation of the ciliary body with intraocular inflammation caused by laser treatment [in German]. *Ophthalmologe.* 2002;99:60-61.
12. Lin LT, Liang CM, Chiang SY, Yang HM, Chang CJ. Traumatic macular hole secondary to a Q-switch Alexandrite laser. *Retina.* 2005;25:662-665.
13. Liu HF, Gao GH, Wu DC, et al. Ocular injuries from accidental laser exposure. *Health Phys.* 1989;56:711-716.
14. Moseley H. Operator error is the key factor contributing to medical laser accidents. *Lasers Med Sci.* 2004;19:105-111.
15. Pham RT, Tzekov RT, Biesman BS, Marmor MF. Retinal evaluation after 810 nm Dioderm laser removal of eyelashes. *Dermatol Surg.* 2002;28:836-840.
16. Sliney DH. Laser safety. *Lasers Surg Med.* 1995;16:215-225.
17. Biesman B, Zachary C. Laser safety: will eye injuries spell the end of laser and light therapy? In: Arndt KA, Dover JS, eds. *Controversies and Conversations in Cutaneous Laser Surgery: An Advanced Symposium, August 8-10, 2003.* Chicago, Ill: AMA Press; 2003.
18. American National Standards Institute Standard Z136.3. American National Standards Institute Accredited Standards Committee Web site. <http://www.z136.org>. Accessed December 23, 2006.
19. Bader O, Lui H. Laser safety and the eye: hidden hazards and practical pearls. Poster presented at the annual meeting of the American Academy of Dermatology; February 10-15, 1996; Washington, DC. <http://www.eyesafety.4ursafety.com/laser-eye-safety.html>. Accessed October 1, 2006.
20. Laser safety guidelines and publications. Laser Institute of America Web site. <http://www.laserinstitute.org>. Accessed October 1, 2006.