Retinal Injury During Laser Epilation: Case Report

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ABSTRACT

The increase in cosmetic surgery procedures via laser hair removal has led an increase in cutaneous and ocular complications. Although such procedures are mostly performed by individuals trained in this field, a large number of healthcare facilities, cosmetic institutes and tattoo centers offer these services today due to their commercial potential and seemingly simple procedures. While the complications that develop during laser hair removal most commonly occupy dermatologists, ophthalmologists also have started to encounter these complications frequently. Laser beams can damage eye adnexes (periocular skin tissue, eyelids), anterior segment (cornea, lens) and posterior segment (retina, choroid) structures. Retinal injuries are more important as they can be associated with more serious irreversible vision loss. In this article, it was aimed to present a case of accidental retinal damage during hair removal with diode laser and to review the literature.

Keywords: Laser, Hair removal, Retina.

INTRODUCTION

In last decades, laser technology is used to remove unwanted hair and tattoo with increasing demand. The intensive demand together with its practicality has led commercialization of the procedure, resulting more common use by individuals with insufficient competence on these procedures.[1] As a result, the laser beam-related complications have become increasingly more common. Majority of these complications are dermatological; however, considerable number of ocular complications has also been reported.

Since eyelids are thin, laser beam may pass through eyelids and cause ocular injury. Periocular and anterior segment complications reported in relation with laser beam can be listed as eyelid edema, erythema, punctuate bleeding, pain, conjunctival hyperemia, pupillary distortion, iris atrophy and transillumination defects, posterior synechia, pigment dispersion, glaucoma, posterior subcapsular cataract and anterior uveitis.[2-4] Intraocular surgeries such as phacoemulsification and trabeculectomy at younger age have been reported due to these complications. Retina is particularly susceptible to injuries resulting from laser beam since laser beam is focused on retina by cornea and lens, increasing energy intensity on retina.[5]

Here, we aimed to present prognosis of retinal injury in a 20-years old patient with laser beam exposure to right eye during hair removal via diode laser without protective glasses and to review literature on retinal injury caused by laser devices used for cosmetic purposes.

CASE REPORT

A 20-years old woman presented to our clinic with acute loss of vision on right eye. In the anamnesis, it was found out that, a few hours ago, the right eye of the patient was exposed to laser beam (Leda Epi 808, Alma Lasers, Israel) during hair removal on left arm. In the examination, best-corrected visual acuity was 0.5 in right eye and 1.0 in the left eye (Snellen charts). The diode laser parameters employed were 27 J/cm^2 and 9 msec. Bilateral anterior segment examination was normal. The fundus was normal in the left eye while laser burn localized at inferotemporal region of fovea in the right eye (Figure 1). On macular optical coherence tomography (OCT) imaging, it was seen that there was subfoveal fluid, retinal pigment epithelium (RPE) injury and intraretinal hemorrhage-related hyper-reflectivity in inner retinal layers (Figure 2). The patient was given dexamethasone 0.1% eye drop (8x1) (Maxidex, Novartis, Switzerland) and nepafenac 0.1% eye drop (3x1) (Nevanac, Novartis, Switzerland) for a month. In control visit on month 1, BCVA was improved to 0.8 and there

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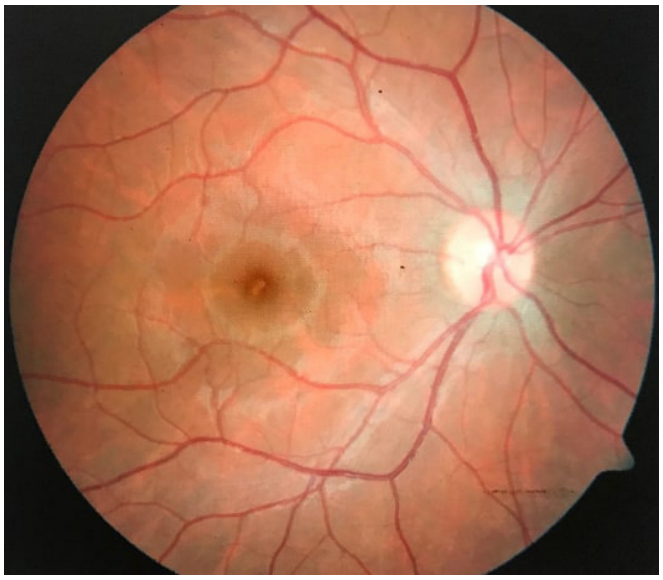

Figure 1: *Fundus image at presentation.*

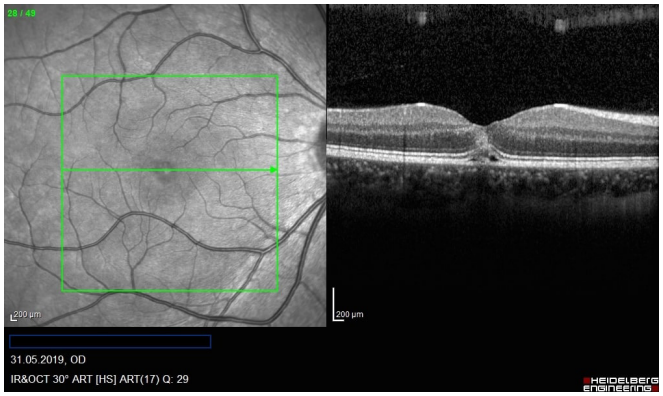

Figure 2: *Macular OCT image at presentation.*

was regression in subretinal fluid. No complication was observed during follow-up visits and BCVA was found as 0.9 (Snellen chart) in affected eye in final control visit. It was seen that laser burn was persisted in fundus examination (Figure 3) while subfoveal fluid and hyper-reflectivity were regressed but RPE injury was persisted on macular OCT imaging (Figure 4).

DISCUSSION

Over more than five decades, laser beam has been used to remove unwanted hair and prevent its recurrence as long as

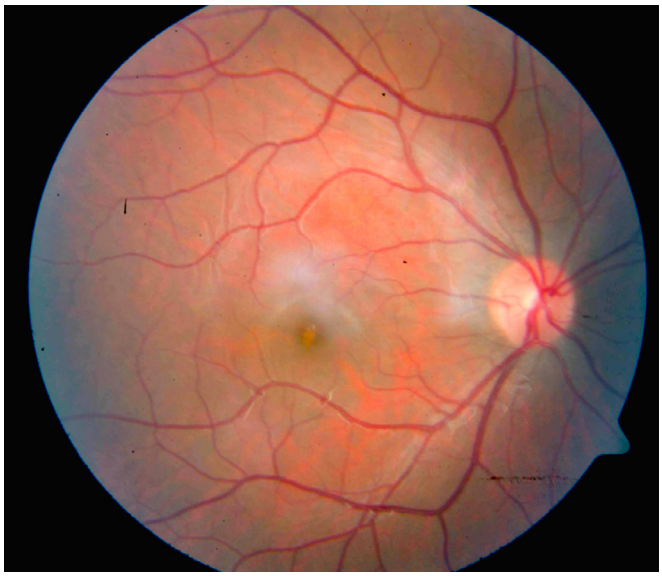

Figure 3: *Fundus image at year 1.*

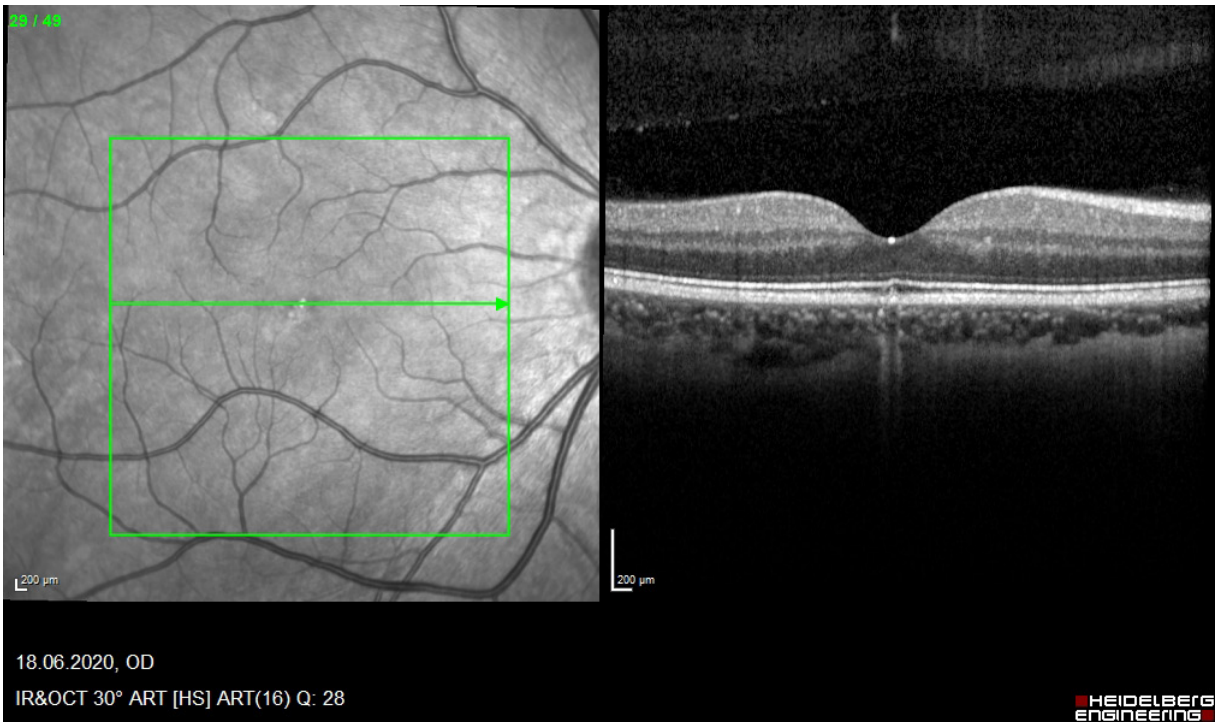

Figure 4: *Macular OCT image at year 1.*

possible in aesthetic surgery community.[6] For laser beam, 3 major chromophore are water, melanin and hemoglobin in human body. Laser beam targets melanin at hair matrix. The melanin pigments located at matrix absorbs light at wavelength of 600-1100 nm.[8] The melanin converts the absorbed light energy at appropriate wavelength to heat energy which is dispersed to surrounding tissues. This selective thermal reaction results in cell death and damage hair follicle. The amount of energy absorbed by melanin is correlated with wavelength, energy density (J/cm^2) and duration. The most selective thermal damage occurs when pulse duration converges to thermal relaxation duration of target chromophore.[7] If pulse duration is longer than thermal relaxation duration, energy is dispersed before chromophore reaches target heat and if it is shorter, tissue injury develops due to excessive heat. Laser beam 590-1200 nm are used in the hair removal systems as they target melanin: long-pulsed ruby laser (694 nm), long-pulsed alexandrite laser (755 nm), long-pulsed diode laser (810 nm), long-pulsed Nd: YAG laser (1064 nm) and intense-pulsed light (IPL; 590-1200 nm). The diode laser and Nd: YAG laser, used for aesthetic purposes, are also commonly used in the ophthalmology. These laser have good penetration to retina and choroid. Alexandrite laser has been familiarized to ophthalmologists due to ocular traumas in laser hair removal. In the literature review, our case is the first patient exposed to retinal injury during hair removal using diode laser.

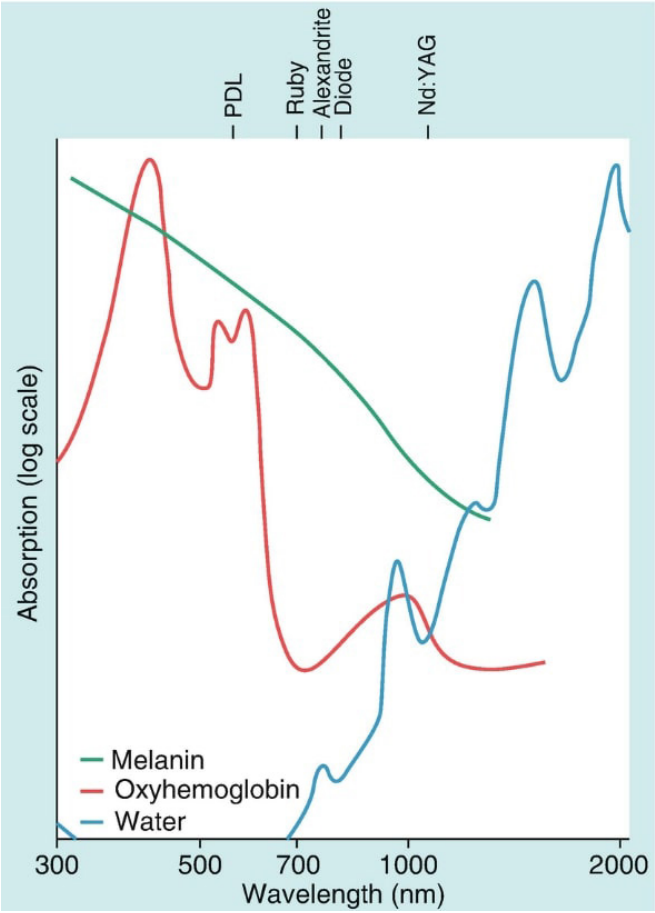

Figure 5:

According to electromagnetic wavelength, visible light (400-700 nm) is placed between ultraviolet light (UV, 100-400 nm) and infrared light (700-1200 nm). The laser beams at wavelength <400 nm are absorbed by organic molecules of ocular media and laser beams at wavelength >1400 nm are absorbed by water molecules in anterior segment; thus, these laser beams are considered as harmless.[8] Laser beams at wavelength >1400 nm do not produce posterior segment injury as they could not be focused on retina; however, they may induce cornea or lens injury. The laser beams at 400-140 nm are harmful for retina. The diode laser used in our patient has wavelength (810 nm) comprising risk for retina.

The energy intensity and pulse duration determine tissue injury. Since sufficient amounts of energy intensity is absorbed by chromophores within micro-seconds and seconds, it produces photothermal injury, e.g. retinal photocoagulation resulting from absorption of frequency double Nd: YAG laser and argon laser. Since high-energy is absorbed within pico-seconds or nano-seconds, the energy is rapidly accumulated within tissue and cooling due to heat dispersion cannot occur, resulting in photo-mechanical damage, e.g. iridotomy or capsulotomy by Nd-YAG laser. If the energy is absorbed at low dose and long pulse duration, photochemical injury occurs, e.g. molecular damage in nucleic acids by UV light).[8] The ocular structures susceptible to laser beam include cornea and lens due to high water content and retina and uvea due to melanin and vascular structures (hemoglobin). Besides melanin and hemoglobin, xanthophylls located at macular plexiform layer are also target for laser beam.[9] No tissue has a condition similar to retina where light is focused. Thus, retinal exposure to laser beams occurs at higher intensity than cornea and laser beam may result in severe retinal injury even at lower doses and shorter duration. RPE commonly accompanies to laser-related retinal injury; this is due to dense melanin content in this region. In our case, RPE damage was observed at presentation.

In the literature review, among retinal injuries associated with laser devices used (15 eyes of 14 patients), alexandrite laser was used in 9 cases and Nd: YAG laser (1064 nm) in 4 cases; in one case, the laser source was not specified (Table 1). The visual acuity at presentation ranged from finger counting to 20/20. It was seen that, based on clinical presentation and complications during follow-up, a wide spectrum of treatment were employed in these patients, including follow-up with no treatment, topical and systemic steroids, systemic NSAIDs, intravitreal anti-VGEF

Table 1. Laser hair removal cases presented with retinal injury

Publication	*Age, gender, affected eye, protective equipment use*	*Laser and laser parameters used*	*Baseline VA*	*Initial lesions*	*Treatment*	*Final lesions*	*Final VA and follow-up duration*
Marcus, 2000	40, F, Left / None	Nd:YAG laser	Finger counting	Day 0; VH, choroidal rupture Week 1 Macular hole Month 6 CNVM	No treatment, follow-up alone	Enlarging macular hole and scar	20/200 9 years
Lin, 2005	28, F (Pregnant), Right / None	Alexandrite laser 5.8 J/cm^2, 80 ns, 10 Hz	3/60	Maküler hemoraji	No treatment, follow-up alone	Macular hole, SRF	1/60 7 months
Gao, 2007	36, M, Right / None	Nd:YAG laser 500 mj, 8 nanosec, 10 Hz	20/200	Day 0 VH Day 6 Macular hole Month 1 SRF Month 5 ERM	Follow-up without treatment initially, Pars plana vitrectomy plus ERM peeling on month 5	Pigment changes in retina	20/200 13 months
Park, 2009	23, K, Right / None	Nd:YAG laser	20/100	Laser burn at fovea, VH	Oral prednisolone (60 mg starting dose, tapered by 10 mg/week)	ERM	20/100 6 years
Milani, 2011	25, not specified, Bilateral / None	Nd:YAG laser 400 mj, 10 ns	20/20 R 20/60 L	Laser burn at inferior macula in right eye, foveal laser burn at hemorrhage in the left eye	Systemic prednisolone (50 mg for 8 days followed by tapering) ,	focal RPE atrophy at involved site.	20/20 (bilateral) 6 months
Anmonthsa-Alaminos, 2014	26, F, Right / None	Alexandrite laser 10 J/cm^2, 5 msec	20/200	Foveal laser burn	No treatment, follow-up alone	Foveal laser burn (stabl)	20/200 1 years
Kontadakis, 2015[21]	Early 30s, F, Right / None	Alexandrite laser	20/200	Day 0 RPE changes Day 5 CNVM	Follow-up without treatment initially, Single dose anti-GEF on day 5	Macular scarring	20/200 5 months
Bulut, 2016[22]	35, M, Right / None	Alexandrite laser	10/10	Day 0 Foveal laser burn Week 2 SRF	Initially: Topical steroid Week 2: Intravitreal dexamethasone implant	Macular scarring	20/20 3 months
Wang, 2016	30, F, Left / None	Alexandrite laser	20/40	Day 0 Impaired IS/OS band Week 1, cystoid macular edema Week 3 SRF, CNVM	Follow-up without treatment initially Oral prednisolone (20mg) on week 1; 5 doses of ranibizumab after week 3	Focal fibrovascular pigment epithelium detachment	20/50 51 weeks
Asiri, 2017	34, F, Right / Var	Alexandrite laser	20/20	Intraretinal hemorrhage in fovea	No treatment, follow-up alone	Complete resolution	20/15 6 months
	28, K, Left / None	Alexandrite laser	20/200	SRF, CNVM	Intravitreal Bevacizumab	Small RPE detachment	20/20 6 months
	43, K, Left / None	Alexandrite laser	20/30	SRF, CNVM	Intravitreal Bevacizumab	Complete resolution	20/20 3 months
Balyen, 2019	49, K, Left / None	Alexandrite laser	20/200	Foveal laser burn	Systemic and topical NSAID, topical steroid, cyclopenthate	Impaired IS/OS band	20/200 3 months
Arslan, 2013	26, K, Left / None	NA	Finger counting	Macular edema and hemorrhage	İntravitreal triamcinolone on month 1 Intravitreal Bevacizumab and photodynamic therapy on month 8	CNVM	Finger counting 9 months

Retinal VH: Vitreous hemorrhage, CNVM: Choroidal neovascular membrane, ERM: Epiretinal membrane, NSADİ: Non-steroidal anti-inflammatory drug, IS/OS: retinal (inner segment/outer segment), VEGF: Vascular endothelial growth factor SRF: Subretinal fluid, Day 0: presentation, VA: visual acuity

(ranibizumab, bevacizumab), intravitreal dexamethasone implant, photodynamic treatment and surgery such as pars plana vitrectomy. It was seen that CNVM was developed in 6, macular hole in 3, vitreous hemorrhage in 3 and epiretinal membrane (ERM) in 2 of 14 patients during clinical course. Anti-VGEF agent trial was attempted for treatment in 5 of 6 cases with CNVM. However, there were short-term follow up (3-to 6 months) in these cases . Visual acuity of 20/20 was achieved in 2 cases by single dose of intravitreal bevacizumab. In another patient with CNMV, despite 5 doses of intravitreal ranibizumab injection, visual acuity was worsened from 20/40 to 20/50 during 51-weeks follow-up. Again, in another patient with CNMV developed 5 days after presentation, macular scarring was resolved by a single dose intravitreal anti-VGEF injection at 5-months follow-up; however, no improvement was observed in visual acuity when compared to baseline. In one case report, authors reported a case with CNMV which was followed over 9 years without treatment and recovered with macular scarring and hole.

Gao (2007) reported pars plana vitrectomy plus ERM peeling plus SF6 tamponade 5 months after presentation (due to patient-related delay) in a patient with macular hole, subretinal fluid (SRF) and ERM. The visual acuity (20/200) showed no improvement compared to baseline in this patient.[10] Oral steroid therapy was attempted in 2 cases due to Nd-YAG laser reported in 2009 and 2011. In first case, authors reported no visual acuity gain in the patient who developed ERM after 6-years follow up.[11] In the second case, bilateral laser beam exposure was noted and visual acuity was improved to 20/20 in both eyes at 6-months follow-up after treatment.[12] Oral steroid therapy (20 mg) was given to a patient developed cystoid macular edema one week after alexandrite laser exposure; however, fibrovascular pigment epithelium detachment and CNMV development was detected on week 4; thus, 5 doses of intravitreal ranibizumab injection was given.[13] Balyen used topical and systemic NSAIDs, topical steroid and cyclopentolate drop as similar to our case and reported that visual acuity was stabilized at 20/200 due to damage in IS/OS band after 3 months of follow-up.[14] Arslan et al. treated a CNMV patient with visual acuity of finger counting at 1 m at presentation using intravitreal triamcinolone acetate on month 1 and intravitreal bevacizumab plus photodynamic therapy on month 8. Authors reported no improvement in visual acuity when compared to baseline.[15] Conservative treatment was adopted in 4 cases with isolated laser burn at presentation. Complete resolution with VA improved to 20/15 in one[16] and complete resolution with VA improvement from finger counting to 20/200 in the other[17] were reported after 6 months while it was reported that laser burn and poor VA (20/200) were persisted on year 1 in the third case.[18] The fourth case was followed without treatment because of pregnancy; in this patient, isolated laser burn was complicated with macular hole and SRF and baseline VA (3/60) was worsened to 1/60) on month 7 [19]. In our patient, topical steroid and a NSAID was used in the treatment and no complication was observed during one-years follow-up. The visual acuity was improved to 0.8 on month 1 and 0.9 at year one (baseline visual acuity: 0.5). Some ocular complications have milder course and may recover at short-term while there are also patients with visual acuity below level of legal blindness. Thus, some authors recommended not to perform hair removal laser at periocular areas.[20]

This patient population, consisting of younger adults with active labor force participation, may be face with chronic medication and/or intraocular surgery in order to treat or minimize or prevent worsening in visual damage resulting from ocular complications. The wavelength, duration and energy intensity of laser beam exposed can explain variations in clinical course of cases reported. In the literature, individual approaches have been employed; in fact, treatment attempts were focused on complications developed. To prevent potential ocular complications, training of staff performing procedure, appropriate precautions , closure of reflective surfaces (glass, mirror etc.) in the area, and wearing protective glasses with appropriate specifications (wavelength-specific glasses or corneal shield) are of important.

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