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Case report

Vitrectomy for a traumatic macular hole caused by cosmetic laser in a beauty salon: A case report

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ABSTRACT

Background: The Nd:YAG laser is widely used in various aspects of work and life. Currently, it has become a popular cosmetic technique in beauty salons. The laser can be dangerous when it flashes into people's eyes.

Case presentation: A 34-year-old female sustained a 1064-nm Q-switched Nd:YAG laser injury to her left eye. One month after the injury, she presented to our clinic with best-corrected visual acuity (BCVA) of 20/250 and a full-thickness macular hole on the optical coherence tomography (OCT). The patient received pars plana vitrectomy, internal limiting membrane peeling and sterile air injection 3 months after the injury. OCT showed closure of the hole 9 days post-operatively. After a 3-month follow-up, her BCVA improved to 20/100.

Conclusions: This case report comprehensively introduces the whole progression of a cosmetic laser-induced macular hole from formation to recovery. Due to the potential threats of the laser and its irreversible damage to the retina and choroid, sufficient education should be given before performing any laser devices, especially those without professional knowledge.

1. Introduction

The Nd:YAG laser is widely used as a non-invasive treatment in Ophthalmology and Dermatology Department. Laser treatments in clinics are performed by professional medical staff. Nevertheless, laser-induced retinal injury happens occasionally due to its high energy. Nowadays, more and more beauty salons emerge, and Q-switched Nd:YAG laser devices are commonly used cosmetically. We report a case of laser-induced retinal injury in a young female technician when applying a 1064-nm Q-switched laser without wearing protective goggles in a beauty salon. This case report depicts the progression of the formation of the macular hole and how it recovered after surgery, thus may help us better understand the mechanism of the damage to the retina caused by the laser.

2. Case presentation

A 34-year-old female accidently looked at a laser light reflected from the blade of an eyebrow trimmer while applying a 1064-nm Q-switched laser to remove eyebrow tattoos of her guest in a beauty salon without wearing protective goggles. She immediately experienced blurry vision with a central scotoma and distortion in her left eye. The next day, she attended the local ophthalmic clinic. Fundus examination showed some vitreous hemorrhage. Optical coherence tomography (OCT) showed macular edema and

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disorganization of the outer retinal layer(Fig. 1A and B). The patient was diagnosed with laser-induced retinopathy and was treated with optic nerve growth factor injection immediately and fluorometholone eyedrops for a week. 7 days after the injury, the OCT showed a full-thickness macular hole (FTMH**)** with hyper-reflective material within the base of the hole, ellipsoid and retinal pigmented epithelium (RPE) layer disruption, macular edema and subpigment epithelial hemorrhage. The average minimum diameter (MD) and base diameter(BD) of the FTMH measured 195 and 998μm respectively (Fig. 1C and D). 2 weeks after the injury, the cystoid edema, FTMH and outer retinal disruption still existed, and the diameter of the hole did not change much(MD = 214μm, BD = 1005μm). The hyper-reflective material in the macula reduced while the subfoveal hyperreflectivity was observed(Fig. 1E and F). 1 month after the accident, the patient turned to our hospital for no visual improvement. The BCVA of her left eye was 20/250 with a manifest refraction of +0.50D-0.75D × 180. Fundus examination showed a macular hole with vitreous hemorrhage(Fig. 2B–D). OCT showed a full-thickness macular defect(MD = 177μm, BD = 979μm) with cystoid macular edema along with disruption of the adjacent ellipsoid zones and RPE layer(Fig. 2A–C). The patient was diagnosed with a traumatic FTMH**.** The BCVA of the other eye was 20/20 and the fundus examination was normal**.** After observation for two months, the BCVA of her left eye remained 20/250 and the macular hole did not tend to recover. The MD and BD of the macular hole measured 268μm and 875μm, respectively(Fig. 2E). Therefore, pars plana vitrectomy, internal limiting membrane (ILM) peeling and sterile air injection were successfully performed. Prone positioning for a week was required after the surgery. The macular hole was identified as closed 9 days postoperatively with the resolution of the macular edema, but the ellipsoid layer disruption and subfoveal hyperreflective lesion still existed. 3 months postoperatively, her BCVA improved to 20/100. Fundus examination showed no abnormality(Fig. 3B–D). OCT showed the ellipsoid zone remained uneven (Fig. 3A–C). And the patient still complained of burry vision and a central scotoma.

3. Discussion and conclusion

Previous reports have demonstrated that various kinds of lasers may lead to an FTMH accidently, including titanium-sapphire laser [1], blue light laser [2,3], argon laser [4] and most frequently, the Q-switched Nd:YAG laser [5–11]. These lasers can be found in industry [4], laboratory [9,12], hospital [6,7,10,13–15] and even people's daily life, i.e. laser pointers [16]. Other morphological changes besides the macular hole include disruption of the RPE and ellipsoid layer, macular edema, retinal and vitreous hemorrhage, and serous retinal detachment. The lesion mainly focuses on the outer layer of the retina, though it can be deep into the choroid, leading to impairment of the choroidal blood perfusion [17]. Therefore, it takes time and measures to recover.

The mechanism of laser injury has three aspects: thermal, mechanical, and photochemical damage [18]. For thermal damage, tissue enriched in pigments absorbs light easily and its temperature increases immediately, leading to protein denaturation and coagulation [19]. Therefore, it can be explained why the lesion mainly focuses on the outer retinal layer and subfoveal choroid. When high heat is produced, the electrons strip from atoms and the tissue transforms into a plasma state. Subsequently, it causes an "explosion" when the vaporization of water occurs [19,20]. And this is how mechanical damage happens. The photochemical process destroys the tissue via

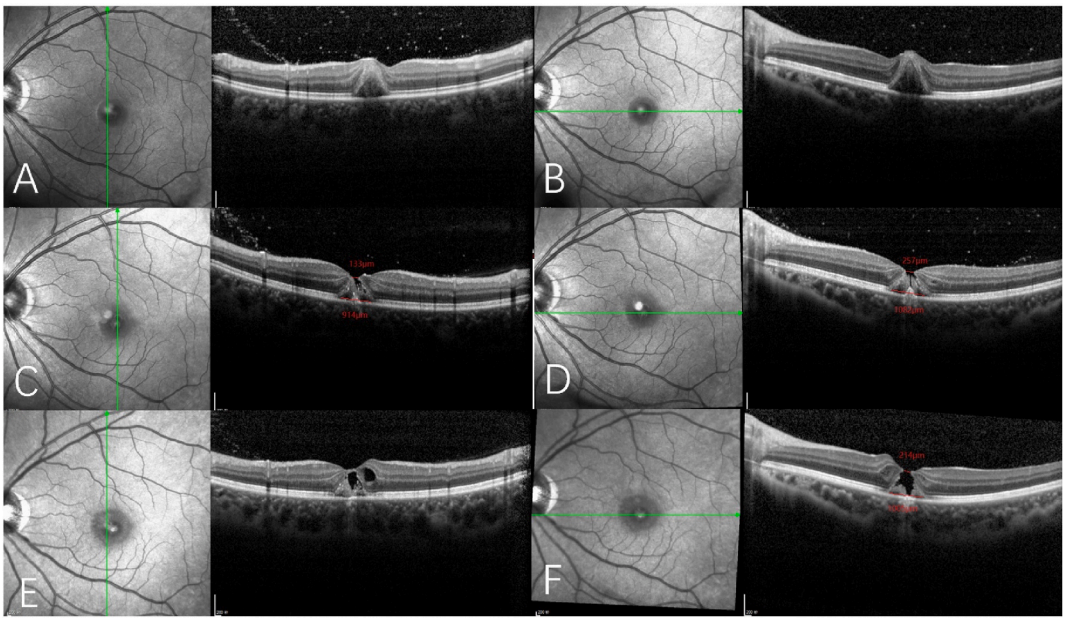

Fig. 1. (A, B) 1 day after the injury, OCT showed some vitreous hemorrhage, macular edema and outer retinal layer disorganization.
(C, D) 1 week after the injury, OCT showed a full-thickness macular hole with hyper-reflective material within the base of the hole, ellipsoid and retinal pigmented epithelium layer disruption, macular edema and subpigment epithelial hemorrhage.
(E, F) 2 weeks after the injury, OCT showed a full-thickness macular hole with cystoid macular edema and outer retinal disruption. Hyperreflectivity was observed beneath the macula.

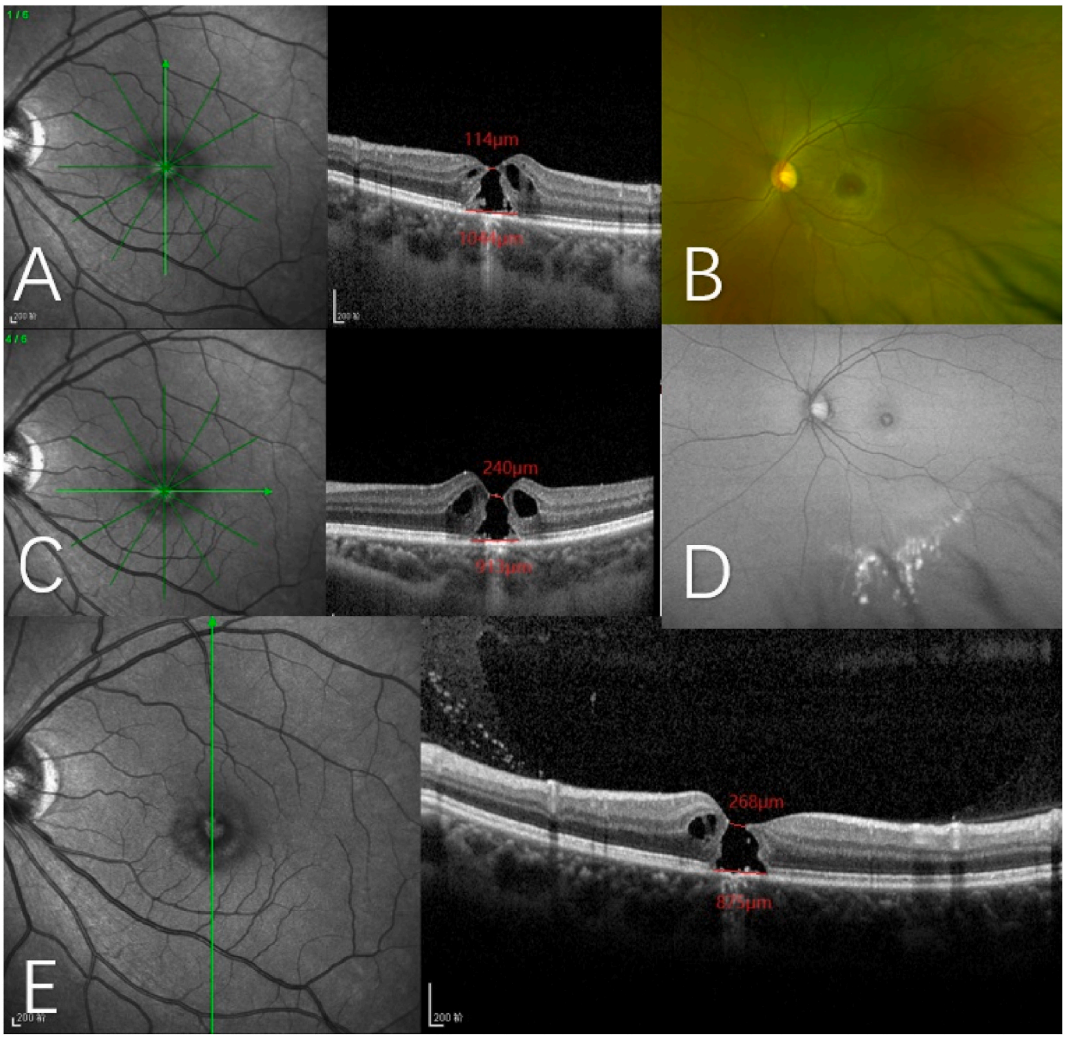

Fig. 2. (A, B, C, D) 1 month after injury, fundus image showed a macular hole with vitreous hemorrhage. OCT shows a full-thickness macular hole and cystoid macular edema along with disruption of the adjacent ellipsoid zones and RPE layer.
(E) 2 months after the injury, the macular hole still exists, with cystoid macular edema and vitreous hemorrhage.

every single photon's breaking molecular bond in nucleic acids and structural proteins. And this kind of injury is more prominent when the laser has relatively lower energy and longer pulses. Damage in this way may recover to some degree with time. Nevertheless, thermal and mechanical damage leads to irreversible scars [21].

In the current case, the Q-switched Nd:YAG laser could produce very short pulses and lead to retinal and vitreous impairment when transforming the tissue molecules into a plasma state. At the very beginning, when the accident happened, severe impairment to the macula was evident, while the macula hole hadn't formed yet. 7 days later, OCT showed an FTMH. Vitrectomy with ILM peeling and sterile air injection fully resolved the macular hole. It was likely that the laser damaged the macula first, and with the traction of the ILM and vitreous, the hole formed. Therefore, the direct damage to the macula, tangential traction from the ILM and sagittal force from the vitreous all worked to form the macular hole. Chen et al. [22] reported 2 children's laser-induced macular holes achieved closure by ILM peeling without vitrectomy. And they supposed it was the tangential traction from the ILM rather than the sagittal force from the vitreous that contributed more to the laser-induced macular holes. Nevertheless, this hypothesis needs more cases to verify.

In most published case reports, Nd:YAG laser-induced macular holes often require surgical intervention after observation for days to months. The treatment usually includes pars plana vitrectomy with gas injection. Nevertheless, a few macular holes achieved spontaneous closure. Suren et al. [15] reported a 19-year-old male's spontaneous closure of a macular hole after Nd:YAG laser treatment for Valsalva retinopathy after a 6-month observation. Parikh et al. [23] reported the resolution of an FTMH resulting from YAG laser capsulotomy in a 13-year-old girl with a previous history of retinal detachment repair and cataract surgery. The prognosis of laser-induced macular holes treated with surgical intervention varies among cases published. Although nearly all macular holes achieved closure, some patients' BCVA improved to 20/20 [8,22], while others had a relatively poor final BCVA [7]. There is no substantial evidence that early surgical interventions could contribute to a better final BCVA. According to the published cases of Nd:

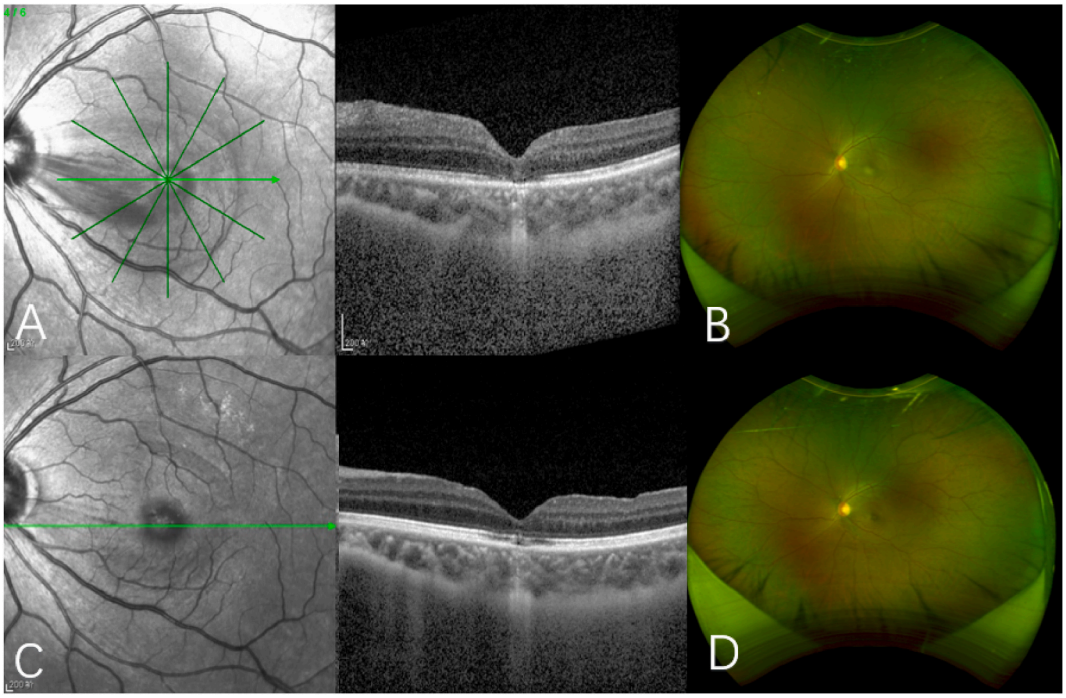

Fig. 3. (A, B) 9 days postoperatively, the macular hole was closed and the cystoid edema was resolved. Ellipsoid layer disruption still existed. (C, D) 3 months postoperatively, the structure of the outer retinal layer tended to recover compared with last visit (A), but the ellipsoid zone remained irregular.

YAG laser-induced macular holes, the interval between injury and surgery of the patients who achieved good final BCVA ranged from one month to eleven months [8,24]. Based on the previous studies and this case [24,25], the preoperative BCVA and the severity of the damage, including the size of the hole and the integrity of the outer layer of the retina, may contribute more to the prognosis, compared with the duration from the onset to surgery. And it still needs more studies including more cases to demonstrate this theory statistically.

As in this case, the limitation of PPV is obvious. The patient did not achieve a satisfying BCVA due to the irreversible damage of the EZ layer's disruption. Other complications of PPV, like post-operative cataracts, are barely reported. However, considering the potential risk of surgical intervention, observation for a short period of time is considered first. During observation, some key factors need to be followed up on, and the decision on surgical intervention depends on them. We need to pay attention to the visual acuity and the shape of the macular hole. Conventional treatment may be the first choice if the patient has a relatively good BCVA and a small macular hole. Besides, if the BCVA tends to improve and the macular hole is recovers over time, observation time should be extended [23, 26–28]. If the macular hole remains the same or enlarges, and the BCVA does not improve progressively, we recommend surgical intervention.

In our case, the accident happened in a beauty salon. A beauty technician hurt herself while operating the machine without wearing protective goggles. Although the macular hole was successfully closed after surgery, BCVA was only partially restored. Unlike patients in other cases, who were professional dermatologists, nurses, undergraduates and engineers, she had little knowledge of the hazard of the laser and hence had a higher risk of injury. Nowadays, a great number of cosmetic centers like beauty salons emerge, and laser treatments are performed every day. Due to the potential threats of the laser and its irreversible damage to the retina and choroid, it should be highly emphasized to make safety education and ask the staff to wear protective equipment because laser injury can be irreversible and with lots of uncertainty of the prognosis.

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Ethics approval and consent to participate

Written informed consent for publication of this case and any accompanying images were obtained from the patient. Ethics Committee approval was obtained. All research adhered to the tenets of the Declaration of Helsinki.

Consent for publication

Written informed consent was obtained from the patient for publication of this case report and all accompanying images. A copy of the written consent is available for review.

CRediT authorship contribution statement

Songyue Yang: Writing – review & editing, Writing – original draft, Investigation. **Chunyan Lei:** Writing – review & editing, Supervision, Data curation. **Meixia Zhang:** Supervision, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

List of abbreviations

OCT	Optical coherence tomography
BCVA	best-corrected visual acuity
FTMH	full-thickness macular hole
RPE	retinal pigmented epithelium
ILM	internal limiting membrane
BD	base diameter
MD	minimum diameter

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