Nd:YAG Laser Photodisruption of the Vitreous Traction in Avulsed Retinal Vessel Syndrome

Tetsuo Tatsui, MD  
Kunitoshi Ohara, MD  
Hiroyuki Shimizu, MD

ABSTRACT
We applied Nd:YAG laser photodisruption to vitreous traction in three patients with avulsed retinal vessels syndrome. In every case the vitreous traction on the avulsed vessels was relieved and the vessel that had been avulsed in the vitreous cavity returned to the retinal surface postoperatively. There were no serious intraoperative and postoperative complications, nor was there any evidence of recurrence of vitreous hemorrhage after the treatment.

Vitreous hemorrhage associated with avulsed retinal vessels with retinal holes was first reported as a clinical entity by Robertson and associates.¹ According to their description, the avulsed retinal vessel is attached to an overlying operculum of a retinal hole in the vitreous cavity, and condensed vitreous exerts traction on the vessel, frequently precipitating recurrent vitreous hemorrhage.¹ De Bustros and Welch termed the entity “the avulsed retinal vessel syndrome,” including in it the vitreous hemorrhage associated with vessels bridging across horseshoe tears.²

To prevent hemorrhaging from the patent avulsed vessels, the vessels must be occluded, or the vitreous traction on them must be eliminated. Photocoagulation and cryopexy with or without scleral buckling usually have failed to accomplish these aims,¹³ although Theodossiades and associates obtained good results using scleral buckling in conjunction with cryopexy or photocoagulation.¹⁴,¹⁵ Folk and associates successfully used extensive photocoagulation to occlude the vessels.⁷ Scleral silicone implants with external diathermy and photocoagulation with temporary balloon buckles also have been recommended.⁸,⁹

We applied Nd:YAG laser photodisruption to the vitreous traction on the avulsed vessels in three outpatient cases: two involving a retinal hole caused by branch retinal vein occlusion, and one involving a retinal tear. These applications were successful, with no postoperative recurrence of vitreous hemorrhage.

MATERIALS AND METHODS
We studied three eyes of three patients with vitreous hemorrhage associated with a patent avulsed retinal vessel. The patients’ profiles are summarized in Table 1. In each case the vessel was bridging across the retinal tear, and the condensed vitreous was exerting traction on the vessel.

CASE REPORTS
Case 1: A 59-year-old woman complained that she had had numerous floating spots in her right eye for several days. Her best corrected visual acuity was 20/20 bilaterally. Indirect ophthalmoscopy and slit-lamp biomicroscopy using a Goldmann three-mirror...
table 1
preoperative data of the patients

<table>
<thead>
<tr>
<th>case no</th>
<th>age (years)</th>
<th>sex</th>
<th>affected eye</th>
<th>preoperative visual acuity</th>
<th>types of retinal break</th>
<th>no of preoperative vitreous hemorrhages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>59</td>
<td>f</td>
<td>od</td>
<td>20/20</td>
<td>tear</td>
<td>1/4 months</td>
</tr>
<tr>
<td>2</td>
<td>65</td>
<td>f</td>
<td>od</td>
<td>20/20</td>
<td>tear</td>
<td>2/3 months</td>
</tr>
<tr>
<td>3</td>
<td>69</td>
<td>m</td>
<td>od</td>
<td>40/200</td>
<td>tear</td>
<td>1 month</td>
</tr>
</tbody>
</table>

figure 1: a patent avulsed retinal vessel overlying the large retinal tear before treatment (arrow) in case 1.

figure 2: a patent avulsed retinal vessel overlying the retinal tear before treatment (arrow) in case 2.

contact lens revealed a large retinal tear, five disc diameters posterior to the ora serrata along the superotemporal retinal vein, and slight hemorrhage in the inferior vitreous cavity in her right eye. she was admitted to the hospital, and the tear was prophylactically surrounded with argon laser photoagulation.

four months later, fresh hemorrhaging developed in the inferior vitreous cavity in her right eye. the vitreous hemorrhage was assumed to have derived from the avulsed retinal vessel, because there were no other vitreoretinal lesions that could have caused it. examination by a goldmann three-mirror contact lens revealed a patent avulsed retinal vessel overlying the photoagulated retinal tear and vitreous traction on the vessel (fig 1). 10

case 2: a 65-year-old woman complained that she had had numerous floating spots and photopsias in her right eye for 1 week. her best-corrected visual acuity was 18/20 bilaterally. there was an inferonasal branch retinal vein occlusion in her right eye, along with a large retinal tear at the 6 o'clock position 3 disc diameters inferior to the optic disc, and a slight hemorrhage in the vitreous cavity. fluorescein angiography revealed that the retina around the tear was nonperfused, that there was no neovascularization, and that the vein overlying the tear formed a patent avulsed vessel. we assumed that the vitreous hemorrhage resulted from the avulsed retinal vessel, because there was no other vitreoretinal lesions that might have caused it. argon laser photoagulation was applied to heal the retinal tear, and the avascular retina was treated with argon laser scatter photoagulation.

three months later, the patient complained again of numerous floating spots in the same eye. this time we found that the retinal tear was completely surrounded by photoagulation scars, but there was a slight hemorrhage in the vitreous cavity, and the avulsed retinal vessel was still patent (fig 2).

case 3: a 69-year-old man complained that he had had severe visual loss for several weeks in his right eye. his best-corrected visual acuity was 20/200 od and 20/20 os. indirect ophthalmoscopy revealed a superotemporal branch retinal vein occlusion and a flame-shaped fresh retinal hemorrhage in the same quadrant, with macular involvement. a retinal tear had formed along the superotemporal retinal vein, five disc diameters from the optic disc. the tear was prophylactically surrounded with argon laser photoagulation, and argon laser scatter photoagulation was applied to the retina with the flame-shaped hemorrhage.

one month later, the patient complained of numer-
ous floating spots. We found the patent retinal vein avulsed from the retinal surface bridging the retinal tear (Fig 3) and a slight hemorrhage in the inferior vitreous cavity. We assumed that the vitreous hemorrhage derived from the avulsed vessel, because there were no other vitreoretinal lesions that might have caused it.

Nd:YAG laser photodisruption using a Nd:YAG laser (Coherent model 9900 Q-switched Nd:YAG ophthalmic laser) was applied to these three eyes to relieve the vitreous traction. The instrument also had an argon laser beam for retinal photocoagulation. After topical anesthesia, a Peyman 25-mm YAG laser corneal contact lens was applied, and the aiming beam was focused in the posterior vitreous cavity 1 to 2 mm anteriorly from the avulsed vessel to prevent the beam from directly hitting the vessel. We increased the energy settings stepwise from 2.0 to 6.0 mJ to produce visible photodisruption in the vitreous cavity.

**RESULTS**

The vitreous traction on the avulsed vessels in all three eyes treated with Nd:YAG laser therapy was relieved (Figs 4-6). Table 2 shows the energy settings required to obtain the visible photodisruption, the number of treatment sessions, the number of pulses per burst, the total number of pulses, postoperative visual acuity, and relief of traction. Only 440 pulses in a single session were needed to relieve the vitreous traction in case 1. However, cases 2 and 3 required several treatment sessions to complete the photodisruption; over 1000 laser pulses were used in these eyes. Most of these pulses, however, seemed ineffective, producing no visible photodisruption; because of difficulties in focusing the targeting spots by the He-Ne beam, no sparks, bubbles, or shock waves were observed.

Slight vitreous hemorrhaging, arising from the avulsed vessel itself, occurred intraoperatively in
TABLE 2
Setting, Doses, and Postoperative Results in Nd:YAG Laser Photodisruption

<table>
<thead>
<tr>
<th>Case No</th>
<th>Energy Setting (MU)</th>
<th>No of Sessions</th>
<th>No of Pulses Per Burst</th>
<th>Total No of Pulses</th>
<th>Postoperative Visual Acuity</th>
<th>Relief of Traction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.0-5.2</td>
<td>1</td>
<td>1 and 2</td>
<td>440</td>
<td>20/20</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>3.5-5.2</td>
<td>5</td>
<td>1 and 2</td>
<td>3104</td>
<td>20/20</td>
<td>+</td>
</tr>
<tr>
<td>3</td>
<td>5.1-5.4</td>
<td>4</td>
<td>1, 2, and 3</td>
<td>1042</td>
<td>40/200</td>
<td>+</td>
</tr>
</tbody>
</table>

FIGURE 7: The intraoperative minimum vitreous hemorrhage from the avulsed retinal vessel (arrow) seen in case 1.

FIGURE 8: Postoperative fluorescein angiogram (arteriovenous phase) in case 2. No leakage of fluorescein.

every case, but it was easily arrested by manual pressure on the eyeball (Fig 7). No new retinal break or choroidal hemorrhage due to shock wave was noted intraoperatively. Postoperative fluorescein angiography, performed in two of the cases, showed no choroidal neovascularization at the posterior pole (Fig 8). At least 24 months after treatment there was no recurrence of vitreous hemorrhage in any of the three eyes (Table 3).

DISCUSSION

Because occlusion of a patent avulsed vessel requires extensive photocoagulation of the vessel and adjacent retina, it is often difficult to achieve complete occlusion. Relief of the vitreous traction on the vessel is an alternative treatment. Treatment with scleral buckles combined with photocoagulation, cryopexy, and diathermy procedures usually has been unsuccessful. Nd:YAG laser, however, is an effective means of relieving the vitreous traction, because it can directly disrupt it, it is nonsurgical, and it can be repeated on an outpatient basis.

Short pico- or nanosecond pulses can disrupt the nonpigmented, translucent intraocular tissues. Nd:YAG laser photodisruption of the vitreous traction on the avulsed vessels was successful in our three cases, with the avulsed vessels returning to the retinal surface. There were no serious intraoperative complications such as new retinal break formation or choroidal rupture. Nor did any vitreous hemorrhages recur.

Because it was difficult to aim the laser precisely in the vitreous cavity, some pulses were unsuccessful, resulting in an increase of the number of pulses required in cases 2 and 3. The pupil edge, diffraction and scattering of the beam, relatively hazy media after vitreous hemorrhage, and optical aberrations can reduce the transmission of laser energy to the targeting spots. Unsuccessful pulses did not create discernible photodisruption. However, even the relatively low energy of the unsuccessful pulses introduced into the vitreous cavity must have had some effect on the vitreous and the retina.

Jampol and associates noted microperforation of a retinal vein and local areas of damage to the retinal pigment epithelium after Nd:YAG laser vitreolysis.
performed 2 to 3 mm from the retina using a modified contact lens.\textsuperscript{15} We kept the target spots 1 to 2 mm away from the avulsed vessel, which was bridging 1 to 3 mm above the retinal surface.

Fankhauser and associates reported that estimates of radiation damage posterior to the focus are purely speculative, since the damage mechanism and its spatial distribution are still unknown.\textsuperscript{12} When we applied the Nd:YAG laser, the total distance between the targeting vitreous and the retina, which ranged from 2 to 6 mm, may have been great enough to avoid damage. Or, perhaps, the argon laser photocoagulation of the affected retina prior to photodisruption may have prevented retinal and choroidal damage from the Nd:YAG laser.

Although Nd:YAG laser treatment is useful, candidates for it must be selected carefully. If the avulsed retinal vessel is in the peripheral retina, the Nd:YAG laser photodisruption cannot be applied, because of the extreme difficulty this situation poses for focusing the aiming beam. A reasonable distance between the target spot and the retina and the avulsed vessel must always be maintained to avoid possible retinal and choroidal complications.

REFERENCES