NEODYMIUM:YAG LASER TREATMENT FOR PREMACULAR HEMORRHAGE

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Background: To investigate the effects of drainage of premacular subhyaloid hemorrhage into the vitreous with Nd:YAG laser in 13 eyes of 12 patients with 3 months follow-up.

Method: The study was conducted between January 2001 and December 2001. Thirteen eyes of 12 patients had a circumscribed premacular hemorrhage and were treated with Nd:YAG laser to drain the blood into the vitreous cavity. The hemorrhage originated from diabetic retinopathy (8 eyes), retinal macroaneurysm (2 eyes), acute myeloblastic leukemia (AML) (2 eyes), and branch retinal vein occlusion (1 eye). The size of the hemorrhage was expressed in disc diameters.

Results: The success of the laser procedure was defined as clearing of premacular hemorrhage within 3 months. By this definition drainage of premacular subhyaloid hemorrhage into the vitreous with Nd:YAG laser succeeded within three months in eleven out of thirteen eyes treated without requiring further membranotomy. One eye had persistent, dense, and nonclearing vitreous opacity for at least 3 months. One clotted hemorrhage did not drain into the vitreous. Overall visual improvement was best in eyes with AML and macroaneurysm. During the follow-up, neither macular epiretinal membranes nor tractional retinal detachments occurred in any eyes.

Conclusion: Drainage of premacular subhyaloid hemorrhage into the vitreous with Nd:YAG laser is a viable treatment alternative for eyes with recent bleeding. However, to establish Nd:YAG laser treatment as a routine procedure, the risks and benefits have to be weighed in a randomized trial and compared with those of deferral of treatment or primary vitrectomy.

Keywords: Diabetic retinopathy • laser surgery • retinal hemorrhage

Introduction

Subhyaloid hemorrhage in the macula may occur after the Valsalva maneuver (Valsalva retinopathy) and in association with retinal vascular disorders such as proliferative diabetic retinopathy and retinal arterial macroaneurysms. Other rare causes are blood dyscrasia, retinal vein macroaneurysm, branch retinal vein occlusion, postlaser in situ keratomileusis (post-LASIK), and shaken baby syndrome. Depending on the location, the hemorrhage may cause a profound visual loss.

Spontaneous clearing of premacular hemorrhage in Valsalva retinopathy usually occurs and may take several months. A fibrotic epiretinal membrane overlying the macula may develop after a premacular hemorrhage due to either diabetic retinopathy or a macroaneurysm. In proliferative diabetic retinopathy a tractional macular detachment may result as early as five weeks after premacular hemorrhage.

Observation or vitrectomy is the present method of managing a dense premacular hemorrhage. Neodymium:YAG (Nd:YAG) laser posterior hyaloidotomy has been described as a viable alternative to vitrectomy as management for extensive premacular subhyaloid hemorrhage. This method enables the drainage of entrapped premacular subhyaloid blood into the vitreous, and may facilitate the absorption of blood cells.

Faulborn was the first to describe the use of the Q-switched Nd:YAG laser for the treatment of the premacular hemorrhage in 1988. He used...
multiple laser applications in a grid pattern on the anterior surface of the hemorrhage to drain blood into the vitreous cavity for an eye with diabetic retinopathy.

One year later Gabel et al described a different technique, treating three patients with hemorrhagic detachment of the internal limiting membrane by perforating the anterior surface of hematoma with only a few Nd:YAG laser pulses. The range of energies used was from 3.6 to 50 mJ and resulted in rapid drainage of blood and visual acuity improvement within days after treatment.

Tassignon et al and Stempels et al reported four cases with similar results. In all of the above-mentioned cases, no complications occurred as a result of the treatment.

Raymond reported on six cases with a premacular hemorrhage, originating from proliferative diabetic retinopathy in 4 eyes and from retinal macroaneurysm in 2 eyes, treated with laser energies up to 11.5 mJ. During a follow-up period of (mean) 20 months, one patient had rhegmatogenous retinal detachment months after treatment. Another patient had extensive rebleeding in the preretinal space, including premacular zone, five weeks after Nd:YAG laser treatment, so that pars plana vitrectomy was performed

In a series described by Mansour, premacular hemorrhage failed to drain in one case. This was probably due to clotted blood. In another series by Ulbig et al, drainage of premacular subhyaloid hemorrhage into the vitreous with Nd:YAG laser was performed in 21 eyes with hemorrhage of various severity and causes. Good visualization of the macular region of the retina was rapidly restored within one month in most cases. However, a total of seven eyes ultimately required an additional vitrectomy. This was due to the persistence of the dispersed blood in the central vitreous for more than 3 months in 4 eyes, a clotted hemorrhage that refused to drain into the vitreous despite an opening at the vitreoretinal interface, a macular hole, and a retinal detachment. Thus, in one-third of the eyes, the laser procedure failed to prevent vitrectomy in the long term.

Our series of cases were evaluated to assess the value of Nd:YAG laser posterior hyaloidotomy in achieving rapid intravitreal dispersion of extensive premacular subhyaloid hemorrhage. In addition, we evaluated the complications of this new mode of treatment such as macular hole and retinal detachment.

Patients and Methods

This was a pilot study of the new mode of treatment. Twelve patients were recruited for the study from Motahari and Postchi Eye Clinics, Shiraz, Iran. The patients were included if (1) the duration of hemorrhage was not greater than one month; (2) no significant media opacities were present to preclude the use of Nd:YAG laser; (3) the hemorrhage occupied more than 3 disc diameters (DD) in size as judged by fundoscopy; and (4) the hemorrhage caused severe visual loss (visual acuity (VA) ≤ 20/800). A total of 13 eyes from these 12 patients were studied.

The laser procedures were performed between January 2001 and December 2001. Six patients (50%) were males and six (50%) females. Their age ranged from 15 to 64 years. The period of follow-up was 3 months. Diabetic retinopathy (8 eyes), retinal macroaneurysm (2 eyes), acute myeloblastic leukemia (AML) (2 eyes), and branch retinal vein occlusion (1 eye) were diagnosed. The process of informed consent was designed to make the patients familiar and comfortable with the reasonable expectations and foreseeable risks. The surgeon discussed these issues with the patients and assisted them in their decision-making.

Pre and posttreatment examinations included stereoscopic biomicroscopy of the posterior pole and peripheral retina, best-corrected visual acuity, and color fundus photograph (in selected patients).

The procedure was performed with maximal mydriasis and topical anesthesia, using a Goldman fundus contact lens, with a Q-switched Nd:YAG laser. Single bursts were emitted from this laser. The aiming helium: neon beam could be focused on a point on the lower surface of the hemorrhage, which was judged to (1) be far from the fovea; (2) not overlie a major retinal vessel; and (3) overlie a sufficient thickness of blood to protect the underlying retina and choroids. Thus, the puncture was performed in the lower and most prominent area of hemorrhage to protect the foveola from laser impact and to support outflow by gravity. To create membranotomy, laser exposures commenced with energy levels of 5 mJ and were then increased by one mJ in each step until perforation became visible at the surface of hemorrhage and drainage of blood was evident. When an effective perforation had been achieved, premacular blood could be seen draining into the vitreous gel immediately. In each case, the energy per exposure did not exceed greater than 10 mJ and...
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if drainage of blood did not occur after ten bursts the procedure was discontinued. The patients were followed up at one week, one month, and 3 months posttreatment.

**Results**

The success of the laser procedure was defined as clearing of premacular hemorrhage within 3 months (Figure 1A and B). Using this definition, drainage of premacular subhyaloid hemorrhage into the vitreous with the Nd:YAG laser succeeded within three months in eleven out of thirteen eyes treated without requiring further membranotomy. The pretreatment visual acuities ranged from hand motion to 20/800.

The mean power required to perform posterior hyaloidotomy was 8 mJ. The mean number of laser energies required to perform posterior hyaloidotomy was four. One week after hyaloidotomy, visual acuity ranged from hand motion (HM) to 20/30 (median, 20/200), and one month after hyaloidotomy, visual acuity ranged from HM to 20/20 (median, 20/100), and was not significantly different from visual acuity 3 months after hyaloidotomy. Rebleeding did not occur in any of the eyes. In two eyes visual acuity remained poor. In one eye, drainage of blood into the vitreous failed because of a clotted premacular hemorrhage of a 28-day duration despite visible puncture at the

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**Figure 1.** A) Fundus photograph of right eye of a 53-year-old diabetic woman (Table 1, patient No. 7) shows boat-shaped preretinal hemorrhage of 5 days duration. B) One month after laser treatment, shows clearing of preretinal hemorrhage and circinate line in posterior pole demarcating extent of preretinal hyaloid membrane.

**Table 1.** Nd:YAG laser treatment for premacular hemorrhage.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age/ Sex</th>
<th>Diagnosis</th>
<th>Size of hemorrhage</th>
<th>Visual acuity Before treatment</th>
<th>Visual acuity After 1 week</th>
<th>Visual acuity After 1 month</th>
<th>Visual acuity After 3 months</th>
<th>No. of laser pulses</th>
<th>Energy per pulse (mJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39/M</td>
<td>Macraneurism</td>
<td>10 DA</td>
<td>HM</td>
<td>20/40</td>
<td>20/20</td>
<td>20/20</td>
<td>3</td>
<td>5/6/7</td>
</tr>
<tr>
<td>2</td>
<td>40/F</td>
<td>DM</td>
<td>5 DA</td>
<td>20/1200</td>
<td>20/400</td>
<td>20/100</td>
<td>20/100</td>
<td>5</td>
<td>5/6/7/8/9</td>
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<tr>
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<td>46/F</td>
<td>Macraneurism</td>
<td>8 DA</td>
<td>HM</td>
<td>20/70</td>
<td>20/50</td>
<td>20/50</td>
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<tr>
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<td>48/M</td>
<td>DM</td>
<td>8 DA</td>
<td>HM</td>
<td>20/200</td>
<td>20/50</td>
<td>20/50</td>
<td>3</td>
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<tr>
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<td>50/M</td>
<td>BRVO</td>
<td>6 DA</td>
<td>20/1200</td>
<td>20/400</td>
<td>20/100</td>
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<tr>
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<td>51/M</td>
<td>DM</td>
<td>9 DA</td>
<td>HM</td>
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<tr>
<td>7</td>
<td>53/F</td>
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<td>5 DA</td>
<td>20/1200</td>
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<td>20/100</td>
<td>10</td>
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</tr>
<tr>
<td>8</td>
<td>58/M</td>
<td>DM</td>
<td>10 DA</td>
<td>HM</td>
<td>HM</td>
<td>HM</td>
<td>HM</td>
<td>3</td>
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<tr>
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<td>61/F</td>
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<tr>
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</tr>
<tr>
<td>12</td>
<td>15/F</td>
<td>AML</td>
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<td>20/800</td>
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<td>13</td>
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<td>HM</td>
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<td>20/20</td>
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<td>3</td>
<td>5/6/7</td>
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</tbody>
</table>

M = male; F = female; DM = diabetes mellitus; BRVO = branch retinal vein occlusion; HM = hand motion; DA = disc area; AML = acute myeloblastic leukemia.
surface of the hemorrhage (Table 1, patient No. 6). In another eye, severe vitreous hemorrhage persisted after three months (Table 1, patient No. 8).

Overall visual improvement was best in eyes with AML and macroaneurysm. During the follow-up, neither macular epiretinal membranes nor tractional retinal detachments occurred in any eyes.

Discussion

Premacular hemorrhage under the internal limiting membrane and premacular subhyaloid hemorrhage usually causes profound loss of vision. Therapeutic options currently available include observation, vitrectomy, and laser (either Nd:YAG laser or argon green laser10, 16) treatment.

The efficacy of early vitrectomy is difficult to evaluate, because only 6% to 10% of diabetic vitrectomies are performed for premacular hemorrhage9, 17 – 21 and large prospective series such as Early Treatment Diabetic Retinopathy Study22 and Diabetic Retinopathy Vitrectomy Study23 – 25 have not defined this subgroup from other patients undergoing early vitrectomy for vitreous hemorrhage. Retrospective studies indicate that early vitrectomy may be beneficial in preventing fibrovascular proliferation and improving visual prognosis in this subgroup.9, 17 – 20 In the largest reported series involving 26 eyes, a final anatomic success rate of 85% was achieved, with the visual acuity of 20/20 to 20/50 in 54% of eyes.18 However, a significant risk of intraoperative complications was reported, including active bleeding in 62% of eyes; anterior retinal breaks in 11%; posterior breaks in 11%; and macular contusion injury in 5%. Furthermore, postoperative hemorrhage, obscuring retinal detail for at least one month, was present in 46% of eyes. Similar results have been reported in other studies.9, 19

As there are only a few reported cases describing the use of the Nd:YAG laser for this purpose, here we report our experience and technique regarding the treatment of these patients.

In our series, thirteen eyes underwent membranotomy, a relatively simple outpatient procedure, within one month of the hemorrhage. The results confirm that a recent premacular subhyaloid hemorrhage can be drained into the vitreous with the Nd:YAG laser treatment. Good visualization of the macular region of the retina was restored within one month in all cases. This is in accordance with the results of Raymond6 and Ezra et al.26 However, one eye required an additional vitrectomy due to a clotted hemorrhage that refused to drain into the vitreous despite an opening at the vitreoretinal interface. The pretreatment duration of the hemorrhage appears to be of prognostic importance. We could not drain clotted premacular subhyaloid hemorrhage of 28 days duration into the vitreous. This is in accordance with a report by Mansour15 and Ulbig et al.6 Usually soon after bleeding, a fluid level resulting from the settling of cellular components of the blood gives a characteristic boat-shaped appearance. With time the hemorrhage turns yellowish because of the degeneration of hemoglobin. This clotted blood is then unlikely to drain into the vitreous gel despite successful perforation.6

Visual improvement after Nd:YAG laser treatment was seen within one month in eleven out of thirteen eyes treated. The degree of visual improvement of treated eyes depended on the underlying diagnosis and preexisting macular damage. In our study, the eyes with macroaneurysm and AML fared relatively best. In premacular subhyaloid hemorrhage with underlying retinal disease such as diabetic neovascularization or macular edema, there is not only short-term benefit from the Nd:YAG laser treatment but also improved retinal visualization and expedited access for focal photocoagulation.26 By contrast, dispersion of the trapped blood into
the vitreous gel may be disadvantageous and prevent panretinal photocoagulation.6

There is a controversy surrounding the effects of preretinal blood on the retina. Epiretinal membrane formation may be induced and a toxic effect of dissolving hemoglobin has been suggested after long-standing contact between blood and retina.9, 18, 27, 28

Furthermore, it is unclear which anatomic layer covering a premacular subhyaloid hemorrhage is targeted with the Nd:YAG laser puncture. It is generally agreed that premacular hemorrhages are located at the vitreoretinal interface. The most common site is at the posterior pole, where the premacular bursa provides a preexisting anatomic space for this kind of hemorrhage.34, 29 The presence of a glistening light reflex and fine striae on the surface of the hemorrhage upon fundoscopic examination may indicate involvement of the internal limiting membrane. It is believed that in cases with Terson syndrome and Valsalva retinopathy, the premacular hemorrhage occurs beneath the internal limiting membrane.12, 30, 31 During our study, it was documented in one diabetic patient, using fundus photography, that posterior hyaloid cortex was targeted with the Nd:YAG laser puncture (Figure 2).

The macular hole identified after Nd:YAG laser treatment in a young woman with Valsalva retinopathy is another complication reported by Ulbig and colleagues.6 It is possible that the photo disruptive effect was too close to the macula. The entrapped blood is believed to act as a cushion, dampening the disruptive impact of the Nd:YAG laser burst, as indicated by visible fluid waves. In a small hemorrhage, the laser burst occurs close to the macula, and the protective dampening effect may be insufficient and this serious complication clearly limits the safety of the procedure. This may be important for small premacular subhyaloid hemorrhage, which is considered self-limiting.10 Therefore, we advocate laser drainage only if the size of the hemorrhage is large. Precise focusing of the surface of the hemorrhage by aiming the beam and 0.125 mm anterior displacement of laser beam seems to be important, too, and we do not exceed energies of 10 mJ for safety reasons.32

Based on our experience and the few other reports in the literature, it seems that the Nd:YAG laser treatment is a justified therapeutic option for recent premacular subhyaloid hemorrhage beyond 3 disc in diameter. Clinical benefits include rapid visual rehabilitation, visualization of the underlying retina, and expedited access for macular photocoagulation. It must be taken into consideration that the other therapeutic option is pars plana vitrectomy with its known complications. The rapid resolution of the blood is particularly beneficial for patients with poor vision in the partner eye and for patients with an occupational need for rapid restoration of binocular vision. With a limited and short-term view from our study, selected cases would seem to benefit from this procedure, but further long-term surveillance of laser-treated cases is necessary and only randomization with deferral of treatment or vitrectomy can define benefits and disadvantages.

References


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