Argon Laser Pretreatment in Nd:YAG Iridotomy

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ABSTRACT
Argon laser pretreatment prior to Nd:YAG laser iridotomy may decrease the incidence of operative hemorrhage. In a prospective, randomized clinical trial involving 12 patients (24 eyes), one eye was randomly assigned treatment with the Nd:YAG laser alone, while the other eye was pretreated with argon laser photocoagulation immediately prior to Nd:YAG laser. Eight of the 12 eyes (67%) treated with Nd:YAG laser alone had operative hemorrhages; only 2 of the 12 (17%) pretreated eyes did. Thus, argon laser pretreatment significantly reduced the incidence of hemorrhage during Nd:YAG iridotomy (P = .012).

Since laser iridotomy has replaced surgical iridectomy for treatment of primary closed angle and pupil block glaucomas, controversy has arisen as to which method of laser iridotomy is best. A comparison of argon and Nd:YAG laser iridotomy results has shown that it is easier to create a patent iridotomy in most irides with the Nd:YAG laser, but that the incidence of hemorrhage from the iridotomy site also is greater with this method.1-4

A review of Nd:YAG iridotomy results shows that the incidence of hemorrhage from the iridotomy site is approximately 59% (Table).1-10 Although the bleeding is usually self-limiting, significant hyphema formation, associated with elevation of intraocular pressure (IOP), has been reported to occur after Nd:YAG iridotomy.11-12 Such increased pressure could be devastating to the vision of a person with severe glaucomatous optic neuropathy.

While bleeding from the iridotomy site is rarely a complication of argon laser iridotomy, closure of the iridotomy site often is problematic with this procedure. The incidence of pigment proliferation with late failure of patency after argon laser iridotomy may be as high as 30%.1-2

We reasoned that argon laser treatment prior to Nd:YAG iridotomy might reduce the incidence of bleeding from the iridotomy site without adversely affecting the low iridotomy closure rate of routine Nd:YAG iridotomy.

MATERIALS AND METHODS
Twelve patients with narrow angles or closed angle glaucoma who required bilateral laser iridotomy were enrolled in the study. Each patient gave informed consent. One eye of each patient was randomly assigned treatment with Nd:YAG laser alone (control group); the other eye of each patient received argon laser pretreatment immediately prior to Nd:YAG iridotomy (pretreatment group).

The indications for laser iridotomy were combined mechanism glaucoma (open and closed angle components), 14 eyes (58%); narrow angles, 4 eyes (17%); chronic closed angle glaucoma, 2 eyes (8.3%); acute closed angle glaucoma, 2 eyes (8.3%); and 2 fellow eyes (8.3%).

The average age of the 12 patients was 67 years (range, 57 to 83 years); six were men, six were women; nine were white and three were black. Seven had brown irides, five had blue.

A complete eye examination, including Goldmann applanation tonometry, Zeiss gonioscopy, and indirect ophthalmoscopy, was performed on all patients.
TABLE
Incidence of Operative Hemorrhage During Nd:YAG Laser Iridotomy

<table>
<thead>
<tr>
<th>Author</th>
<th>Eyes</th>
<th>Hemorrhage</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Klapper, 1984</td>
<td>20</td>
<td>3</td>
<td>15%</td>
</tr>
<tr>
<td>Robin/Pollack, 1984</td>
<td>20</td>
<td>9</td>
<td>45%</td>
</tr>
<tr>
<td>Robin/Pollack, 1986</td>
<td>33</td>
<td>12</td>
<td>36%</td>
</tr>
<tr>
<td>Robin, 1986</td>
<td>44</td>
<td>23</td>
<td>52%</td>
</tr>
<tr>
<td>Drake, 1986</td>
<td>51</td>
<td>42</td>
<td>82%</td>
</tr>
<tr>
<td>Moster, 1986</td>
<td>38</td>
<td>13</td>
<td>34%</td>
</tr>
<tr>
<td>Wise, 1987</td>
<td>30</td>
<td>19</td>
<td>63%</td>
</tr>
<tr>
<td>Naveh, 1987</td>
<td>40</td>
<td>8</td>
<td>20%</td>
</tr>
<tr>
<td>Wand, 1988</td>
<td>100</td>
<td>100</td>
<td>100%</td>
</tr>
<tr>
<td>Del Priore, 1988</td>
<td>43</td>
<td>19</td>
<td>44%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>419</td>
<td>248</td>
<td>59%</td>
</tr>
</tbody>
</table>

preoperatively. Those who were intolerant of glaucoma medicines, or who had coagulation disorders, interfering corneal pathology, or complicating systemic disorders were excluded from the study.

Preoperative medications included topical pilocarpine 4%, 30 minutes prior to iridotomy. Apraclonidine hydrochloride 1%, unavailable in the early stages of the study, was not used. Anesthesia was supplied with topical proparacaine 0.5%. An Abraham iridotomy lens was used in all cases. Iridotomy patency was achieved in a crypt located in the peripheral superior iris at the 11 or 1 o'clock position. A successful iridotomy was confirmed by direct visualization of the anterior lens capsule. If bleeding occurred at the iridotomy site, digital pressure was applied to the contact lens.

Nd:YAG iridotomy was performed with an American Medical Optics Q-switched Nd:YAG laser. Single 5-mJ pulses, 20 nanoseconds each, were repeated until a patent iridotomy was created.

A Coherent Medical Division 920 argon/krypton laser was used in the pretreatment eyes. The laser was set to the green wavelength, 1 W of power, 50-μm spot size, and 0.50-second duration. The duration of each argon pulse was subjectively controlled by the examiner with the laser foot pedal in order to avoid full-thickness iris penetration. Only one shot of argon green laser was used in each pretreatment eye. Afterward, single 5-mJ Nd:YAG laser pulses were repeated until a patent iridotomy was formed.

Postoperatively, all patients were started on topical prednisolone acetate 1% four times daily, beginning on the day of laser treatment and continuing until the end of the first postoperative week. Preoperative glaucoma medicines were continued as necessary. Those in whom IOP rose more than 10 mm Hg after iridotomy were placed on oral acetazolamide 250 mg four times daily in addition to topical glaucoma medicines. Postoperative, masked, examinations were performed at 1 hour, 4 hours, 1 week, 1 month, 3 months, and 6 months. Patients were evaluated for changes in visual acuity, IOP, cataract formation, degree of anterior segment inflammation, late failure of patency, and laser-related posterior pole pathology.

RESULTS
Iridotomy patency was achieved in a one-treatment sitting in 6 of the 12 (50%) Nd:YAG control eyes, and in 11 of the 12 (92%) pretreatment eyes. Three of the 12 (25%) Nd:YAG control eyes needed two-treatment sittings to achieve patency; the remaining three control eyes (25%) needed three treatments. Obscuration of the iridotomy site during Nd:YAG iridotomy by iris pigmentary dispersion and bleeding was the major reason for multiple treatment sittings in the Nd:YAG control group.

A mean of 26 pulses was required to create a patent Nd:YAG laser iridotomy (mean total dosage, 129±58 mJ; median, 60 mJ). A mean of 16 pulses was required to create patency in the pretreatment group (mean total dosage, 78±36 mJ; median, 38 mJ). The dosage of Nd:YAG energy needed to create a patent iridotomy was less with pretreatment, although the effect of pretreatment in this respect was not statistically significant (P = .56).

Each patient developed anterior segment inflammation after laser iridotomy. The cell and flare response was graded according to a modified uveitis classification system described by Hogan and co-workers.13 The inflammatory response was assessed using a slit-lamp beam of maximum width, 2 mm long. The degree of cell response was graded as (1) "mild or less than 25 cells per field," (2) "moderate or between 25 to 50 cells per field," or (3) "marked or greater than 50 cells per field." The degree of flare response was graded as (1) "mild or barely visible," (2) "moderate with iris and lens detail clear," or (3) "marked with iris and lens detail hazy." Most eyes developed a moderate to marked cell and flare response immediately after laser iridotomy. There was no significant inflammatory difference between the Nd:YAG control eyes and the pretreatment eyes, except at 24 hours postoperatively in the cell response; the pretreatment eyes tended to have a more pronounced reaction after laser iridotomy (P = .01).

The mean preoperative IOPs of the Nd:YAG control and pretreatment eyes, 18 mm Hg and 23 mm Hg, respectively, were not significantly different, (P = .22). The peak IOP occurred at the first postoperative hour in 67% of the eyes. There was no statistically significant difference in the peaks or the final IOPs of
the two groups ($P = .31$ and $.62$, respectively). In three of the 12 (25%) Nd:YAG control eyes and in 5 of the 12 (42%) pretreatment eyes, IOP rose more than 10 mm Hg, requiring treatment with oral acetazolamide.

Bleeding from the iridotomy site occurred in 10 of the 24 eyes (42%). In all cases, the bleeding was controlled with digital pressure on the contact lens. No hyphemas formed. Eight of the 12 (67%) Nd:YAG control eyes had bleeding from the iridotomy site; only 2 of the 12 (17%) pretreatment eyes did. The argon laser pretreatment group had a significantly lower incidence of bleeding from the iridotomy site during Nd:YAG iridotomy ($P = .012$, Fig 1).

The appearance of the pretreatment iridotomies was strikingly different than that of the standard Nd:YAG iridotomies. In most irides the pretreatment iridotomy was larger, more rounded, and had more cleanly cut edges (Fig 2). The typical Nd:YAG iridotomy was smaller, more oval, and had somewhat ragged edges (Fig 3). At postoperative examinations 6 months after iridotomy, there was no evidence that pretreatment had induced premature iridotomy closure.

Complications following laser iridotomy were minimal. Four Nd:YAG control eyes and one pretreatment eye developed nonprogressive focal endothelial opacities over the iridotomy site. None of these eyes had decreased Snellen visual acuity or corneal endothelial decompensation. One pretreatment eye developed a persistent corneal epithelial defect, but it resolved 1 month after surgery. We believe that the epithelial defect was related to the contact lens rather than to the laser treatment.

Snellen visual acuity deteriorated in two pretreatment eyes and in two Nd:YAG control eyes after laser iridotomy. Two Nd:YAG control eyes and one pretreatment eye lost 1 to 2 lines of Snellen acuity secondary to the miotic effect of pilocarpine used postoperatively to control the IOP. Due to progression of mixed-component glaucoma, acuity in another pretreatment eye deteriorated from 6/60 to hand motion.

A nonprogressive focal lenticular opacity developed under the iridotomy site in one Nd:YAG control eye, but no opacity appeared in the pretreatment eyes. There was no posterior pole pathology in either treatment group.

**DISCUSSION**

The mechanism of argon and Nd:YAG iridotomy has been well described. The effect of the argon laser is primarily thermal. Thermal energy cauterizes and then vaporizes iris tissue, creating a progressively
deeper iris defect. Bleeding from the iridotomy site is rare, because adjacent iris blood vessels are coagulated in the process.

By contrast, the Nd:YAG laser produces an explosion, and the ensuing shock wave has a mechanical cutting effect on iris tissue. Iris stromal blood vessels thus are vulnerable to disruption, and frequently there is bleeding from the iridotomy site.

Because it coagulates iris stromal blood vessels, argon laser pretreatment reduces the incidence of iris hemorrhage following Nd:YAG laser iridotomy. Also, because it decreases the amount of pigment dispersion and hemorrhage from the iridotomy site, pretreatment may allow better visualization of the iris, thereby facilitating Nd:YAG iridotomy in certain irides.

In previous clinical studies, as contrasted with ours, Nd:YAG laser iridotomy routinely was performed in one treatment session.1-10 In each of these studies, a larger Nd:YAG dosage per pulse and/or multiple pulses per burst were used, making Nd:YAG iridotomy more efficient. Furthermore, performing Nd:YAG iridotomy with the Lasag CGI and the Wise 103-diopeter contact lenses has been demonstrated to require less energy than performing the procedure with the Abraham lens.2-3,5,9 Therefore, the Nd:YAG energy requirements and number of shots were greater in our study.

Despite the larger Nd:YAG dosage, the number of eyes in our study with complications was low. Five of the 24 eyes (21%) had focal nonprogressive corneal opacities over the iridotomy site. This incidence is similar to that reported in previous studies using the Abraham contact lens, 18 to 35%.1,4,6,7

There was bleeding from the iridotomy site in 10 of the 24 eyes (42%). This finding is consistent with previous data showing frequent bleeding during Nd:YAG iridotomy (Table).1,4,10 The IOP elevation in these eyes was not statistically different from the rise in pressure in the eyes that did not bleed (P = .17).

There was no significant difference between the Nd:YAG control and pretreatment groups with respect to postoperative Snellen visual acuity, IOP rise after iridotomy, dosage of Nd:YAG energy required, and late iridotomy closure. Inflammation tended to be more frequent with pretreatment, consistent with previous studies showing more inflammation after argon laser iridotomy.1

Several methods of argon laser pretreatment prior to Nd:YAG iridotomy have been reported. Naveh-Floman described performing Nd:YAG iridotomy several weeks after inducing iris atrophy with multiple argon laser pulses.14 Bechetteille recounted his experiences using the argon laser prior to Nd:YAG laser iridotomy in his book Glaucomes.15

Ours is the first prospective, randomized clinical trial examining the safety and efficacy of argon pretreatment prior to Nd:YAG iridotomy. To increase standardization of results we used one shot of argon pretreatment. Our results suggest that such pretreatment can be advantageous. Other pretreatment modalities may be just as effective, but further investigation is required.

Pretreatment with argon laser appears to be a safe and effective alternative to routine Nd:YAG iridotomy. It may be especially useful in patients at greater risk for iris hemorrhage (due to uveitis, and anticoagulation) and in those with glaucomatous optic neuropathy, who may not be able to tolerate an acute elevation of IOP secondary to hyphema.

REFERENCES