Neodymium:YAG Membranectomy for Pupillary Membranes on Posterior Chamber Intraocular Lenses

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**Purpose:** To evaluate the effectiveness of neodymium:YAG laser for the removal of membranes from the anterior surface of intraocular lenses.

**Methods:** Seven patients had reduced vision due to a membrane on the anterior surface of a posterior chamber intraocular lens (PC IOL). Six of the membranes developed after extracapsular cataract surgery and PC IOL combined with trabeculectomy and one after pars plana vitrectomy. Six of the membranes developed in the early postoperative period in association with a fibrinous reaction of the anterior chamber. One formed 7 months after surgery in an eye with iris capture behind the IOL. The membranes persisted despite intensive topical steroid therapy. A neodymium:YAG (Nd:YAG) laser was used to remove the membranes from the anterior of the IOL in all the seven cases.

**Results:** The Nd:YAG laser effectively severed the peripheral connections of the membranes to the iris and lens, creating a clear central zone within the visual axis. The settings were fundamental mode, 1.2- to 3.1-mJ energy per shot and 48.3 ± 20.1 single pulses. Vision improved significantly in six patients, whereas elevated intraocular pressure was observed in one patient.

**Conclusion:** Postoperative pupillary membranes may be successfully lysed with use of the Nd:YAG laser. *Ophthalmology* 1995;102:1846-1852

Opacities may develop on the anterior surfaces of an intraocular lens (IOL) after cataract surgery.1-10 They usually are precipitates of inflammatory cells, pigment, or fibrin and disappear with time and topical steroid therapy. However, in some cases, visually significant membranes may form on the IOL surface and persist despite medical treatment.

In the current study we observed seven patients (Table I) in whom a dense membrane developed on the anterior surface of a posterior chamber IOL after combined surgery for cataract and glaucoma (6 eyes) and pars plana vitrectomy (1 eye). The membranes reduced visual acuity and were resistant to medical treatment. We reported our treatment results with use of a neodymium:YAG (Nd:YAG) laser.

**Methods**

Seven patients with cataract and poorly controlled glaucoma on maximal medical treatment underwent extracapsular cataract extraction (ECCE) combined with tra-
### Table 1. Clinical Course of Pupillary Membranes on Posterior Chamber Intraocular Lenses

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs)</th>
<th>Sex</th>
<th>Diagnosis</th>
<th>Surgery AC</th>
<th>Surgery-YAG (reaction duration)</th>
<th>Visual Acuity Before YAG</th>
<th>Visual Acuity After YAG</th>
<th>Pulses</th>
<th>Energy</th>
<th>Cause of Visual Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>63</td>
<td>M</td>
<td>OAG, CAT</td>
<td>ECCE, IOL, Trab, SI</td>
<td>10 mos</td>
<td>20/400</td>
<td>20/50</td>
<td>66</td>
<td>1.6</td>
<td>Glaucoma</td>
</tr>
<tr>
<td>2</td>
<td>71</td>
<td>F</td>
<td>OAG, CAT</td>
<td>ECCE, IOL, fibrinoid, Trab, SI</td>
<td>5 wks</td>
<td>HM</td>
<td>20/100</td>
<td>51</td>
<td>3.0</td>
<td>Glaucoma</td>
</tr>
<tr>
<td>3</td>
<td>65</td>
<td>F</td>
<td>OAG, CAT</td>
<td>ECCE, IOL, fibrinoid, Trab, RI</td>
<td>4 wks</td>
<td>20/400</td>
<td>20/60</td>
<td>21</td>
<td>2.8</td>
<td>Glaucoma</td>
</tr>
<tr>
<td>4</td>
<td>65</td>
<td>M</td>
<td>OAG, DM, CAT</td>
<td>ECCE, IOL, 2+ cells; Trab</td>
<td>16 mos</td>
<td>20/200</td>
<td>20/40</td>
<td>32</td>
<td>2.5</td>
<td>Glaucoma, DR</td>
</tr>
<tr>
<td>5</td>
<td>55</td>
<td>M</td>
<td>OAG, DM, CAT</td>
<td>ECCE, IOL, 3+ cells; Trab</td>
<td>3 mos</td>
<td>20/200</td>
<td>20/80</td>
<td>80</td>
<td>2.7</td>
<td>Glaucoma, DME</td>
</tr>
<tr>
<td>6</td>
<td>91</td>
<td>M</td>
<td>OAG, EOPH</td>
<td>PPV, fibrinoid</td>
<td>12 mos</td>
<td>20/100</td>
<td>20/100</td>
<td>49</td>
<td>3.1</td>
<td>CNVM</td>
</tr>
<tr>
<td>7</td>
<td>77</td>
<td>M</td>
<td>OAG, CAT</td>
<td>ECCE, IOL, 3+ cells, Trab, SI</td>
<td>21 mos</td>
<td>20/40</td>
<td>20/25</td>
<td>39</td>
<td>2.1</td>
<td>Glaucoma</td>
</tr>
</tbody>
</table>

OAG = open-angle glaucoma; DM = diabetes mellitus; CAT = cataract; EOPH = endophthalmitis; Trab = trabeculectomy; ECCE = extracapsular cataract extraction; IOL = intraocular lens; SI = sector iridectomy; RI = radial iridotomy; PPV = pars plana vitrectomy; AC = anterior chamber; HM = hand motions; DR = diabetic retinopathy; DME = diabetic macular edema; CNVM = choroidal neovascular membrane.

*Persistent IOP elevation after YAG membranectomy requiring a trabeculectomy 2 weeks later.*
Two weeks later, the patient's visual acuity had improved to 20/80 and the markedly shrunken membrane was present in the center of the IOL. Two laser pulses were applied to the center of the membrane and slightly inferiorly. A posterior capsulotomy was then performed. The topical steroids were tapered and discontinued after 3 weeks. Visual acuity 3 months after laser membranectomy was 20/50. A remnant of the membrane remained on the inferior iris surface (Fig 3).

**Case 2.** A 71-year-old woman underwent uncomplicated ECCE and trabeculectomy including superior sector iridectomy in the left eye. Preoperative visual acuity was hand movements. On the first postoperative day, circulating erythrocytes were observed in the anterior chamber above a 1-mm hyphema. The patient was treated with 1% prednisolone acetate every 2 hours, and the hyphema cleared in 2 days. However, a fibrinoid anterior chamber reaction remained, and 1 week later a diaphanous pupillary membrane was observed on the IOL surface. Topical steroid dosage was increased hourly. One week later, the membrane had coalesced into a dense band that extended diagonally across the pupil (Fig 4).

Topical steroids were applied hourly for 3 more weeks. Although the anterior chamber inflammatory reaction resolved, the membrane persisted. Attempts to dilate or constrict the pupil were unsuccessful. Visual acuity was hand movements. The posterior capsule was clear.

The Nd:YAG laser (51 pulses in the fundamental mode) was used 5 weeks after surgery to sever the membrane band from its attachments at each end (Fig 5). There was no nicking of the IOL. The membrane contracted centrally. Topical prednisolone acetate was applied hourly. Two weeks later, the membrane had disappeared completely, leaving a clear visual axis (Fig 6). Visual acuity improved to 20/100, which, in this case, was considered the best possible acuity obtainable, given the previous glaucomatous damage involved.

**Case 3.** A 65-year-old man underwent uncomplicated cataract/glaucoma surgery that included a radial iridotomy closed with a 10-0 polypropylene (Proline) suture in the right eye. His preoperative vision was 20/400. A 5% hyphema was observed 1 day after surgery. Topical prednisolone was prescribed four times daily. The hyphema cleared in 6 days, but the remaining fibrinoid reaction condensed 1 week later into a pupillary band on the anterior IOL surface. Topical steroids were continued to
angle glaucoma underwent ECCE, implantation of a PC IOL, and trabeculectomy in the right eye. Preoperative visual acuity was 20/400. One week after surgery, a fibrinous membrane had developed on the anterior surface of the IOL, and visual acuity was 20/200. The patient’s acuity did not improve despite clearing of the postoperative anterior chamber reaction. Three months after surgery, the patient underwent Nd:YAG anterior membranectomy in the fundamental mode, with use of 80 single pulses and 2.7-mJ energy. Her vision subsequently improved to 20/80, with the remainder of her visual deficit attributed to the presence of diabetic macular edema, which was treated with focal laser photocoagulation. This could only be performed after the anterior membranectomy allowed for adequate visualization of the posterior pole.

**Case 6.** A 91-year-old man with advanced primary open-angle glaucoma and previous trabeculectomies in both eyes underwent ECCE and PC IOL implantation in the right eye. His preoperative vision was 20/200. Preoperative medications included timolol maleate (Timoptic) 0.5% in both eyes twice daily, pilocarpine 4% in the left eye four times daily, and dipivefrin (Propine) 0.1% in the left eye twice daily. The postoperative course was complicated by the development of endophthalmitis, which required pars plana vitrectomy and injection of intravitreal vancomycin and gentamicin. An inflammatory membrane was also removed from the anterior chamber at the time of surgery. Cultures of the anterior chamber and vitreous were positive for *Staphylococcus epidermidis*.

After the vitrectomy was performed, a fibrinous anterior chamber reaction developed; it resolved over the next several weeks, leaving behind a pupillary membrane. Postoperative visual acuity never improved to better than 20/100, and 12 months after the initial surgery a Nd:YAG anterior membranectomy was performed in the fundamental mode with use of 49 single pulses and 3.1-mJ energy. Vision did not improve after surgery, but IOP, which had been well controlled on maximal medical therapy, rose to approximately 25 mm Hg 6 weeks after surgery and was sustained. Therefore, 2 weeks later, a repeat trabeculectomy was performed on the right eye. The IOP was effectively lowered and the pupillary membrane did not recur. However, visual acuity remained at 20/100, and dilated fundoscopic examination revealed a macular choroidal neovascular membrane superior to the fovea, with a subretinal hemorrhage extending under the fovea. Fluorescein angiography confirmed the clinical findings, and focal laser photocoagulation was performed.
Case 7. A 77-year-old man with primary open-angle glaucoma in both eyes and a visually significant cataract in the left eye underwent a combined trabeculectomy, ECCE and PC IOL implantation. Preoperative visual acuity was 20/100. At the time of surgery, a sector iridectomy was performed to facilitate expression of the nucleus. After surgery, a marked inflammatory reaction occurred, leading to the development of posterior synechiae and a fibrin sheet covering the anterior surface of the IOL. Three months after surgery, the synechiae had regressed, several perforations had developed in the fibrin sheet, and the eye was quiet. Still, best corrected vision remained at 20/40 under ideal lighting. Neodymium:YAG anterior membranectomy was performed without complication in the fundamental mode with use of 39 single pulses and 2.1-mJ energy. Best corrected vision in the left eye improved to 20/25.

Discussion

Membranes on the anterior lens surface have been reported after the implantation of anterior chamber, iris-fixated and PC IOLs.1-6 The reported incidence of pupillary fibrin membranes in the United States after various surgical procedures is unknown, although the recently reported figure of 4.4% in Japan after cataract extraction and PC IOL implantation suggests that it is a common complication.7 Nishi8 found the incidence of 7.6%, and Walinder and associates,9 incidence of 11% to 17% in Sweden. A strong association with exfoliation syndrome was found, an increased vascular permeability was suggested as a probable cause of the reaction.9

The other risk factors for the development of membranes include marked inflammation,1-6 rubeculous iridids,7 hyphema,8 iris surgery,1-2 iris-fixated lenses,1-2 toxic reactions to IOL coatings,4 blood–aqueous barrier disruption and residual lens remnants and epithelial cells.7 Miyake et al7 suggested that the formation of the fibrin membrane is a kind of immunologic reaction in which a dry-sterilized IOL or residual lens may produce a soluble antigen, and an antibody, perhaps IgG, may enter through disruption of the blood–aqueous barrier.

Surgical trauma is responsible for barrier breakdown through which chemical mediators, such as prostaglandins, synthesized in the anterior uvea enter the anterior chamber.10 Galin and associates11 noted that disruption of the blood–aqueous barrier in cases of IOL implantation provides a suitable environment for an immunologic reaction. In an experimental study, Nishi noted that fibrous metaplasia of human lens epithelial cells was enhanced by contact with polymethylmethacrylate with more production of prostaglandin-E-2 and interleukin-1. These mediators were considered to disrupt the blood–aqueous barrier and cause flare spikes between 4th and 14th days in pseudophakic eyes.12 The incidence of fibrin reaction was reported to be lower with the preoperative and postoperative use of prostaglandin inhibitors.7,13 Chen and associates14 observed an association of pupillary membranes with chronic use of miotics. Because pilocarpine changes the permeability of the blood–aqueous barrier and the iris vessels, its use may promote transfer of protein, cells, and fibrin into the aqueous.15,16 In our study, combined cataract and glaucoma surgery, PC IOL surgery (cases 1–7) and iris surgery (cases 1–5 and patient 7) may be risk factors, as may be long-term use of miotic therapy.

Histologic examination of visually significant, pseudophakic pupillary membranes has disclosed a variety of structural elements. Some membranes consist of an inflammatory exude containing fibrin and polymorphonuclear leukocytes.2-4 Others may consist primarily of residual lens elements, such as proliferating lens epithelium from the anterior lens capsule. A third type of membrane has been shown ultrastructurally to be derived from activated fibroblasts from the iris stroma.1 The iris fibroblasts may elaborate a collagenous “cocoon membrane,” which, in at least one case, totally ensheathed a four-loop iris plane lens.1 Recently, Pavlack and co-workers,17 using immunofluorescence, characterized the specific collagenous components of a peripseudophakic membrane. Types I and III were predominant. Additionally, Type IV was seen in association with blood vessels and Type VI with avascular areas. The membranes in patients 2 to 7 had a clinical course suggesting an inflammatory origin. They developed in the early postoperative period after hyphema in a context of marked inflammation and cleared after laser and steroid therapy. The membrane in patient 1 may have contained some collagen, lens epithelial cells, or other noninflammatory cells. This membrane developed much later after surgery, was not associated with any anterior chamber inflammation, and did not resorb completely after therapy. Michels recommended cutting the fibrin membranes with a Ziegler knife.18 However, nonlaser surgical techniques to remove membranes may be difficult and risk damage to the IOL optic, lens dislocation, and rupture of the posterior capsule. In one case involving an iris-supported lens, the membrane could not be scraped off the anterior lens surface with a Ziegler knife, and the eye eventually required corneal transplantation and IOL removal.1 Although it is usually possible to cut the membrane, the cuts are often small and tend to close because of recurrent fibrin membrane formation. In contrast, the laser allows removal of a large portion of membrane. Further, invasive intraocular manipulations tend to exacerbate the fibrin response.19 Anterior chamber reaction, corneal edema, and cystoid macular edema were observed less commonly with YAG laser membranectomy than with surgical removal of the fibrinous membranes in aphakia.20 Because the laser is less disruptive, the stimulus for fibrin recurrence is diminished. Surgery posed the risk of other complications as well, such as infection and the need for anesthesia.

Argon laser membranectomy was reported by Lunde21 and Lewis.22 However, argon laser may create retinal burns. Deutsch observed such burns in the fundus of an eye treated with argon laser.23 Also, the effectiveness of argon laser depends on tissue pigmentation, and most pupillary membranes are nonpigmented. Vega and Sebates reported a single unilateral case of persistent pupillary membrane treated by the Nd:YAG laser without complications.24 Similarly, Ramakrishnan and associates suggested Nd:YAG laser lysis for persistent pupillary membranes in patients...
older than age 2 who are unresponsive to medical treatment. The Nd:YAG laser has been shown to be effective in performing posterior capsulotomies and incising aphakic or pseudophakic pupillary membranes. Membranes located on the anterior surface of IOLs may present additional difficulties, because they may be firmly attached to the IOL. Furthermore, the membrane must be removed from the visual axis instead of simply incised. In patients 2 to 7, the membrane was attached peripherally, both to the lens and the pupillary margin. In patient 1, the superior portion of the membrane was attached directly to the IOL surface (Fig 1).

In a Food and Drug Administration report on Nd:YAG lasers, Stark and co-workers noted intraoperative complications of Nd:YAG laser capsulotomies, such as damage to the IOL (20%), rupture of the anterior hyaloid face (19%), corneal edema (0.3%), bleeding (1%) and iris damage (0.4%). The major postoperative complications were elevation of IOP (39%), cystoid macular edema (50%), iritis (0.6%), vitritis (0.3%), retinal detachment (0.5%) and retinal hemorrhage (0.4%). A small amount of iris bleeding developed in all of the cases, apparently as a shock wave or traction effect, because the iris was not struck directly by laser pulses.

Despite the proximity of the IOL, with careful focusing, six of the membranes were incised without lens nicking. In one case, a few visually insignificant nicks were created in the IOL periphery. During photodisruption, a posterior chamber IOL lying in front of the focus may be more easily damaged than if the implant is behind the plane of the focus. This may explain the higher incidence of IOL damage in posterior capsulotomies compared with anterior membranectomies. Therefore, the potential damage to an IOL may be significantly less when a membrane is opened on its anterior surface. Such protection is present even before the plasma shield is formed.

Summary

In seven patients, an Nd:YAG laser anterior membranectomy effectively opened pupillary fibrin membranes that had formed after combined trabeculectomy, ECCE, and PC IOL implantation and pars plana vitrectomy. The only significant complication was persistent elevation of IOP requiring further glaucoma surgery.

References


