Modified Goniotomy for Inflammatory Glaucoma

Histologic Evidence for the Mechanism of Pressure Reduction

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• A modified goniotomy (trabeculodialysis) was performed on both eyes of a 33-year-old woman who had glaucoma secondary to sarcoid uveitis. One month after trabeculodialysis, a cataract extraction was performed on one eye and a histologic specimen was obtained from the area of the filtration angle that was previously incised. Successful control of intraocular pressure has been maintained in both eyes for 18 months following trabeculodialysis. By light and electron microscopic examination, there was a nonhealed incision between the anterior chamber and Schlemm's canal. Trabeculodialysis, it is concluded, works by providing direct communication between the anterior chamber and Schlemm's canal, and might be effective in all trabecular obstructive glaucoma of short duration before secondary changes occur in the outer drainage channels.

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Glaucoma secondary to uveitis has remained a frustrating and difficult problem. If medical control is not adequate, filtering operations have a low rate of success. Poor results with filtering operations are most likely due to the young age of patients who have uveitis and the increase in inflammation caused by the operative insult. Haas[1] first suggested, several years ago, that goniotomy (trabeculodialysis) be applied to inflammatory glaucoma. He reported an encouraging but small series of modified goniotomies performed on patients with uveitis who were aphakic. Because of its simplicity, easy repeatability, and seeming lack of inflammatory response, the procedure was thought to be well suited for treating inflammatory glaucoma. In a recent article, Hoskins et al[2] reviewed their experience with the surgical treatment of inflammatory glaucoma and also recommended trabeculodialysis as a useful surgical technique, especially in glaucoma secondary to Still's disease (juvenile rheumatoid arthritis).

Trabeculodialysis is performed in a manner very similar to the classical Barkan goniotomy.[3] However, rather than being incised, the trabecular meshwork is scraped from the scleral sulcus with the flat side of a goniotomy blade. This scraping maneuver is performed because elasticity of the limbic tissue in adults is less than in infants, and a simple incision tends to close up. The trabecular sheets are quite friable in inflammatory glaucoma and may be easily scraped away.

Presumably, trabeculodialysis lowers intraocular pressure by increasing outflow facility, but the mechanism by which this occurs has never been documented histologically. The mechanism of successful goniotomy in primary infantile glaucoma has not been established either, even though it has been the preferred procedure for many years.[3]

This case report describes a 33-year-old woman who had sarcoid uveitis, secondary glaucoma, and cataracts. Her glaucoma became medically uncontrollable, and trabeculodialysis was performed on both eyes. One month later, a cataract extraction was performed on one eye, and a histologic specimen was obtained from the trabecular meshwork incised by the trabeculodialysis (Fig 1).

REPORT OF A CASE

In July 1974, facial numbness, pain around the mouth, red eyes, lymphadenopathy, and night sweats developed in a 33-year-old woman. A chest roentgenogram showed hilar adenopathy and a liver biopsy specimen indicated noncaseating granulomas. Both findings supported the diagnosis of systemic sarcoidosis. The patient was treated with oral prednisone for one month. Although her condition improved systemically, her ocular symptoms continued, and she received injections of prednisolone acetate in the sub-Tenon's space four times in the right eye and three times in the left eye.

She first came to the Bascom Palmer Eye Institute, Miami, in February 1975 for evaluation of her uveitis and secondary glaucoma. Her medications at the time included topical 1% prednisolone acetate four times a day in both eyes, topical 1% atropine sulfate twice a day in both eyes, and 500 mg of oral acetazolamide twice a day. Visual acuity was 20/25 in both eyes. The IOP determined by Goldmann applanation tonometer was 20 mm Hg in both eyes. She had irregular posterior synechiae, early posterior subcapsular cataracts, mild cell and flare in the anterior chamber, and some cells in the vitreous. Scattered peripheral anterior synechiae were seen gonioscopically in the filtration angles. The optic discs showed early glaucomatous cupping, but no rim loss was noted. There was no evidence of periphlebitis. Visual fields showed a shallow paracentral defect superiorly in the right eye. The

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Over the next year and a half, she continued to suffer from chronic uveitis with moderate cell and flare in the anterior chamber of both eyes. The treatment for this consisted of 1% prednisolone four times a day, 1% atropine twice a day, 1% epinephrylborate twice a day (all topically applied to both eyes), and 500 mg of oral acetazolamide twice a day. By January 1976, the IOP was 29 mm Hg in the right eye and 14 mm Hg in the left eye on this treatment regimen. Visual acuity was reduced to 20/70 in the right eye and 20/200 in the left eye.

By November 1976, the peripheral anterior synechiae had become more extensive in both eyes, associated with IOPs consistently above 40 mm Hg in the right eye and around 30 mm Hg in the left eye. Visual acuity had decreased to finger counting at 30 cm in the right eye and finger counting at 240 cm in the left eye due to advanced cataracts. The discs were difficult to evaluate but the right cup appeared to be enlarging.

A trabeculodialysis procedure, stripping away the nasal trabecular sheets, was performed through a temporal approach on the right eye on Dec 7, 1976.

Postoperatively, because the acetazolamide therapy was stopped, the IOP rose in the left eye to 48 mm Hg and corneal edema developed. One week following the surgery on the right eye, a trabeculodialysis was performed on the left eye. Postoperatively, the patient was treated with intensive topical and oral prednisone and 1% pilocarpine hydrochloride medication. The IOP rose in both eyes over the next two weeks, and the patient was restarted on a regimen of 500 mg of acetazolamide twice a day, 4% pilocarpine four times a day, and 1% epinephrine twice a day in both eyes. The patient was scheduled for combined cataract extraction and trabeculectomy in the right eye. However, on admission for surgery one month after the initial trabeculodialysis, the IOP was 17 mm Hg in the right eye and 16 mm Hg in the left eye. There was no corneal edema present and, by gonioscopic examination, a trabecular cleft could be seen in the area of trabeculodialysis in both eyes. Because of the patient's need for better vision, a cataract extraction was performed on the right eye (first eye to have trabeculodialysis). Since the future course of the IOP regulation was uncertain, a trabeculectomy was combined with the cataract extraction. Care was taken to excise the trabeculectomy specimen from the nasal end of the cataract section so that the specimen would include the trabecular meshwork that had previously undergone trabeculodialysis.

A bleb developed initially following trabeculectomy, but closed within six weeks. Associated with the closure of the bleb, the IOP rose to 30 mm Hg in the right eye, and 1% pilocarpine therapy was restarted. This was increased to 4% pilocarpine and epinephrine, and has since been gradually tapered. The right eye has a visual acuity of 20/20, moderate glaucomatous cupping, and an early visual field defect. The IOP has remained below 20 mm Hg since March

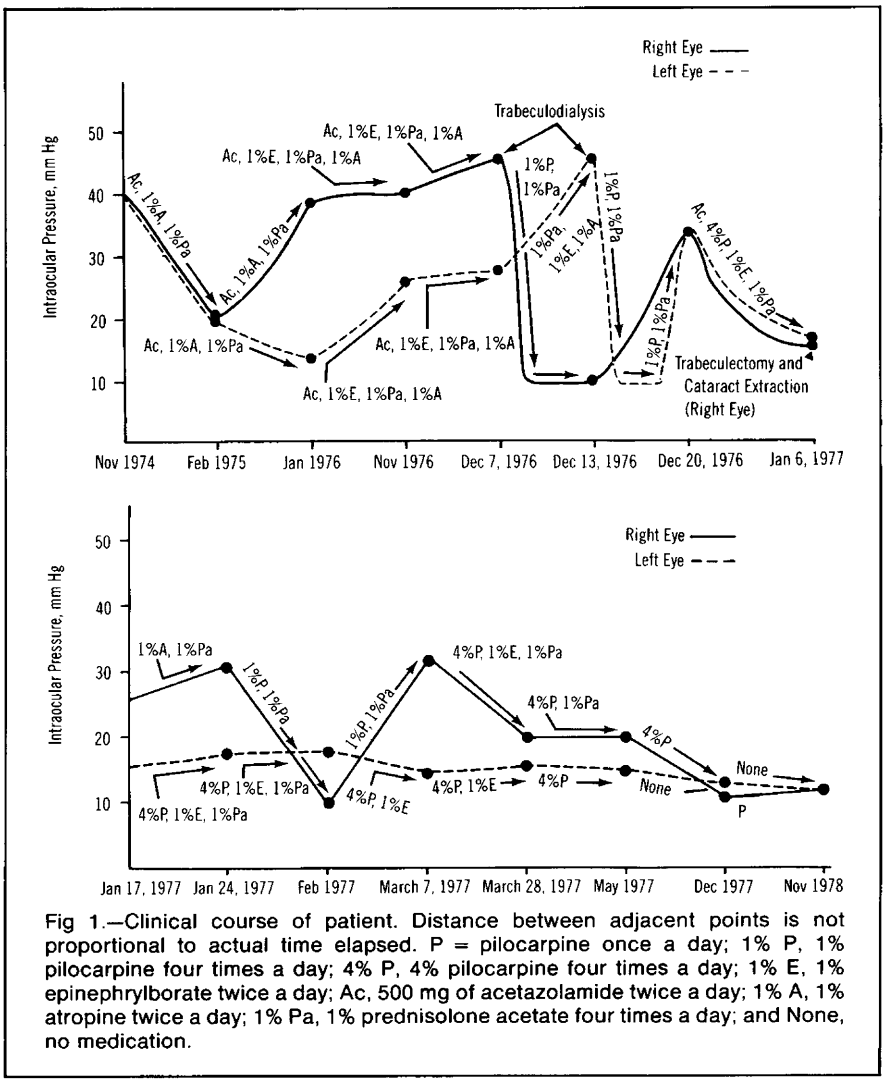
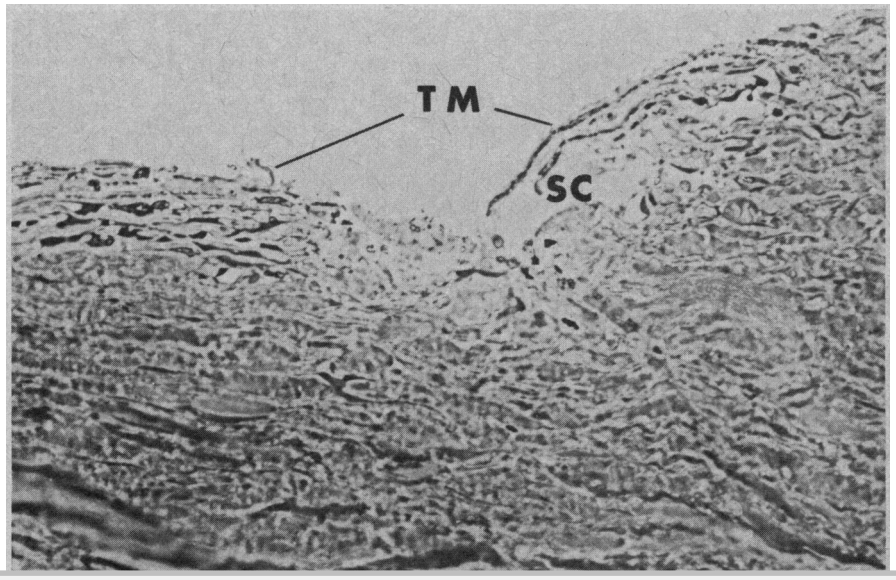


Fig 1.—Clinical course of patient. Distance between adjacent points is not proportional to actual time elapsed. P = pilocarpine once a day; 1% P, 1% pilocarpine four times a day; 4% P, 4% pilocarpine four times a day; 1% E, 1% epinephrylborate twice a day; Ac, 500 mg of acetazolamide twice a day; 1% A, 1% atropine twice a day; 1% Pa, 1% prednisolone acetate four times a day; and None, no medication.

Fig 2.—Phase contrast photomicrograph of trabeculectomy specimen from area of filtration angle incised by trabeculodialysis one month previously. Trabecular meshwork (TM) has been disrupted and shows no signs of healing. Schlemm's canal (SC) is bared to anterior chamber (paraphenylenediamine, ×275).



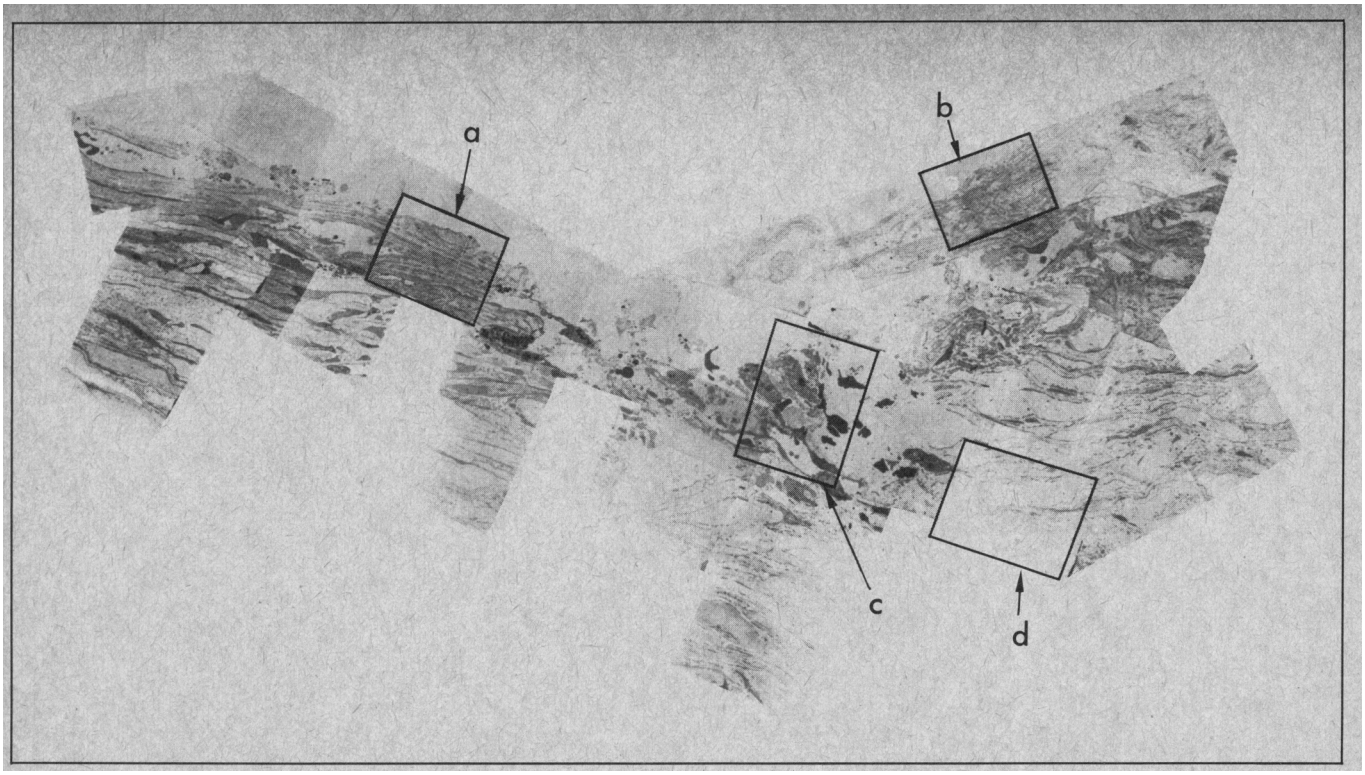
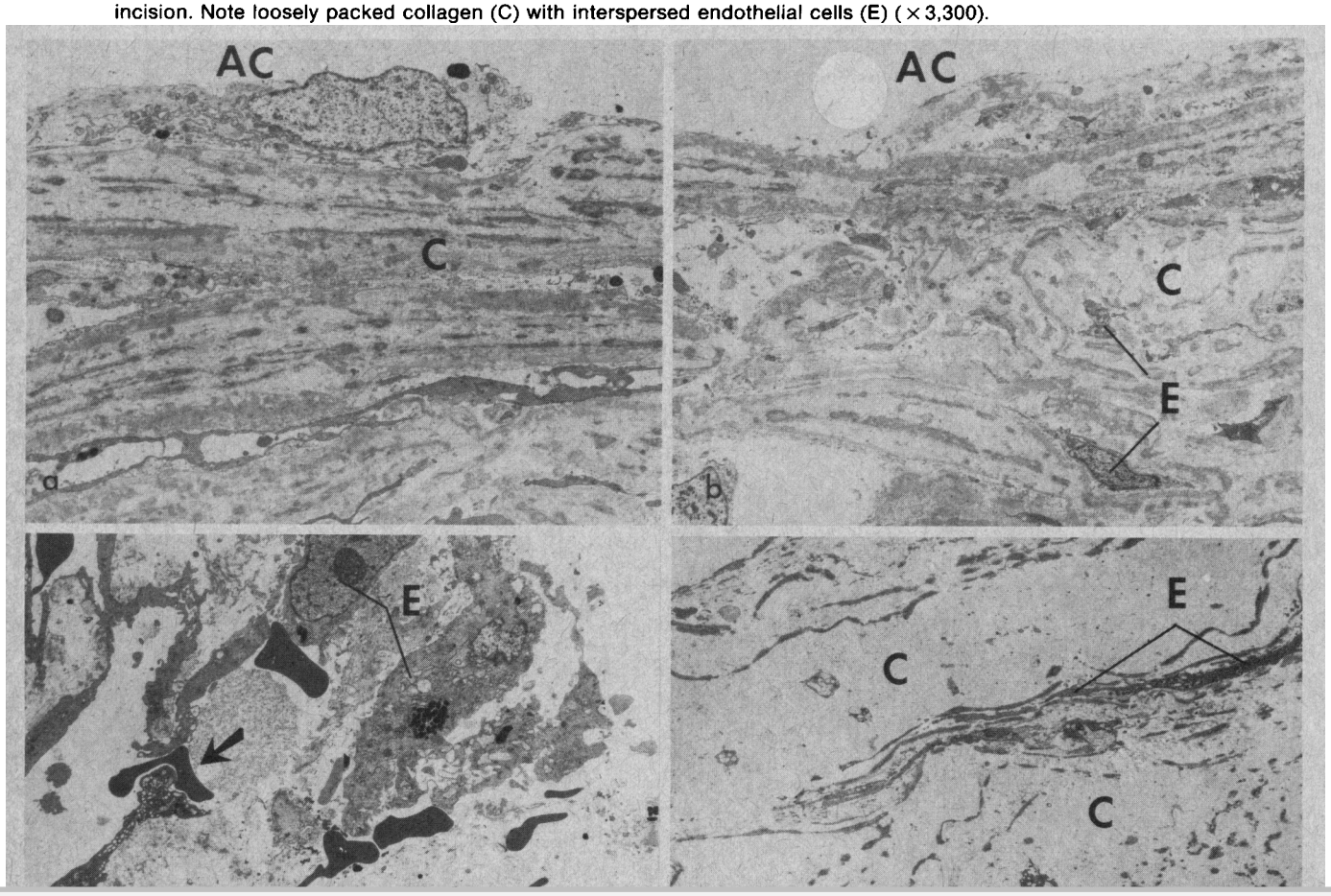


Fig 3.—Electron micrograph montage. Same area as in Fig 2. Areas outlined indicate fields of view in Fig 4.

Fig 4.—Electron micrographs of areas indicated in Fig 3. (a), Trabecular meshwork anterior to goniotomy incision. Adjacent collagen (AC) cores (C) are collapsed and adherent. (b), Trabecular meshwork just posterior to goniotomy incision. Note disorganization of trabecular sheets (C), loss and fragmentation of endothelium (E), and absence of intertrabecular spaces. (c), Endothelial cells (E) lying in sulcus exposed to anterior chamber by goniotomy. Fresh RBCs are present. RBC is entering endothelial lined (collector) channels (arrow). (d), Sclera posterior to goniotomy incision. Note loosely packed collagen (C) with interspersed endothelial cells (E) (×3,300).



1977 and is kept steady with a regimen of 4% pilocarpine taken at night.

The left eye's medication has gradually been tapered, and since May 1977 the eye has required no further medication. The left eye has had no further surgery (only the single trabeculodialysis), and continues to have IOP between 12 and 15 mm Hg with no medication required. Since the left eye has only had a trabeculodialysis, no possibility of external filtration exists, and the lowering of pressure can only be ascribed to this procedure. Although the situation in the right eye is more complicated, due to the subsequent trabeculectomy operation, the IOP was normal at the time the histologic specimen was obtained and at that time no possibility of external filtration existed for the right eye either.

HISTOPATHOLOGY OF SPECIMEN

Light microscopic examination of the surgical specimen (Fig 2) showed a superficial, nonhealed incision through scarred trabecular meshwork into the area of Schlemm's canal. Electron microscopic examination (Fig 3) showed disruption in the scarred, collapsed trabecular meshwork.

In the trabecular meshwork anterior to the incision (Fig 4, a), adjacent collagen cores were cemented together with loss of endothelial covering and absence of intertrabecular spaces. The posteriorly hinged flap of trabecular meshwork created by the trabeculodialysis incision shows the same collapsed structure (Fig 4, b).

In the cleft created surgically, endothelial lined channels communicate with the anterior chamber (Fig 4, c). These may represent either preexisting collector channels or newly formed aqueous channels. However, the collagen that lies at the base of the incision is loosely packed and disorganized with bands of endothelial cells interspersed (Fig 4, d). This may reflect a change in the collagen produced by exposure to aqueous humor, as occurs in the lining of filtering blebs.[4]

COMMENT

In his original study, Haas[1] pointed out that goniotomy is presumed to work by reducing the resistance to outflow of aqueous through the trabecular meshwork, but that the mechanism by which this occurs had not yet been established. The opening produced by goniotomy or trabeculotomy in nonglaucomatous experimental animals (such as the rhesus monkey) scars within one month after surgery.[5,6] Tears in the trabecular meshwork in rhesus monkeys also scar soon after injury.[7] In contrast, the human eye with glaucoma seems to have a different healing tendency, as shown by the histologic specimen in this case. One possible explanation is that in a glaucomatous eye there is a generalized increased trabecular resistance, and when the resistance to flow is reduced over a small area (eg, with goniotomy), the aqueous humor is routed through this area, keeping the surgical site open. However, in an eye with normal outflow facility (such as the normal eye of an experimental animal), there is a continued flow through the nonincised trabecular meshwork, and the injured area undergoes healing and scarring.

Our observations in this case suggest that in glaucomatous eyes with functional outer filtration channels (Schlemm's canal and the outer collector channels), satisfactory control of IOP may be achieved through the normal drainage pathways by establishing a patent communication between the outer channels and the anterior chamber, provided this communication remains open.

This is consistent with the clinical experience that goniotomies work well in early cases of infantile glaucoma,[3,8] and in inflammatory glaucoma.[1,2] On rare occasions, goniotomy has been applied successfully to corticosteroid-induced glaucoma.[9] All three types of glaucoma have in common the relatively short duration of elevated pressure prior to surgery. In contrast, goniotomy is less successful late in the course of infantile glaucoma,[3,8] or in chronic open-angle glaucoma in adults.[10] Perhaps the poor results of goniotomy in these two instances are due to secondary changes that have occurred in Schlemm's canal, the collector channels, or both, due to the long interval of elevated pressure prior to surgical intervention. An alternate, but more unlikely, explanation is that chronic open-angle glaucoma and late infantile glaucoma are due to a primary malfunction of Schlemm's canal or the collector channels.

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