A Case of Open-Angle Glaucoma Successfully Treated Using Canaloplasty

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Objective: We report the case of a patient with open-angle glaucoma who underwent canaloplasty and subsequently maintained good intraocular pressure (IOP) control for the entire duration of the 4-year follow-up.
Subjects: The patient was a 68-year-old man who was diagnosed with open-angle glaucoma and uncontrollable IOP at the Tokai University Hachioji Hospital in January 2011. Visual field examination revealed an arcuate visual field defect in the left eye, but no visual field defect in the right eye. In order to lower the IOP, canaloplasty was performed on his left eye.
Results: There were no complications either during or after the surgery. The IOP values at 2 weeks, 1 month, 6 months, 1 year, 2 years, 3 years, and 4 years were, 13, 14, 18, 12, 10, 12, and 8 mmHg, respectively. No deteriorations in visual field or reductions in visual acuity were detected during this follow-up.There were no long-term complications such as cataract formation or exposure of the suture. Spectral domain optical coherence tomography showed that the trabecular meshwork was inwardly distended because of the intracanalicular suture in the affected eye.
Conclusion: Canaloplasty can be a safe and effective surgical method for lowering the IOP in glaucoma patients.

Key words: open-angle glaucoma, canaloplasty, trabecular meshwork, intraocular pressure

INTRODUCTION

Glaucoma is one of the most common causes of visual loss worldwide [1, 2] and it is known to be aggravated by high intraocular pressure (IOP). In fact, lowering IOP is the only established treatment modality for the disease [3]. When IOP is not sufficiently lowered by medical and/or laser therapy, clinicians consider surgical intervention. In this regard, the trabeculectomy is the surgical procedure most frequently used to treat glaucoma [4]. The operation involves diverting the aqueous humor to a preformed space under the conjunctiva, the bleb, thus lowering the IOP. However, this procedure can be accompanied by several complications, including flat anterior chamber, choroidal detachment, cataract formation, and late-onset bleb related infection, which can lead to immediate blindness in the affected eye [5, 6].

Furthermore, the trabeculectomy remains effective only as long as the filtering bleb persists. For this reason, late-onset bleb related infection can occur at any time after the surgery, and the incidence of this complication has been reported to be no less than 2.2% in Japanese patients [7].

Canaloplasty is a new kind of canal surgery that does not depend on bleb formation to lower the IOP [8, 9]. In this procedure, a 10−0 polypropylene suture is inserted, under the guidance of an illuminated optical fiber tip, into the entire Schlemm's canal. The suture is then tied in order to distend the canal and facilitate aqueous humor flow into the collector channel and ultimately into the aqueous vein. This results in an IOP decrease. Several studies have reported the effects of canaloplasty [8−16], but long-term reports are rare, and there have been no long-term reports involving Japanese patients [13]. In this article, we report the case of a patient who was followed up for 4 years after canaloplasty. The patient maintained good IOP control.

CASE AND METHODS

A 68-year-old man was referred to the Department of Ophthalmology at the Tokai University Hachioji Hospital in January 2011 with a diagnosis of open-angle glaucoma and uncontrollable IOP. At the initial visit, his visual acuity was (0.9) in the right eye and (1.0) in the left. His IOP was 19 mmHg in the right eye and 20 mmHg in the left. Slit-lamp examination revealed slight cataracts in both eyes, with no inflammation in the anterior chambers. Moreover, in both eyes the anterior chamber was wide open, although there were several peripheral anterior synechiae. The optic discs of both eyes showed cupping, with a cup-disc ratio of 0.7 vertically and 0.7 horizontally. Visual field examination revealed an arcuate visual field defect in the left eye, but no visual field defect in the right eye (Figs. 1a & 1b). The patient had no systemic disease or systemic abnormality suggesting previous ocular inflammation. Travoprost, carteolol, and brinzolamide were prescribed for both eyes, but the IOP could not be lowered. Specifically, the IOP with this medication was 21 mmHg in the right eye and 28 mmHg in the left eye on June 17, 2011. With written informed con-

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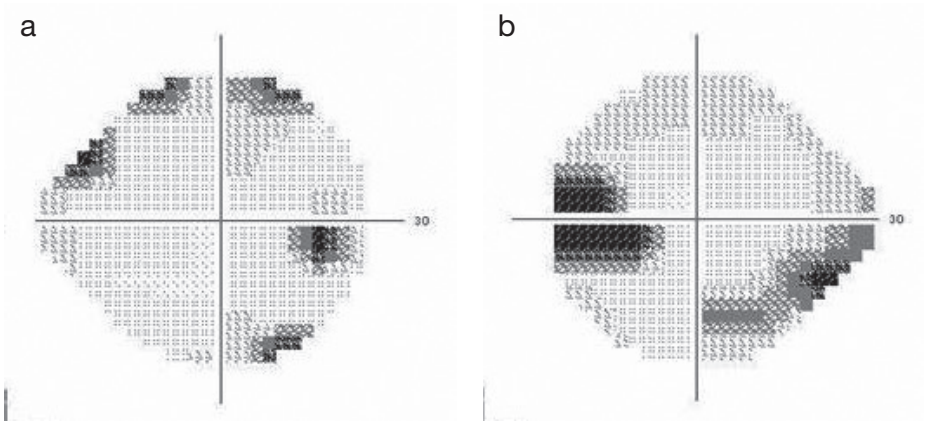

Fig. 1 Visual fields examination results at the first visit. No visual field defect in the right eye (1a) and an arcuate visual fields defect in the left eye (1b).

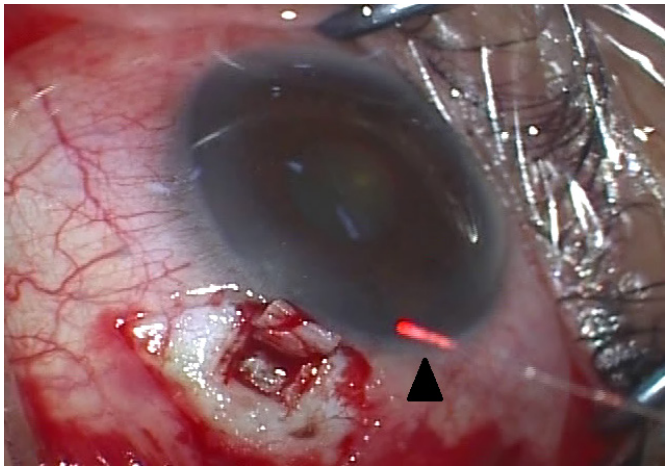

Fig. 2 An optical fiber with an illuminated beacon tip (Arrow) and Schlemm's canal opening.

sent, canaloplasty was planned in the left eye.

SURGERY

Canaloplasty was performed on the patient's left eye on July 2, 2011. The conjunctiva was cut at the limbus of the cornea from the temporal inferior side. A 5 x 5 mm, parabola-shaped scleral flap of about one-third the thickness of the sclera was made using a 15-degree slit knife. The scleral flap was prepared 1 mm, in an anterior direction, into the perilimbal clear cornea. Under Visceral to thise first scleral flap, a secondary scleral flap, somewhat smaller than the superficial one, was created. This deep scleral flap was extended to Schlemm's canal, and the canal was opened and unroofed. Further incision was then performed in order to expose a small segment of Descemet's membrane; in this regard, the slit knife was used, combined with blunt separation using a sponge. The deep sclerocorneal flap was then excised from the clear corneal part using scissors. An ophthalmic viscosurgical solution (sodium hyaluronate, 2.3 % [Healon V, Abbott Medical Optics Inc., USA) was injected into the opening of Schlemm's canal on both sides. An optical fiber with an illuminated beacon tip (Glaucolight, DORC, the Netherlands) was the inserted into the inferior side of the Schlemm's canal opening using a needle folder and forceps (Fig. 2). The outer diameter of the optical fiber was 150 μm/40G. Under guidance from the illuminated beacon tip, which could be observed through the sclera, the fiber was advanced 12 clock-hours into the canal. After reaching the other opening of Schlemm's canal, the distal tip was exposed at the surgical site, and a 10−0 polypropylene suture was tied to it. The optical fiber was then gently withdrawn, pulling the suture into the entire length of the canal. The suture was cut from the optical fiber and tied in a loop, encircling the inner wall of the canal. The superficial scleral flap was repositioned and tightly closed using four sutures of 10−0 nylon. The ophthalmic viscosurgical solution was injected under the scleral flap, and the conjunctiva was repositioned and fixed using two absorbable 8−0 sutures. After the surgery, a topical antibiotic was instilled. There were no complications, such as flat anterior chamber or anterior chamber hemorrhage, during the surgery.

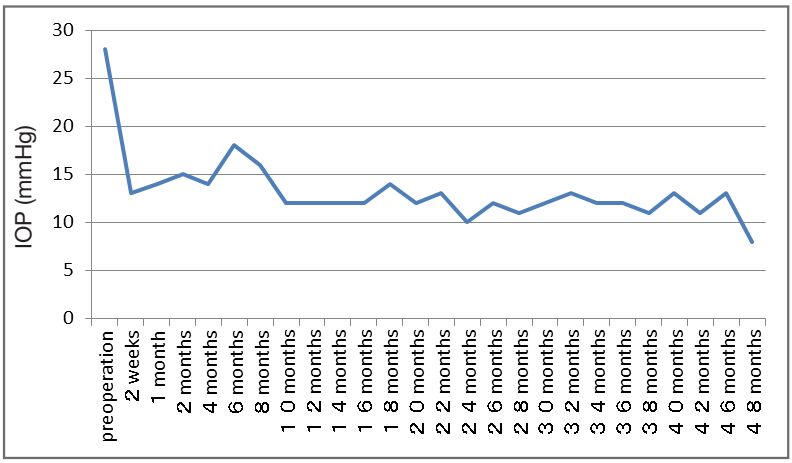

Fig. 3 Time course of the IOP in the operated eye. Good IOP control was mainta ined up to four years.

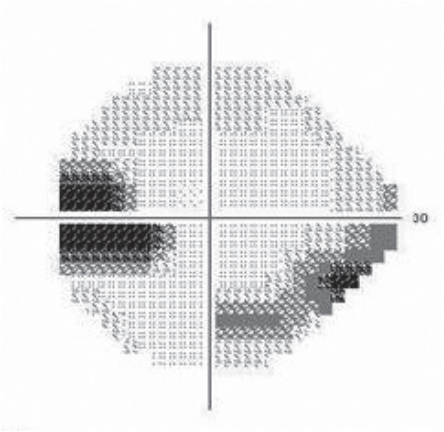

Fig. 4 Visual field examination results of the left eye after three years of operation. There was no deterioration of visual fields.

RESULTS

On the day after the surgery, the IOP in the left eye was 10 mmHg. Wound adaptation was good, and the anterior chamber was deep. There was slight inflammation in the anterior chamber, but no apparent hemorrhaging was detected. What is more, no choroidal detachment or other fundus complications had occurred. The IOP values at 2 weeks, 1 month, 6 months, 1 year, 2 years, 3 years, and 4 years were 13 mmHg, 14 mmHg, 18 mmHg, 12 mmHg, 10 mmHg, 12 mmHg, and 8 mmHg, respectively. That is, good IOP control was maintained for at least 4 years after the surgery (Fig. 3). No visual field deterioration (Fig. 4) or reduction in visual acuity was detected. In addition, there were no long-term complications, such as cataract formation or exposure of the suture. The anterior chamber angle was examined using spectral domain optical coherence tomography (SD-OCT; Cirrus HD-OCT, Carl-Zeiss, Germany) on June 6, 2014 (Fig. 5a, 5b). The SD-OCT scanner had been modified using an attachment that allows observation of the anterior segment of the eye. Compared with that in the right eye, the trabecular meshwork in the left eye was inwardly distended because of the intracanalicular suture.

DISCUSSION

Canaloplasty is a rather new surgical method for lowering IOP in glaucoma patients. Although several studies have reported good IOP control after this procedure [8–16], we were only able to find 1 short-term report involving the Japanese population [13]. In that report, 11 cases of primary open-angle glaucoma were treated using canaloplasty in 9 Japanese patients, who were then followed up for 12 months. Mean IOP decreased, from a preoperative value of 23.5 ± 5.5 mmHg, to 13.7 ± 2.8 mmHg after 1 month, 12.8 ± 3.5 mmHg after 3 months, 14.0 ± 4.4 mmHg after 6 months, and 15.0 ± 4.1 mmHg after 12 months. In the present case report, The IOP decreased, from a preoperative 28 mmHg, to 14 mmHg at 1 month, 18 mmHg at 6 months, 12 mmHg at 1 year, 12 mmHg at 2 years, 11 mmHg at 3 years, and 8 mmHg at 4 years. Our results therefore suggest that canaloplasty can lead to good long-term IOP control in Japanese open-angle glaucoma patients.

There are two kinds of instruments commercially available for this procedure – a microcatheter with a 200 μm diameter shaft and an atraumatic distal tip of approximately 250 μm diameter (iTrack, iScience, USA), as well as the instrument we used in the present case. The former instrument has a lumen of about 70 μm, as well as a connecter, and it can deliver either dye or ophthalmic viscosurgical solution into Schlemm's canal; the latter instrument has a smaller outer diameter, thus rendering it easier to insert into the canal, and more maneuverable. In most previous reports [8–11, 13–16], the surgery was performed using the microcatheter, because this was introduced for general use first.

Canaloplasty has several advantages over other glaucoma surgeries. The procedure does not require making a bleb as in trabeculectomy, so patients and doctors need not worry about late-onset bleb related infection. No artificial material, other than 10–0 polypropylene suture in the Schlemm's canal, is left behind after the surgery. Thus, the exposure of foreign materials, such as sometimes happens after tube-shunt surgeries, is very unlikely. The use of the illuminated beacon tip of the optical fiber ensures insertion of the suture into Schlemm's canal, which is difficult to confirm in suture trabeculotomy. Based on previous reports, the IOP-lowering effect of canaloplasty seems to be stronger than that of other canal surgeries such as trabeculotomy *ab interno* and *ab externo* [17–19], and viscocanalostomy [20]. In addition, the procedure does not necessitate entering the anterior chamber; thus intraocular infection is much less likely than in other intraocular surgeries.

On the other hand, there are some drawbacks to this surgery. The IOP-lowering effect of canaloplasty is weaker than that of trabeculectomy or tube-shunt surgeries. The insertion of the fiber into the entire Schlemm's canal is not always easy, and in some cases, the fiber cannot pass through the entire canal.

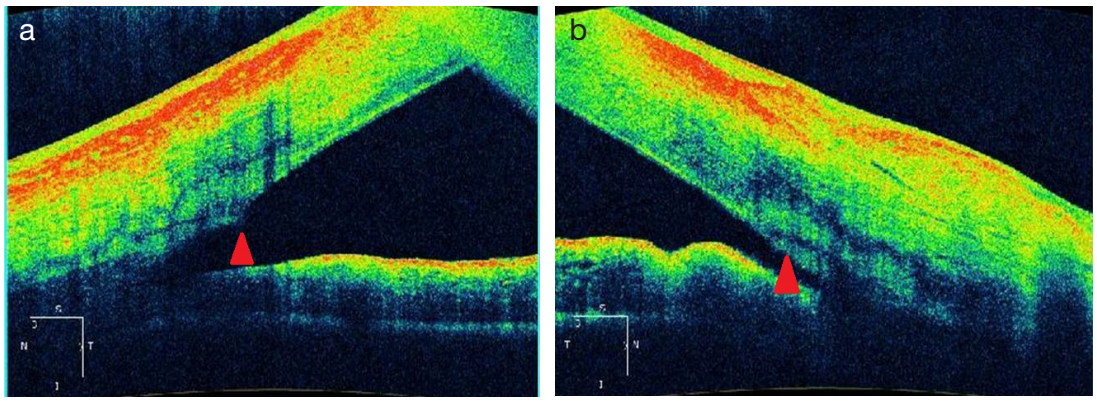

Fig. 5 The nasal side of anterior chamber angle examined with a spectral domain optical coherence tomography. Compared with the right eye (5a), the left eye (5b) showed the trabecular meshwork (arrows) was inwardly distended due to the intracanalicular suture.

In such instances, insertion of the fiber from the other side may allow the fiber to be pushed into the canal. Additionally, it is possible that the inner wall of Schlemm's canal will be broken during the course of the surgery, in which case a conversion to trabeculotomy is necessary. Lastly, because the 10-0 polypropylene suture tied inside the Schlemm's canal may gradually loosen, the IOP-lowering effect may decrease over time.

In conclusion, we have demonstrated the long-term efficacy of canaloplasty in a Japanese open-angle glaucoma patient. Canaloplasty can be a safe and effective surgical method for lowering IOP in glaucoma patients. We recommend that the long-term effectiveness of canaloplasty be investigated in future studies that evaluate a large number of patients with long-term follow-up. Such studies would further confirm the efficacy and reliability of the procedure.

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