

## Cyclophotocoagulation ab externa (Usui's method) for neovascular glaucoma with uncontrolled intraocular pressure

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### Abstract

The long-term results after cyclophotocoagulation ab externa for neovascular glaucoma are presented. Nine patients (11 eyes) with neovascular glaucoma resistant to treatment with antiglaucoma drugs and panretinal photocoagulation underwent this surgical procedure. The underlying causes of neovascularization of the anterior chamber angle structures and iris were advanced proliferative diabetic retinopathy in 9 eyes, longstanding chronic uveitits in 1 eye, and retinal detachment in 1 eye. The average intraocular pressure (IOP) was 35.7 mmHg before operation and 16.9 mmHg after a mean postoperative follow-up period of 24.7 months. A postoperative IOP less than 21 mmHg was achieved in 9 eyes (81.8 %) with or without use of topical antiglaucoma drugs. No severe complications were seen after the operation. Eight eyes retained visual acuity at the preoperative level after surgery. This surgical method is very useful for the treatment of neovascular glaucoma refractory to conventional operation and various medications.

### Introduction

Neovascular glaucoma (NVG) is one of the most intractable ocular disorders encountered in ophthalmological clinics. Patients with uncontrolled NVG are poor candidates for various surgical managements and are conventionally treated with topical and oral medications to reduce intraocular pressure (IOP). However, medical treatments are not adequate to control IOP below 21 mmHg for long periods in advanced NVG cases even after panretinal photocoagulation has been given to improve retinal hypoxic condition. Cyclotherapy<sup>1~5)</sup>, neodymium : YAG transscleral cyclophotocoagulation<sup>6, 7)</sup>, and implantation of a Molteno glaucoma drainage device<sup>8, 9)</sup> have been used to treat NVG cases with un-

controlled IOP, and long-term outcome of these operations has been reported.

In 1992, we reported a new surgical method, termed cyclophotocoagulation ab externa (Usui's method), for NVG and this procedure was performed in 6 eyes of 5 patients with uncontrolled NVG<sup>10)</sup>. The procedure was subsequently assessed by other investigators, and several reports have described the effects of this operation and good IOP control after the operation<sup>12~17)</sup>. In this paper, we present the long-term postoperative results in 11 eyes with advanced NVG and demonstrate a slight modification of the original cyclophotocoagulation ab externa procedures.

### Material and Methods

Nine patients (11 eyes) with uncontrolled

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NVG who underwent cyclophotocoagulation ab externa since January 1992 and were followed postoperatively for at least 13 months by December 1999 were included in the present series. Their ages ranged from 58 to 73 years (mean,  $63.8 \pm 5.5$  years). Six patients were male, and 3 were female. The underlying causes of NVG were proliferative diabetic retinopathy in 9 eyes, chronic uveitis in 1 eye and retinal detachment in 1 eye (Table 1). All patients had advanced NVG of stage 3, manifesting angle closure glaucoma caused by a fibrovascular membrane covering the trabecular meshwork in the anterior chamber angle, and marked iris neovascularization. All patients had been treated with antiglaucoma medications or trabeculectomy. Cyclocryotherapy or Molteno implant operation were the two options to control high IOP. The investigational nature of cyclophotocoagulation ab externa was discussed with the patient, and informed consent was obtained.

The surgical method of cyclophotocoagulation ab externa aims to combine the effects of cyclophotocoagulation and pars plana filtering procedure<sup>11)</sup>. In general, a hyperosmotic agent (e.g., mannitol 20%) was injected intravenously 2 hours before the operation. After retrobulbar or peribulbar anesthesia

with 2% xylocain®, a conjunctival flap based on the fornix or the limbus was made, and the sclera in the upper two quadrants of the operated eye was exposed. Then, a  $3 \times 7$  mm scleral flap 3 mm from the limbus was made by a crescent knife in each quadrant (Figure 1). The thickness of this flap should be less than one-half of the full thickness of the sclera. The remaining approximately half thickness of the scleral bed was removed by Vannas scissors, and the ciliary body was exposed directly as two windows in the scleral bed (Figure 2).

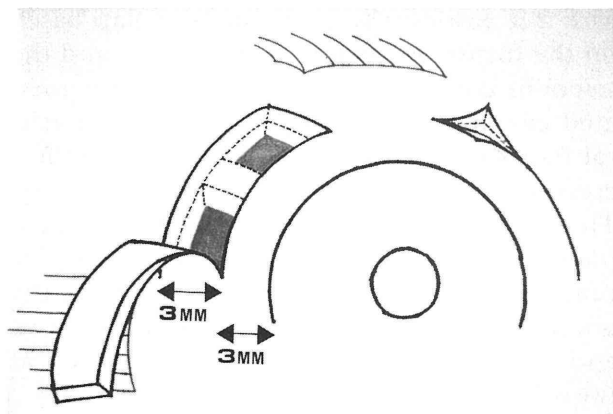
Argon laser photocoagulation was performed on the surface of the exposed ciliary body at the bottom of the scleral bed, using a  $200 \sim 300 \mu\text{m}$  spot size at laser power of 0.6 to 1 Watt. Laser irradiation was continued until the pars plana of ciliary body was penetrated with outflow of intraocular fluid (Figure 3). Laser photocoagulation was done at less than 9~12 spots in each window. After cyclophotocoagulation, the scleral flap was closed with four 10-0 nylon sutures, and the conjunctival flap was sutured with 9-0 nylon or 8-0 silk. Then, subconjunctival steroids and antibiotic were administered to the inferior part of the bulbar conjunctiva, and the operation was completed.

Postoperatively, topical steroids and cyclo-

Table 1 Background of patients with neovascular glaucoma

Patient No.	Sex	Age	Operated eye	Cause	Previous operation
1	M	59	R L	PDR PDR	
2	M	70	R	PDR	PRP pseudophakia vitrectomy
3	F	73	R	PDR	
4	F	58	L	PDR	
5	M	69	R	PDR	
6	M	61	R L	PDR PDR	PRP PRP trabeculectomy
7	M	61	R	RD	aphakia trabeculectomy
8	M	64	L	chronic uveitis	trabeculectomy
9	F	59	L	PRD	pseudophakia PRP

M: male, F: female, R: right, L: left, PDR: proliferative diabetic retinopathy  
RD: retinal detachment, PRP: panretinal photocoagulation

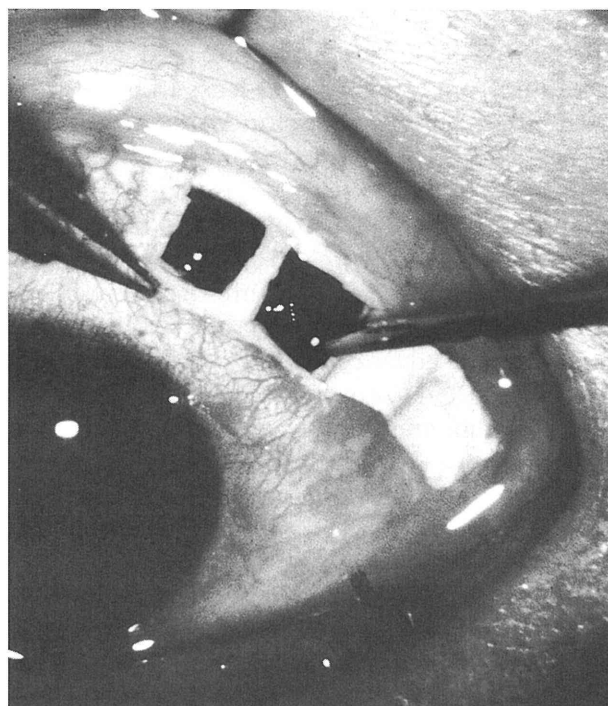


**Figure 1** Design of scleral flap and bed to coagulate ciliary body by Argon laser in eye with neovascular glaucoma.



**Figure 2** Ciliary body exposed at bottom of scleral bed before cyclophotocoagulation.

plegics were tapered over the first few weeks after the operation. Most patients discontinued the oral and topical antiglaucoma medications used before surgery from postoperative day 1. Visual acuity, antiglaucoma medication used after operation, and IOP were recorded for each postoperative patient visit. Intraocular pressure was measured using a Goldmann tonometer, and the coefficient of aqueous outflow (C value) was calculated after measuring IOP for 4 minutes with a Schiötz



**Figure 3** Argon laser photocoagulation of the surface of exposed ciliary body at the bottom of scleral bed, at 0.6 or 1 Watt of laser power.

tonometer.

### Results

Preoperative IOP in the 11 eyes ranged from 20 to 53 mmHg with a mean of  $35.7 \pm 10.3$  mmHg, while the patients were on a combination of several antiglaucoma medications.

The mean follow-up duration in these cases was  $24.7 \pm 7.7$  months (range; 13 to 40 months). Within this period, the mean postoperative IOP with or without antiglaucoma medications was  $16.9 \pm 6.3$  mmHg. Among the 11 eyes, 4 (36.3%) achieved a postoperative IOP less than 21 mmHg without antiglaucoma medication, 5 (45.5%) were controlled within 21 mmHg with use of topical antiglaucoma medications. Only two (18.2%) of 11 eyes had an IOP over 21 mmHg even with topical and oral antiglaucoma therapies. The C value in 6 cases measured within 6 months after the operation ranged from 0.10 to 0.56 (mean  $0.34 \pm 0.17$ ).

Iris neovascularization gradually disappeared in the eyes controlled at a IOP less than 21 mmHg (Figures 4–5).

Among the 11 eyes, 2 achieved improvement of visual acuity by 2 lines after the operation,

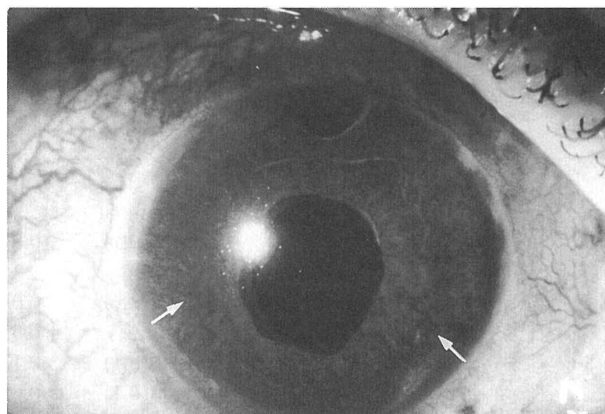
3 (27.3 %) had a deterioration of visual acuity by more than 2 lines from an initial preoperative visual acuity below 0.1, and the remaining 6 eyes retained the same visual acuity before and after operation throughout the follow-up period. Deterioration of visual acuity after surgery was not severe, and preoperative visual acuity remained stable for a long time after the surgery (Table 2).

Early postoperative complications occurred in only one of 11 eyes, in which slight fibrin exudation was observed in the anterior chamber on postoperative day 1, which resolved by subconjunctival steroids injection until postoperative day 3. No other severe complications were noted.

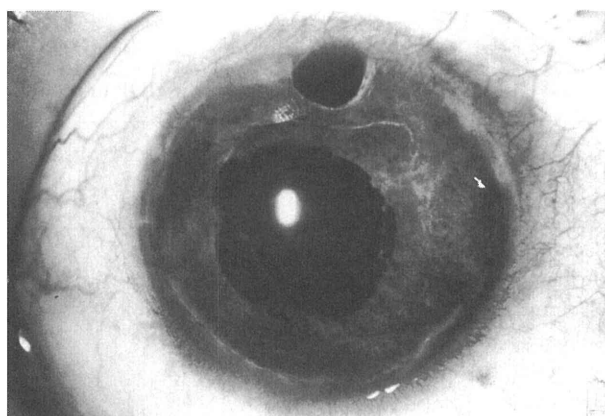
### Discussion

It is most difficult to maintain IOP within normal level (below 21 mmHg) in long-term follow up even after an adequate operation for uncontrolled NVG. Using cyclocryocoagulation, the frequency of postoperative IOP control ranged from 26.3% to 66.0% in reported cases<sup>1~5</sup>). Recently neodymium: YAG transscleral cyclocoagulation has been used successfully to lower IOP<sup>6</sup>) and the success rate of IOP control to less than 21 mmHg with this treatment was very high (62.5% to 67.9%)<sup>6, 7</sup>). However, cyclocryocoagulation and YAG transscleral cyclocoagulation are associated with a relatively high risk of phthisis bulbi, ranging from 10.7% to 15.4%<sup>5, 6</sup>). In contrast, the reported long-term outcome of Molteno implant drainage for NVG indicated 50~60% success rates for IOP control over an average of 24 months after the operation<sup>8, 9</sup>). However, this implant device is very expensive and sometimes causes severe postoperative complications such as endophthalmitis, corneal decompensation and phthisis<sup>8, 9</sup>).

Since our report of cyclophotocoagulation ab externa in 1992, several authors had applied this surgical treatment, and favorable results of the operations have been reported<sup>12~17</sup>). In the present series, the long-term outcome of our surgical procedures over a median of 13 months was extremely satisfactory, and the success rates of IOP control to less than 21 mmHg ranged from 74.1 % to 94.1 % in other long-term follow-up studies<sup>13, 15~17</sup>) (Table 3). In our present series, 9 of 11 eyes



**Figure 4** Conjunctival redness and ciliary injection were noted in Case Number 7 before operation due to high IOP. Marked rubeosis iridis (white arrows) was present.



**Figure 5** Eye redness and iris neovascularization disappeared gradually in the same eye with IOP controlled within normal level after operation, but iris atrophy and uveal ectropion became marked 6 months after operation.

(81.8 %) had IOP less than 21 mmHg with or without antiglaucoma drug therapy, but complete success of IOP control without any antiglaucoma medication was achieved in only 4 eyes. However, visual acuity monitoring showed that only three cases with preoperative visual acuity below 0.1 had deteriorated by more than 2 lines during the postoperative period. Interestingly, the rate of deterioration of visual acuity after the operation was less 38 % in other reported series<sup>12~15</sup>) (Table 4), which may mean that this operation reliably maintains visual function for a long time due to adequate control of IOP, reflecting good C value after operation as shown in our series (Table 2).

**Table 2** 11 cases of neovascular glaucoma treated by cyclophotocoagulation ab externa and followed for longer than 13 months

Patient No.	Pre-IOP	Post-IOP	Pre-VA	Post-VA	C value after operation (months)	Antiglaucoma medication	Follow-up period (months)
1	34-42	12-18	LP(-)	LP(+)	ND	+	27
	27-33	11-21	30 cm/CF	50 cm/HM	0.35(4)	-	28
2	20-24	19-21	0.04(0.1)	0.05(0.1)	0.1(5)	+	30
3	48-53	10-14	LP(-)	LP(-)	0.49(4)	-	24
4	20-25	16-20	0.02(n.c.)	0.02(n.c.)	ND	+	40
5	36-40	17-21	0.1(n.c.)	0.03(n.c.)	ND	+	29
6	27-30	24-30	0.05(0.1)	0.1(0.1)	ND	+	24
	30-36	11-17	0.08(0.1)	0.03(0.1)	ND	+	25
7	42-46	4-12	LP(-)	LP(-)	0.56(3)	-	18
8	40-46	6-18	0.1(n.c.)	0.1(n.c.)	0.33(4)	-	14
9	47-51	16-26	0.04(n.c.)	0.04(0.06)	0.20(6)	+	13

Pre-: preoperative, Post-: postoperative, IOP: intraocular pressure, VA: visual acuity  
 LP: light perception, CF: counting finger, HM: hand movement, ND: not done  
 C: coefficient of aqueous outflow

**Table 3** Pre- and post-operative IOP in reported cases treated with cyclophotocoagulation ab externa

Authors	Mean preoperative IOP (mmHg)	Mean postoperative IOP (mmHg)	Follow-up period (months)	Success rate of the operation (IOP ≤ 21 mmHg)
Machida et al, 1944 <sup>12)</sup>	44.6	19.5	2-11 (5.3)	11/14 (78.6 %)
Kurihara et al, 1995 <sup>13)</sup>	48.9	44.9	10-23 (14.6)	16/17 (94.1 %)
Takemura et al, 1996 <sup>14)</sup>	49.7	20.6	1-7 (4.5)	5/7 (71.4 %)
Iwaki et al, 1996 <sup>15)</sup>	42.1	16.5	8-38 (22.3)	20/27 (74.1 %)
Kono et al, 1998 <sup>17)</sup>	44.0	15.2	9-29 (18.5)	9/10 (90.0 %)
This report	35.7	16.9	13-40 (24.7)	9/11 (81.8 %)

IOP: intraocular pressure

**Table 4** Deterioration of visual acuity after cyclophotocoagulation ab externa in reported cases

Authors	Rate of deterioration of VA
Machida et al, 1994 <sup>12)</sup>	5/14 (35.7 %)
Kurihara et al, 1995 <sup>13)</sup>	1/17 (5.9 %)
Takemura et al, 1996 <sup>14)</sup>	1/7 (14.3 %)
Iwaki et al, 1996 <sup>15)</sup>	10/27 (37.0 %)
Kono et al, 1998 <sup>17)</sup>	3/10 (30.0 %)
This report	3/11 (27.3 %)

VA: visual acuity

**Table 5** Peri- and post-operative complications associated with cyclophotocoagulation ab externa

Authors	Complications (frequency of cases)
Machida et al, 1994 <sup>12)</sup>	RD (1/14)
Kurihara et al, 1995 <sup>13)</sup>	None
Takemura et al, 1996 <sup>14)</sup>	None
Iwaki et al, 1996 <sup>15)</sup>	Hyphema (5/27), CD (1/27), RD (1/27)
Kono et al, 1998 <sup>17)</sup>	None
This report	Slight fibrin exudation in anterior chamber (1/11)

CD: choroidal detachment, RD: retinal detachment

There were no severe postoperative complications (Table 5), and our method is safer compared with cyclocryocoagulation, YAG transscleralcyclocoagulation, and Molteno implant procedure.

In conclusion, cyclophotocoagulation ab externa is useful for the treatment of NVG

with uncontrolled IOP, not only in terms of reducing IOP to less than 21 mmHg in long-term follow-up, but also in maintaining or improving postoperative visual acuity compared with the preoperative level.

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