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Research Article

Diode Laser Transscleral Cyclophotocoagulation in Combination with Trabeculectomy for Surgical Therapy of Canine Refractory Glaucoma

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Abstract

In dogs, glaucoma is one of difficult diseases to be controlled. In this study, we evaluated advantage of diode laser transscleral cyclophotocoagulation (TSCP) in combination with trabeculectomy for a new treatment of glaucoma in canine subjects. Under general anesthesia, diode laser was delivered at a site 2–3 mm posterior to the limbus. After TSCP, trabeculectomy was performed to avoid postoperative ocular hypertension. The intraocular pressure (IOP) was monitored regularly for more than 3 months after surgery. Effectiveness of the combination therapy was compared with independent treatment of TSCP or trabeculectomy. In most dogs that were received the combination therapy, the IOP was normalized by a single treatment. On the other hand, in dogs treated with TSCP alone or treated with trabeculectomy alone, the IOP was not acceptably controlled. Combined TSCP with trabeculectomy may be effective for normalizing the IOP in refractory glaucoma in dogs without remarkable side effects.

ABBREVIATIONS

IOP: Intraocular Pressure; **TSCP:** Transscleral Cyclophotocoagulation

INTRODUCTION

Glaucoma comprises a group of diseases with different pathological processes sometimes leading to the irreversible blindness without treatment [1]. Recent researches on glaucoma have changed our views on the pathogenesis of glaucoma; however novel approaches to control glaucoma are not fully advanced in dogs.

There are two primary surgical treatments for canine glaucoma, the filtering procedure that increases the aqueous outflow and the cyclodestructive procedure that reduces the aqueous production [1-6].

The filtering procedures, including iridectomy, sclerectomy, trabeculectomy, and gonioimplants, are used solely or in combination [2,5-8]. Trabeculectomy is one of the beneficial filtering techniques to improve clinical conditions of both open- and closed-angle glaucoma. Despite the immediate advantage of reducing IOP after trabeculectomy, the scleral incision is often closed within a few months and that may lead re-elevation of the IOP. The cyclodestructive procedures include cyclodiathermy [3,6], cyclocryotherapy [1-6], the laser cyclophotocoagulation

(neodymium: yttriumaaluminum garnet [9], and diode [10,11]. Diode laser TSCP is an effective cyclodestructive procedure in the treatment of advanced refractory glaucoma [10,12,13]. Although clinical experiences in the veterinary field are limited, TSCP has been reported to provide a high success rate for controlling the IOP in cased with primary glaucoma [10]. TSCP is a good choice for glaucoma therapy in dogs because it can be performed rapidly and with relative ease. However, there are some risks of postoperative ocular hypertension and hyphema after TSCP, their inadequate treatment may result in uveitis [10,12,13].

The combined procedure of TSCP and gonioimplantation has been reported to be effective for primary glaucoma in dogs [14]. However, the implants may lead to some adverse effects such as chronic inflammation, fibrosis, and implant occlusion [15,16]. Thus, it would be better if the IOP could be controlled adequately without the use of implants.This report describes the effectiveness of TSCP combined with trabeculectomy for the successful management of refractory glaucoma in dogs without postoperative ocular hypertension. This combination surgical therapy resulted in an acceptable reduction in the IOP (≤ 25 mmHg [5]) more than 3 months after the treatment. Our result provides a novel procedure for effective treatment of different types of glaucoma in dogs.

MATERIALS AND METHODS

Patients

Thirteen eyes of 11 dogs with glaucoma refractory to conventional treatments and receiving the maximum-tolerated medical therapy were used in this study. The clinical data of the dogs were recorded in (Table 1). All dogs had received standard medical therapy for glaucoma including hyper-osmotics, topical carbonic anhydrase inhibitor, beta-adrenergic antagonists, prostaglandin analogs, or the combination. The dogs with glaucoma used in this study failed to respond to medical therapy or responded initially but became resistant. The animals received ophthalmic examination, using the applanation tonometry (Tono-Pen® XL, Mentor, Ophthalmics, Norwell, MA, USA) and the slit-lamp biomicroscope (Kowa SL-14, Nihonbashi-Honcho, Tokyo, Japan) preoperatively. At presentation, all the eyes were diagnosed to be blind based on the results from menace testing, light reflex, obstacle navigation, and electroretinography, expect cases No. 8 and No. 11. All the procedures were performed under informed consent provided by owners of each dog and complied with the standards in the guidelines of the University Animal Care and Use Committee in Tokyo University of Agriculture and Technology.

Surgical procedure

Four eyes of 4 dogs were treated by TSCP (cases No. 1–4), 3 of 2 dogs were treated by the filtering surgery (cases No. 5 and 6), and 6 of 5 dogs were treated by combined TSCP and trabeculectomy (cases No. 7–11). Summary of clinical data and performed procedures in each dog were described in (Table 1). All treatments were performed under general anesthesia. Predonisolone sodium succinate (1 mg/kg, IV) was given preoperatively for anti-inflammation. Local anesthesia was performed by peri-retrobulbar injection of a 50% mixture of lidocaine and bupivacaine hydrochloride to inhibit ocular movement during the operation as well as to provide postoperative analgesia. Each dog was given either TSCP or filtering surgery, or both ac indicated in Table 1.

Contact TSCP was performed using an 810-nm diode laser (Dio Vet Laser system, Iris Medical Instrument, Mountain View, CA, USA) with energy delivered via a fiber optic system through a 600-micron-diameter ball tip directly applied to the sclera (Figure 1). The probe was positioned perpendicular to the globe 3–5 mm posterior to the limbus. Twenty-five to 30 sites were treated avoiding the 3-o'clock and 9-o'clock position. Power settings of 1,100–2,000 mW for the duration 2,000 ms were used. An audible pops could usually be heard during at least one of the five treatments. This parameter was used to adjust the power up

Table 1: Clinical data and performed procedures in each case.

Case No.	Breed	Sex	Age	Affected eyes	Diagnosis	Pre-operative IOP (mmHg)	Performed operation
1	American Cocker Spaniel	M	8	OS	AG	60	TSCP
2	Bichon Frise	M	11	OS	PG	45	TSCP
3	Yorkshire Terrier	M	12	OD	PG	40	TSCP
4	Shiba	F	10	OD	PG	45	TSCP
5	Boston Terrier	M	10	OD	LL	32	Filtering
6	Mongrel	F	8	OD	PG	48	Filtering
				OS	PG	36	Filtering
7	American Cocker Spaniel	M	7	OS	AG	49	Combination
8	Yorkshire Terrier	M	9	OS	AG	43	Combination
9	Shiba	F	8	OD	PG	54	Combination
				OS	PG	49	Combination
10	Shiba	F	8	OS	PG	33	Combination
11	Border Collie	F	2	OS	LL	52	Combination

Abbreviations: M, male; F, female; OD, right eye; OS, left eye; AG, aphakic glaucoma; PG, primary glaucoma; LL, lens luxation

or down (50 mW increments) to achieve 50 to 70% pops during the remaining treatment.

Following TSCP, trabeculectomy was performed with a slight modification. A limbal-based conjunctival flap was created around the 12-o'clock position for the dorsa lateral limbus. A microcautery was used for hemostasis. An incision was made through the Tenon's capsule, exposing the sclera. Under the limbal-based flap, slit-knife (MANI®, Ophthalmic Knife, slit-angle 3.2 mm, MANI, Inc., Utsunomiya, Japan) was used to excise 1-by-3-mm window on the sclera 2–3 mm posterior to the limbus (Figure 2A). After the posterior sclerectomy, the iris forceps was introduced into the anterior chamber from the scleral window. Basal part of the iris including the trabecular meshwork was extracted with the forceps, and cut with the iris scissors to form a bypass (Figure 2B).

The anterior chamber was irrigated with an oxiglutatione solution. Mitomycin C applied under the conjunctival flap over the scleral window for 5 min with a small piece of the sterilized gauze which had been soaked in a 0.4 mg/ml solution [13]. The sclerectomy window was not sutured. The conjunctival flap was closed with interrupted 7-0 vicryle sutures. Methylprednisolone sodium succinate (5 mg/eye) was administered by subconjunctival injection immediately after operation.

Topical dexamethasone sodium metasulfobenzoate and ofloxacin (1–2 drops, q 8 h, 5 min interval), and oral administration of amoxicillin (20 mg/kg, q 12 h) were used for 2-3 weeks after surgery. Topical dorzolamide (1 drop, q 12 h or q 8 h) or systemic isosorbide solution (1 ml/kg, q12 h) was sometimes required to normalize the IOP for a week after the operation. In case No. 7 that was impossible to get rid of the acceptable management of the IOP after the first combination therapy, the same combination treatment with TSCP and trabeculectomy was performed again. The IOP of the dogs was monitored for at least 3 months after surgery. Success of the procedure was defined as the IOP less than or equal to 25 mmHg without any medical treatment.

RESULT

As indicated in (Table 2), postoperative ocular hypertension was obvious in individual eyes treated by TSCP alone, while the IOP was normalized to less than or equal to 25 mmHgsoon after surgery in all eyes received trabeculectomy. However, within 3 months, the IOP elevated again in 2 of 3 eyes treated with

Figure 1 Diode laser TSCP: the probe positioned 3 mm posterior to the limbus.

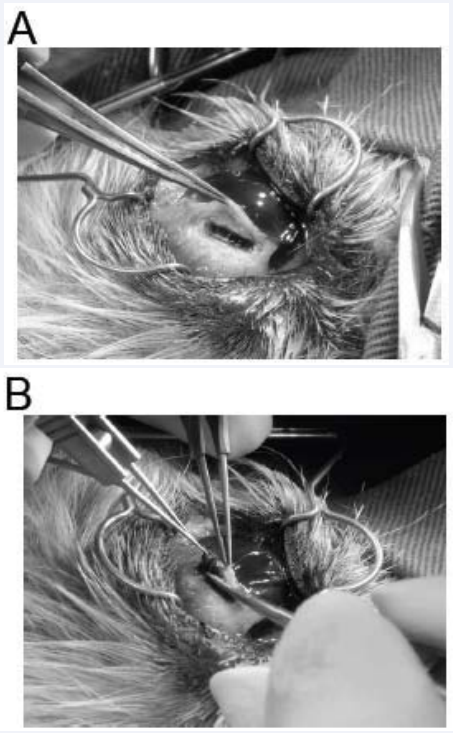

Figure 2 (A) Sclerectomy. By using a slit-knife, 1-by-3-mm window on the sclera 2–3 mm posterior to the limbus is made. (B) Trabeculectomy. A basal part of the iris including the trabecular meshwork is extracted with the forceps.

Table 2: Post-operative complications and IOP (after 3 months) in each case.

Case No.	Ocular hypertension*	Inflammation**	Hyphema	Uveitis	Vision	IOP (mmHg) after 3 months
1	+	+	-	-	-	55
2	+	+	-	+	-	46
3	+	-	-	-	-	30
4	+	-	-	-	-	45
5	-	-	-	-	-	50
6 (OD)	-	-	-	-	±	14
6 (OS)	-	-	-	-	-	45
7	-	-	-	-	-	55
8	-	-	-	-	+	13
9 (OD)	-	-	-	-	±	15
9 (OS)	-	-	-	-	±	15
10	-	-	-	-	+	14
11	-	-	-	-	±	30

Abbreviations: OD; right eye; OS; left eye.
The vision scale was defined according to the results of obstacle avoidance test under the both bright and dim light. -, impossible to avoid obstacles, ±, possible to avoid obstacles under the bright light, but not under the dim light; +, possible to avoid obstacles under both condition.
*A rise of the IOP recognized within one week after the operation.
**Tyndall's effect recognized in the anterior chamber.

trabeculectomy alone. In the right eye of case No. 6, the IOP rose again 4 months after the surgery. One eye treated by TSCP alone exhibited severe uveitis after the operation.

Combined TSCP and filtering surgery was performed on 6 eyes of 5 dogs, and the IOP in 5 of 6 eyes was normalized and acceptably controlled to less than or equal to 25 mmHgeven 3 months after the operation by a single treatment (Figure 3). Although case No. 7 kept the reduced IOP until 29 days after the surgery, the IOP rose again after the day 30th (Figure 4). Because of poor response to medication of intravenous mannitol (2g/kg) and topical dorzolamide, the eye in case No.7 was re-treated with TSCP and trabeculectomy as the same procedure. After the second surgery, the IOP of less than 20 mmHg was achieved following 3 months without anti-glaucoma medication (Figure 4). In cases No. 8–11, an overall progressive reduction in the IOP was obtained even after 3 months (Table 2). Cases No. 8 and 11 have preserved vision for 3 months after the surgery. The IOP of case No.11 was maintained slight high (30 mmHg); however, pain-related clinical symptoms were not observed and general condition of the dog was improved. All dogs received combination surgery of TSCP with trabeculectomy had no complication such as infections, aqueous flare, hyphema and uveitis. No significant postoperative discomfort including pain was observed in all the subjects.

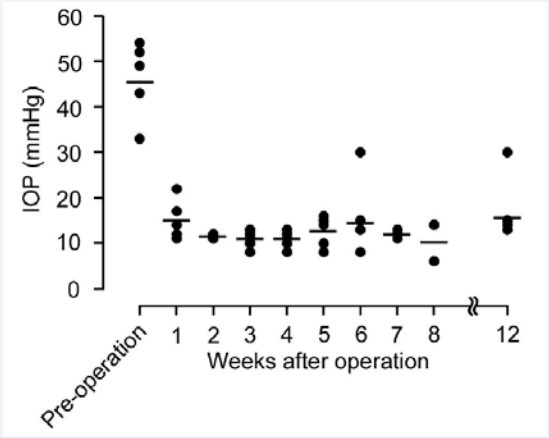

Figure 3 IOP in eyes of cases No. 8–11 before and after the combination surgery. Acceptable control was obtained by a single treatment even after 3 months.
▬ Average of the IOP in all cases.

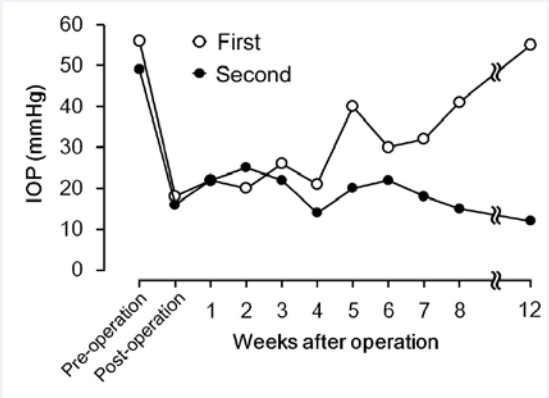

Figure 4 The IOP in the eye of case No. 7. IOP elevated again 2 months after the first combination surgery (○); however, the IOP was normalized after the second combination therapy (●) and never rose again during 3 months. The IOP on one day after the operation was indicated as the one of post-operation.

DISCUSSION

Glaucoma is one of the most common causes of blindness in dogs [1]. A continuous increase in the IOP results in serious problems such as hyphema, lens luxation, and dysfunction of the optic nerve [17]. Primary glaucoma without any concurrent ocular disease may occur in many breeds of the dog [18]. Aphakic glaucoma is commonly caused by closure of the iridocorneal angle after phacoemulsification or intracapsular lens extraction [17]. In order to retain the vision as well as to relieve the ocular pain in dogs, early recognition and appropriate treatment of glaucoma are necessary.

In this study, we found that the combination procedure of diode laser TSCP with trabeculectomy was more effective in controlling the IOP and retaining the vision in dogs with refractory glaucoma than each procedure performed independently. The IOP was normalized in 83% of eyes by a single combination treatment, while continuous medication and/or the repeated surgery were needed when most glaucomatous eyes were treated with either TSCP or the filtering surgery. Trabeculectomy reduced the immediate postoperative IOP elevation reported in previous studies concerning diode laser TSCP [10,14]. When the IOP is normalized as soon after its elevation as possible, more than 50% of the dogs with primary glaucoma may be able to preserve or regain their vision [14]. In cases No. 8 and 11, vision was preserved more than 3 months after the surgery. Therefore, the early diagnosis and immediate radical treatment are necessary to protecting the glaucomatous eyes from vision loss.

For blind eyes, the objectives of treatment are to relieve the dogs from any associated discomfort and to prevent complications accompanying by prolonged globe enlargement. Enucleation of the painful and unsightly eye is a reasonable option for the dog. However, this salvage procedure may be cosmetically unaccepted to many owners. Diode laser TSCP with the surgical filtering normalizes the IOP and may result in the preservation of an acceptable appearance of the globe without pain. Therefore, we concluded that combination of diode laser TSCP and trabeculectomy was very effective to normalize the IOP in glaucomatous dogs without the risk of implantation. If the procedure would be applied to primary glaucoma in the early stage of the disease, many glaucomatous dogs may be released from risks of resulting in blindness.

CONCLUSION

Combination of TSCP and trabeculectomy can be an effective therapy to control IOP in refractory glaucoma in dogs.

CONFLICT OF INTEREST

None of the authors of this paper has a financial or personal relationship with other people or organizations that could inappropriately influence or bias the content of the paper.

REFERENCES

1. Brooks DE. Glaucoma in the dog and cat. Vet Clin North Am Small Anim Pract. 1990; 20: 775–779.
2. Cook CS. Surgery for glaucoma. Vet Clin North Am Small Anim Pract. 1997; 27: 1109–1129.
3. Martin C L. Glaucoma. In: Slatter D Textbook of Small Animal Surgery Volume II, second ed. WB Saunders. Philadelphia. 1993; 1263–1276,
4. Pickett JP. Glaucoma. In: Tilley L P, Smith, F W K J. (Eds.). The 5 Minute Veterinary Consult, first ed. William & Willkins, Baltimore, 1997; 744–745.
5. Slatter D. Glaucoma. In: Fundamentals of Veterinary Ophthalmology, second ed. WB Saunders, Philadelphia, 1990; 338–364.
6. Whitley RD. Surgical management of glaucoma. In: Bojrab, M.J. (Ed.), Current Techniques in Small Animal Surgery, third ed. Lea & Febiger, Philadelphia, 1990; 104–112.
7. Cullen CL. Cullen frontal sinus valved glaucoma shunt: preliminary findings in dogs with primary glaucoma. Vet Ophthalmol. 2004; 7: 311–318.
8. Garcia-Sanchez GA, Whitley RD, Brooks DE, Trigo F, Pinon A. Ahmed valve implantation to control intractable glaucoma after phacoemulsification and intraocular lens implantation in a dog. Vet Ophthalmol. 2005; 8: 139–144.
9. Nasisse MP, Davidson MG, English RV, Jamieson V, Harling DE, Tate LP. Treatment of glaucoma by use of transscleral neodymium:yttrium aluminum garnet laser cyclocoagulation in dogs. J Am Vet Med Assoc. 1990; 197: 350–354.
10. Cook C, Davidson M, Brinkmann M. Diode laser transscleral cyclophotocoagulation for the treatment of glaucoma in dogs: results of six and twelve month follow-up. Vet Comp Ophthalmol. 1997; 7: 148–154.
11. O'Reilly A, Hardman C, Stanley RG. The use of transscleral cyclophotocoagulation with a diode laser for the treatment of glaucoma occurring post intracapsular extraction of displaced lenses: a retrospective study of 15 dogs (1995-2000). Vet Ophthalmol. 2003; 6: 113–119.
12. Hardman C, Stanley RG. Diode laser transscleral cyclophotocoagulation for the treatment of primary glaucoma in 18 dogs: a retrospective study. Vet Ophthalmol. 2001; 4: 209–215.
13. Pablo LE, Gomez ML, Pueyo M, Ramirez T, Torron C, Melcon B, et al. Semiconductor diode laser transscleral cyclophotocoagulation versus filtering surgery with Mitomycin-C. Int Ophthalmolology. 1996–1997; 20: 11–14.
14. Sapienza JS, van der Woerdt A. Combined transscleral diode laser cyclophotocoagulation and Ahmed gonioimplantation in dogs with primary glaucoma: 51 cases (1996-2004). Vet Ophthalmol. 2005; 8: 121–127.
15. Bentley E, Miller PE, Murphy CJ, Schoster JV. Combined cycloablation and gonioimplantation for treatment of glaucoma in dogs: 18 cases (1992-1998). J Am Med Assoc. 1999; 215: 1469–1472.
16. Bentley E, Nasisse M, Glover T. Implantation of filtering devices in dogs with glaucoma: preliminary results in 13 eyes. Vet Comp Ophthalmol. 1996; 9: 243–246.
17. Gelatt KN, Brooks DE. The canine glaucomas. In: Gelatt K N, Veterinary Ophthalmology, third ed. Lippincott William & Willkins, Philadelphia, 1997; 744–745.
18. Gelatt KN, Mackey EO. Prevelence of the breed-related glaucomas in pure-bred dogs in North America. Vet Ophthalmol. 2004; 7: 97–111.

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