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CASE REPORT

The use of semiconductor diode laser for deflation and coagulation of anterior uveal cysts in dogs, cats and horses: a report of 20 cases

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Abstract

Objective To describe semiconductor diode laser use for anterior uveal cyst deflation and coagulation in dogs, horses and cats.

Animals studied The presenting clinical signs, surgical technique and postoperative results for four dogs, nine horses and seven cats with anterior uveal cysts treated with diode laser are described. Treated cysts were of sufficient size and/or number to potentially impair vision, damage the corneal endothelium, or increase intraocular pressure (IOP). One dog with free-floating cysts exhibited 'fly biting' behavior. Cysts were suspected of causing shying on the affected side and/or head-shaking behavior in seven horses. Cysts were free floating within the anterior chamber in dogs, occurred in the corpora nigrum in horses and were attached to the posterior iris surface in cats. In cats, shallowing of the anterior chamber and dyscoria were observed. In all cats prior to cyst deflation, IOP increased after pharmacologic pupil dilation. Cats were more likely than dogs and horses to have bilateral and multiple cysts.

Procedure Two dogs and all horses were treated without general anesthesia and two dogs and all cats were treated under general anesthesia. Diode laser was used to perforate, deflate and coagulate the cysts.

Results Postoperatively, all eyes were free of discomfort or significant inflammation and minimal or no topical or systemic anti-inflammatory therapy was required. Abnormal behavior improved or resolved in all cases. In all cats, IOP 24 h after photocoagulation was lower than the postdilation IOP. Cysts did not recur, but new cysts were discovered in several cases.

Conclusion Semiconductor diode laser coagulation of anterior uveal cysts is safe, effective and noninvasive.

Key Words: canine, equine, feline, photocoagulation, uveal cysts

INTRODUCTION

Uveal cysts arising from the iris or ciliary body pigmented epithelium are described in humans, cats, dogs and horses.[1–13] Cysts may be attached at the pupillary margin, to the posterior iris or to the ciliary body or may be free floating in the anterior chamber. In dogs, free-floating translucent cysts in the anterior chamber are most commonly diagnosed.[4–7] In horses, cysts of the corpora nigra are most common and are associated with head shaking, shying and vision disturbance.[10] In cats, cysts are thick-walled, generally do not transilluminate and are typically attached to the posterior iris or at the pupillary margin.[12,13] Although trauma and inflammation have been implicated as a cause of anterior uveal cysts,[11,14] the cysts are more commonly spontaneous, benign and of clinical significance only when large enough to impair vision, obstruct aqueous flow[15] or mechanically damage the corneal endothelium.

With the advent of laser surgery, problematic iris and corpora nigra cysts may be addressed with minimal invasiveness, complications and anesthesia compared to previous intraocular techniques, which included limbal incision with manual extraction using fine forceps or needle aspiration, fine-needle aspiration through the limbus or automated irrigation/aspiration

Table 1. Dogs. Power and duration settings, number of spots, total energy per eye and follow-up

Case no./ Age (year)	Eye	Cyst # & size (mm)	Power range (mW)	Power avg. (mW)	Duration range (ms)	Duration avg. (ms)	No. of spots	Total energy (J)	Follow-up
1 (8)	OD	15–20@0.5–3.0	1000	1000	800	800	130 (10–15/cyst)	104 (5–7/cyst)	19 months
	OS	10–15@0.5–3.0	1000	1000	800	800	130 (10–15/cyst)	104 (7–10/cyst)	
2 (9)	OD	1@6–7	500–1200	1083	500–1500	937	24	25.6	1 year
3 (8)	OS	1@6	1000	1000	1500	1500	6	9	15 months
4 (6)	OS	1@7–8	1000	1000	500	500	15	7.5	7 months

OD, right eye; OS, left eye; mm, millimeters; mW, milliwatts; ms, milliseconds; J, joules.

of the cysts from the anterior chamber.[2,3,5,8,10,12,13] Current techniques using neodymium:yttrium-aluminum-garnet (Nd:YAG)[10] laser may be performed without general anesthesia as an outpatient procedure.[1,10,16] Semiconductor diode laser photocoagulation has not previously been described as a means of eliminating anterior uveal cysts, nor has photocoagulation of anterior uveal cysts in dogs or cats been reported. However, the diode laser has been found to be a successful method of cyst elimination. This report will discuss the use of semiconductor diode laser for deflating anterior uveal cysts in dogs, cats and horses.

HISTORY, CLINICAL FINDINGS AND TREATMENT

Canine patients

Four dogs (cases 1–4) were presented for evaluation of pigmented masses in the anterior chamber detected by the referring veterinarian on routine physical examination. Abnormal behavior related to the cysts was observed in cases 1 and 2. The dogs ranged in age from 6 to 9 years and the breeds represented were a Boston Terrier, a Collie, a Basset Hound and a Golden Retriever. All masses transilluminated and were diagnosed as iris cysts. Intraocular pressures were normal in all cases. All cysts were treated using the diode laser (DioVet, Iris Medical Instruments, Inc., Mountain View, CA, USA). The surgical protocols are summarized in Table 1. The average power setting was 1000 mW, the average duration ranged from 500 to 1500 ms and the average number of spots per cyst was 14.

Case 1 was an 8-year-old, male Boston Terrier that presented with a 3-year history of an increasing number of free-floating cysts in the anterior chamber of both eyes. The owner observed 'fly biting' behavior, presumably as a result of movement of the cysts, and reported that a corneal ulcer had occurred OS 2 years previously. Ophthalmic examination revealed approximately 10–20 cysts, 0.5–3.0 mm in size filling the ventral two-thirds of the anterior chamber in the right eye (Fig. 1) and the ventral one-third in the left eye. A cyst had ruptured on the axial endothelium in the left eye leaving a 3-mm lightly pigmented opacity. Preoperatively, tropicamide 1% ophthalmic solution was administered OU for mydriasis, 1% prednisolone acetate was applied topically every 30 min for three treatments, and flunixin meglumine (Fort Dodge, Fort Dodge, IA, USA; 0.5 mg/kg) was given intravenously at induction of general anesthesia. The diode laser operating microscope attachment (OMA) was attached to an operating microscope (Zeiss Universal S3B, Carl Zeiss Inc., Thornwood, NY, USA) and used at ×5 magnification and 1000 mW, 800 ms, and 0.3 mm spot size settings for a total of 130 spots in each eye to rupture and coagulate the cysts. Postoperatively, the eyes were comfortable and pigment dispersion was noted transiently in the aqueous humor. The patient was discharged with prednisolone acetate 1% OU every 6 h for 1 week. Two small (0.5-mm) cysts were observed in subsequent examinations by the referring ophthalmologist, but vision was not affected and the 'fly biting' behavior did not recur during the 19 month follow-up period.

Case 2 was a 9-year-old, neutered male Collie presented for evaluation of a pigmented mass noted by the referring veterinarian. The owner reported that the dog rubbed the right eye (OD) excessively. The right eye contained a 6–7 mm lightly pigmented cyst in the anterior chamber that obscured the pupil and abutted the axial corneal endothelium, preventing movement of the cyst in the chamber. Preoperatively, the eye was treated with 1% prednisolone acetate every 30 min for four treatments and received 1 dose of 1% atropine sulfate solution. Under general anesthesia, the diode laser was used with an indirect ophthalmoscope headset and a 20 diopter lens (Volk Laser Plus® 20 Diopter lens, Volk Optical Inc., Mentor, OH, USA) to photocoagulate the cyst. The spot size was kept as small as possible (approximately 0.4 mm) by maintaining a highly focused aiming beam with the lens held at 16 inches from the eye. Energy and duration were gradually increased to effect to perforate and coagulate the cyst. Care was taken to avoid the area immediately adjacent to the corneal endothelium to prevent secondary thermal-induced corneal damage. Remnants of the cyst remained attached to the corneal endothelium axially. The patient was discharged the same day, and 1% prednisolone acetate solution was applied OD every 12 h for 5 days postoperatively. One day later, the owner reported via telephone call that no ocular discomfort had occurred. One year postoperatively, there was no recurrence of the cyst, and rubbing of the eye resolved.

Cases 3 and 4 were an 8-year-old, intact male Basset Hound and a 6-year-old, castrated male Golden Retriever, respectively, each referred for evaluation of a single 6–8 mm cyst located within the pupil. A smaller 1–2 mm cyst was also

Figure 1. Multiple 1–2 mm lightly pigmented iridal cysts fill the ventral two-thirds of the anterior chamber in an 8-year-old, male Boston Terrier (case 1).

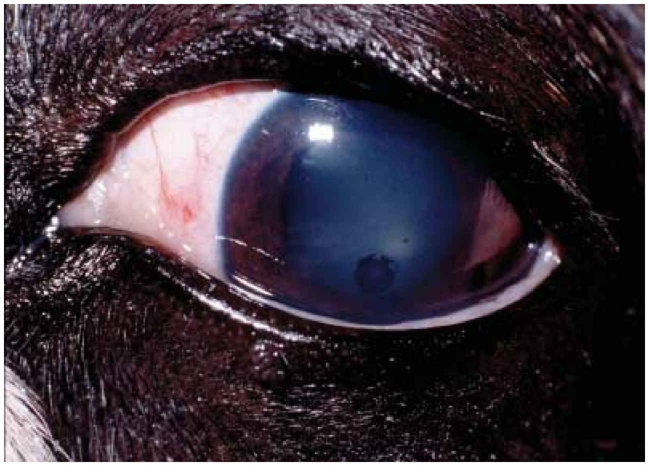

Figure 2. Pigmented cyst remnants are visible attached to the corneal endothelium of an 8-year-old, male Basset Hound (case 3) immediately following diode laser coagulation of a 6–7 mm iris cyst.

Figure 3. (a) A 4-mm corpora nigra cyst blocks the ventrotemporal pupillary aperture of the right eye in a 15-year-old Holsteiner gelding (case 8). (b) Appearance of the deflated cyst immediately following diode laser coagulation.

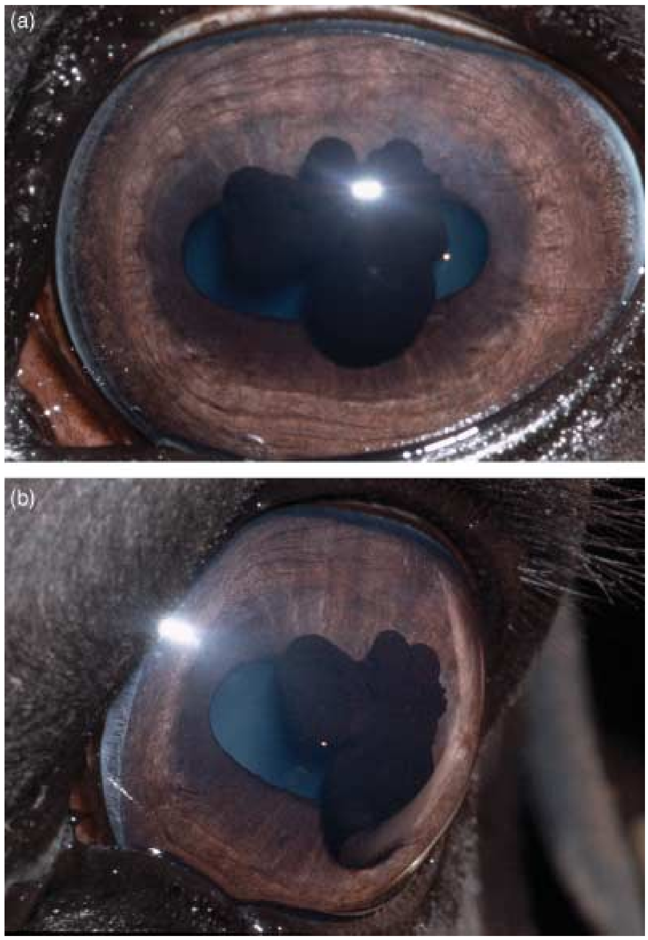

Figure 4. (a) Multiple dorsal corpora nigra cysts are apparent blocking the pupil in a 16-year-old Dutch warmblood gelding (case 10). (b) Cysts extend dorsally and ventrally from the dorsal corpora nigra and the largest cyst fills the anterior chamber nearly abutting the corneal endothelium.

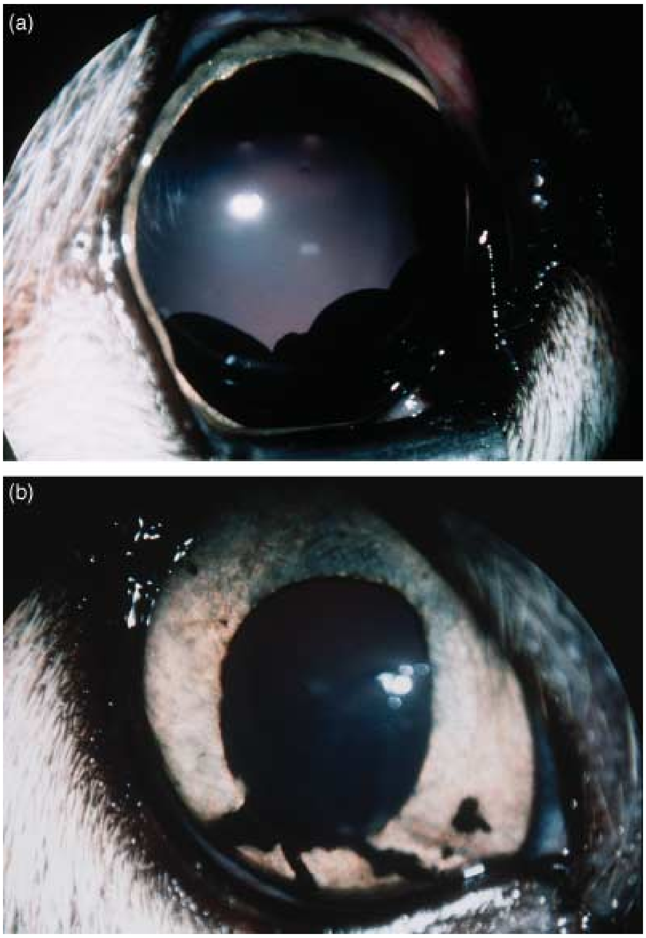

Figure 5. (a) Preoperative appearance of multiple cysts of the posterior iris in a 7-year-old spayed female Domestic Short-haired cat (case 16). The cysts distort the ventral pupillary margin and result in shallowing of the anterior chamber and posterior displacement of the lens.
(b) Pupil constriction and strands of pigment are visible in the anterior chamber immediately following diode laser coagulation of the cysts.

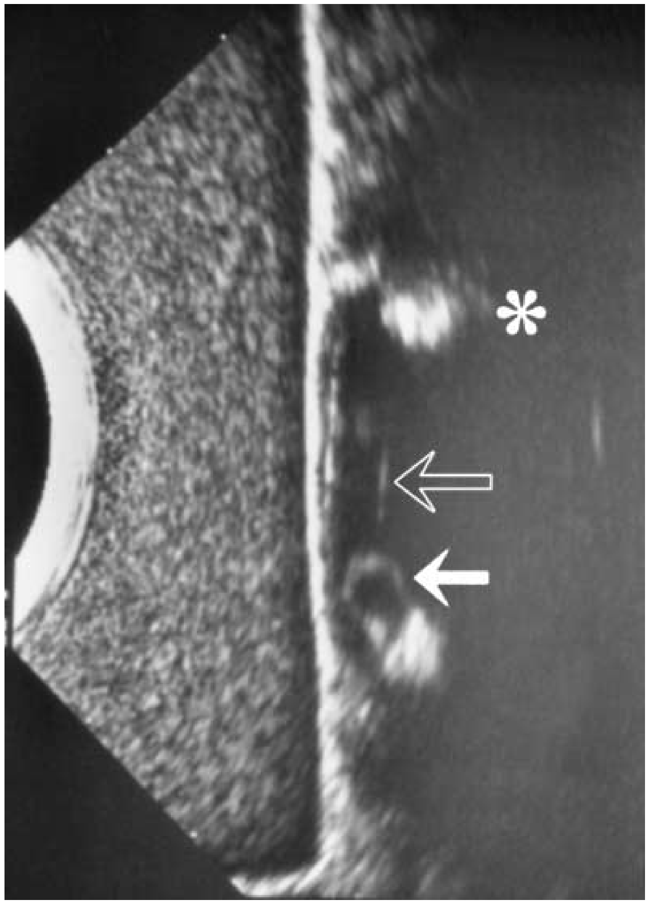

Figure 6. Ultrasonographic appearance of a cyst of the corpora nigra of a 2-year-old Morgan gelding. The asterisk denotes the dorsal corpora nigra, the open arrow denotes the anterior lens capsule and the closed arrow identifies the cyst characterized by a round hypoechoic structure with a hyperechoic wall.

noted inferiorly in the anterior chamber in case 3. Both cases were treated similarly without sedation or general anesthesia. Proparacaine solution was applied to the cornea, and the cysts were ablated using an indirect ophthalmoscope headset and a 20 diopter lens. No discomfort or aqueous flare was apparent postoperatively. Figure 2 shows the appearance of cyst remnants attached to the corneal endothelium in case 3 immediately postoperatively. In case 4, postoperative examination revealed focal retinal hemorrhage and edema nasal and inferonasal to the optic nerve head, presumed to be the disruptive effect of several misdirected bursts of laser energy on retinal blood vessels and the choroid. Atropine 1% was applied topically at the conclusion of the procedure and prednisolone acetate 1% was prescribed OS every 6 h for 24 h, then every 12 h for 5 days. Owners noticed no ocular discomfort or vision problems after the procedure. Case 3 was re-evaluated for cysts 15 months after laser surgery. The 2-mm cyst remained in the inferior anterior chamber OD and a new 3-mm cyst attached at the pupillary margin OS was noted. The cysts were not impairing vision or causing other problems and treatment was therefore not recommended. Case 4 was re-evaluated 1 month after surgery and the cyst remained deflated and attached to the iris and cornea. The retinal hemorrhage was resolving and a focal 0.5-disc-diameter retinal scar was observed. Seven months postoperatively, the owners noted no cyst recurrence or other problems.

Equine patients

Nine horses (cases 5–13) were presented for evaluation of pigmented iridal masses found in conjunction with shying and/or head-shaking behavior in seven horses, and the cyst was an incidental finding in cases 12 and 13. The horses ranged in age from 4 to 18 years and the thoroughbred ($n = 3$), quarter horse ($n = 3$), Arabian ($n = 1$), Holsteiner ($n = 1$), and Dutch warmblood ($n = 1$) breeds were represented. Seven horses were geldings and two were mares. All horses were diagnosed with 5–9-mm corpora nigra cysts at

Table 2. Horses. Power and duration settings, number of spots, total energy per eye and follow-up

Case no./ Age (year)	Eye	Cyst# & size (mm)	Power range (mW)	Power avg. (mW)	Duration range (ms)	Duration avg. (ms)	No. of spots	Total energy (J)	Follow-up
5 (10)	OS	1@4	500–600	586	500	500	128	38	LFU
6 (18)	OD	4@1	600	600	500	500	11	3.3	6 months. NR, NB
	OS	1@8	600	600	500	500	55	16.5	
7 (13)	OD	1@8–9	500–600	574	500–800	758	101	44	2.5 years. NR
8 (15)	OD	1@4	600	600	500	500	10	3	5 years. NR, NB
	OS	1@9	600	600	500	500	81	24.3	
9 (13)	OD	1@5	500	500	500	500	90	22.5	2 years. NR, NB
10 (16)	OS	1@9, 1@4, 3@1–2	500	500	500	500	186	46.5	7 months. NR, NB
11 (10)	OS	8	600	600	500	500	87	26.1	4 years. NR, NB
	OD	1 @3, 1@7	600	600	500	500	164	49.2	NC-19 months. NR, NB
12 (16)	OD	1 @6	400–500	450	500	500	149	34.3	17 months. NR, NB
13 (5)	OS	1 @4	500–600	550	500	500	44	12.1	6 weeks. NR, NB

OD, right eye; OS, left eye; mm, millimeters; mW, milliwatts; ms, milliseconds; J, joules; LFU, lost to follow-up; NR, no recurrence; NB, normal behavior; NC, new cyst.

the pupillary margin that did not transilluminate, but otherwise had a characteristic clinical appearance. Cases 6 and 8 had bilateral cysts and cases 6, 10 and 11 had multiple cysts. The larger cysts in all cases were of sufficient size to impair vision, particularly with pupil constriction, and/or were suspected of causing the shying or head-shaking behavior (Fig. 3a). In several cases the cysts abutted the corneal endothelium (Fig. 4a,b). Therefore, cyst deflation and coagulation was recommended. The intraocular pressures were normal in all eyes.

All horses were sedated with butorphanol (Fort Dodge Animal Health, Fort Dodge, IA USA; 0.011 mg/kg) and xylazine (Fort Dodge; 0.33 mg/kg) or detomidine (Pfizer, New York, NY, USA; 0.11 mg/kg) intravenously, and an auriculopalpebral nerve block was performed using 2% carbocaine (Pharmacia Upjohn, Kalamazoo, MI, USA). Prior to surgery, flunixin meglumine (Fort Dodge; 1 mg/kg) was given intravenously and proparacaine (Alcon Laboratories, Fort Worth, TX, USA) was applied to the corneal surface. All eyes were treated with the diode laser using an indirect ophthalmoscope headset and a 20 diopter condensing lens to photoablate the cyst. The spot size was kept as small as possible (0.4 mm) by positioning the lens 16 inches from the eye and maintaining a highly focused aiming beam. Care was taken to avoid aiming the laser beam at the area immediately adjacent to the corneal endothelium to prevent secondary thermal damage. Energy and duration were gradually increased to effect to perforate and coagulate the cyst. Table 2 summarizes the energy and duration settings used. The power setting ranged from 400 to 600 mW, the duration was 500 ms and the average number of spots required to coagulate a single cyst was 50. Following coagulation, the cysts appeared collapsed with a darkened and moth-eaten surface and pigment streaming in the aqueous humor was noted (Fig. 3b). All eyes were free of ocular pain immediately postoperatively and a single dose of 1% atropine topically successfully dilated the pupil. Twenty-four h postoperatively, two horses were treated by the owner for mild blepharedema with a single dose of flunixin meglumine (0.5 mg/kg) orally.

Cysts did not recur in any of the eight horses for which follow-up information was available. The follow-up period ranged from 6 weeks to 5 years. In case 6 at re-evaluation 10 months postoperatively, the cysts remained deflated and coagulated. The larger deflated cyst did not move with aqueous current and no evidence of vision disturbances or shying was found. A new 0.5-mm cyst was found on the dorsal corpora nigra of each eye but neither was significant to vision at the time of examination and therefore treatment was not recommended. In case 7, the referring veterinarian reported that no ocular problems occurred postoperatively and head shaking had improved for about 5 months after the procedure, then became more frequent. The cyst was no longer visible and photic head shaking was diagnosed. The head shaking had improved dramatically over 2–3 weeks with ciproheptadine (Bayer Corporation, West Haven, CT, USA) treatment. The largest cysts treated were found in case 10 (Fig. 4a,b). The referring veterinarian reported 7 months after surgery that evidence of prior cysts was not apparent and the horse's behavior was normal. In case 11, new cysts were discovered and treated OD when the horse began refusing jumps such as had occurred when the cysts OS were diagnosed 2 years previously. Nineteen months after the second surgery, the owner reported that the cysts had not recurred OU and that behavior again improved following cyst coagulation OD.

Feline patients

Seven Domestic Short-haired cats (cases 14–20) were presented for a change in the appearance of one or both eyes noted by the owner or the referring veterinarian. An intraocular mass suspected to be a tumor was reported in most cases. Multiple posterior iris cysts were diagnosed, unilateral in three animals (case 16 initially unilateral; later became bilateral), and bilateral in four animals. The cysts were large (2–7 mm), and in all cases the anterior chamber was shallow

Table 3. Cats. Intraocular pressures pre and post dilation and post lasering; power and duration settings, number of spots, estimated total energy per eye and follow-up

Case no./ Age (year)	Eye	Cyst #	IOP1/2 (mmHg)	IOP3 (mmHg)	Power (mW)	Duration (mSec)	No. of spots	OMA spot size (mm)	Est. total Energy (J)	Follow-up
14 (4)	OD	> 1	18/24	12	300	200	30	0.3	1.8	1 month
	OS	> 1	18/23	14	300	200	15	0.3	0.9	
15 (9)	OS	1	18/19	13	600–1200	2000	39	0.8	70.2	
16 (7)	OD	> 1	19/26	17	1200	1000–2000	60	0.3	108	6 years
	OS affected 6 years later	> 1	18		No surgery					Cat died
17 (10)	OD	> 1	14/29	30 @1 h postop 14 @ 24 h postop	800–1000	1000	231	0.3–0.8	208	10 months
	OS	> 1	15/34	33 @1 h postop 15 @ 24 h postop	800–1000	1000	247	0.3–0.8	222	10 months
18 (13)	OS	> 1	22/26	14	400	500–2000	57	0.3	285	3 years
19 (15)	OD	> 1	21/23	18	300–400	Continuous mode: 68 s.	◇	0.3	23.8	
	OS	> 1	19/20	13	300–400	Continuous mode: 27 s.	◇	0.3	9.5	15 months–new cysts OU. No tx.
20 (14)	OD	> 1	17/28	12	300–400	Continuous mode: 55 s.	◇	0.3	19.7	10 months
	OS	> 1	15/19	12	300–400	Continuous mode: 102 s.	◇	0.3	35.7	

OD, right eye; OS, left eye; IOP1, predilation intraocular pressure; IOP2, postdilation intraocular pressure; IOP3, postlaser intraocular pressure; mW, milliwatts; ms, milliseconds; J, joules.

due to anterior iris displacement by the cysts, and in most cases the pupil was deviated (Fig. 5a). All cats were treated with two applications of 1% tropicamide at 15-min intervals preoperatively. Intraocular pressure (IOP) in all eyes increased after pharmacologic pupil dilation. All cats were premedicated with butorphanol (0.11 mg/kg) and atropine (0.06 mg/kg) administered subcutaneously. General anesthesia was induced in all cats using propofol (Schering-Plough, Union, NJ, USA; 6 mg/kg IV) and maintained by administration of isoflurane gas through an endotracheal tube. All eyes were treated using the diode laser under an operating microscope and a 0.3 or 0.8 mm OMA spot size. Energy and duration of laser application and number of spots treated or length of time of continuous treatment were altered to effect to achieve rupture and coagulation of the cysts. Table 3 summarizes the surgical protocols. For cases in which the laser energy was applied in pulses, the average power setting was 700 mW, the average duration was 1000 ms, and average number of spots required to coagulate all the cysts in an eye was 97. Minimal anterior chamber debris was observed after cyst treatment, with the exception of cases 16 and 17. After cyst coagulation in case 16, pigmented strands were visible in the anterior chamber (Fig. 5b) and persisted for 2 months postoperatively, then resolved. In case 17, multifocal adhesions of the cysts to the corneal endothelium persisted postoperatively OU. Corneal edema, aqueous flare and fibrin persisted for 1 week after surgery. The cat had no cyst recurrence or IOP elevation at the last examination, 10 months postoperatively. In case 19, new cysts were discovered at the 15-month re-evaluation. The IOP was normal OU and the owner declined treatment due to the cat's advanced age.

RESULTS

The anterior uveal cysts were effectively reduced in size or eliminated by diode laser photocoagulation in all cases treated. Photocoagulation was the more common result of diode laser energy application rather than photodisruption. Photodisruption refers to vaporization of intra- and extracellular fluid with subsequent cellular disruption accompanied by an audible shock wave.[17] Photocoagulation refers to the desired effect of laser application: local tissue hyperthermia with subsequent coagulation necrosis and tissue shrinkage.[17] Cyst tissue contracted with laser application, eventually resulting in perforation and collapse of the cyst wall, with coagulation occurring in subsequent applications. Pigment streaming from the surface of the cyst was grossly visible during application of laser energy. At the conclusion of the procedure, the cyst surface appeared wrinkled, darkened and rough. Postoperatively, blood–aqueous barrier breakdown, evidenced by aqueous flare, was minimal to absent in all cases, and none of the treated eyes showed signs of discomfort. However, aqueous pigment dispersion and cyst remnants were present in all cases and resulted in focal corneal endothelial and anterior lens capsule pigmentation in several eyes.

The mean ages of dogs, horses and cats were 7.8 years (range 6–9 years), 12.6 years (range 4–18 years) and 10.3 years (range 4–15 years), respectively. The total energy levels required per eye in dogs, horses and cats are listed in Tables 1, 2 and 3 and ranged from 0.9 to 285 J (J). The mean total energy required to ablate individual cysts in dogs and horses was difficult to interpret due to variable number and size of cysts and limitations of retrospective analysis of surgical technique (e.g. the amount of energy applied per individual cyst was not recorded). After excluding the four eyes with multiple cysts present, the mean total energy applied per cyst in dogs was 11.8 J per cyst and for horses was 24.5 J per cyst. Energy level required to ablate cysts of similar size was lower for dogs than horses. This observation was attributed to the denser pigmentation typical of the equine corpora nigrum cyst. Further, lower energy and duration settings with a greater number of spots tended to work more effectively for equine cysts, probably due to the apparent thickness of the cyst wall compared to dogs.

In cats, laser treatment was administered in a pulse or continuous mode to effect until rupture and deflation of the cysts occurred. The mean total energy application per eye was estimated in cats (range = 0.9–285 J; mean = 89.5 J); however, mean total energy application per cyst could not be calculated due to variation in surgical technique and the presence of multiple cysts in all but one eye. An elevation of intraocular pressure occurred after pharmacologic pupil dilation in all feline cases examined. Predilation IOP ranged from 14 to 22 mmHg with a mean of 19.5 mmHg. Postdilation IOP ranged from 19 to 34 mmHg with a mean of 24.6 mmHg. With the exception of both eyes in case 17, the IOP immediately following cyst coagulation was lower or equal to the predilation IOP. In case 17, the IOP was unchanged at 1 hour after surgery and decreased to the predilation IOP within 24 h postoperatively. Excluding case 17, postoperative IOP in all cases immediately postoperatively ranged from 12 to 18 mmHg with a mean of 13.9 mmHg. Including case 17, the mean IOP immediately postoperatively was 17.1 mmHg and 24 h postoperatively was 14.2 mmHg.

DISCUSSION

In all species, it is important to consider the typical clinical appearance and primary differential diagnosis for uveal cysts, namely iridal or uveal melanoma.[1,10,11,18,19] Additionally, in horses, iris hypoplasia and hypertrophy of the corpora nigra must also be considered.[2,9,10,20] Characteristically, the cysts are round to ovoid and transilluminate and are often movable or free floating in the anterior chamber. If the cysts are fixed and do not transilluminate, as commonly seen in horses and cats, ultrasonography of the cyst may confirm the diagnosis by revealing an anechoic (fluid-filled) center (Fig. 6).[21] However, ultrasonography is not usually necessary for an experienced examiner.

Before treatment of anterior uveal cysts is considered, a thorough ophthalmic examination should be performed to look for any underlying causes of the cysts such as trauma or chronic inflammation,[11] even though the majority of cysts are assumed to be idiopathic or developmental.[13] The cysts may arise from the pupillary margin, the posterior iris face or the pars plicata of the ciliary body, and examination through a dilated pupil may facilitate visualization of cysts in the posterior chamber.[7] The clinical significance of the cysts should be assessed during examination and IOP should be evaluated before and after pupil dilation, especially in cats. Potential sequelae of larger cysts include vision impairment, corneal endothelial opacities and degeneration, pigmentation of the anterior lens capsule, mechanical interference with iris function and aqueous outflow obstruction with secondary ocular hypertension.[1,6,7,14,15]

Canine uveal cysts consist of two layers of pigmented iris or ciliary epithelium containing Alcian blue-positive material consistent with hyaluronic acid.[3,4,14] Congenital cysts are thought to form due to faulty closure of the two neuroectodermal layers of the embryonic cup.[3,4] Anterior uveal cysts in dogs are most commonly seen in middle-aged to older Golden Retrievers, Labrador Retrievers and Boston Terriers, are usually unrelated to trauma or inflammation, usually transilluminate, and are rarely of clinical significance.[4,5] However, a syndrome of uveitis and secondary glaucoma associated with iridociliary cysts has recently been described in Golden Retrievers. Cysts were clinically apparent in only 13% of these cases. However, a histologic review of globes and evisceration contents of blind and glaucomatous eyes found that thin-walled iridociliary epithelial cysts were present in 83% of the specimens. It is unclear whether the cysts are a primary or secondary problem, but they appear to contribute to the development of glaucoma in this breed and in Great Danes.[11,14,15]

In horses, corpora nigra cysts tend to be unilateral, singular, and seen in middle-aged and older animals. Common presenting complaints are vision impairment, head shaking, shying on the affected side and decreased athletic performance.[10] Corpora nigra cysts rarely transilluminate, and initiating trauma or inflammation is not implicated.

In prior reports of iris cysts in cats, the Siamese breed appears to acquire cysts without any predisposing ocular disease.[12] No breed predilection was noted in this study. Cysts in cats may also be associated with trauma or inflammation.[12,13] Alternatively, older cats without predisposing ocular disease may acquire cysts originating from the posterior pigmented epithelium of the iris. When sufficiently large, these cysts displace the iris anteriorly resulting in compromise of the iridocorneal angle and subsequent modest elevations in intraocular pressure, particularly after pharmacologic pupil dilation. The mean IOP in the feline cases prior to pupil dilation were comparable with the normal reported mean of 20.2 mmHg, but the mean postdilation IOP of 24.6 mmHg exceeded the normal mean value suggesting low grade ocular hypertension.[22] It is assumed that the postdilation IOP was higher due to exacerbation of the mechanical narrowing of the iridocorneal angle by the cysts when the iris was displaced peripherally. Immediately following the laser procedure, IOP was reduced despite persistence of pupil dilation, indicating that coagulation of the cysts was responsible for the IOP decrease.

The semiconductor diode laser contains galium, arsenic and aluminum to produce light, with a wavelength of 810 nanometers. This wavelength is preferentially absorbed by melanin-containing tissues such as the uveal tract and uveal cysts. Coagulation necrosis of the tissue results from the thermal energy produced.[23–25] Attachments including the endoprobe, the glaucoma probe, the operating microscope attachment and the indirect ophthalmoscope facilitate a variety of ophthalmic applications. However, only the latter two delivery systems that emit a converging laser beam should be used for transcorneal treatment of intraocular cysts and tumors. The endoprobe and the glaucoma probe utilize a diverging laser beam resulting in energy concentration near the tip of the probe and a wider distribution of energy at the point of laser absorption. Therefore, transcorneal treatment of cysts with these probes would result in higher laser energy levels at the cornea and more diffuse energy application at the cyst wall. As the clear cornea does not absorb laser energy, this technique may be used successfully if the cyst wall is not touching the corneal endothelium, but is neither ideal nor advisable.

Rupture of a cyst requires that a focal point of the wall of the cyst receive enough laser thermal energy to cause it to break. The amount of energy required will vary with the thickness of the wall, the amount of pigment and the angle of contact of the laser beam. In thinner and more lightly pigmented cysts, it is often advantageous to aim for the perimeter of the cyst so that a tangentially directed beam will contact a greater surface of the cyst wall. With this many variables, the continuous mode of photocoagulation effectively permitted a build-up of energy until cyst rupture occurred. However, general anesthesia is required for patient positioning and accurate aiming of the laser beam when the OMA and a continuous mode are used. The indirect ophthalmoscope attachment and a 20-diopter lens coated for diode laser use was used in all horses and three dogs. This method was efficient and portable for use in dogs and horses with or without light sedation. Case 2 was anesthetized in order to safely establish a protocol for canine cyst coagulation using the indirect ophthalmoscope attachment. The Boston Terrier (case 1) was anesthetized to permit magnification of the multiple small cysts and to allow manipulation of the globe to place the cysts in the axial anterior chamber rather than inferiorly, where they contacted the corneal endothelium and the OMA was used for precise aiming and concentration of laser energy. General anesthesia may not be necessary when cysts are few, large and/or fixed in position and the temperament of the patient is amenable to an accurate surgical technique. In cats, due to the posterior location of the cysts, general anesthesia and the use of the OMA are recommended for the most accurate application of the laser energy. The recommended beginning power and duration setting for dogs is 1000 mW, 500 ms and for horses is 500 mW and 500 ms. As horses and dogs are routinely lasered without general anesthesia, a short duration rather than a continuous mode of laser application is recommended to accurately aim each burst of laser energy and thereby decrease the risk of inadvertent damage to peripheral ocular tissues. In cats, a continuous mode may be more effective for cyst rupture. It is recommended to start the procedure with a 0.2 or 0.5 spot size on the OMA and a power of 200 mW and duration of 1000 ms. If a photocoagulative effect is not seen after 1 s, the power may be increased and/or the angle of the beam altered to achieve the desired effect.

The potential peri-operative complications of laser coagulation of anterior uveal cysts are corneal edema due to thermal endothelial damage, anterior uveitis, posterior synechia, dyscoria, corneal and/or anterior lens capsule pigmentation, cataract formation and retinal burns. However, these complications are avoided by precise aiming techniques. Theoretically, in case 1 the multiple cysts and marked amount of pigmented debris exiting through the iridocorneal angle could have resulted in secondary glaucoma. However, intraocular pressure postoperatively remained normal. With the exception of cases 4 and 15, the only peri-operative complications observed in this series were pigment dispersion in the aqueous and minor corneal endothelial and anterior lens capsular pigment deposition. Minor retinal hemorrhage and chorioretinal scarring occurred in case 4 due to imprecise aiming of the laser beam. Complications of aqueous flare, fibrin and corneal edema occurred in feline case 15 where cysts were of sufficient size to contact the corneal endothelium.

Nd:YAG laser was recently described by Gilger *et al.* for successful ablation of corpora nigra cysts in eight horses without the need for general anesthesia.[10] Mean ± SD energy required to rupture cysts was 36.2 ± 17.5 mJ per cyst. In this study, postoperative topical anti-inflammatories were used for 5–7 days in the first four horses, but not in the remaining horses as neither ocular discomfort nor inflammation were observed. All horses in that study showed improved function after treatment of the cysts.

Our results using the diode laser in horses were different, with a mean total energy application of 24.5 J per cyst. The difference in energy requirements between the Nd:YAG and diode procedures is attributed to the photodisruptive or explosive property of the Nd:YAG laser, which ruptured and deflated an equine cyst with a mean of 3.6 energy bursts. Several additional bursts were applied to create addition perforations.[10] With the diode laser, cyst deflation required several spots to perforate the cyst wall, then multiple additional applications were used to coagulate the entire surface of the cyst. It is unknown whether the entire cyst surface should be coagulated to prevent recurrence; however, treating the entire surface resulted in an immediate and considerable reduction in the cyst size. Similar to the Gilger *et al.* study, topical anti-inflammatory treatment was not required postoperatively and horses remained comfortable with normal vision. Short-term systemic anti-inflammatories were used prophylactically in one case, and one additional dose after discharge from the hospital was required for mild blepharedema and blepharospasm in two cases. Function was improved in all of the horses for which follow-up was available. In case 7, shying on the right side resolved; however, head shaking behavior improved but did not resolve after the cyst was deflated. Photic head shaking should be considered in the differential diagnosis for head shaking in horses.[26]

In cats, diode laser photocoagulation was successful in rupturing multiple cysts and achieving a lowering of IOP compared to postdilation IOP in all eyes treated. It is likely that as the cysts deflated, the mechanical displacement of the iris was alleviated, restoring aqueous humor outflow through the iridocorneal angle.

CONCLUSIONS

Semiconductor diode laser deflation and coagulation of canine and feline uveal and equine corpora nigra cysts is a simple noninvasive technique with minimal surgical complications and postoperative care. The diode laser also provides a means of deflating large cysts attached to the posterior iris or the ciliary body and relieving ocular hypertension associated with these cysts. Posteriorly located cysts such as these could be difficult to access via intraocular surgical techniques. Techniques described prior to the development of the laser required general anesthesia and were more invasive, requiring penetration of the anterior chamber. Some of the described procedures include iridectomy, fine needle aspiration, limbal incision with manual extraction, irrigation and electrocauterization.[1,3,5,8,12,13] In general, these techniques present the risk of anterior uveitis, damage to the iris and lens and iridal hemorrhage.[8,12,27] However, techniques such as fine needle aspiration and automated irrigation and aspiration afford the ability to remove the cyst wall rather than leaving it attached to the iris or corneal endothelium, or allowing cyst wall fragments to clog the trabecular meshwork. This may be an important consideration when treating large axial anterior chamber cysts and dogs with numerous free-floating cysts.

Potential advantages of semiconductor diode laser over Nd:YAG laser for coagulation of corpora nigra and iris cysts include lower cost of the equipment, portability, ability to perform the technique without general anesthesia and accurate control of spot size. In dogs and horses, impaired vision or athletic performance may be associated with large iris and corpora nigra cysts. In cats, ocular hypertension may be associated with iridal cysts and IOP should be monitored accordingly. Since this safe, noninvasive treatment modality is available, uveal cysts should be addressed when they are clinically significant. Various diode laser attachments and techniques are adaptable according to individual clinical characteristics and the species treated. The treatment parameters of spot size, energy and duration vary greatly depending on many factors, particularly the thickness and degree of pigmentation of the cyst wall.

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