Veterinary Ophthalmology (2014) **17**, 5, 343–350 DOI:10.1111/vop.12082

Histopathological study of the causes for failure of intrascleral prostheses in dogs and cats

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Abstract

Objective To characterize the histopathological causes for failure of intrascleral prosthesis placement in dogs and cats.

Procedures The Comparative Ocular Pathology Laboratory of Wisconsin database was searched to find canine and feline evisceration samples that were diagnosed with neoplasia. A second population included canine and feline scleral shells that were removed after an evisceration surgery had been performed. The causes for removal were divided into: neoplasia, corneal abnormalities, and other causes.

Results In dogs, 163 of 1985 evisceration samples (8.21%) contained a neoplasm, whereas 17 of 88 (19.31%) evisceration samples in cats contained a neoplasm. In dogs, severe corneal disease was diagnosed in 38 of 80 scleral shells (46.25%) and neoplasia was diagnosed in 31 of 80 scleral shells (38.75%). Malignant melanoma was the most frequently diagnosed tumor, in 14 of 31 scleral shells. In cats, eight of 12 scleral shells contained a tumor (66.7%), with feline diffuse iris melanoma being diagnosed most commonly (six of eight shells). Two of 12 feline scleral shells had severe corneal disease (16.7%). Epithelial downgrowth, lining the inner aspect of the fibrous tunic, was seen in 14 of 38 canine scleral shells and in two of two feline scleral shells with severe corneal disease.

Conclusions Severe corneal disease and neoplasia are the most common causes for intrascleral prosthesis failure in dogs, whereas neoplasia is the single most common cause for intrascleral prosthesis failure in cats.

Key Words: cat, dog, epithelial downgrowth, evisceration, histopathology, intrascleral prosthesis

INTRODUCTION

Evisceration consists of removal of the contents of the globe leaving only the corneoscleral shell and inserting an intrascleral prosthesis.[1,2] It is a common surgical procedure among veterinary ophthalmologists.[2–4] Reported indications for evisceration include blind painful eyes suffering either from glaucoma, from noninfectious uveitis or from severe trauma, to prevent enucleation, phthisis bulbi, and improve cosmesis.[1,2,4–6]

Accurate case selection is crucial to achieve a high success rate of this surgery, so reported contraindications include phthisical or microphthalmic eyes, eyes with corneal disease, the presence of intraocular neoplasia and cases of endophthalmitis of infectious origin;[1,4–8] however, some authors postulated that the presence of a benign intraocular neoplasm may not always be a contraindication for evisceration, although the presence of malignant neoplasia should warrant enucleation.[6] A retrospective study[8] reported nine cases (eight dogs and one cat) in which a tumor was diagnosed in the evisceration specimen. Two of the tumors regrew within the scleral shell, and the eyes were enucleated. It was concluded that the dogs' overall survival time was not affected by the evisceration of an eye containing a neoplasm whether it was benign or metastatic. The one cat included in the study died of metastatic disease of a feline diffuse iris melanoma (FDIM) 4 years after the evisceration. It was stated in the article that enucleation late in the disease, by the time glaucoma developed, would not have offered protection against metastases. For metastatic neoplasms, the article argued that evisceration did not affect the overall survival time.[8]

Complications for evisceration are reported to occur in 9–16% of the patients and include regrowth of unidentified neoplasm, scleral wound dehiscence with extrusion of implant, corneal ulceration/mineralization, postoperative scleral infection, keratoconjunctivitis sicca (KCS), and secondary entropion. The rate of enucleation in previously eviscerated eyes ranged from 4.5% to 8%.[2,4–6,8,9]

The purpose of this study is to evaluate the histopathological findings in scleral shells submitted to an ocular pathology service, with the aim of determining the common causes leading to failure of the intrascleral prosthesis, defined as the necessitation for scleral shell removal.

MATERIALS AND METHODS

The database of the Comparative Ocular Pathology Laboratory of Wisconsin (COPLOW) was used, and two populations of cases were selected. First, evisceration samples that had been submitted to the laboratory and were diagnosed with a neoplasm were collected, and the type of tumor diagnosed was recorded. The second population consisted of enucleated scleral shells from eyes in which evisceration had been previously performed, and the histopathological cause for the failure was allocated to one of the following categories: (i) neoplasia, (ii) severe corneal abnormalities, including corneal ulceration and perforation, incision dehiscence, keratitis, and epithelial downgrowth, or (iii) other causes. Epithelial downgrowth was defined as the growth of surface epithelium, usually nonkeratinized stratified squamous epithelium, lining the inner aspect of the cornea and sclera within the shell.[10] Each of these populations was obtained for canine and feline submissions. For the cases in which the scleral shell was received, signalment, laterality (right – OD, left – OS, or both eyes – OU), time from evisceration to enucleation of the scleral shell and previous history, when available, was recorded from the submission form.

RESULTS

Evisceration samples with intraocular neoplasia

In dogs, 1985 evisceration samples were received at the time of completion of this project. Of these, 163 samples (8.21%) contained a neoplasm. The types of tumor diagnosed included: 56 iridociliary tumors (34.35%), 51 melanocytomas (31.3%), 21 malignant melanomas (12.9%), 15 (9.2%) were diagnosed as metastatic tumors (including one histiocytic sarcoma), eight spindle cell tumors of blue-eyed dogs (4.9%), five lymphomas (3%), two primitive neuroectodermal tumors (PNET) (1.2%), one choroidal melanocytoma (0.6%), and four malignant tumors of undetermined origin (2.5%).

In cats, 88 eviscerations were received, 17 (19.31%) of which contained a neoplasm. The distribution of tumor types was as follows: 10 FDIMs (58.8%), four lymphomas (23.5%), two iridociliary tumors (11.7%), and one posttraumatic sarcoma (5.9%).

Scleral shells – dogs

Common corneal changes in scleral shells evaluated histopathologically included epithelial hyperplasia with or without keratinization, corneal epithelial and/or superficial stromal pigmentation, stromal fibrosis, and neovascularization (Fig. 1a). A thick, dense, cell-poor fibrous membrane was frequently found replacing the endothelium and lining the inner aspect of the sclera and cornea circumferentially around the prosthesis (Fig. 1b). Multifocal variably sized aggregates of pigmented tissue (uveal remnants) were also frequently seen on the inner aspect of the sclera.

Within the canine population, 80 scleral shells were received, with the following distribution of diagnoses: 38 scleral shells from 37 dogs (46.25%) received a diagnosis of severe corneal disease; 31 scleral shells (38.75%) had a tumor within them; six scleral shells (7.50%) were prophylactically enucleated (either because of a previous histopathological diagnosis of neoplasia on the evisceration sample or concern about a tumor developing within the shell) and showed the typical microscopic findings described above; three scleral shells (3.75%) had inflammation within them independent of corneal disease; one scleral shell (1.25%) had extensive hemorrhage within the shell; and one scleral shell (1.25%) had no significant microscopic lesions other than those expected for a scleral shell (previously described). Thirty-five of the scleral shells had uveal remnants (43.75%), three had remnants of retina (3.75%), and two had lens remnants (2.5%).

The signalment, time from evisceration to enucleation, laterality, diagnosis, and presence of uveal remnants of

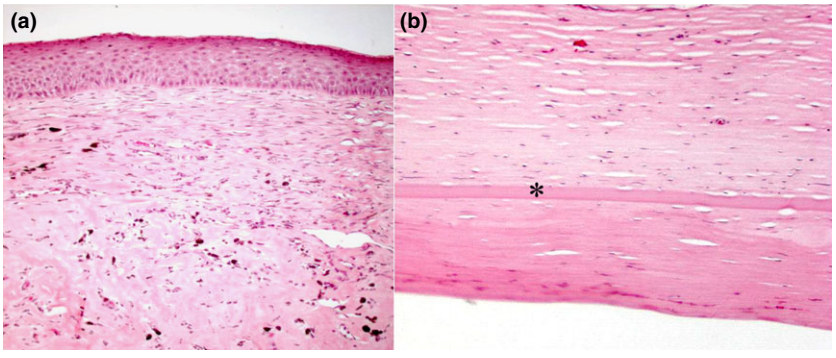

Figure 1. Typical histopathological corneal changes in enucleated scleral shells. (a) Epithelial hyperplasia, stromal fibrosis with neovascularization and pigment deposition. Hematoxylin and eosin, original magnification 10×. (b) A thick, cell-poor fibrous membrane lines the inner aspect of the cornea. The asterisk indicates where Descemet's membrane is. Note the absence of endothelium. Hematoxylin and eosin, original magnification 20×.

the 38 shells with corneal disease are summarized in Table 1. The mean age was 8.77 ± 3.98 years (range, 7 weeks to 15 years). The mean time elapsed between the evisceration surgery and the enucleation of the scleral shell was 11.49 ± 20.38 months (range, 2 days to 7 years). Only two of the dogs, a Poodle and a mixed breed, were reported to be diabetic. Eight dogs reportedly had KCS of which two were diagnosed before the evisceration (two Shih tzu dogs), two were diagnosed after the evisceration (a Shih tzu and a Cockapoo), and the time of diagnosis was unknown for the other four dogs (one case each of a Basset Hound, Boston terrier, Italian Greyhound, and Cocker Spaniel). Clinically, seven globes were diagnosed with corneal ulcers, two of them before the evisceration (a Pug and a Shih tzu), and five of them after the evisceration (a Boston Terrier, a Shih Tzu, a Toy Poodle, a Chihuahua, and a Pit Bull mix). Three dogs had a history of trauma with scleral rupture (an American Eskimo and a Pug) or a corneoscleral laceration (a Yorkshire terrier), prior to evisceration. In three dogs (a Shih tzu, a Cocker Spaniel, and a Weimaraner), there was a history of self-trauma that triggered the enucleation of the scleral shell. Of the 38 scleral shells with corneal disease, there were 20 perforations (including the two eyes from the same dog; 52.63%), 10 keratitides (26.31%), seven suture dehiscences (18.42%), and one global keratomalacia (2.63%). The implant was extruded from the scleral shell in seven cases, four shells

Table 1. Signalment, laterality, time from evisceration to enucleation, and histopathological features of scleral shells from dogs with corneal disease

Case	Breed	Gender	Age (years)	Eye	Time* (months)	Diagnosis	ED†	Uveal remnants
1	Cocker	M	8	OS	1	Dehiscence	N	N
2	Cockapoo	FS	11	–	0.6	Dehiscence	Suture	N
3	Shih tzu	MC	8	OD	–	Perf (A)	Lining	N
4	Basset Hound	FS	13	OS	48	Perf (A)	Y	N
5	A. Eskimo	MC	11	OD	1	Perf (A)	N	N
6	Boston Terrier	M	5	OS	8	Keratitis	Y	N
7	Pug	F	0.5	OD	1.75	Perf (A)	Y	Y
8	Pit bull mix	F	5	OD	1	Perf (A)	N	N
9	Toy poodle	M	3	OU	3	Perf (A) OU	Lining OU	Y
10	Shih tzu	MC	9	OD	5	Keratitis	Suture	N
11	A. Eskimo	MC	6	–	–	Perf (A)	Lining	N
12	Akita	MC	12	OS	0.4	Perf (A)	Lining	N
13	Chow Chow	FS	7	OD	0.4	Dehiscence	Lining	N
14	Chow Chow	MC	12	OS	60	Perf (A)	Y	N
15	Cocker	FS	8	OD	1	Dehiscence	Lining	Y
16	Mix	FS	10	OS	0.2	Perf (A)	Lining/suture	N
17	Golden	FS	12	–	3	Keratitis	Suture	N
18	Boxer	M	0.15	OS	0.1	Perf (A)	N	N
19	Shih tzu	FS	9	OS	0.25	Keratomalacia	Lining	Y
20	Shih tzu	MC	3	OS	12	Keratitis	Y	N
21	Yorkshire	FS	8	OS	0.25	Dehiscence	Lining	Y
22	Pug	FS	3	OD	6	Keratitis	Y	Y
23	Toy poodle	FS	15	OS	–	Perf (P)	Y	Y
24	Cocker	MC	9	OS	24	Perf (P)	Y	Y
25	Bichon Frise	F	15	OS	12	Keratitis	Y	N
26	ACD	FS	14	OD	48	Keratitis	N	Y
27	Basset Hound	FS	14	OS	–	Perf (A)	N	Y
28	Weimaraner	FS	4	OD	0.13	Dehiscence	N	Y
29	Greyhound	MC	14	OD	3	Perf (P)	Y	N
30	–	MC	11	OD	1	Perf (A)	Suture	Y
31	Dachshund	FS	7	OS	0.75	Dehiscence	Y	Y
32	Poodle	FS	12	–	0.3	Perf (A)	Lining/suture	N
33	Shih tzu	FS	10	OD	5	Perf (A)	Y	Y
34	Pekingese	FS	–	OD	3	Perf (A)	Y	Y
35	Chihuahua	FS	7	OD	84	Keratitis	Y	N
36	Cockapoo	FS	11	OS	10	Keratitis	N	N
37	Cocker	FS	9	OD	35	Keratitis	N	N

A = axial; ACD = Australian cattle dog; A. Eskimo = American Eskimo; F = female; FS = female spayed; M = male; MC = male castrated; N = no; OD = right eye; OS = left eye; OU = both eyes; P = peripheral; Perf = perforation; Y = yes.
(–) Indicates that the information was not available.
*Time from evisceration to enucleation.
†Lining: corneal epithelium lining the edges of corneal ulcer or perforation; suture: discrete islands of epithelium within the superficial corneal stroma or associated with suture tracts at the limbus.

with perforation and three diagnosed with suture dehiscence.

Perforations occurred an average of 9.67 ± 18.34 months postevisceration (range, 4 days to 60 months). Perforations occurred in the axial cornea in 17 globes, whereas three perforations were peripheral. The mean interval between evisceration and enucleation of the scleral shell for keratitides was 22.03 ± 26.10 months (range, 3–84 months). The keratitis was chronic in all cases, with mixed inflammation (lymphocytes, plasma cells, neutrophils, and/or macrophages), neovascularization, and fibrosis. There was band keratopathy in three of these 10 globes. Suture dehiscence occurred an average of 0.59 ± 0.35 months after the surgery (range, 4 days to 1 month). In two of the globes with dehiscence, there were intralesional bacteria. The global keratomalacia occurred in a Shih tzu 1 week after evisceration. Seven months before evisceration, this dog received a laser retinopexy, 10 days after which it developed acute KCS with a melting corneal ulcer that subsequently resolved.

Epithelial downgrowth was seen in 14 of the scleral shells with corneal disease (diagnosed with corneal perforation, keratitis, and dehiscence in seven, six, and one cases, respectively; Figs 2a and b). In seven of these shells, the corneal epithelium lined the edges of an axial corneal perforation (three cases) or the edges of a dehisced incision (one case), becoming contiguous with the epithelium lining the inner aspect of the fibrous tunic. In another 15 shells, there was sliding of epithelium into a corneal ulcer/perforation bed (11 cases) and/or presence of discrete islands of epithelium, either within the superficial corneal stroma or associated with suture tracts at the limbus (six cases).

The signalment, laterality, time lapse between evisceration and enucleation surgeries, tumor diagnosis of the scleral shell, tumor diagnosis of the previous evisceration (when available), and the presence of uveal remnants of the 31 shells with neoplasia are summarized in Table 2. The mean age was 8.95 ± 2.94 years (range, 9 months to 14 years). The mean time elapsed between evisceration and enucleation of the scleral shell was 15.1 ± 21.93 months (range, 10 days to 72 months).

The distribution of the 31 tumors within the scleral shells was as follows: malignant melanoma in 14 cases (45.16%), four cases each of melanocytoma and iridociliary tumors (12.90%), three spindle cell tumors of blue-eyed dogs (9.67%), two malignant anaplastic neoplasms of undetermined origin (6.45%), and one each of corneal leiomyosarcoma (Fig. 3), metastatic carcinoma, PNET, and lymphoma (3.22%).

In 19 of these dogs, both the evisceration sample and the subsequent enucleated scleral shell were received. In 17 canine cases, the diagnoses in the evisceration and in the scleral shell concurred (five malignant melanomas; three each of melanocytoma and ciliary body tumor; two spindle cell tumors of blue-eyed dogs; and one each of PNET, lymphoma, metastatic carcinoma, and anaplastic neoplasia). In one case (case number 16), no tumor had been found in the evisceration material, whereas a malignant melanoma was diagnosed in the scleral shell. In another case (case number 21), malignant melanoma was diagnosed in the evisceration and, although no tumor was detected in the scleral shell, in this dog, the tumor regrew in the orbit and biopsied fragments of the orbital tissue confirmed the presence of malignant melanoma.

Scleral shells – cats

For cats, 12 scleral shells were received, of which 8 (66.7%) contained a tumor, two cases (16.7%) had corneal disease (keratitis), one shell was removed prophylactically for a previous diagnosis of a FDIM in the evisceration and was diagnosed with a suppurative keratitis, as well as the typical microscopic changes of scleral shells described above (8.3%), and one case (8.3%) showed eosinophilic inflammation within the scleral shell. The two cases with corneal disease had evidence of epithelial downgrowth. Uveal remnants were found in six of the shells (50%).

The signalment, laterality, time lapse between evisceration and enucleation surgeries, and histopathological

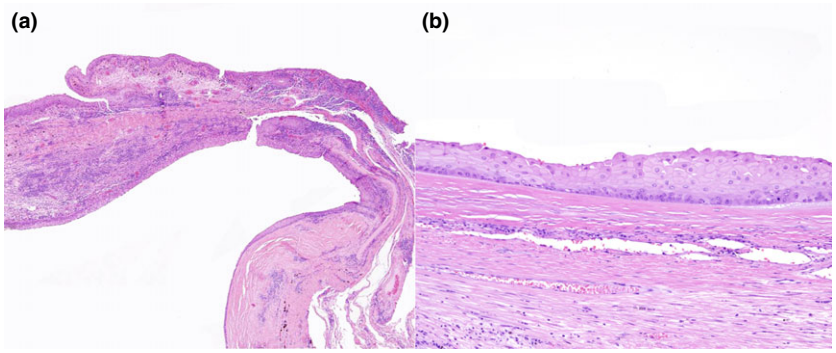

Figure 2. Epithelial downgrowth within an enucleated canine scleral shell. (a) Low magnification showing cornea and sclera at the limbus, with a continuous lining of epithelium on the inner aspect. Hematoxylin and eosin, original magnification 2 × . (b) On higher magnification, a nonkeratinizing stratified squamous epithelium is lining the inner aspect of the sclera. Hematoxylin and eosin, original magnification 10×.

Table 2. Signalment, laterality, time from evisceration to enucleation, and histopathological features of scleral shells from dogs with neoplasia

Case	Breed	Gender	Age (years)	Eye	Time* (months)	Diagnosis	Diagnosis of evisceration	Uveal remnants
1	Beagle	FS	0.75	OS	0.7	PNET	PNET	N
2	Rottweiler	FS	8	OD	0.5	Anaplastic	–	Y
3	Cocker	FS	11	OS	6	MM	–	N
4	Cocker	FS	13	OD	19	CBA	CBA	Y
5	Husky	FS	9	OD	4	SCTBED	SCTBED	Y
6	NFL	MC	8	OS	3	Anaplastic	Anaplastic	N
7	Ridgeback	FS	6	OS	11	MM	MM	N
8	N. Elkhound	MC	14	OS	12	Metastatic	Metastatic	N
9	Mix	MC	10	OS	60	SCTBED	–	N
10	Mix	FS	10	OD	4	SCTBED	SCTBED	N
11	Boxer	M	4	OD	1	Lymphoma	Lymphoma	Y
12	Rottweiler	FS	8	OS	12	Melanocytoma	Melanocytoma	N
13	Pomeranian	MC	5	OS	2	MM	MM	Y
14	Mix	MC	7	OS	30	MM	–	Y
15	Beagle	MC	11	OD	6	MM	–	N
16	Chihuahua	FS	9	OD	32	MM	NTS	N
17	Labrador	FS	8	OS	84	Leiomyosarcoma	–	Y
18	Cocker	FS	13	OS	–	MM	–	Y
19	Mix	MC	7	OS	17	Melanocytoma	Melanocytoma	N
20	JRT	MC	13	OD	5	MM	–	N
21	Labrador	FS	10	OS	0.6	NTS (MM in orbit)	MM	Y
22	Labrador	MC	12	OS	23	CBA	CBA	N
23	Wheaton	MC	9	OS	1.5	MM	MM	Y
24	Affenpinscher	MC	7	OD	1	MM	–	Y
25	Ridgeback	FS	10	OS	2.5	CBA	CBA	N
26	Mix	FS	8	OS	0.3	Melanocytoma	Melanocytoma	N
27	Labrador	MC	10	OS	3	MM	MM	N
28	Labrador	MC	10	OS	24	MM	–	Y
29	Maltese	FS	12	OD	–	Melanocytoma	–	Y
30	Labrador	MC	10	OS	72	CBA	–	N
31	Bassett Hound	M	4.8	OD	1	MM	MM	Y

CBA = ciliary body tumor; F = female; FS = female spayed; JRT = Jack Russell Terrier; M = male; MC = male castrated; MM = malignant melanoma; N = no; N. Elkhound = Norwegian Elkhound; NFL = Newfoundland; NTS = no tumor seen; OD = right eye; OS = left eye; OU = both eyes; PNET = primitive neuroectodermal tumor; SCTBED = spindle cell tumor of blue-eyed dogs; Y = yes.
(–) Indicates that the information was not available.
*Time from evisceration to enucleation.

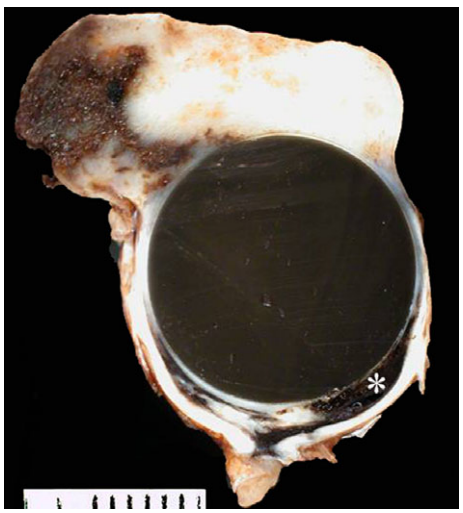

Figure 3. Corneal leiomyosarcoma in an enucleated canine scleral shell. Note that the silicone prosthesis is still within the shell. The asterisk shows remains of uveal tissue on the posterior aspect of the fibrous tunic. Bar = 1 cm.

features of the feline shells are summarized in Table 3. The mean age at enucleation of the shell was 11 ± 4.8 years (range, 3–19 years). The time between evisceration and enucleation was 14.68 ± 12.53 months (range, 2–36 months). The tumor diagnoses were FDIM in six cases (75%; Fig. 4), and two cases were diagnosed with post-traumatic sarcoma (25%). Both, the evisceration and enucleation samples were received from three cats, and the diagnosis concurred in both specimens for all three cats (FDIM).

DISCUSSION

Results of this retrospective study reveal that severe corneal disease and recurrence of an intraocular tumor are the most common causes of intrascleral prosthesis failure in dogs. Recurrent neoplasia is the single most common cause of scleral shell failure in cats. This study underscores the importance of submitting evisceration contents for histopathological analysis,[11] especially in eyes in which

Table 3. Signalment, laterality, time from evisceration to enucleation, and histopathological features of scleral shells from cats

Case	Breed	Gender	Age (years)	Eye	Time* (months)	Diagnosis	Diagnosis of evisceration	ED	Uveal remnants
1	DSH	MC	9	–	–	Eosinophilic inflammation	–	N	Y
2	DSH	M	8	OD	2	FDIM	–	N	N
3	DLH	MC	10	OS	14	PTS	–	N	N
4	DLH	MC	15	OD	36	PTS	–	N	N
5	Siamese	MC	11	OD	12	FDIM	–	N	N
6	DSH	MC	10	–	100	Keratitis	–	Y	Y
7	DSH	MC	13	OD	7	FDIM	FDIM	N	N
8	DSH	FS	3	OD	13	FDIM	FDIM	N	Y
9	Himalayan	MC	10	OS	2.5	FDIM	FDIM	N	Y
10	DMH	MC	19	OD	31	FDIM	–	N	Y
11	DSH	FS	11	OS	1	Keratitis (prophyl)†	FDIM	N	Y
12	DLH	FS	8	OS	2	Keratitis	–	Y	N

ED = epithelial downgrowth; DLH = domestic long-haired; DMH = domestic medium-haired; DSH = Domestic Short-haired; F = female; FDIM = feline diffuse iris melanoma; FS = female spayed; M = male; MC = male castrated; N = no; OD = right eye; OS = left eye; OU = both eyes; PTS = post-traumatic sarcoma; Y = yes.
(–) Indicates that the information was not available.
*Time from evisceration to enucleation.
†This globe was prophylactically removed because of a previous diagnosis of FDIM.

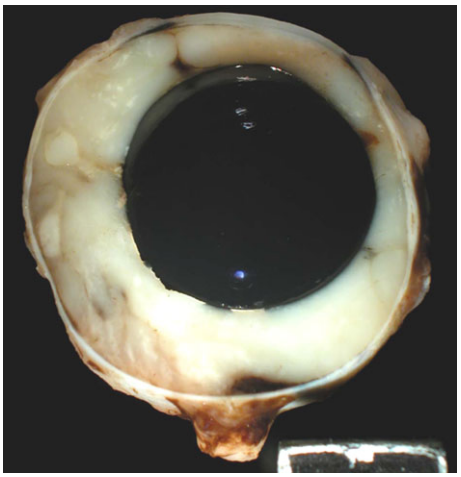

Figure 4. Feline scleral shell showing the regrowth of a diffuse iris melanoma. Note that the silicone prosthesis is still within the shell. Bar = 1 cm.

opacity of the media precludes a complete ophthalmic examination.

Typical histological findings in enucleated scleral shells included corneal epithelial hyperplasia and keratinization, corneal stromal pigment, fibrosis and neovascularization, and a thick cell-poor fibrous membrane lining the inner aspect of the fibrous tunic and replacing the endothelium. The corneal epithelial and stromal changes may be a consequence of postoperative keratitis, which in turn is believed to be caused by corneal exposure or damage during surgery and loss of the uveal tract and aqueous humor, with the possible contribution of a transient KCS.[6,9] The dense, inflammation-free fibrous membrane is likely a response to the inert, nontoxic silicone prosthetic implant.[1] This same reaction has been reported to occur on the surfaces in contact with the silicone implant in enucleated and eviscerated eyes of dogs.[12]

Corneal disease has been described as one of the most common complications after evisceration surgery,[1,2,5,6,9] which is supported by the results of the canine population included in this histopathological study. Only 10 of the 38 scleral shells (26.31%) belonged to dogs of brachycephalic breeds, which indicates that any breed is at risk of these complications.

Although pre-existing corneal disease has also been reported as a contraindication for evisceration surgery, some authors report success even in the face of corneal laceration.[13] In our case series, seven of the 38 scleral shells with corneal complications had a history of corneal/scleral disease (two KCS, two corneal ulcers, two scleral ruptures, and one corneoscleral laceration) prior to evisceration, but we do not have information about eviscerated globes with pre-existing corneal disease in which the procedure was successful as a control population.

Perforations, most commonly axial, were the most frequent corneal disease encountered in enucleated scleral shells in the current study, followed by keratitides and suture dehiscences. Axial corneal ulcers were the most common postoperative complication in one study[9] and were seen in over half of the globes undergoing evisceration in another study.[14] The authors attributed it to potential neurotrophic keratitis, because nerve fiber density is greatest in the central cornea of the dog.[15] Corneal sensitivity did not significantly decrease after evisceration surgery, although both preoperative and postoperative sensitivities were lower when compared with control eyes; this difference was attributed to the presence of buphthalmos rather than the surgery itself.[14] A decrease in aqueous tear production was reported in a few patients postoperatively, and KCS was considered as a possible long-term

complication after evisceration surgery.[9,14] In our study, two dogs were reported to develop KCS between the evisceration and the enucleation surgery, and in four more it was not specified whether KCS developed before or after the evisceration.

The definition of epithelial downgrowth is the intraocular invasion of nonkeratinized stratified squamous epithelium progressively covering the inner aspect of the globe, including posterior aspect of the cornea, iris, and posteriorly into the ciliary body.[16] It is an uncommon complication of intraocular surgery or penetrating intraocular trauma.[10,16] In humans, it is most commonly seen after cataract surgery, but it is also described after other procedures, such as penetrating keratoplasty, perforated corneal ulcer, intracapsular lens extraction, and pterygium excision.[10] The pathogenesis is unclear and believed to be multifactorial. The corneal and/or conjunctival epithelium is thought to be the origin of the epithelium that is introduced by implantation, tissue flap, or ingrowth along a tract. Epithelial downgrowth is associated with multiple complications, the most severe of which is secondary glaucoma through various mechanisms: epithelial growth over the trabecular meshwork, angle closure from peripheral anterior synechia, clogging of the meshwork with epithelial cells or mucus, and pupillary block.[10] In humans, three cases of epithelial downgrowth have been described as a very rare complication after evisceration surgery.[17–19]

In the veterinary literature, epithelial downgrowth has only been reported once, in a dog following intracapsular lens extraction.[20] In our case series, 14 scleral shells with corneal disease, including corneal perforation, suture dehiscence, and keratitis, had epithelial downgrowth. The presence of epithelium at the edges of perforations or surrounding suture material at the limbus suggests that epithelium may have grown along corneal or scleral defects or might have been implanted during surgery as has been described in the human ophthalmic literature.[10] The presence of this epithelial tissue within the fibrous tunic in eviscerated globes may have contributed to inflammation and implant extrusion in some of the cases presented here.

The most common tumor type found in canine scleral shells was malignant melanoma, accounting for almost half of the shells with neoplasia. Melanocytic tumors are considered the most common primary intraocular neoplasia,[21] with melanocytomas being more commonly encountered than malignant melanomas.[22] The higher proportion of the histologically malignant counterpart of melanocytic uveal tumors within scleral shells could indicate that these have a higher tendency to recur. Occurrence of malignant melanoma within melanocytoma has also been reported,[22] and could be that the more malignant cells within these tumors are the ones to proliferate in the scleral shell. In the cases in which both the evisceration material and the scleral shell of the same animal were histologically evaluated the diagnoses concurred, so this hypothesis cannot be confirmed at this point.

The present study shows that in dogs, benign neoplasms such as uveal melanocytomas, ciliary body tumors, and spindle cell tumors of blue-eyed dogs can also recur in the fibrous tunic. These three tumor types accounted for 71.15% of the eviscerations diagnosed with a tumor, and 35.47% of the scleral shells with a tumor. Although these two populations are not directly comparable because not all the eviscerations with a tumor were eventually enucleated and examined histologically, the relative decrease in the proportion of benign tumors could be attributed to the fact that indeed some of these might not recur in the scleral shell. Alternatively, it is also possible that tumors perceived to be malignant by the clinician are more likely to undergo enucleation in the first place, relatively increasing the proportion of benign tumors seen in eviscerated contents. The recurrence of a benign neoplasm within the scleral shell could be due to the presence of tumor cells in the sclera at the time of evisceration. In a histopathological study about melanocytic intraocular neoplasm it was found that most of the tumors had invaded the sclera at the time of enucleation.[23] Adenocarcinomas of iridociliary origin are defined by the presence of tumor cells invading the sclera.[24] In the present study, it was not uncommon to find uveal remnants in the inner aspect of the scleral shell, which indicated that, potentially, even if the tumor was not invading the sclera, it was possible that neoplastic uveal remnants within the shell were the origin of the regrowth. Similarly, in the dog in which no tumor was seen in the evisceration sample, but a malignant melanoma was diagnosed in the scleral shell, it could be speculated that the tumor arose from the uveal remnants within the scleral shell, although this cannot be proven. Alternatively, it is possible that the tumor was not present in the plane of section of the evisceration material on the slide, although it is standard in the COPLOW to include all the uveal, retinal, and lens fragments received in the histology cassette.

Of interest is the diagnosis of a corneal leiomyosarcoma in one fibrous tunic. To the best of the authors' knowledge, this tumor has not been previously reported to occur in the cornea. We did not have information about the ophthalmic medical history of this globe prior to evisceration, but the time elapsed between evisceration and enucleation (84 months) and the occurrence of the tumor in the cornea itself could indicate that this neoplasia might have arisen de novo in the fibrous tunic after the evisceration procedure.

Metastatic disease was diagnosed in 12.2% of canine eviscerations with neoplasia (including the five lymphoma cases) and in two canine scleral shells. The discovery of a metastatic neoplasm within the eye should prompt a search for the primary tumor and, even if the primary tumor has already been diagnosed, extensive follow-up and appropriate treatment should be discussed with the owner.[8]

Performing an evisceration in feline eyes is controversial, although successful results are reported in the

literature.[25,26] The major reason for intrascleral prosthesis failure in this species was neoplasia growing within it, most commonly FDIM. FDIM is the most frequent primary intraocular tumor in cats[22,27] and, like the majority of intraocular feline neoplasia, bears metastatic potential.[22,27,28] The possibility of post-traumatic sarcoma occurring after intraocular surgery in this species has also been speculated,[29] and close monitoring should be discussed with the owner. In the present study, two of the eight feline scleral shells with tumor had a post-traumatic sarcoma, but the evisceration specimen of these cases was not available to assess tumor presence prior to evisceration.

In conclusion, the most common causes for intrascleral prosthesis failure in dogs are corneal disease followed by neoplasia, whereas in cats, most failures are due to the presence of a tumor within the shell. Evisceration contents and scleral shells should always be submitted for histopathological analysis to assess the presence of inadvertent neoplasia and hence plan the postoperative management accordingly.

ACKNOWLEDGMENTS

The authors would like to thank Kate Lieber for her help in managing the paperwork of the cases and with the references.

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