



## Diagnosis, Medical and Operative Treatments of Lens Diseases in Cats and Dogs

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**How to cite:** Demir A, Düzgün O. Diagnosis, medical and operative treatments of lens diseases in cats and dogs. Erciyes Univ Vet Fak Derg 2021; 18(3): 152-165

**Abstract:** Lens diseases are common causes of blindness. These diseases, which cause vision loss if not diagnosed and treated early, are among the most important eye problems that negatively affect the living standards of cats and dogs. The aim of this study was to determine the distribution of lens diseases among cats and dogs according to breed, age and etiological causes, determine the conditions affecting the diagnosis and treatment of these diseases, report the success of the treatment, and present the data. The study material consisted of a total of 45 patients, 17 cats and 28 dogs of different ages, sexes and breeds brought to Istanbul University-Cerrahpaşa, Faculty of Veterinary Medicine, Department of Surgery and diagnosed with lens disease. After an anamnesis, signalement, a detailed eye examination, the diagnosis of the disease and its relationship with other ocular and systemic diseases were investigated, treatment procedures were determined and performed. Postoperative results of the surgical technique and success rates were determined. Patients were checked at regular intervals after treatment.

**Keywords:** Canine, cataract, feline, lens, treatment

### Kedi ve Köpeklerde Lens Hastalıklarının Tanısı, Medikal ve Operatif Tedavileri

**Öz:** Lens hastalıkları, körlüğün yaygın nedenlerindedir. Erken teşhis ve tedavi edilmediğinde görme kaybına neden olan bu hastalıklar, kedi ve köpeklerin yaşam standartlarını olumsuz etkileyen en önemli göz problemlerinden biridir. Bu çalışmanın amacı, kedi ve köpeklerde lens hastalıklarının ırk, yaş ve etiyolojik nedenlere göre dağılımı, bu hastalıkların tanı ve tedavisine etki eden durumları belirlemek, tedavi başarısını raporlamak ve verileri sunmaktır. Çalışmanın materyalini İstanbul Üniversitesi- Cerrahpaşa, Veteriner Fakültesi Cerrahi Anabilim Dalı'na getirilen ve lens hastalığı tanısı konulan farklı yaş, cinsiyet ve ırktan 17 kedi ve 28 köpek olmak üzere toplam 45 hasta oluşturdu. Anamnez, signalement, detaylı göz muayenesi, hastalığın tanısı ve diğer oküler ve sistemik hastalıklarla ilişkisi araştırılarak tedavi prosedürleri belirlendi. Cerrahi tekniğin postoperatif sonuçları ve başarı oranları belirtildi. Tedaviden sonra hastalar düzenli aralıklarla kontrol edildi.

**Anahtar kelimeler:** Katarakt, kedi, köpek, lens, tedavi

### Introduction

Lens diseases are common eye diseases seen in small animal practice (Ramani et al., 2013). They should be classified as developmental and acquired disorders (Mitchell, 2013). Developmental lesions can be seen in the form of aphakia, Peter's anomaly/keratolenticular dysgenesis, lenticonus-lentiglobus, coloboma, microphthalmia, and embryonic vascular anomalies caused by physiological and pathological changes in the embryonic period, and examples of acquired lesions are postpartum lens sub/luxation, cataract, and senile nuclear sclerosis (Gilger, 2013; Mitchell, 2013). While rare developmental disorders of this structure, which is very important in terms of providing vision, are usually seen together with another eye anomaly, acquired disorders of the lens are quite common (Gilger, 2013). The most common lesions in small animals are cataracts and lens luxa-

tion (Gilger, 2013; Ramani et al., 2013). The variety of underlying causes is quite extensive and includes numerous types of trauma (bunt, sharp), congenital anomalies, genetic defects, intraocular diseases (uveitis, glaucoma, etc.), senile degeneration, neoplasia, physiologic, infection (bacterial, fungal, viral), metabolic diseases (diabetes other endocrine diseases), toxic, nutritional, radiation (Mitchell, 2013; Ramani et al., 2013). Diagnosis of lens diseases is often possible with anamnesis, physical examination and a detailed ophthalmic examination (intraocular pressure (IOP) measurement, ophthalmoscopy, slit-lamp bio microscopy, ocular ultrasonography (USG), electroretinography, orbital magnetic resonance imaging, and computed tomography) (Lowe, 2014). Treatment is divided into two groups as medical and operative depending on the etiopathogenesis and clinical form of the disease, the relationship of the lens with other ocular structures, and the degree of the opacity of the lens (Mitchell, 2013). Medical treatment consists of the use of appropriate drugs (preserving the position

of the lens, preventing the formation of secondary uveitis and glaucoma) and antioxidant formulations in cases in which operative treatment cannot be performed (Zhao et al., 2015). Operative treatment involves the removal of the lens or lens material using the dissection-aspiration, intracapsular lens extraction (ICLE), extracapsular lens extraction (ECLE), phacoemulsification-aspiration (phaco) methods (Gilger, 2013; Arican et al., 2014).

The rate of eye diseases in cats and dogs brought to our clinic is increasing day by day. Among these, the number of lens diseases is considerable. In this study, possible etiology and clinical appearance of lens lesions and diseases encountered in cats and dogs are revealed; It is requested that sharing the results obtained from diagnosis and applied treatment methods contribute to the knowledge and to our clinician colleagues.

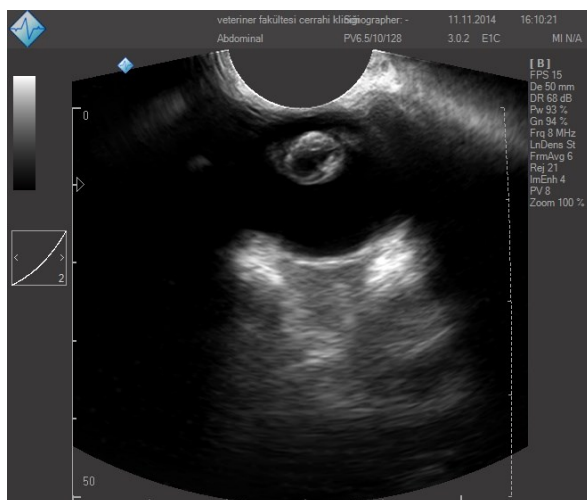
## Material and Method

### Study group of animals

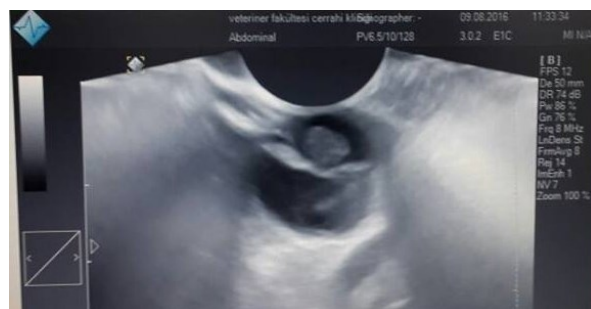
The clinical cases of 28 dogs of different breeds with lens diseases were managed with medical and surgical methods at the Ophthalmology Clinic, Department of Surgery at Istanbul University-Cerrahpaşa, Veterinary Faculty, were evaluated complete ophthalmic and systemic examination findings, signalement, causes, duration and morphological features of the lesions were evaluated and recorded.

### Evaluation of lesions

After anamnesis, a detailed ophthalmic examination was performed using fluorescein test, schirmer's tear test, tonovet, direct ophthalmoscope, and ocular ultrasound (Figure 1-2).



**Figure 1.** Ultrasonographic image of a mature cataract in a 10-year-old Cocker Spaniel.



**Figure 2.** Ultrasonographic appearance of eye with traumatic lens luxation and cataract in a 4-year-old British shorthair cat.

Lenticular lesions were classified into 5 groups as follows: cataract (n=50), lens luxation /subluxation (n=14), aphakia (n=1), PPM (n=3) and lenticular coloboma (1).

## Treatment

### 1-Medical treatment

In cases of lens sub/luxation, 1 g/kg systemic mannitol (20%, Mannitol, Polifarma, Turkey) intravenous (IV) and topical carbonic anhydrase inhibitor timolol maleate and dorzolamide 3x1 (Cosopt®, Merck Sharp and Dohme, Turkey), which reduce secondary aqueous humor production, were applied to prevent and treat secondary increase in IOP, and 2x1 prednisolone sodium phosphate (Norsol MEF, Turkey) was administered to prevent secondary inflammation. In several cases in which a cataract was detected and the lens material did not mature, topical antioxidant 2% N-acetyl-carnosine, glutathione, cysteine, ascorbate, L-taurine, and riboflavin (OcluVet, Practivet, USA) were administered three times a day for three to six months. The follow-up of the patients in the medical treatment group were performed at two, four and eight weeks after the initiation of treatment. In the follow-up session, improvement or disease progression in the lens material was evaluated.

Patients who were brought to our clinic with corneal and lenticular capsular perforation and did not require surgery were administered ofloxacin (Exocin, Abdi Ibrahim) and sodium hyaluronate (Eyestil, Teka) 5x1 for the first 3 days every hour, and cyclopentolate (Sikloplejin, Abdi Ibrahim) 2x1 for 2-4 weeks to prevent reflex uveitis. The position and transparency of the lens, the duration of the lesion, and the effect of accompanying ocular findings on the success rate of the operated eye were evaluated.

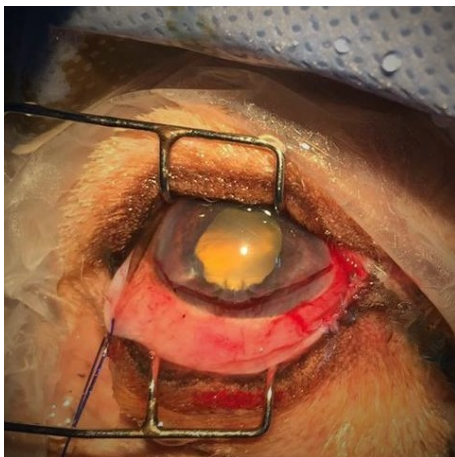
### 2-Surgical treatment

**Preoperative procedures;** Topical broad-spectrum antibiotics 0.3% ofloxacin (Exocin, Abdi Ibrahim) and prednisolone sodium phosphate (Norsol, MEF) were given 3x1 prior the operation. For mydriasis 1% tropi-

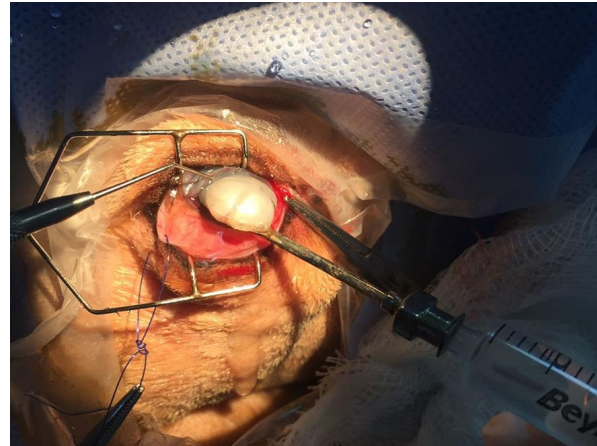
camide (Tropamid, Bilim Pharmaceuticals) and 1% cyclopentolate hydrochloride (Sikloplejin, Abdi İbrahim) were applied as 2x1 for three days before the operation, and as two drops each one hour before the operation at 10-minute intervals. Use was made of 1 g/kg systemic mannitol (20%, Mannitol, Polifarma, Turkey) intravenous (IV) and topical carbonic anhydrase inhibitor timolol maleate and dorzolamide 2-3x1 (Cosopt®, Merck Sharp and Dohme, Turkey) to prevent or to decrease secondary intraocular pressure increase for the ICLE method in the lens sub/luxation. Systemic ceftriaxone (Novosef® Zentiva, Turkey) 25 mg / kg intravenous (iv) and meloxicam (Melox, Nobel, Turkey) 0.2 mg / kg subcutaneous (sc) were applied one hour before surgery.

**Surgical procedures:** All operations were undertaken with a microscope (YSX Series Light-Weight). Premedication consisted of 0.5-1 mg/kg IV xylazine hydrochloride (Rompun, Bayer, Turkey), and anesthesia was induced by administration of 5 mg/kg IV ketamine hydrochloride (Ketamine, Bremer Pharma, Germany) and maintained by 2-3% isoflurane (Isoflurane USP, Adeka, Turkey). The patients were placed in a dorsal decubency position under general anesthesia. Surgical preparation of the eyes included thorough lavage of ocular surface and conjunctival sacs 0.5 % povidone iodine solutions followed by flushing of the eye with sterile saline. The eyelids were scrubbed with 5% povidone iodine solution and washed with sterile saline. After ocular surface cleaning, the eyeballs were fixed with several temporary sutures using 3/0 propylene and/or blepharosta depends on the situation.

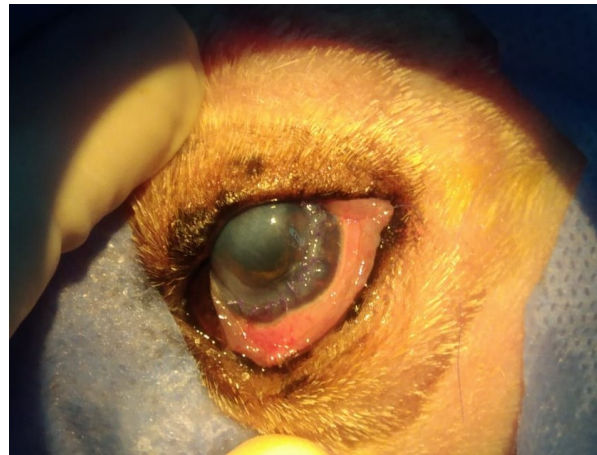
**Intracapsular lens extraction technique (ICLE):** In most or all cases of damaged zonular fibrils, lens extraction was achieved using the ICLE method. After performing a 3.2-mm main incision, viscoelastic 1.4% sodium hyaluronate (Healon GV-OVDs, USA) gel was injected. The corneal incision was enlarged to 150-170 mm in length (Figure 3).



**Figure 3.** Corneal incision for intracapsular lens extraction.

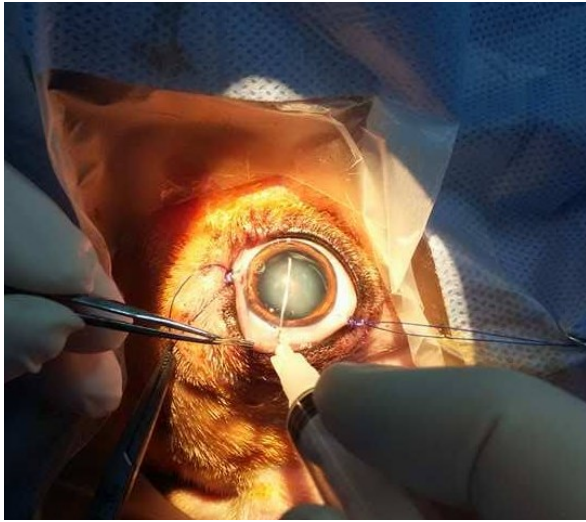


**Figure 4.** Removal of the luxate lens by intracapsular extraction method.

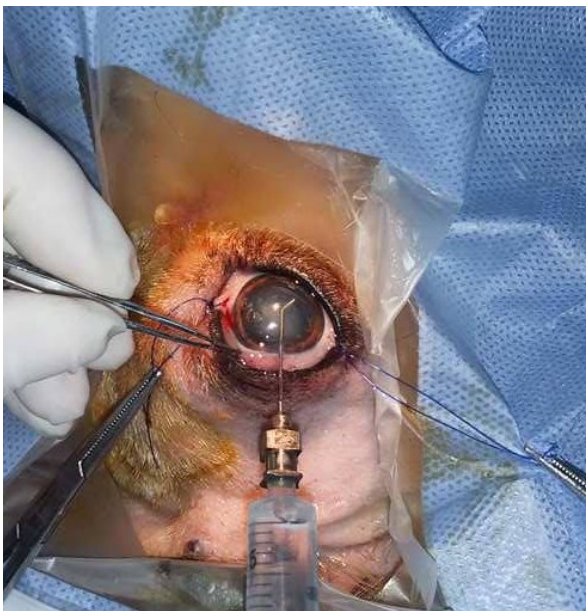


**Figure 5.** Closing the corneal incision with simple separate sutures after the ICLE method.

**Extracapsular lens extraction technique (ECLE):** ECLE was used in some of the cases in which the lens material was matured (mature and hyper mature cataracts). The technique was started with a 150-170 mm wide non-full-thickness incision from the limbus. The entry was made at the 12 o'clock position with a 3.2-mm corneal knife, and 0.5-1 ml trypan blue was injected. Viscoelastic gel was injected into the eye to restore the volume of the anterior chamber that had collapsed. The capsulorhexis procedure was started with a cystotome and completed with ultrata forceps (Figure 6).



**Figure 6.** Capsulorhexis procedure with cystotome.

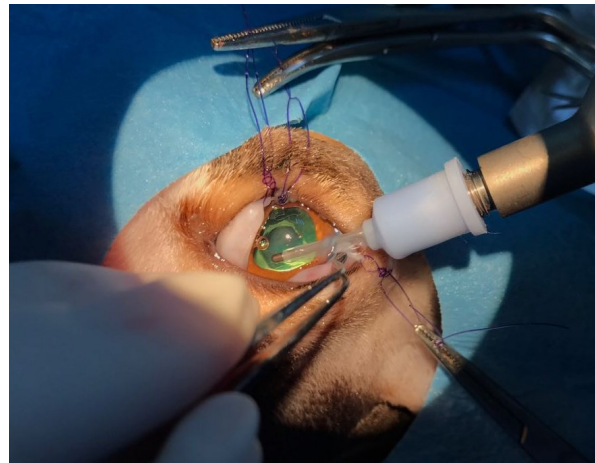


**Figure 7.** Hydro dissection process before phacoemulsification with blunt triple irrigation cannula.

The non-full-thickness corneal incision was converted to full-thickness using corneal scissors. The moving lens material was removed from the eye using a lens manipulation hook by applying pressure from the 12 o'clock position. The remaining part of the cortex and viscoelastic material was cleaned by aspiration-irrigation. The corneal incision was closed with 8/0 polyglactin 910 (Vicryl, Ethicon, USA) using simple individual sutures.

**Phacoemulsification-aspiration technique:** In cases where the lens material was removed by the

phacoemulsification method, the preparation steps of the operation were performed as in the ECLE method. The operation was started with a 1.2-mm side entry from the corneal region at the 1-2 o'clock position and trypan blue was injected into the eye. The main incision was made with a 3.2-mm corneal knife at the 10-12 o'clock. Other procedures until the release of the lens material were repeated as in the ECLE method. The released cataract material was disintegrated by the phacoemulsification method and removed from the eye. Emulsification was performed bimanually in most cases with the help of a phaco chopper inserted through the side incision. The remaining cortex material was cleaned by aspiration-irrigation (Figure 8), and the cornea was closed with 8/0 polyglactin 910 (Vicryl, Ethicon, USA) using simple individual sutures (2-3 sutures).



**Figure 8.** The appearance during aspiration-irrigation after phacoemulsification in a cat.

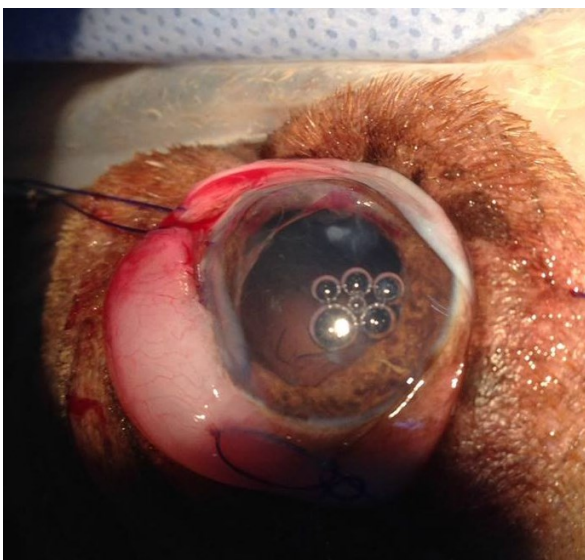
**Discission-aspiration:** This method was used in immature and intumescent cataracts (in cats) where the lens material was soft. The procedure is the same as the phaco method, but it was carried out in a very short time without using any ultrasonic vibration during the removal of the lens material and withdrawn from the inside of the eye (Figure 9), and the other stages continued in the same way as in the phacoemulsification.



**Figure 9.** The appearance of the eyes after bilateral dissection-aspiration of the 2nd cat case.

**Corneal repairing technique:** The patients that presented with corneal perforation and lens damage and required emergency surgery underwent corneal perforation repair under general anesthesia, as well as lens removal if necessary. Corneal repair was achieved by simple sutures with 8/0 vicryl (PGA). After corneal sutures, tarsorrhaphy was also applied to some of the patients and these tarsorrhaphy sutures were removed after 10-14 days. Intensive postoperative medical treatment was applied as in the ECLE and phacoemulsification methods.

**Postoperative treatment and follow-up:** After the operation, all patients were administered 2-4 mg of dexamethasone (Decorte, Deva, Turkey) at a dose of 8 mg/2 ml using the subconjunctival route (Figure 10), and 25 mg/kg IM systemic antibiotic ceftriaxone (Novosef, Zentiva, Turkey) was applied for one week and 2 mg/kg oral prednisone (Prednol, Mustafa-Nevezat, Turkey) for one to two weeks.



**Figure 10.** Conjunctival swelling due to subconjunctival injection after phacoemulsification in a 7 year old Pointer.

Topical 0.3% ofloxacin (Exocin, Abdi İbrahim, Turkey) and prednisolone sodium phosphate (Norsol, Mefar, Turkey) were applied every hour for the first three days, followed by 6x1, reducing the dose every week. For mydriasis, 1% cyclopentolate HCl (Sikloplejin, Abdi İbrahim, Turkey) was administered as two drops on the first day, followed by one drop once a day for a total of two weeks. As a prophylactic against an increase in IOP, topical carbonic anhydrase inhibitor was given 2x1 for the first three days, followed by 1x1 for a week. In cases with a preoperative increase in IOP, one drop of topical carbonic anhydrase inhibitor was applied 3x1 for three to six weeks and 1 g/kg IV systemic mannitol (Mannitol, Polifarma, Turkey) was administered for three days. Mydriatic was not applied to these cases. In cases where postoperative corneal edema occurred, 5% sodium chloride (Hypertonic solution, Liba, Turkey) was included in the treatment as 4x1 for one to two weeks. The follow-up of all the patients in the operative group was performed on the first and three days, first and second weeks and first and second months postoperatively.

## Results

A total of 69 eyes of 17 cats (27 eyes) and 28 dogs (42 eyes) were included in this study. Table 1 and 2 show breed, age, sex of dogs and cats affected with lenticular lesions, diagnosis and etiology, clinical examination findings, treatment and prognosis (Table 1 and 2). The distribution of lens diseases of cats and dogs according to breeds is shown in Tables 1 and 2.

Table 1. The signalment, clinical findings, results of treatment of 28 dogs with lens disorders

Case No:	Age	Sex	Eye	Disease of Lens				Etiology of disorders				IOP				Treatment					Surgery	
				Right (R)		Left (L)		Right	Left	Right	Left	Right	Left	Medical	Surgery		Phaco		Enuc		R	L
				R	L	R	L	R	L	R	L	R	L	R	L	E	E	R	L			
1	9mths	M	R+L	C	C	Trauma	Trauma	9	11	X	X					X						+
2	13 yrs	F	R	C	-	Senil	-	12	-	-	X											-
3	15yrs	F	R+L	C	C	Senil	Senil	13	11						X							+
4	13yrs	F	L	-	L+C	-	Luxation	14	20	-	-											-
5	8 mths	M	R+L	C+P	C+P	Congenital	Congenital	12	14						X							-
6	13 yrs	M	L	-	C	-	Senil	-	11						X							+
7	6yrs	F	R	C+Co	-	Hereditary	-	17	15	x	x											+
8	1.5 yrs	M	L	-	C	-	Congenital	15	12						X							+
9	10yrs	M	R	C	-	Senil	-	11						X								+
10	6yrs	M	L	-	SL	Trauma	Trauma	21	65					X								-
11	7yrs	M	R	C	-	Trauma	-	12	16						X							+
12	6yrs	F	R+L	C	C	Diabet	Diabet	12	14	x	x											+
13	6yrs	F	R	SL	-	Hereditary	-	60	17					X								-
14	14 mths	M	L	-	C	-	Hereditary	17	7	x	x											-
15	8.5 yrs	M	R+L	C	C	Senil	Senil	11	14	x	x											-
16	3.5 yrs	M	R+L	C+L	C	Hereditary	Hereditary	74	16											X		-
17	2.5 yrs	F	R+L	C	C	Hereditary	Hereditary	12	18						X							+
18	15yrs	F	R	C+L	-	Luxation	-	36	17	x	x											-
19	14mths	M	R+L	C	C	Hereditary	Hereditary	5	11						X							+
20	11yrs	M	R	L	-	Hereditary	-	36		x	x											-
21	10yrs	F	R+L	C	C	Senil	Senil	16	17	x	X											-
22	15yrs	M	R+L	C	C	Senil	Senil	15	17						X							-
23	8yrs	M	R+L	C	C	Hereditary	Hereditary	14	12	x	X											-
24	10yrs	M	R+L	SL	SL+C	Luxation	Luxation	15	49	X	X			X								-
25	8.5 yrs	F	R+L	L+C	SL+C	Hereditary	Hereditary	32	48	x	x											-
26	6 yrs	M	R	A	-	Trauma	-	18	16	x	x											+
27	3.5 yrs	F	R	L+C	-	Hereditary	-	78						X								+
28	4 yrs	M	R+L	C	C	Hereditary	Hereditary	15	17	x	X											+

C.: Cataract, L.: Luxation, Co: Coloboma, SL.: Subluxation, A: Aphakia, ICLE: Intracapsular lens extraction, ECLE: Extracapsular lens extraction, Phaco: Phacoemulsification, Enuc: Enucleation.

**Table 2.** The signalment, clinical findings, results of treatment of 17 cats with lens disorders

Case No:	Age	Sex	Eye	Disease of Lens		Etiology of disorders		IOP		Treatment				Surgery			
				R	L	Right (R)	Left (L)	R	L	Medical	Surgery	Phaco	D-A	E	R	L	
1	3mths	F	R+L	C	C	Inflammation	Inflammation	11	13					X		+	+
2	4mths	M	R+L	C	C	Inflammation	Inflammation	17	18					X		+	+
3	8mths	M	R+L	C	C	Congenital	Congenital	8	9				X			+	+
4	4mths	F	R+L	C	C	Nutritional	Nutritional	14	16	X	X						
5	4mths	M	R	C	C	Inflammation	Inflammation	15	7					X			+
6	1.5 yrs	F	R+L	L	C	Inflammation	Inflammation	53	10		X				X		+
7	6 mths	M	R+L	C	C	Nutritional	Nutritional	14	17				X			+	+
8	1.5 yrs	F	R+L	C	C	Inflammation	Inflammation	12	11				X				+
9	4mths	F	R+L	C	C	Inflammation	Inflammation	9	10	X	X						
10	5mths	M	R+L	C	C	Inflammation	Inflammation	6	8	X	X						
11	2yrs	M	L	C+PPM	C	Congenital	Congenital	14	16				X				-
12	7yrs	M	R+L	C	C	Inflammation	Inflammation	7	11				X				-
13	4yrs	M	R	L+C	C	Trauma	Trauma	12	17				X				-
14	14mths	M	R	C	C	Trauma	Trauma	14	18	X	X					+	+
15	3yrs	M	L	C	C	Trauma	Trauma	15	16	X	X					+	+
16	3yrs	M	L	C	C	Trauma	Trauma	17	15	X	X					+	+
17	9yrs	M	L	SL	C	Inflammation	Inflammation	11	42					X			

PPP: Persistent pupillar membrane, ICLE: Intracapsular lens extraction, ECLE: Extracapsular lens extraction, Phaco: Phacoemulsification, D-A: Discission-Aspiration, E: Enucleation bulbi



**Figure 11.** Lenticular coloboma and insipient cataract in the right eye in a 6 year old Terrier.



**Figure 13.** PPM, iris cyst and cataract in the left eye in a cat 2 years old.

It was determined that aphakia occurred as a result of corneal perforation due to cat trauma in a beagle dog (Figure 14,15).

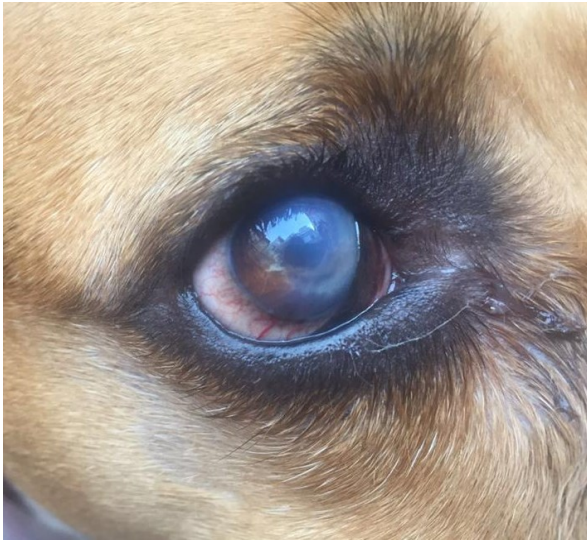


**Figure 12.** Bilateral microphthalmia, PPM and immature cataract in 8 months old King Charles Spaniel.



**Figure 14.** Post-traumatic corneal perforation and acute lens dislocation.

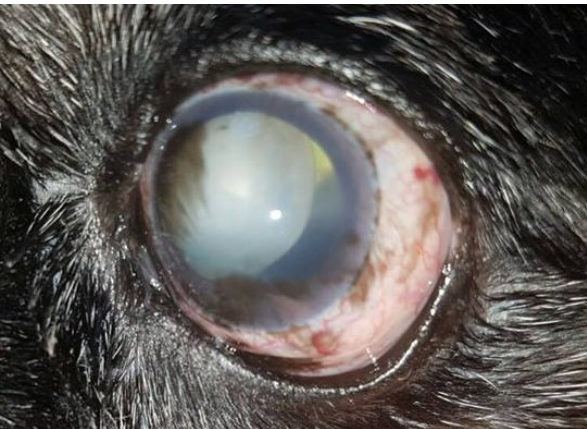




**Figure 15.** The appearance of the cornea 1 month after the operation in the 26th case.



**Figure 16.** Localized corneal edema and vascularisation with anterior lens luxation in a 13-year-old dog.



**Figure 17.** Aphakic crescent, secondary glaucoma, diffuse corneal edema and episcleral congestion appearance at lens subluxation of a dog.

Medical treatment was applied to 4 of 9 dogs with lens sub / luxation, enucleation was applied to one because of poor eye condition, and ICLE method was applied to 4 of them. Although three of the cases had preoperative blindness due to the secondary IOP increase, the lenses were removed by the ICLE method to balance the level of IOP. Postoperatively, vision was recovered in only one of these four dogs. There were no complications related to the ICLE method except postoperative corneal edema. In two of the three cats cases with lens luxation, the eyes were removed using enucleation bulbi method due to the development of secondary IOP increase and buphthalmos (Figure 18), while the lens material was removed using the ICLE method in the remaining case. After the ICLE procedure, the patient developed permanent corneal opacity and phytisis bulbi.



**Figure 18.** Buphthalmos due to secondary lens luxation after uveitis in a 1.5 year old cat.

Corneal suture, tarsarrophy and medical treatment were applied to one of the cat cases who developed cataract due to corneal and lens capsule damage due to penetrating trauma, 1 of them received tarsarrophy and medical treatment, and 2 of them received only medical treatment. Vision was obtained in 3 of 4 cases after treatment.

Cataract was diagnosed in 62 eyes of 40 patients, 24 dogs and 16 cats. According to the degree of maturation of cataracts in dogs, three of the eyes were incipient, 14 were immature, 10 were mature, and 10 were hypermature, while six of the cat eyes were incipient, nine were intumescent, three were immature, four were immature, and three were found to be hypermature (Table 1 and 2).

Topical antioxidant drops were prescribed for the six eyes of the five dogs with cataracts (Cases 7, 14, 16, 17 and 19); however, only the four eyes of three dogs received the drops. After the application in 4 eyes of 3 patients, it was determined that cataracts were

fixed in 2 cases, and cataract dissolved in the left eye of 1 patient and progressed in the right eye.



**Figure 19.** The appearance of both eyes 3 weeks after discission-aspiration in a 4-month-old cat.

Complications developed during the operation in 6 eyes of 5 dogs and 12 eyes of 9 cats that underwent cataract surgery. Hyphema (2/6), lens luxation (1/6), iris herniation (1/6), posterior capsular rupture (1/6), corneal thermal burn, and endothelial damage (1/6) occurred during the surgery of canine cataract cases, whereas in the feline cases; iris herniation (6/12), corneal endothelial damage (4/12) (Figure 20), posterior capsular tears (2/12), and hyphema (3/12) developed intraoperatively.



**Figure 20.** Localized corneal edema in the corneal entrance areas after the cataract material is removed by discission-aspiration in the right eye in a 3-month-old Domestic Shorthair cat.

In canine cases, after cataract surgery, either partial or total corneal edema was seen in almost all dogs, and there was anterior uveitis in eight, anterior syn-

echia in two, posterior capsule opacification in one, retinal detachment in one, glaucoma in three, and loss of vision in three. Among the cats, corneal edema was seen in all cases, anterior uveitis in nine, bullous keratopathy in two, anterior synechia in four, pupillary defect in seven, and fibro pupillary membrane in one. In one feline cataract case (Case no: 3), severe diffuse corneal edema (Figure 21)



**Figure 21.** Diffuse corneal edema and bullous keratopathy due to endothelial damage after phacoemulsification in an 8 month old British Shorthair cat.

occurred on the next days of operation and bullous keratopathy on day 5 day after the operation. One month after tarsorrhaphy sutures were removed and vision was retained only central corneal scar was seen. Vision was recovered in nine of the 13 eyes of the cats, while only slight improvement was observed in two cases due to postoperative complications, and the remaining four eyes had the findings of complete blindness due to intraoperative complications.

### Discussion and Conclusion

When the effect of visual function on living standards in animals is considered, the diseases of the lens which serve as one of the important refractive environments of the eye gain more importance. Lens diseases, which have an important place among the cases that are referred to the clinic and cause vision loss, are common in both dogs and cats (Ramani et al., 2013). These lesions are congenital and acquired; may be primary and secondary to other ophthalmic or systemic diseases (Mitchell, 2013).

The development of the lens and the anterior segment in cats and dogs is closely linked. During the development of the fetus, the existing pupillary membrane consisting of connective tissue and blood vessels normally forms a layer in front of the iris and regresses towards the end of fetal development or immediately after birth. The lack of regression of this tissue leads to the formation of uveal residues known as persistent papillary membrane (PPM), which appears as brown lines extending from the pupillary region to the cornea or lens. Although it is reported that dogs are more common than other species (Bauer et al., 2015), only one case (Case no: 5) was diagnosed as PPM in our study. In literature, it is reported that it is common in Chow Chow, Mastiff, Pembroke Welsh Corgi, and Basenji with anterior sub capsular cataract and microphthalmia (Bauer et al., 2015). In our study, this lesion was seen in a one year old King Charles dog with bilateral, mature cataract, nystagmus and microphthalmia. This rare condition in cats was observed in only one of the cases (Case no: 11). PPM was associated with other congenital anomalies such as unilateral cataract and iris cysts.

Lenticular coloboma due to closure of the optical fissure in the fetal period and lack of tissue induction during embryogenesis of the lens has been reported as a rarely observed lens anomaly. Typically it is reported to be at 6 o'clock and atypically with the presence of cataracts in varying forms in other equatorial areas of the lens (Lowe, 2014). Lenticular coloboma was found incidentally in only one case (Case number 7) of 28 dogs with lens disease and zonular loss areas were seen at 7-9 and 10-12 hours with subcapsular incipient cataract.

Lens subluxations are defined as the total or partial displacement of the lens to the anterior or posterior chamber due to zonular fibril damage (Sandmeyer et al., 2011; Lowe, 2014). They are divided into three groups according to anamnesis, breed, age, and examination findings as congenital, primary and secondary (Sandmeyer et al., 2011; Montgomery et al., 2014). Congenital lens luxation is a rare condition caused by developmental weakness or absence of zonular fibrils (Montgomery et al., 2014). Primary lens luxation (PLL) is an inherited ocular lesion that is bilateral but does not occur simultaneously in both eyes, and results in severe pain and often blindness (Lowe, 2014). In dogs, it has been reported to develop spontaneously mostly in the adult period (Gharahkhani et al., 2012; Betschart and Spiess, 2014). Of the four canine PLL cases in the current study, three belonged to Cocker Spaniels and one to a Siberian Husky. The mean age at which the disease was recognized in Cocker Spaniels was determined as 7.5 years. The results obtained were consistent with the previous publication which reported that PLL developed in Cocker Spaniel dogs sponta-

neously in adulthood (Engelhardt et al., 2008). In feline cases, predisposition to PLL was previously reported for the Siamese breed (Payen et al., 2011), but we did not have that breed in our study. Secondary lens luxations (SLL) are known as lens displacements that occur following zonular degeneration due to various factors, such as trauma, age, chronic intraocular inflammation, vitreous syneresis, and glaucoma (Mitchell, 2013). Betschart and Spiess, (2014) reported that in dogs, SLL developed mostly due to glaucoma, followed by cataract and trauma. In our study, it was determined that the canine SLL cases had been caused by age, cataract, and trauma. The results were consistent with those reported in the literature. In regard to the three feline lens-luxation cases in our study, two were secondary caused by anterior uveitis associated with systemic infection and one was due to penetrating trauma. These findings are in agreement with the literature studies indicating that lens luxations in cats mostly occur following secondary uveitis (Payen et al., 2011). Age is reported to be an important factor in the formation of lens luxations (Sandmeyer et al., 2011). In a study evaluating 20 dogs with lens luxations, Saroglu et al. (2007) reported that the mean age of the cases was 7.2 years, and Stuhr et al. (2009) calculated the mean age of 19 canine lens luxation cases as 8.6 (4-14) years. In the current study, the mean age of the nine dogs with lens luxations 7.38 (3.5-15) years. We also determined that the mean age of the four dogs with PLL was 7.1 years and that of five dogs with SLL was 10.1 years. These findings are consistent with the literature studies reporting that PLL is more common in younger cases while SLL is mostly caused by the degeneration of zonular fibrils at older ages (Betschart and Spiess, 2014).

Acute blindness is reported to occur due to physical obstruction and secondary rapid increase in IOP associated with the mechanical disruption of the normal intraocular fluid flow by the sub/luxate lenses and the consequent draining of the vitreous (Sandmeyer et al., 2011). Sandmeyer et al. (2011) reported that in the vast majority of the patients with lens subluxation, IOP was greater than 30 mmHg. In the current study, the mean IOP of the dogs with lens subluxation was 45.5 mmHg. This secondary IOP increase prior to the lens extraction process also has a significant effect on the prognosis. It is suggested that in cases of lens luxation with the indications for lens extraction, the lens should be removed from the eye within 72 hours after the formation of luxation before the increase in IOP; otherwise, the prognosis would be poor (Sandmeyer et al., 2011). We found that the patients that underwent lens extraction, all four canine cases and two of the three feline cases had an increased preoperative IOP. Furthermore, it was determined that the time from the formation of the lesion to presentation to the clinic was long for three of the

dogs and both cats and short for the remaining dog. Except case 8 that was brought to the clinic immediately after the lesion occurred, all canine and feline cases of lens luxation (Cases 10, 13 and 24) did not achieve the desired level of vision due to the delay in the detection and treatment of the lesions. While only the ICLE procedure was used to control IOP in some of these cases, enucleation was performed in others.

Cataract, which causes partial or total loss of vision, lowers living standards to a great extent (Mitchell, 2013). There are significant differences in the distribution of the cataract incidence in dogs according to breeds. In previous studies, the dog breeds that most commonly developed cataracts were reported to be German Shephard by Lal et al. (2017) and Yorkshire Terrier by Donzel et al. (2017). In addition, Cocker Spaniels (Lim et al., 2011) and Terriers (Bulut, 2016) were more frequently seen to develop cataracts. In the current study, of the 24 canine cataract cases, most were Terriers (n=10) and Cocker Spaniels (n=5), which is consistent with the reported distribution of the disease among dog breeds in the literature.

It is known that age has a very important effect on the formation of cataracts. The mean age of cataract occurrence was reported to be  $9.4 \pm 3.3$  years for dogs and  $12.7 \pm 3.5$  years for cats (Lim et al., 2011). Mitchell, (2013) found that older dogs had a higher incidence of cataract formation, with varying degrees of opacity observed in dogs older than 13.5 years. Lim et al. (2011) reported that the age of cataract formation in dogs varied according to breeds. Engelhardt et al. (2008) stated that in Cocker Spaniels, cataracts most frequently developed between the ages of four to seven years. In the current study, the majority of canine cases (62.5%) were middle-aged (7-15 year, mean 7.36 years), while the majority of feline cataract cases (64.70%) were in the early period of life under one year of age (mean 1.30 year).

Etiologic factors, such as genetics, metabolic diseases, senile degeneration, and ocular trauma (capsule tears), nutritional deficiency, toxic factors, radiation, intraocular diseases (inflammation, glaucoma, retinal diseases, etc.) are effective in the formation of cataract (Ramani et al., 2013; Patil et al., 2014; Thayananuphat, 2015). Some studies in the literature (Patil et al., 2014) implicate primary genetic conditions in the formation of cataracts in dogs while Ramani et al. (2013) suggest that age is an important factor. Patil et al. (2014) reported that the most common causes of cataract were hereditary defects, metabolic disease, anterior uveitis, age, and nutritional deficiency. In our study, the cases of canine cataract were mostly hereditary and senile, and those of feline cases were caused by anterior uveitis and trauma. These findings are consistent with the studies showing that cataracts in dogs are mostly hereditary and senile

(Thayananuphat, 2015; Donzel et al., 2017) while they are mostly associated with anterior uveitis in cats (Mitchell, 2013).

Lens capsule damage in penetrating trauma associated with corneal perforation is a common cause of lens lining and traumatic cataracts in veterinary medicine. One of the most common causes of this condition associated with penetrating and blunt objects is penetration by cat scratch (Paulsen and Kass, 2012). In our study, there were six traumatic cataracts that belonged to two dogs and four cats. Of the two canine cases (Cases 1 and 11), one was young and the other was middle-aged (unilateral in one and bilateral in the other), and both were due to blunt trauma. It was determined that the feline cases developed cataracts due to lens capsule damage after penetrating trauma at a young age. Although there are no publications reporting the effect of gender on cataracts, Bell et al. (2013) found that this type of lesion was more common in male cats. Similarly, all of our cats with traumatic cataracts were male. There are differences of opinion among researchers in the treatment of this damage. While some researchers (Lew et al., 2017) stated that the lens material should be prophylactically removed in capsule tears of 1.5-mm or greater to prevent the possibility of phacoclastic uveitis, others (Paulsen and Kass, 2012) suggested that cats and dogs could tolerate this condition and recover spontaneously through lens epithelial cell metaplasia or posterior synechia without the need for surgery. Paulsen and Kass (2012) reported that functional vision was achieved in eight patients after approximately one month follow-up of nine patients with corneal perforation and lens capsular damage. In our study, 100% operative success and functional vision were achieved through medical treatment in three cats with traumatic lens capsular damage (Cases 14 to 16). These findings indicate that in narrower lens capsule damages, application of medical treatment to prevent secondary lesions without the removal of the lens material is very important in the treatment of this group of patients, confirming the literature results (Paulsen and Kass, 2012).

In recent years, commercial formulations have been developed that contain natural antioxidants, such as N-acetyl carnosine, which are thought to dissolve the cataract material. It is considered that these substances, whose effects cannot yet be fully elucidated, have an effect on various free O<sup>2</sup> radicals. Some researchers (Zhao et al., 2015; Dubois and Bastawrous, 2017) reported varying degrees of reduction in lens opacities after the use of these agents. Williams and Munday (2006) applied topical drops of 2% N-acetyl carnosine, glutathione, cysteine ascorbate, L-taurine, and riboflavin (OcluVet™, Practivet, Phoenix, AZ, USA) to 30 dogs of various breeds and ages and reported that 47 of the 57 eyes (82%) had a measurable decrease in opacity. According to the

observations of the owners, 78% of the patients had increased visual acuity, 14% had no significant changes, and 8% had loss of vision. This application was performed in four eyes of three dog cases in our study material. There was no significant change in the two eyes of the two cases, but the progression in opacity did not continue during use, while in the remaining case, there was a decrease in the opacity of one eye (right eye) while the drug was ineffective for the other eye (left eye) and the opacity progressed. Although the results obtained from the current study are not in agreement with those reported by Williams and Munday (2006) we consider that this may be due to the insufficient number of cases treated in the current study.

In the surgical treatment of cataract, there are four different methods: dissection-aspiration, ICLE, ECLE, and phacoemulsification. The success of these methods is reported to depend on the early removal of the lens material (Lim et al., 2011). Özgencil (2005) applied ECLE and phacoemulsification in the treatment of 41 eyes of 25 dogs with cataracts and stated that there was no significant difference in the results and that the operation being performed in the intumescent-immature phase of cataract was more important for the success of the operation. Lim et al. (2011) similarly suggested that the postoperative success of cataracts in the mature and hyper mature stages was lower than those in the immature stage. In our study, it was observed that phacoemulsification was most effective in canine cataracts cases and dissection-aspiration in cats. Furthermore, the latter was found to have 100% success when applied to the five eyes of cats with an intumescent cataract, in which the lens material was very soft.

The phacoemulsification method, although having a high success rate and is less traumatic for the eye, has certain complications during and after surgery. Intraoperative complications include mycosis, hyphemia, radial tear, iris herniation, corneal thermal burn, posterior capsular tears and phagodenesis (Patil et al., 2014). The most common intraoperative complications were reported to be posterior capsular tears by Bulut (2016). In the current study, we observed hyphemia, lens luxation, iris damage, iris herniation, posterior capsular tears, corneal thermal burn, and endothelial damage in dogs and iris herniation, corneal endothelial damage, posterior capsular tears, and hyphemia as complications that developed in cats during the operation.

In the postoperative period, corneal ulceration, posterior synechia, ocular hypertension, persistent uveitis, endophthalmitis, hyphemia, capsular opacities, retinal detachment, iris bombe, wound opening, corneal edema, bullous keratopathy, and blindness have been reported (Thayananuphat, 2015; Wilkie et al., 2015). Özgencil (2005) mostly detected uveitis and

posterior capsular opacification while Wilkie et al. (2015) observed uveitis, glaucoma, intraocular hemorrhage, fibrin, and retinal detachment postoperatively. In our study, the postoperative complications according to their incidence were as follows: corneal edema, anterior uveitis, permanent corneal opacity, pupillary dyscoria, anterior synechia, blindness, and bullous keratopathy. We found corneal edema, permanent corneal opacity, papillary dyscoria, and anterior uveitis, findings in all the cat and dog cases during the postoperative follow-up, which is consistent with the publications indicating that these complications are common after cataract surgery (Lim et al., 2011; Bulut, 2016).

In order to be successful in the treatment of lens diseases, which are very important in providing visual function affecting the living standards of animals, it is thought that early diagnosis should be made, the appropriate treatment option should be determined and periodic controls should be done regularly. The results of this study showed that the most common and treatable cataract cases among lens diseases depend on the maturity level of the cataract and lens luxation operations should be performed before secondary glaucoma. In addition, this study will help veterinarians and owners to detect lens diseases earlier and take preventive measures for these diseases.

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