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Ocular Lesions and Neurologic Findings in Traumatic Birds: A Retrospective Evalution of 114 Cases

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Summary: This study was conducted to identify the occurrence and types of trauma-related ocular disorders in 114 birds belonging to 39 species. For this purpose, both detailed neurological examination and ophthalmologic examination results of the birds admitted to our clinics with a trauma history or trauma findings are presented. Thirty cases were evaluated to suffer from trauma-related eye injuries. Uvea lesions (n=12) were the most frequent disorder of traumatic eye injury. On cranial nerve assessment, anisocoria, pupillary light reflex, menace response, globe and third eyelid position, palpebral reflex, and nystagmus were evaluated. The most frequent neurologic finding of traumatic eye injury was anisocoria (n=9). Ophthalmologic examination accompanying neurological examination is the most important factor in the early management of traumatic birds.
Key words: Bird, cranial nerve assessment, treatment, traumatic eye injuries, uvea

Travmatik Kuşlarda Oküler Lezyonlar ve Nörolojik Bulguları: 114 Olgunun Retrospektif Değerlendirilmesi

Özet: Bu çalışma, 39 türe ait 114 kuşta travmaya bağlı göz bozukluklarının oluşumunu ve tiplerini belirlemek için yapılmıştır. Bu amaçla kliniğimize travma öyküsü veya travma bulguları ile başvuran kuşların hem detaylı nörolojik muayene hem de oftalmolojik muayene sonuçları sunulmuştur. Otuz vaka travmaya bağlı göz yaralanmalarından muzdarip olarak değerlendirildi. Uvea lezyonları (n=12) en sık travmatik göz yaralanması bozukluğuydu. Kraniyal sinir değerlendirmesinde anizokori, pupiller ışık refleksi, tehdit yanıtı, glob ve üçüncü göz kapağı pozisyonu, palpebral refleks ve nistagmus değerlendirildi. Travmatik göz yaralanmasının en sık görülen nörolojik bulgusu anizokoriydi (n=9). Nörolojik muayeneye eşlik eden oftalmolojik muayene, travmatik kuşların erken tedavisindeki en önemli faktördür.
Anahtar kelimeler: Kuş, cranial sinir değerlendirmesi, tedavi, travmatik göz hasarı, üvea

Introduction

Vision is often one of the five senses necessary for the social interaction between living animals and for raptors to survive, fly, find and seek food, understand the changing environment, and understand sexual selection and reproductive behavior (HoltandLayne, 2008; Moore et al., 2017). Especially for the nocturnal raptors hunting at night, the senses of vision and hearing are necessary to survive in the wild life (Seruca et al., 2012). Birds have large eyeballs relative to their body mass, with a strong siliar attachment to the lens, scleral bone and cartilage, thin cornea, large posterior segment, vascular pecten and avascular retina, and complete chiasm of optic nerve fibers (Davidson, 1997; Holtand Layne, 2008). Although the morphological structure of the bird eyes has been adjusted for high visual function, due to their ocular anatomy and unfavorable environmental conditions, especially free-living raptors are very vulnerable to ocular lesions, and trauma is the most common cause of ocular morbidity in these birds (Murphy et al., 1982; Bayon et al., 2007). The combination of these ocular features in birds contributes to the formation of a pathological process due to ocular trauma (Holt and Layne, 2008; Hudecki and Finegan, 2018). The majority of ocular injuries in free-living or captive wild animals are reported to be due to blunt or penetrating traumas (Moore et al., 2017). Blunt traumas are the most common eye injuries and occur as a result of hitting objects, such as parked or moving cars, windows, trees, and buildings during hunting and/or migration (Murphy et al., 1982; Davidson, 1997). It is also reported that more than 30% of traumatized birds have simultaneous ocular trauma findings (Seruca et al., 2012; Moore et al., 2017). Ocular lesions after trauma vary between bird species according to the anatomical structure, feeding style, and living conditions (Murphy et al., 1982). These ocular lesions affect retinal illumination, visual acuity, perception of depth, and binocular vision and cause negative changes in living conditions (Holt and Layne, 2008). The accurate and timely diagnosis and treatment of these lesions is, therefore, very

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important for free-living organisms.

The aim of this study was to evaluate the distribution of species, the causes of trauma, and the relationship between trauma and ocular disorders in traumatic birds admitted to the emergency department of an animal hospital.

Materials and Methods

This was a retrospective study of clinical case records to identify trauma-related ocular lesionsand neurologic findings of 114 birds of different species and ages admitted to the Small Animal Emergency Department of İstanbul University from January 2017 to February 2020. First of all, from the people who presented the bird to us, what exactly it was, why it was and the detailed information about the bird was taken. The type of trauma was divided into two as blunt or penetrating, and the ocular trauma cases were classified according to disease duration (e.g., acute and chronic) and based on anamnesis and/or pathological features, but the exact mechanism and history of injury could not be determined for most birds. In the clinical assessment of the birds, after physical evaluation by inspection, palpation, and if necessary radiography, the examination of the cranial nerves and a detailed ophthalmological examination were also undertaken in cases with visual impairment or ocular lesion findings. At the first assessment, the patient's posture, mental status, movements, and gait were observed remotely. Anisocoria, pupillary light reflex, menace response, globe and third eyelid position, palpebral reflex, and nystagmus reflexes were evaluated in the functional examination of cranial nerves. In cases showing physical signs of cranial trauma with an unknown etiology, a complete radiographic examination was performed to determine whether there was gunshot injury. The ophthalmic assessment started with a close examination of the skin of the eyelids, the integrity of the orbit and the position of the eyeball. Orbita, eyelid and bulbus injury, visual acuity of both eyes, response to light, anterior and posterior segments were evaluated. The presence of visual acuity, menace and pupil (direct and indirect) light reflex, the birds' ability to follow moving objects, and their attempt to peck an approaching object were determined based on their movement in the cage. Fluorescein staining was used to identify corneal erosions or ulcers in a dark room. The problems related to the cornea were evaluated by changing the discoloration and smoothness of the surface.

The course of the disease was assessed as acute or chronic according to the changes observed in ocular tissues. In eyelid lacerations, the presence of fresh hemorrhage or exudate, new appearance of wound lips, acute rupture, swelling of wound edges, cicatricial deformations, and presence of scar tissue were evaluated as chronic. Acute anterior uveitis, fibrin and active bleeding in the anterior chamber (Figure 1);

Figure 1. Diffuse iris neovascularisation with hyphema in Eurasian eagle-owl *(Bubo bubo)* 5 days after blunt trauma

chronic uveitis were accepted according to the presence of pupillary anterior or posterior synechia, fibrosis, and anterior segment deformities (Figure 2).

Figure 2. Two weeks after blunt trauma, hyphemare solution and pupillary irregularity and posterior synechia at 7 o'clock in a honey buzzard*(Pernis apivorus)*

In addition, multiple injuries (soft tissue injuries, fractures, torticollis, ear bleeding, etc.) with or without ocular findings were also identified in most of the cases.

The patients were treated with topical and systemic antibiotics, non-steroidal anti-inflammatory, antiglaucomatous drugs and fluids according to the injury. In cases of corneal perforation, the ruptured corneal region with 8/0 polyglactin 910 was closed with simple separate stitches and covered by tarsorrhaphy. During treatment, most of the birds were closely monitored for possible complications. During the followup, a detailed eye examination was performed, and the visual results were recorded.

Ethical approval: The conducted research is not related to animals use. No ethical approval was obtained because this study did not involve laboratory animals and only involved non-invasive procedures (e.g. collection of waste tissue after surgery, fecal samples, voided urine etc).

Results

In this study, a total of 114 cases, of which 102 were wild 8 (free-living) and 12 were cage birds (captive birds), were evaluated. The trauma-induced ocular lesions were examined in birds of 39 different species. Of the 114 birds in the records, 30 (26.3%) had an ocular problem at admission. Ocular lesions were detected in 10 (8.7%) out of 12 cage birds and 20 (17.5%) out of 102 wild birds due to trauma. Most of the cases (89.4%), which were considered to have findings compatible with traumatic ocular damage, were found to be free-living birds.

Of the birds diagnosed with traumatic injuries (n = 114), four had been hit by a car, 18 had other blunt trauma injuries, 13 had injuries inflicted by other animals (predators), four had gunshot injuries, and 76 had an unknown etiology. The species and injuries were classified according to trauma outcomes as shown in Table 1.

ror, cage, chandelier, etc.) (Figure 4).

Figure 3. Periorbital ecchymosis, eyelid laceration and mucopurulent discharge in a cockatiel after cat attack

Secondary traumatic non-ocular lesions (i.e., soft tissue injury, limb fractures, or torticollis) constituted seven of 30 traumatic cases (23.3%).

Of all the ocular lesions, 86.6% involved the anterior segment, 13.3% involved the posterior segment, and 3.3% involved both segments (Table 2).

Table 1. Species and distribution of injuries (n=114)

Species	Number of cases	Type of injury
Yellow legged gull *(Larus michahellis)*	21	f
Tawny owl (*Strix aluco)*	4	o,f
Honey buzzard *(Pernis apivorus)*	3	o,f
Nightjar *(Caprimulgus europaeus)*	3	o,f,st
Pigeon	10	o, f, st
Little owl *(Athene noctua)*	3	o,f
Laughing dove *(Spilopelia senegalensis)*	4	f, st
Stork *(Ciconia ciconia)*	10	o,f,st
Common buzzard *(Buteo buteo)*	10	o,f
Hooded crow *(Corvus cornix)*	3	f
Cage birds	12	o,st,t
All other species	31	o,f, st,t,i

f: fracture, i: immobile, o: ocular lesion, st: soft tissue injury, t: torticollis

Larger species (e.g., storks and the honey buzzard) suffered from blunt trauma injuries, whereas smaller species (e.g., nightjars and the laughing dove) suffered from those penetrating trauma caused by predators. For the vast majority of free-living birds, the reason for trauma could not be determined because they had been found and brought to the clinic by citizens after the event. According to the anamnesis and clinical data, 25% of the ocular lesions seen in cage birds were due to the attack of other animals (Figure 3), and 75% were due to blunt trauma (hitting a mir-

In cases with traumatic ocular lesions (n=30), the eyelids and the periorbital and conjunctival regions were affected in 10/30, cornea in seven, anterior chamber, iris and pupilla in twelve, lens in two, posterior segment in three. In addition, both eyelids, the conjunctiva, and the anterior chamber were affected in one bird, the cornea and iris in two cases, iris and lens in one case, and the anterior and posterior uvea in a further case. According to the order of incidence, there was hyphema in 12 of 30 cases, periorbital

Figure 4. Periorbital and conjunctival hemorrhage in right eye in a budgerigar

ocular trauma also varied between species. In nine of the cases, the lesion was determined to have been due to penetrating trauma, and in 21, it was caused by blunt trauma according to the birds' history and clinical examination findings.

Corneal erosions/superficial ulcers were typically focal and cleared without vascularization or signs of infection. Of the seven cases with corneal lesions (two caged and five free-living), five had superficial ulcers in the cornea (Figure 6), one had a descemetocele, and one had a corneal rupture.

The cataracts were unilateral in both cases and developed secondary to uveitis and hyphema after trauma to the eye. In uveitis, hyphema was observed in most cases, and fibrin in the anterior segment in some cases. Most of the patients with uveitis also had a low intraocular pressure .

At least one cranial nerve dysfunction was also diagnosed in all patients with ocular problems (Figure 7).

Table 2. Distribution of ophthalmic disorders

Eyelid- Conjunctiva		Cornea		Uvea	Lens	Retina
Palpebral laceration	**Conjunctivitis**	**Ulcer**	**Perforation**	**Hyphema**	**Cataract**	**Retinal dekolman**
4	6	5	2	12	2	2

swelling in eight, corneal ulcer in five, corneal perforation in two, palpebral laceration in four, and cataract two. Hyphema accounted for 40% of all ocular problems and was the most common lesion in this study (Figure 5).

Figure 5. The appearance of hyphema, pupillary occlusion and cataract after 1 week in the left eye after blunt trauma in a common buzzard *(Buteo buteo)*

Hyphema developed due to blunt trauma in nine cases and penetrating trauma in three. Except for 2 cases, the other 10 cases were observed due to penetrating trauma in both hyphema-free birds and both cage birds. The ocular lesions were caused by blunt trauma in nine of the free-living birds. The causes of

Figure 6. Central cornea ulcer in the left eye in a common king fisher (*Alcedo atthis)* with positive fluorescence staining

Figure 7. Anisocoria after head injury in a little owl *(Athene noctua)*. Left eye pupil size normal, right one is miotic

In two cases, globe position, pupillary light reflex, third eyelid position, anisocoria, and nsytagmus could not be evaluated due to periocular edema and swelling. The cranial nerve assessment findings are presented in Table 3.

Table 3: Outlines used in birds to evaluate the function of cranial nerves and results of examination (Cranial nerve assessment adapted from Clippinger et al. (2007))

Assessment	Function / dysfunction	Neurological structures	Results of examination
Menace	Eyelids close in response to Perceived threat	Optic nerve (CN II) Trigeminal nerve (CN V)	Positively in 23 cases, negatively in 7 cases
Pupillary Light Reflex	Pupil constricts in response to focused light source	Optic nerve (CN II) Oculomotor (CN III)	Positively in 20 cases, negatively in 8 cases, unevaluated in 2 cases
Globe Position	Centrally located and normally responsive pupil/ Ventrolateral deviation (CN III), Dorsolateral deviation (CN IV), Medial deviation(CN VI)	Oculomotor nerve (CN III), Trochlear nerve (CN IV), Abducens (CN VI)	Evaluated normally in 28 cases and unevaluated in 2 cases
Third eyelid Position	Normal retracted position	Abducens nerve (CN VI)	Retracted in 26 cases, protrusion observed in 2 cases, unevaluated in 2 cases
Palpebral reflex	Blink in response to touching the medial canthus	Trigeminal nerve (CN V)	Positively in 25 cases, negatively in 5 cases
Facial Expression	Normal symmetry of the face	Facial nerve (CN VII)	Normal in 30 cases
Nystagmus	Normal physiologic nystagmus with fast phase in direction of horizontal movement.	Vestibulocochlear nerve (CN VIII) Brainstem	Positively in 2 cases, negatively in 26 cases, unevaluated in 2 cases

Damage to tissues caused by trauma was treated medically and operatively. Tarsorrhaphy was performed in one case due to the deep corneal ulcer.In five cases with corneal ulcers, medical methods were used in treatment because the lesion was superficial. The majority of the birds were closely monitored during the treatment for possible complications, while the owned birds were followed upat one-week intervals. The birds were released to nature after applying appropriate treatment determined according to ophthalmologic findings and vision ability.

Discussion

One of the most important causes of eye loss in free-living birds is ocular or periocular injury (Seruca et al., 2012). Ocular injury is a common component of avian head trauma, observed in more than 30% of traumatized birds (Seruca et al., 2012), due to the exaggerated orbit accommodating proportionally large eyes and their scleral ossicles (Jolly, 2015). The causes of traumatic ocular findings vary according to the morphological and hunting patterns of birds and ecological conditions (Murphy et al., 1982). They occur when birds flying to hunt or migrate hit objects, such as buildings, trees, and cars (Seruca et al., 2012; Moore et al., 2017). Some studies have reported that ocular trauma lesions in owls are more common compared to other birds of prey due to the anatomical and orbital structure of their eyes (Murphy et al., 1982). In addition, traumatic ocular lesions occur in cage birds due to the unsuitable environment (Murphy et al., 1982). In our study, 26.3% (30/114) of the birds exposed to trauma also had ocular trauma findings. It was determined that ocular lesions were observed mostly in owls (16.6%; 5/30) among free-living birds, and budgerigars were the most common sufferers of ocular lesions among cage birds. Ocular lesions due to trauma in cage birds were mostly caused by striking objects, such as mirrors, cabinets, doors, and being attacked by another animal.

Trauma causes acute and chronic lesions in the eye and is classified as blunt or penetrating depending on the type and cause and may result in damage to different ocular components at different frequencies, resulting in multiple ophthalmic lesions, such as periorbital swelling, corneal ulcer, uveitis, corneal perforation, hyphema, iris prolapse, retinal detachment, lens capsule rupture, and scleral ossicular damage (Willis and Willie, 1999; Moore et al., 2017). It has been reported that blunt trauma during a collision is a more common traumatic injury in birds (Murphy et al., 1982; Davidson, 1997; Moore et al., 2017; Hudecki and Finegan, 2018). The damage to the eye by blunt trauma varies depending on the anatomical and physical structure of the eyeball (Williams, 2006). Scleral oscillate and cartilage integration of birds' eyes provides a more stiff structure than collagen-rich mammalian eyes (Murphy et al., 1982; Holt and Layne, 2008; Moore et al., 2017). This rigid eyeball increases the amount of kinetic energy delivered to the sensitive uvea and/or retina due to head trauma in birds (Murphy et al., 1982; Holt and Layne, 2008; Moore et al., 2017). As a result, severe damage to the uvea and retinal layer develops. Due to this ocular structure, anterior uveitis and secondary cataracts are among the most common findings in birds (Murphy et al., 1982; Holt and Layne, 2008). In some studies, it has been reported that corneal diseases are seen frequently, especially in migratory songbirds (Moore et al., 2017). Corneal ulcers and perforations are more common in wild birds during accidental collisions. Hudecki and Finegan, (2018) found that corneal ulcers due to trauma were the most common eye lesions in this bird species. In this study, the uvea was the most affected ocular structure (14/30) and hyphema secondary to trauma was the most reported uveal disorder (12/14). In addition, ocular lesions were detected in 10 (83%) of 12 cage birds and 20 (19.6%) of 102 wild birds among traumatic cases. These results showed that ocular damage due to trauma was more common in cage birds. The data obtained are consistent with the results reported by Willis and Wilkie, 1999. Furthermore, trauma-related ocular lesions were reported in approximately 14% of 931 injuries of wild raptors admitted to avian clinics in North America (Holt and Layne, 2008). Orbital and periorbital trauma causes acute inflammation in the eye and disruption of the blood-aqueous barrier in the uveal layer. Inflammatory and blood cells accumulate acutely in the anterior chamber (Davidson, 1997).It is determined by pain-related blepharospasm, low intraocular pressure, iridal hyperemia, and the presence of varying degrees of a mycotic or disyscoric pupil. One of the most common ocular signs of uveitis in birds is hyphema, defined as the accumulation of blood cells in the anterior chamber (Hausmann et al., 2016). This is also one of the intraocular symptoms of severe ocular trauma. The presence of hyphema indicates that the structures of the anterior and posteriorsegments of the eye have been subject to serious injuries. It is the most common clinical findings of traumatic ocular lesions in free-living raptors and humans (Davidson, 1997). If hyphema is not complicated, it is usually absorbed and cleared within a few days to two weeks. However, sometimes it causes adhesion to the surrounding tissues in the pupillar iris region (Hausmann et al., 2016). The adhesion of the inflammatory cells that appear as a result of inflammation in the traumatic iris to the lens anterior capsule can cause cataract formation due to focal uveal pigment deposition on the lens and secondary nutritional defect in the lens (Davidson, 1997; Hausmann et al., 2016). In our study, hyphema was the most common eye finding, and it was seen mostly in free-living bird species. In some of the cases, pupillary deformity in the form of dyscoria due to chronic uveitis and secondary cataract formation were observed.

Cataract has been reported to develop in birds in association with skeletal malformations, genetic disorders, age, malnutrition, infection, trauma, toxic effects, and other ocular diseases, such as uveitis and retinal degeneration (Bayon, 2007). Cage birds, including macaws, cockatiel, amazon parrots, and canaries are genetically susceptible to cataract formation (Willis and Willie, 1999; Hvenegaard et al., 2009; Williams, 2017). However, it is reported that cataract can develop in free-living birds due to trauma-induced uveitis and hyphema(Murphy et al., 1982). Williams, (2017) noted that post-traumatic lens opacities were possible causes of cataract in free-living birds. Cataract is mostly observed as a secondary condition among bird species, especially in owls that continue free living after blunt trauma (Holt and Layne, 2008; Moore et al., 2017). Secondary cataract develops mostly in large and severe iridal tissue damage. It should be distinguished from cataract cases due to old age and genetics (Williams, 2017). In our study, two wild bird species, one little owl *(Athenenoctua)* and one common buzzard *(Buteobuteo)*, were diagnosed with lens opacity ranging from the accumulation of inflammatory cells and focal opacity in the anterior capsule of the lens to mature cataracts. In both birds, this secondary lens pathology was observed simultaneously with an adnexal posttraumatic pathology or significant uveitic inflammatory changes (inflammatory cell and/or hyphema) (Holt and Layne, 2008; Moore et al., 2017). Behavioral changes in birds were not significant except for the loss of threat reflex in the affected eye. Perforated injuries cause secondary intraocular infections due to the loss of corneal barrier, and even endophthalmitis, which causes the loss of the eyeball (Williams, 2006). In perforated wounds, the cornea is affected, as well as the intraocular structures of the iris and lens, depending on the condition of the agent and presence of inflammation or blood cells in the anterior chamber (Davidson, 1997). In addition, severe penetrating trauma can damage the ciliary body, resulting in a decrease in aqueous humor production and the shrinking of the eyeball, called phthisis bulbi (Davidson, 1997; Murray et al, 2013). Phthisis bulbi is associated with other severe ocular injuries that cause blindness. Since it is a painless condition, enucleation is often not required unless secondary entropion and ocular discharge are present (Davidson, 1997; Murray et al., 2013).

Traumatic uveitis and other traumatic intraocular changes sometimes occur in the iridocorneal angle, resulting in chronic glaucoma formation (Davidson, 1997; Hausmann et al., 2016). Glaucoma is a common complication of ocular blunt trauma in humans but relatively rare in birds (Davidson, 1997). Its appearance is noticeable with a larger sphere size than the normal eyeball due to the increased intraocular pressure (Hvenegaard et al., 2009). Since it is a very painful condition, eye enucleation is recommended in patients who do not respond to medical treatment (Davidson, 1997; Hausmann et al., 2016). None of our cases presented with direct glaucoma signs, but preventive anti-hypertensive topical eye drops were used in cases where clinical symptoms, such as cataract and hyphema may have caused glaucoma, and no secondary glaucoma developed in any of the patients.

The clinical signs of head trauma include external evidence of bleeding and bruising, an alteration in mental status, development of ataxia or a degree of paresis, head tilt, nystagmus, tremors or other involuntary movements, and seizure activity (Clippinger et al., 2007; Jolly, 2015). In our study, in most cases, the attitude changes were recorded as nystagmus and head tilt. Additionally, auricular hemorrhage, circling, paresis, and ocular lesions were diagnosed as clinical signs of head trauma. Attitude changes resulting in nystagmus, head tilt, leaning, falling, rolling, or circling are common in head trauma patients and can result from central (cerebellum, brainstem or spinal cord) or periph-eral (inner ear, vestibulocochlear nerve) dysfunction (Clippinger et al., 2007). An important part of the examination of traumatic brain injury in the more pork is a thorough ocular examination, examining both internal and external structures of the eye (Jolly, 2015). The ophthalmic examination helps identify problems in optic (CN II), oculomotor (CN III), trochlear (CN IV), abducens (CN VI), and trigeminal (CN V) nerves (Clippinger et al., 2007).

Ocular examination and neurologic assessment play an important role in avian clinical practice. We recommend that these two conditions are evaluated together in both trauma cases and eye diseases. The results of this study can serve as an indicator of occurrence and types of traumatic eye injuries in cage birds and free-living birds, and thus guide future studies.

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