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Avian Ophthalmology

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Anatomic Particularities

Compared with mammals, birds have large and weighty eyes in proportion to body size with relatively low motility. Birds lack a retractor muscle therefore nystagmus manifests as head movements. The globe is located in an incomplete orbit, close to the periocular subcutaneous sinus (respiratory disease affecting them can secondarily cause eye problems). The shape of the globe is supported by the scleral ossicles (bony plates within the sclera) and can vary between plain, conical, and tubular depending on vision requirements. Different periocular conformations have been described in multiple species (featherless edges, different colourations, presence of filoplumes).

The eyelids are thin and in some diurnal species are even transparent. The opening of the eyelids in neonates is progressive and varies depending on the species. The lower eyelid is more mobile except in owls. No meibomian glands are observed in the margins. Most birds have two lacrimal puncta; however, most of aquatic birds have only one, with the exception of penguins which have none. The Harderian gland is very developed. The nasal salt gland is present in some aquatic species and in the budgerigar. The nictitans membrane is very mobile due to the presence of striated muscles and protects the cornea and spreads the tear film. The corneal reflex can be used to monitor the anaesthetic depth.

Accommodation can vary between 2 and 80 diopters (D) depending on the species and can be consequence of modification of the corneal curvature or anterior displacement and squeezing of the lens. The cornea is small and arcuate, more voluminous in nocturnal predators and thicker in aquatic birds. The lens is soft with an annular pad closely associated with ciliary bodies that makes difficult its luxation. The anterior part of the lens has a metabolically active membrane. In some species, juvenile lenses may resemble cataracts.

The retina is anangiotic (no visible blood vessels) and atapetal (no tapetum) (except for Caprimulgiformes). The pecten is a pigmented choroidal structure showing different shapes depending on the species, which protrudes into the vitreous that has a possible role in nutrition, pressure regulation, and light absorption within others (Korbel, 2013). The number of foveae varies from one, two or none between species. Nocturnal birds have less pigmented retinas than diurnal ones. The cones have oil drops that allow filtering of light. Central foveae are used for panoramic vision whereas temporal foveae are used for binocular vision (Lawton, 2002).

The iris has striated muscle so pupillary contraction is voluntary and thus not reactive to common topical mydriatics used in other animals. Its colour could vary with the age and sex depending on the species. The conjunctival bacterial flora of psittacines and raptors is mainly composed of Gram positive bacteria (Abrams et al, 2002).

Haematomas in the skin and periocular tissues may have a green appearance due to the presence of biliverdin instead of bilirubin. While hyphaema are quickly reabsorbed, resorption of vitreal haemorrhage tends to require longer times.

Vision

Vision is the one of the most important senses for birds. Avian species have two to eight times more visual acuity and better slow movement detection than mammals. Their visual field is also wider (360 degrees in some species). Raptors have binocular visual fields. Diurnal species are able to see in the UV light spectrum which has been implicated in as varied functions such as: individual identification, fruit ripeness, camouflage and orientation (Korbel, 2013).

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Ocular Examination

The first part of visual examination should be performed from distance in order to detect abnormal gaits, movements or clinical signs that the bird may hide or avoid once restrained.
Once the whole body has been examined, visual examination of the eyes and adnexae may be started. The head should be examined from every angle looking for asymmetry. It is also important to check the ear canals, because any sign of trauma there may suggest posterior segment trauma. The rest of the ocular examination should be performed under manual or chemical restraint. Menace response is not always accurate. Mild anisocoria might be normal. Direct pupillary reflexes are difficult to evaluate due to the presence of striated muscle in the iris. Indirect pupillary reflexes are not expected in birds due to the complete decussation at the optic chiasma. Contralateral miosis may be a consequence of direct stimulation of the optic nerve through the thin interorbital septum. Ocular structures in the anterior segment should be examined by the use of frontal and lateral illumination, transillumination, retroillumination, direct ophthalmoscopy, or slit-lamp. Direct and/or indirect ophthalmoscopy by using a lens between 30 and 90D, according to the size of the eye and pupil, is highly recommended if lesions in the posterior segment are suspected (Korbel, 2013). The Schirmer tear test (modified or not depending of the size of the eyelids) or red phenol thread test (8-23 mm/ 15 sec) (Storey E-S et al, 2009) have been validated for multiple avian species. Intraocular pressure can be measured by applanation tonometry in corneas larger than 9 mm of diameter whereas rebound tonometer may be a better alternative in individuals with smaller corneas (Jeong, 2007). Ancillary diagnostic tests of utility may include radiology, ultrasonography, MRI, CT-scan, microbiology, molecular testing, and cytology.

Anaesthesia and Mydriasis

Topical anaesthetics should be used with caution to avoid systemic effects. Topical proximethacaine and oxybuprocaine provide local anaesthesia for seven minutes whereas the anaesthetic effect of lidocaine persists for up to 17 minutes.

Topical parasympatholytic agents as tropicamide and atropine are not effective due to the presence of striated muscle in the iris. Depending on the species, mydriasis can be achieved by using topical rocuronium bromide(Barsotti et al, 2010 and 2012) or vecuronium bromide (Mikaellian et al, 1994 and Loerzel et al, 2002), general anaesthesia (ketamine), or intracamerular injection of D-tubocurarine (Lawton, 2002). Intracamerular D-tubocurarine provides mydriasis from 20 minutes to 24 hours but its use should be reserved only for therapeutic purposes as complications may occur (hyphaema, increased intraocular pressure (IOP), infectious uveitis, and systemic effects).

Air sac perfusion anaesthesia (normally through the left caudal thoracic air sac) provides the surgeon free access to skull, a stable IOP, a reversible apnoea, and lack of movement of the head associated with body movements related with respiration.

Ocular Disorders

Ocular disorders are extremely common presenting reasons in wild birds. It is extremely important to rule out or locate lesions. Chronic lesions in the dorsal aspect of the fundus carry a bad prognosis as it includes the central and temporal foveae which may make the bird unsuitable for release into the wild.

Viral disorders

Avipoxvirus infections may vary from crusty cutaneous lesions to systemic diphtheritic forms, is highly contagious (epidemic outbreaks) and systemic palliative (vitamin A and local antibiotics) and supportive care may ameliorate the impact of the infection on the individual or collection.

Paramyxovirus serotype 1 (Newcastle disease) has been associated with posterior synechiae, blindness, iridocyclitis, ocular discharge, and conjunctivitis in combination with systemic clinical signs (depression, anorexia, nasal discharge, coughing, sneezing, dyspnoea, diarrhoea, abnormal positioning of the head, convulsions, circling tremors and paralysis of the legs and wings).

Bornavirus can provoke blindness and is not always associated with proventricular dilatation disease. Diagnosis is by serology and PCR and celecoxib may be used as a palliative (although this is still controversial).

Circovirus (PBFDV) has been associated with changes in the colour of the iris (serology and PCR, no treatment).

Herpesvirus (Marek´s disease) has been associated with blindness.

West Nile virus may provoke chorio-retinal lesions and linear or geographic pattern scars (Pauli et al, 2007).

Other viruses associated with ocular and/or systemic disorders in birds are Cytomegalovirus, Polyoma virus and Papilloma virus.

Bacterial infections

These: may be primary ocular infections or secondary to systemic (haematogenous) or local spread (i.e. spread from surrounding tissues such as the infraorbital sinus). Chlamydiosis, mycoplasmosis, haemophilosis, mycobacteriosis or salmonellosis are frequently reported zoonoses in which ocular manifestations could be the only clinical signs observed.

Fungal infections

Aspergillosis (opportunist, may provoke corneal and systemic lesions , difficult to culture), candidiasis (white corneal lesions) and Cryptococcosis.

Parasitic infections

Toxoplasmosis has been associated with choroiditis, retinal detachment, optic neuritis, and periorbital myositis in canaries and with chorioretinitis in owls; Trichomoniasis may provoke air sacculitis with conjunctivitis and/or blepharitis; *Cnemidocoptes pilae* may provoke periocular, beak and leg hyperkeratotic lesions in immunosuppressed birds; *Encephalitozoon hellem* associated with keratoconjunctivitis in the cockatoo (Phalen et al, 2002); *Plasmodium* spp.; nematodes (periocular); trematodes; leeches, and ticks.

Nutritional disorders

The most commonly reported in birds is Vitamin A deficiency (unbalanced diets based on grain/seed) but it also be a consequence of hepatic dysfunction, pancreatic disorders, or lack of intestinal absorption. Squamous metaplasia of the lachrymal gland, eyelid abscesses, keratoconjunctivitis sicca, conjunctival hyperkeratosis, and epiphora associated with nasolacrimal duct obstruction have been associated with vitamin A deficiency as well as respiratory problems. Immunosuppression provokes secondary infections. Vitamin A deficiency may be treated by administering retinol orally or intramuscular always taking into account the potential risk of iatrogenic toxicity related with overdosing.

Neoplastic disorders

The eyelids and nictitans membrane are the most affected areas, although tumours have been reported elsewhere in the eye.

Congenital abnormalities

Cryptophthalmia (Kern, 1997), symblepharon, ectropion, eyelid agenesis, ankyloblepharon, microphthalmia, retinal dysplasia (Lawton, 2002), and dermoids have been reported in birds (Leber et al, 1999).

Cataracts

The origin may be genetic, toxic, nutritional, infectious, traumatic, post-uveitis, or related with retinal degeneration. Extracapsular extraction or phacoemulsification are considered the treatments of choice. Surgical complications may occur due to size of the globe.

Traumatic injuries

Eyelid trauma should be never underestimated as it could be an indicator of intraocular damage. The presence of the sclera ossicles does not allow the globe to collapse in the event of a globe rupture. If trauma is suspected, fundoscopy should be performed. In cases of third eyelid trauma it is important that it be repaired in order to prevent further damage of the globe due to excessive exposure.

Intoxications

Blindness may be consequence of lead ingestion. The diagnosis may be achieved by confirming elevated levels of lead in the blood and the treatment is with calcium disodium EDTA, and supportive care possibly combined with surgical removal of the source of lead. Botulism is relatively common in aquatic birds and manifests as paralysis. Conjunctivitis has also been associated with tobacco and kitchen fumes exposure.

Other

Uveitis, corneal degenerations, and ulcers are normally managed in a similar way to than in other species.

Surgical Considerations

The oculocardiac reflex, a decrease in pulse rate associated with traction applied to extra ocular muscles and/or compression of the eyeball, should be avoided or minimized as it may have lethal consequences. Different ways to minimize its consequences is the discontinued manipulation of the tissues, the use of intermittent positive pressure ventilations or the use intravenous anticholinergics.

Haemorrhage should be minimized during surgical procedures, especially in small patients.
Some controversy exists about the utility of blepharorrhapies and third eyelid flaps in birds due to their strong palpebral muscles.

When considering enucleation, it should be remembered that the optic nerve is relatively short, so excessive traction may provoke cerebral trauma. Different enucleation techniques have been reported: lateral, trans-aural, and corneal.

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