Avian and Reptile Ophthalmology Including Important Aspects of Small Mammal Ophthalmology – a Practical Approach

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SUMMARY

The overall incidence of ocular disorders in birds rep. reptiles of all patients presented is approx. 7 %. This may appear a high percentage, but it has to be considered, that many ocular disorders in both groups are hidden at the posterior eye segment, the fundus oculi.

Certain avian and reptile specific capacities – like orientation, flying, catching prey – are closely bound to fully functional vision underlining the importance of avian ophthalmology. In addition, ocular lesions in birds and reptiles are an expression of systemic disorders more than in mammals and therefore represent an important diagnostic criterion. The ocular symptomatology frequently enables specific conclusions to be drawn on suspected disorders or it may even be pathognomonic for a certain disease. Thus, the avian and reptile eye may be seen – in a much larger extent than in mammals - as a "diagnostic window". On an average, more than 30% of all traumatised birds (incidence higher in raptors than in pet birds) are suffering from ocular lesions, which are most often hidden within the inner structures of the eye with haemorrhages arising from the pectin oculi as well as the conus papillaris. Ophthalmoscopy, i. e. examination of the posterior eye segment, therefore is obligatory in traumatised birds as well as reptiles. After a short review on anatomical and physiological peculiarities, commonly and newly developed routine ophthalmological examination procedures will be described followed by a description of clinical pictures in the eye of various patient groups based on an etiological schematization. In principle avian and reptile ophthalmology uses techniques commonly used in mammalian ophthalmology, but miniaturized.

INTRODUCTION

In many birds and reptiles the eye is the most important sensory organ. The capacities of the avian and reptile eye are an adaptation to the specific way of life and habitats as well as physical activities that are closely bound to perfectly functioning vision (e.g. flying). Even partial impairment of vision that can be caused by any one of many known eye diseases, always has far-reaching consequences because compensation by other senses (including olfactory and acoustic sensory perceptions) is usually insufficient, if possible at all. Hence ornitho-ophthalmology occupies an important position in avian medicine (Murphy, 1987; Korbel, 2000; Kern, 2007; Korbel and Bohnet, 2007; Korbel and Weise, 2007).

Significance of visual capacities

The eye as the main sense organ in birds and many reptiles and its visual capacities have no general superiority compared to mammals but show a highly specialisation as an adaption to living conditions. Thus visual acuity is 2 to 8 times higher compared to mammals, visual fields are up to 360°, stereopsis ranges from 0° to 70 °, maximum spatial frequence (the ability to dissolve a certain movement into single frames) is up to 160 frames/sec (10-15 in man) and minimum detection of movements is up to 15 °/hour (very slow movements) in many bird species. It should be recognized that ultraviolet-perception (UV-perception between 320 and 680 nm), an ability common in diurnal birds bound to special UV-sensitive rods within the retina and an aspect not investigated very well to date, plays a probably plays a very important role in inter- and intraspecific communication based on plumage-UV-reflection, even in birds and some reptile species which appear monomorphic for the human eye, for the identification/assessment of fruit ripeness based on varying UV-reflection of fruit wax layers, for phenomenons of camouflage, orientation other. On the other hand even complete blindness is not a reason for euthanasia in pet birds. Thus, canaries, suffering from blindness due to cataract formation - a condition which occurs quite often in this species - act normal, as long birds as long as the interior of the cage or aviary is not modified.

Anatomical peculiarities

Though there exist numerous anatomical and physiological differences - like the striated rather than smooth intraocular musculature, the anangiotic fundus oculi, the pecten oculi and the conus papillaris - basically the approach to avian and reptile ophthalmology is quite similar to that employed in mammalian ophthalmology. Some anatomical peculiarities with relevance for the ophthalmologist are:

Size and weight of the eye

- Axial length 8 mm (Kiwi, *Apteryx* sp.) up to 50 mm (Ostrich, *Struthio camelus*)
- Weight (oculus sinister (OS) and oculus dexter (OD) in man 1%, Fowl 7% (adult) resp. 12% (juv.) compared to overall head weight

Shape

- Determination by anulus ossicularis sclerae (10-10 single bony platelets)
- Flat type (diurnal birds with narrow heads, for example columbifomes)
- Conical type (diurnal birds with broad heads, for example falconiformes)
- Tubular eye (nocturnal birds, for example strigiformes)

Adnexal structures

Eyelids

- So-called spectaculum in snakes
- Palpebra inferior larger than palpebra superior (exclusive owls)
- Lower eyelid with “tarsus“, no meibomian glands
- Membrana nictitans highly motile, regulation of praecorneal tear film, protective function for cornea, “snorcel masc effect“ (compensation for loss of refractive power during underwater vision)

Lacrimal glands

- Small or absent glandulae lacrimaliae
- Large glandula lacrimalis membranae nictitantis (vel. Harderian gland)
- Replacement by nasal salt gland (aquatic avian species)

No musculus retractor bulbi
Complete decussation of chiasma opticus (no consensual pupillary reflex)

Anterior eye segment

- Striated intraocular musculature (higly motile iris corresponding to external stimuli, no sensitivity to parasympatholytics/sympathomimetics, no reliable pupillary reflex corresponding to light stimuli)
- Fundus diameter much larger than pupil diameter
- Ligamentum pectinatum/ciliary cleft with species specific peculiarities
- Lens with anulus pulvinus („Ringwulst“), accommodation range 2 (owls) up to 80 (waterfowl) D
- Focussing mechanism while moving the entire lens rather than altering the lens shape (for example in snakes)

Posterior eye segment

- Avascular (anangiotic) retina
- Afoveate, uni- or bifoveate retina
- Rods and cones (inclusive special UV-cones) in functional units
- UV-sensitive cones in most diurnal birds
- Slight retinal pigmentation in nocturnal, heavily pigmented retina in diurnal birds
- No retinal tapetum lucidum
- Pecten oculi (birds)
- Conus papillaris (reptiles)
- Chorioidal, heavily pigmented structure
- Protruding into the vitreous
- Obscuring papilla nervi optici
- Pleated, vaned and conical type
- 32 functional theories: nutritive, thermo- and pressoregulative function most obviously

Ophthalmological equipment and examination procedure

Minimum requirement for basic and general puposes

- Focussed light source with magnification lens (“Finoff transilluminator”)
- Instrumentation for manipulation of the eye lids (Graefe hook)
- Lacrimal cannula (Anel)
- Topical anaesthetics: Proxametacain, Oxybuprocain (duration of action approx. 7 – 8 min.) or Lidocain (duration of action approx. 17 minutes)

Advanced Equipment

- Slit lamp (magnification x 5 – x 15, better x 20)
- Monocular direct ophthalmoscope with 15 D lens or even better
- Head band ophthalmoscope with 30 and 78 D lens (additional aspherical 40, 60, 78, 90 D)

General examination procedure - Adnexal structures and anterior eye segment

- **Without restraint**
  - Assessment of visus via food intake, reluctance to fly, orientation
- **With restraint**
  - Examination of the ear opening
  - Pupillary reflex
  - Examination of the anterior eye chamber with lateral illumination
  - Examination of the anterior eye chamber with lateral transillumination
  - Examination of the anterior eye chamber with retroillumination

Equipment and procedure for specific examinations

- Slit lamp biomicrography
- Gonioscopy (Lovac lens), examination of the angulus iridocornealis with the pectinate ligamentum. Aetiological assessment of primary/secondary glaucoma status.
- Tonometry. Estimation of the intraocular pressure (IOP). Use electronic short time acting tonometer or Schioetz – Tonometer in raptors. Standard reference values measured with an electronic tonometer calibrated for avian eyes, range from 9 to 22 mg Hg and are available for 42 species from 7 orders. Standard reference values for psittacine birds range from 12 – 15 mm HGg for nocturnal birds from 9 – 12 mm Hg, for various poultry species intraocular IOP values are as high as 22 mm Hg, for reptile species 10 – 18 mmg Hg. . Minimum corneal diameter for reliable value is 9 mm. Reference values for newly developed tonometers (Tonovet[R] and Tonolab[R]) will be available soon.
- Schirmer-Tear-Test. Test for the estimation of the lacrimal function (no scientific based data for reptiles available). Use standardised filter strips of 2, 3 and 5 mm width. Standard reference values using filter strips of various width for 42 species from 7 orders showing a wide range of interspecific variations are available. Strigiformes show conspicuously low values.
- Electroretinography. Measurement of retinal function by recording electrical potentials after light stimulation. This technique gives no information about the visus, only on retinal function. Basic principles of electroretinography for routine examination have been established. Indications are retinal disorders and diotric apparatus opacities.
- Laboratory examinations include bacteriological examination of the conjunctival flora. Physiological bacterial flora contains gram positive bacterias, while gram negative bacterias are an indicator for pathological conditions. Standard reference values have been worked out for 42 different bird species from eight orders.

Mydriasis and air sac perfusion technique for birds

Induction of mydriasis is indispensable for the examination of the posterior eye segment (ophthalmoscopy). A major difference between the mammalian and the avian eye however is that the commonly used mydriatics of atropine and tropicamide have little effect in the avian patient due to a striated rather than smooth intraocular musculature. Therefore the iris is partly unter voluntary control. It is essential to have a dilated pupil (mydriasis) to perform an ophthalmoscopy, i. e. examination of the posterior eye segment including the vitreous, the fundus and the pecten oculi. Therefor neuromuscular blocking agents such as d-Tubocurarine (3%; 0,01 - 0,03 ml; 1) may be used. As the drug penetrates the cornea insufficiently it has to be administered directly into the anterior chamber by paracentesis using a 27 - 30 gauge needle. This technique includes substantial risk for injuries of intraocular structures causing i. a. hyphaema, increasing intraocular pressure (IOP), transmission of conjunctival flora with consecutive uveitis and systemic side effects if larger dosis than recommended are used. Therefore it is recommended to use this technique just for therapeutical reasons (prevention of posterior of anterior synechia resulting from uveitis and consecutive miosis).

An alternative for routine induction of a mydriasis as well as for intraocular surgery and surgery in the head area is the air sac perfusion anaesthesia. In principle APA consists of a retrograde perfusion of the lung-airsac-system through a perfusion catheter via the left caudal thoracic airsac. As a carrier gas 0,3 l/min/kg BW of O2 is used. Effect of nitrous oxide application are a low potentiation of isoflurane of approx. 11 % and thus improvement of the circulatory situation and release of the surgeon from isoflurane waste gases. Higher perfusion rates than recommended result in respiratory alkalosis due to a CO2-wash-out-effect causing severe cardiac arrhythmias. Isoflurane maintenance concentrations vary - dependent of different bird species - between 1,0 Vol. % to 2,4 Vol. % (Columba livia Gmel., 1789). Pulsoximetry is indispensable as APA causes a reversible apnoea due to reduced CO2 partial pressure causing a missing stimulation of the respiratory centre. Advantages of APA, a long period anaesthesia, which is used for routine ophthalmoscopy, electroretinography and head surgery in birds, are free surgical access to the head for intraocular surgery, stable or decreasing intraocular pressure and reversible apnoea with an absolute immobilisation of the patient. Achievement of mydriasis for ophthalmoscopy may be optimized by systemic administration of 0,2 mg/kg BW of the muscle relaxant Vecuronium which allows a complete mydriasis and areflexia with a lag period of approx. 26 sec. and a duration of 25 6 min. in pigeons (Columba livia Gmel., 1789) and a reduction of isoflurane consumption of approx. 25 % at the same time. This technique allows examination even of the very lens periphery with the annular pad and the extreme fundus periphery.

APA - PRINCIPLES

- Anaesthesia induced mydriasis and free surgical access to the head area
- Perfusion of lung-airsac-system with oxygen-(nitrous oxide)-isoflurane or sevoflurane mixture
- Retrograd perfusion via left caudal thoracic air sac using a specific air sac catheter
- Induction of a reversible apnoea due to lowering of the CO_2-partial pressure with subphysilogical values (below 48 mm Hg; no stimulation of respiratory center)
- Modified anaesthetic machine with low flow flowmeter (0.01 – 0.5 l/min)

APA – Performance

- Carrier gas O_2
- Induction: Head chamber
- Maintanance: Air sac catheter
- Isoflurane concentration: 1.0 - 2.7 Vol.%
- Monitoring: Pulse oximetry (!, no respiratory movements), reflex score, blood gases, body temperature

APA – Advantages

- Routine method for ophthalmology and head surgery
- Benefits of inhalation anaesthesia and long period anaesthesia
- Free surgical access to the head
- Stable or decreasing intraocular pressure (IOP)
- Reversible apnoea – absolute immobilisation of the patient
- Achievement of mydriasis for ophthalmology

OPHTHALMOSCOPY IN BIRDS AND REPTILES

Ophthalmoscopy, a technique to examine the fundus oculi (a clinical term, describing ocular structures, which are situated behind the lens) using a focussed light beam reflected from the fundus, can be carried out by both monocular and binocular and direct or indirect ophthalmoscopy in combination with double aspherical ophthalmoscopic lenses (at 30, 40, 60, 78 and 90 diopters (D, Volk Bio II) refractive power. In all cases indirect binocular ophthalmoscopy using a head ophthalmoscope is advisable. A 30 D lens is used in birds with larger pupil diameters (nocturnal and diurnal raptors), ophthalmoscopy of most reptile species, pigeons and larger psittacines requires an 78 D lens, those in avian and reptile species with a pupillary diameter smaller than 4 – 5 mm the use of a 90 D lens. Alternatively, monocular indirect ophthalmoscopy (such as an panoptic monocular ophthalmoscopy by Welch Allyn® may easily performed in all reptiles and birds, especially in smaller species. It should be pointed out that within a long term survey including more than 32 % of traumatised birds showed haemorrhages in the vitreous body originating from lesions of the pecten oculi. Thus ophthalmoscopy is obligatory in traumatised birds.

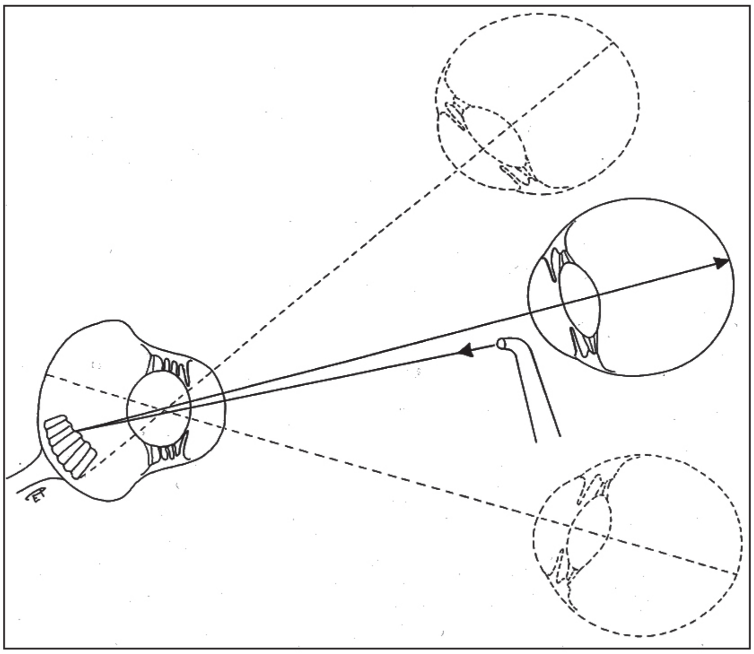

Figure 1: Optical principles of the (monocular direct) ophthalmoscopical examination of avian eyes. Per definition „ophthalmoscopy“ is the examination of ocular structures situated behind the lens, using a focused light beam directed through the pupil and performing the examination using light, reflected from the fundus oculi. As a rule, a nearly coaxial direction of the light beam directed through the (dilated) pupil (Mydriasis) of the patients eye (left) on the one hand and the reflected light beam from the patients fundus to the examiner's eye (right; viewing axis) on the other hand is indispensable in order to project an image on the examiner's retina (taken from Korbel and Bohnet, 2007).

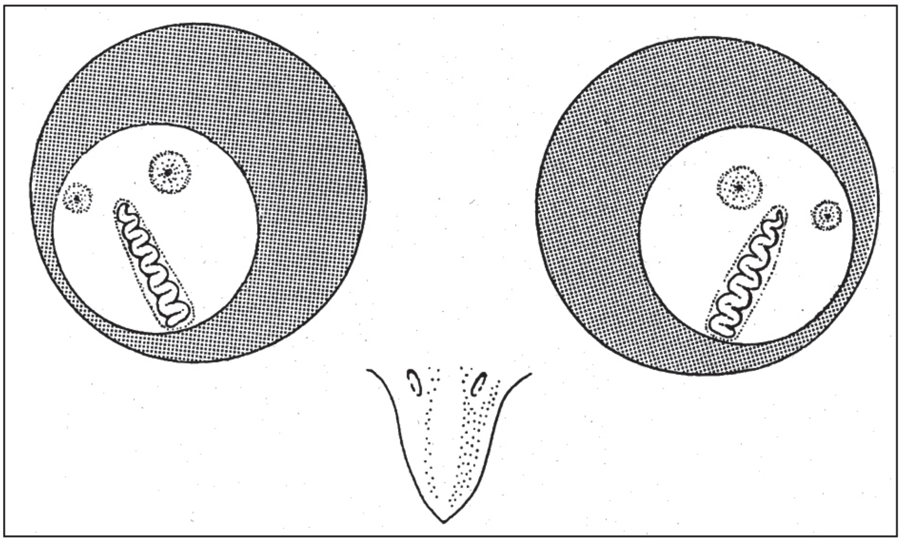

Figure 2: Topograpical landmarks within the avian fundus with the pecten oculi respectively conus papillaris in reptiles and the central and temporal fovea. Accessible viewing field (bright area) using monocular direct ophthalmoscopy (taken from Korbel and Bohnet, 2007).

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