Endoscopic evaluation for the anterior and posterior segment of the eye: A new and useful technique for diagnosis of glaucoma in dogs

Abd-Elhamid M.A, Ali K.M and Ayman A. Mostafa.

Department of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Cairo University, Egypt.
drkhaled_ali@yahoo.com

Abstract: Objective- This study was carried out to evaluate the usefulness of endoscopy for examination of the anterior and posterior segments of the glaucomatous eyes. **Animals:** Fifteen dogs. **Methods:** Ocular examination was done using endoscopic probe (8.5mm diameter, Eickemeyer video endoscope unit supplied with halogen light source 150 watt (vetlux), Germany). The animals were sedated through intravenous injection of Xylazine (1mg/Kg body weight, ADWIA, Egypt). Surface corneal anesthesia was achieved by local application of Benox® (Benoxinate Hydrochloride 4mg, EIPICO, Egypt) to the eye under investigation. After sedation, the endoscopic probe was applied on the cornea and videos were monitored on the laptop and diagnostic images were captured and processed. **Results:** Primary open angle glaucoma was diagnosed in 2 cases. Goniodysgenesis with closure of the iridocorneal angle (ICA) by an iris like sheet was seen in 2 cases. Abnormal thickening of the pectinate ligament with closure of the ICA was observed in one case. Lens induced glaucoma was the most common type of the glaucoma seen in the presented cases (10 cases); phacomorphic glaucoma due to lens displacement was diagnosed in 5 cases, phacoanaphylactic glaucoma secondary to cataractous lens was diagnosed in 3 cases while pupillary block glaucoma (due to swelling of the cataractous lens) was seen in 2 cases. **Conclusion:** endoscopy is non invasive technique for diagnosis of glaucoma in dogs in which interior visualization of the eye is impossible such in cases with corneal edema and cataract.

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Keywords- endoscopy, glaucoma, lens luxation, eye, goniodysgenesis, dogs.

1. Introduction:

Glaucoma is a collection of optic nerve diseases identifiable by a combination of damage to retinal ganglion cells (RGC's) and their axons, tissue remodeling involving both the optic nerve head and the retina[1]. Most of the retinal ganglion cell axon lies outside the eye therefore in glaucoma; axon injury extends from the optic nerve to visual pathways in the brain. [2]

Among the most common causes of secondary glaucoma in dogs are anterior uveitis, lens displacement, intumescent cataract (phacomorphic glaucoma). Anterior lens luxation may cause pupillary block secondary to annular posterior synechiae (seclusio pupillae), resulting in iris bombe, iritis and peripheral anterior synechiae and the closure of the entrance to the ciliary cleft.[3,4]

Eye examinations of the cornea, anterior chamber, lens and posterior chamber, and vitreous are usually carried out with a slit lamp apparatus. Images of the eye fundus can then be obtained using indirect ophthalmoscopy or confocal scanning laser ophthalmoscopy (cSLO).[5] These techniques not only provide reflection images of the retina, they generate fluorescent images from natural pigments (autofluorescence) or fluorescent dyes (e.g., fluorescein and indocyanine green) administered to the patient or animal. Such dye-induced images are particularly useful for assessing blood circulation and blood vessel permeability in the retina and the choroid.

Anatomic sections of the *in vivo* retina can be obtained by optic coherence tomography (OCT), a technique recently associated with cSLO.[6] These techniques use eye optics to visualize the fundus without any contact with the cornea. However, they do not enable the far retinal periphery to be visualized. OCT can provide images of the iridocorneal angle of the eye and ciliary bodies.[7,8]

2. Materials and methods

Animals

Fifteen dogs with glaucoma from attendants to the Surgery Clinic Faculty of Veterinary Medicine, Cairo University were included in this study. Approval of the study procedures and techniques was obtained according to guidelines and regulations for researches involving live animals.

Anesthesia

The animals were sedated through intravenous injection of Xylazine (1mg/Kg body weight, ADWIA, Egypt). Surface corneal anesthesia was achieved by local application of Benox® (Benoxinate Hydrochloride 4mg, EIPICO, Egypt) to the eye under investigation.

Endoscopic examination

Prior to endoscopic examination all animals were subjected to routine ophthalmic examination including measurement of the intraocular pressure. The technique of examination was simple and based on the use of endoscopic probe (8.5mm diameter, Eickemeyer video endoscope unit supplied with halogen light source 150 watt (Vetlux), Germany). Images were obtained by connecting the endoscope through an adapter to a laptop (Fig. 1). After sedation of the animals the endoscopic probe was applied on the cornea, the video was monitored on the laptop and diagnostic images were captured and processed. Evaluation of the cases was done in respect to closure of the iridocorneal angle, iris atrophy, lens opacity, size and displacement, tapetal hyperreflectivity, optic nerve atrophy, and visualization of the retinal blood vessels.

3. Results

Cases diagnosed to be a glaucomatous showed an elevated intraocular pressure (IOP) approximately more than 25 mmHg, photophobia, corneal edema, persistent dilated pupil, episcleral injection, buphthalamos, scleral ectasia and intumscent cataractous lens. Corneal edema was showed commonly in glaucoma due to complete anterior lens luxation.

Primary open angle glaucoma was diagnosed in 2 cases. Goniodysgenesis with closure of the iridocorneal angle (ICA) by an iris like sheet was seen in 2 cases. Abnormal thickening of the pectinate ligament with closure of the ICA was observed in one case. Lens induced glaucoma was the most common type of the glaucoma seen in the presented cases (10 cases); phacomorphic glaucoma due to lens displacement was diagnosed in 5 cases, phacoanaphylactic glaucoma secondary to cataractous lens was diagnosed in 3 cases while pupillary block glaucoma (due to swelling of the cataractous lens) was seen in 2 cases (Table 1).

Cases with open angle glaucoma were characterized by an elevated IOP, episcleral injection dilated pupil, corneal edema. Atrophy for the optic nerve, retina and retinal vasculature was the most characteristic endoscopical findings in cases with chronic glaucoma (Figs. 2 and 3).In case of goniodysgenesis (pectinate ligament dysplasia) a sheet of mesenchymal tissue appeared to occlude the majority of the drainage angle (Fig. 4). Abnormal thinking of the pectinate ligament was seen in one case with recurrent glaucoma (Fig. 5).

Lens induced glaucoma was the most common type of the glaucoma seen in the presented cases. Phacomorphic glaucoma (due to lens displacement) was diagnosed in 5 cases; three cases showed posterior luxation and two cases showed partial luxation. Phacoanaphylactic glaucoma secondary to cataractous lens was diagnosed in 3 cases while pupillary block glaucoma (due to swelling of the cataractous lens) was seen in 2 cases.

Endoscopic examination of cases with Phacoanaphylactic glaucoma showed uveitis with normal or apparently open filtration angle with presence of cataract (Fig. 6). Cases with partially luxated lens were characterized endoscopically by presence of clear aphakic crescent (Figs. 7a, b and c). Endoscopic examination for the anterior segment of the eye in cases with pupillary block glaucoma showed the swollen cataractous lens blocking the pupil and protruded into the anterior chamber (Fig. 8).

Table 1: Causes of glaucoma, number and percentage of cases (15 cases).

Causes and type of glaucoma		Number	Percentage %
Primary open angle glaucoma		2	13.3%
Abnormality in pectinate ligament	Goniodysgenesis	2	13.3%
	Thickening	1	6.66%
Lens induced glaucoma	Phacomorphic glaucoma	5	33.33%
	Phacoanaphylactic glaucoma	3	20%
	Pupillary block glaucoma	2	13.33%

Fig. 1: A photograph showing the endoscopic examination for the eye in a dog. The endoscopic probe connected to a light source and to a computer with a screen display showing the anterior chamber.

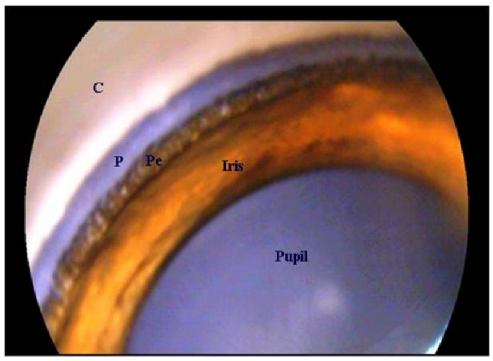

Fig. 2: Endoscopic photograph showing angle glaucoma in a dog. The pectinate ligament (Pe) appear as a multiple strands originating from the base of the iris and inserting at the peripheral inner cornea (C), the pigment layer (P) is clear and continue to cover the scleral shelf.

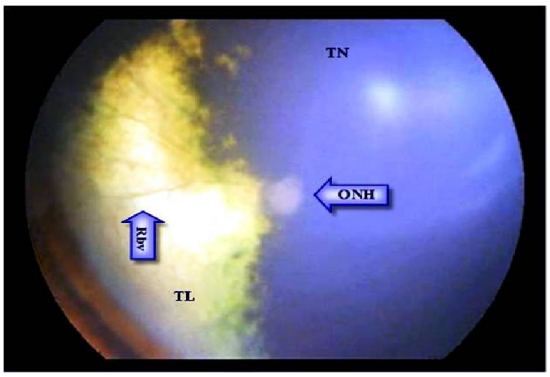

Fig. 3: Endoscopic Photograph showing the ocular fundus in a case with chronic open angle glaucoma with cataract. Note, attenuation of retinal blood vessels (Rbv) and tapetal hyper reflectivity, optic nerve atrophy (ONH).TN, tapetum Negrum, TL, Tapetum Lucidum.

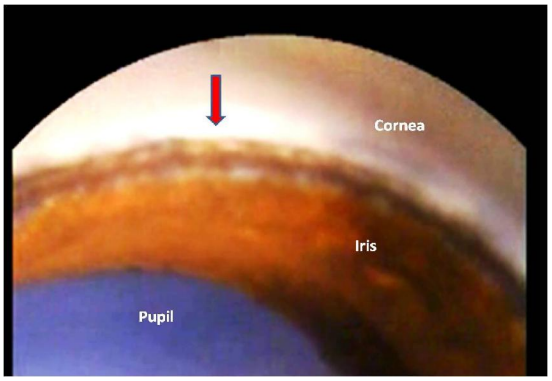

Fig. 4: Endoscopic photograph showing pectinate ligament dysplasia with a sheet of mesencymal tissue (arrow) occluding the ICA.

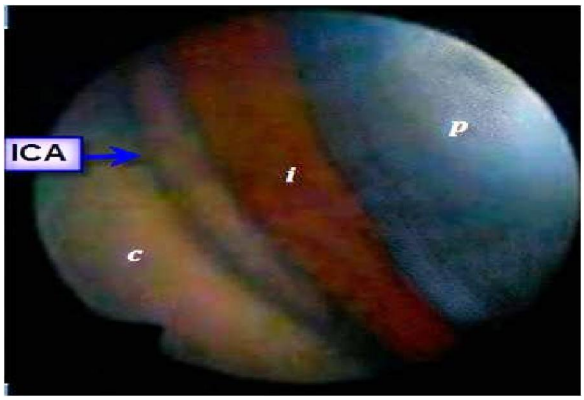

Fig. 5: Endoscopic photograph showing abnormal thickening of the pectinate ligament with closure of the iridocorneal angle (ICA).i, iris; c; cornea;p, pupil.

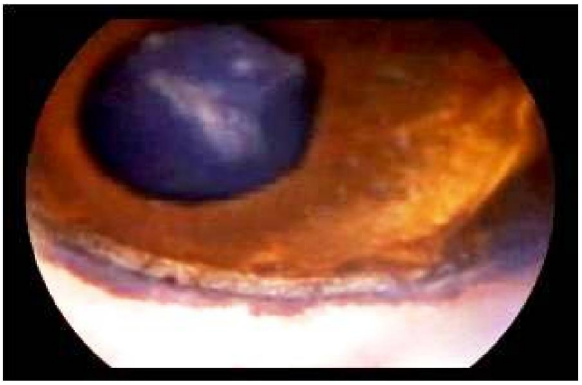

Fig. 6: Endoscopic photograph showing open angle phacoanaphylactic glaucoma, uveitis and posterior cataract in dog.

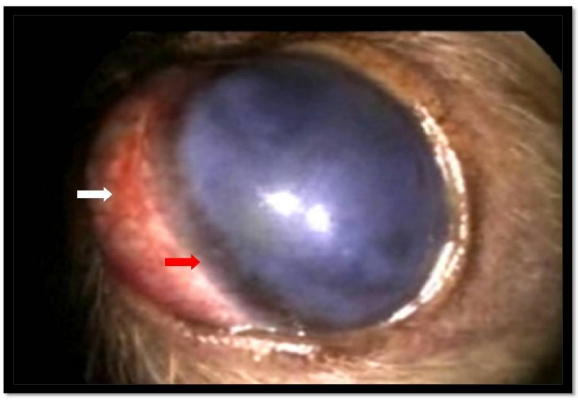

Fig. 7a: Photograph showing eye of a dog with chronic glaucoma secondary to lens luxation. Note the visible corneal edema, scleral ectasia and episcleral injection (white arrow) and typical vascular fringe (red arrow).

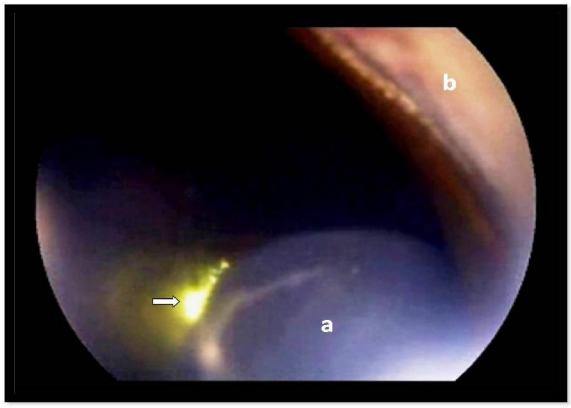

Fig.7b: Endoscopic picture of the same case in figure 7a showing the posteriorely luxated cataractous lens (a), cornea (b). Note the presence of aphakic crescent and tapetal hyper reflectivity (white arrow).

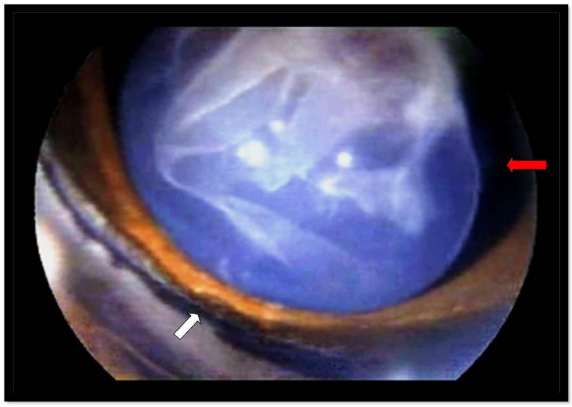

Fig. 7c: Endoscopic picture of a case with partially luxated cataractous lens showing narrowing of the entrance to the ciliary cleft by the lens equator (white arrow).Note the presence of aphakic crescent (red arrow).

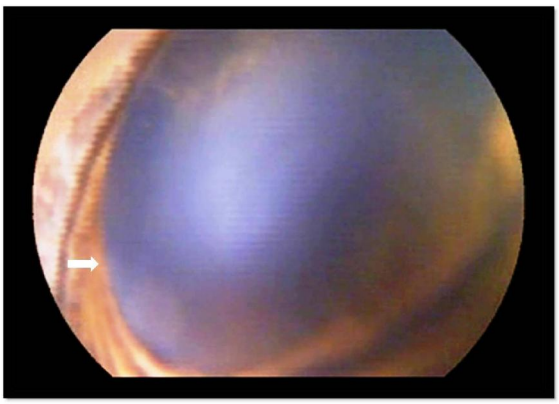

Fig. 8: Endoscopic photograph showing pupillary block glaucoma in. Note the swollen cataractous lens blocking the pupil and protruding into the anterior chamber and the closed ICA (arrow).

4. Discussion

Glaucoma is a large, diverse group of vision impairing disorders that are united only by common theme of intraocular pressure (IOP) that is too high for the optic nerve and retina to function normally. This level is typically >25 mm Hg in dogs.[9,10] In glaucoma site of damage is optic nerve which is generally (but not always) associated with elevated intraocular pressure (IOP) .[11]Visual damage occurs first and in most cases disease is pain free with no obvious symptoms. Therefore early detection and treatment is vital to control disease progression.

The rate of vision loss is proportional to the degree of IOP elevation; with complete blindness resulting in days with marked increases in IOP, and over weeks to months for mild increases.[12] Anterior lens luxation may cause anterior iris displacement, resulting in narrowing or closure of the iridocorneal angle, iritis, or iridocyclitis, peripheral anterior synechiae and, consequently, narrowing or occlusion of the entrance to the ciliary cleft. [7,8] This study revealed lens luxation is one of the most common causes of secondary glaucoma in dogs.

Optic nerve head (ONH) cup enlargement or "cupping" is associated with advanced glaucoma and occurs as a result of axonal loss, laminar plate compression, rotation of the scleral insertion zone posteriorly, outward bowing of the lamina cribrosa, and a widening of the scleral canal behind Bruch's membrane. [13]

In viewing the current study, ocular endoscopy is an easy, noninvasive diagnostic procedure used to evaluate ocular problems and used as a complement to traditional ocular examination. Ocular endoscopy is practiced in animals with glaucoma, disparity in ocular size or with any condition that impedes visualization of posterior ocular structures.[14] In this study, the majority of examined eye cases were suffered from corneal edema and intumscent cataract. Indirect ophthalmoscopy, another technique used for imaging the eye, allows visualization of the fundus without details of the retina. The technique requires an extensive training period for successful visualization of the retina, does not produce high-quality images and cannot be used in case of corneal edema or in cases with cataract. Biomicroscopy with slit-lamp examination also requires a long training period to visualize the anterior chamber, the lens, and the vitreous; this technique is difficult to use in small species.[15]

Examination of the iridocorneal angle is usually performed with a goniolens, which enables the investigator to have a circular view of the iridocorneal angle in an animal.[16] Such a technique, however, does not allow specific areas to be widened for a detailed analysis; rather, images must be produced by indirect

ophthalmoscopy requiring extensive training (e.g., for localization of partial closure of the iridocorneal angle). With endoscopic technique, we observed the iridocorneal angle with a wider view of the pectinate ligament at the trabeculum. These observations could facilitate the diagnosis of glaucoma, especially acute glaucoma with a closed angle.

5. Conclusion:

This topical endoscopic technique provides a unique tool for eye examinations and allows circular view of the anterior (iridocorneal angle) and the posterior (fundus) eye segments from all dogs with glaucoma. This technique is new and easy to use. It can be easily used to the eye of the patient in which interior visualization of the eye is impossible such in cases with corneal edema and cataract.

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