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B- Mode Ultrasonography of Ocular Abnormalities in Dogs

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ABSTRACT

Background: Ultrasonography is a simple, safe and non-invasive method to examine the internal structures of eye in case of opacity of otherwise clear ocular medium like cornea, aqueous, lens, and vitreous.

Methods: 123 dogs with ocular abnormalities from March 2021 to October 2022, presented to the Division of Veterinary Surgery and Radiology were included in this study. All of the animals underwent a thorough ophthalmic examination along with B-scan ultrasonography of both the eyes using a 7.5 MHz linear probe.

Result: Ultrasonography revealed thin hyperechoic lines and a thin hyperechoic rim of the lens, indicating early cataract changes and cortical cataract, respectively. Sixty-two dogs were found to be affected by cataract; 20 dogs were affected by the disease Phthisis bulbi; 16 dogs had a complete retinal detachment showing a typical “morning glory” sign; 10 dogs had vitreous haemorrhage; 6 dogs had a damaged eye with lens dislocation; and 5 dogs had choroidal melanoma and intraocular tumours in 4 dogs out of 123 observed dogs. Further, out of 62 cataract cases, 16 dogs were affected by cortical cataracts, 41 had nuclear cataracts, and 5 dogs were affected by morgagnian cataracts. Therefore, B-scan ultrasonography of the eye was a quick, safe, and accurate way to examine the pathology, especially when opaque media inhibit direct examination or when exophthalmos is evident and the normal anatomy of the eye.

Key words: Anatomy, B- mode, Dog, Ocular abnormalities, Ultrasonography.

INTRODUCTION

The eye is the only organ in all creatures that is responsible for vision. It is intended to absorb and reflect light in the same way that a camera does. Light strikes the retina and electrochemical impulses travel through complex neural pathways via the optic nerve to the visual cortex, where the nerve signal is converted into a visual image (Gelatt, 2013). The fluid content of the eyeball, as well as its superficial location, make it ideal for ultrasonography examination Rubin and Koch (1968) were the first to describe the use of diagnostic veterinary ocular ultrasonography, which is now regarded as a quick, non-invasive modality that gives an in-depth view of the soft tissues encircling the orbit and the intraocular components of the eye (Rubin and Koch, 1968; Ramirezand Tucker, 2004; Tamilmahan *et al.,* 2004).

When the ocular media is cloudy and direct visualization is not possible, ocular ultrasound is a noninvasive method for imaging the eye that is particularly useful for “seeing” retrobulbar and intraocular lesions (Potter *et al.,* 2008). To find retinal detachments, intraocular and intraorbital tumours, foreign bodies and other abnormalities, diagnostic ultrasonography is used (Fielding, 2001). Ultrasonography is useful for ocular examination in animals because it is easily available, affordable, safe, non-invasive and could be carried out with local anaesthetic eye drops Aironiand Gandage (2009); Mettenleiter (2001); Ramirez and Tucker, (2004); Boroffka *et al.* (2007); Dietrich (2007). The diagnostic value of ultrasonography is based on the observation and assessment of intraocular structures of the eyes for diagnoses, prognoses, and treatment planning Gonzalez *et al.* (2001); Penninck *et al.* (2001); Sushma, (2010); Ramirez and Tucker, (2004); Book *et al.* (2008).

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The fluid content and superficial location of the eyeball make it a perfect candidate for ultrasonography examination. For the purpose of identifying and evaluating retrobulbar and intraocular lesions, ocular ultrasound is a technique for taking pictures of the eye (Potter *et al.,* 2008). Structures like ciliary bodies and retrobulbar spaces that are not visible during standard ophthalmologic examination procedures could be assessed using ultrasound (Wilkie and Gilger, 1998; Hoffmann *et al.,* 2004). Ultrasonography is thought to be extremely helpful for the clinical assessment of a variety of ocular and orbital diseases (Tavana and Peighambarzadeh, 2014).

Various conditions diagnosed by conventional B-scan ocular ultrasonography in the 123 dogs brought to the Veterinary Clinical Complex, Faculty of Veterinary Sciences and Animal Husbandry, R.S. Pura, SKUAST-J, UT of J&K, India, during the period from March 2021 to October 2022 were studied. Objective of the following study was to use ultrasonography to identify various intraocular affections that are present in conjunction with other ocular diseases and are therefore difficult to detect with the unaided eye.

MATERIALS AND METHODS

A total of 123 dogs which were presented with various ocular affections to the Veterinary Clinical Complex, F.V.Sc. and A.H, R.S. Pura, Jammu, India, were selected for the study. All the dogs under the study were selected irrespective of breed, sex and age. Case history was recorded based on their owner's knowledge. This was followed by a detailed physical, clinical and ultrasonographic examination. Recording of rectal temperature, pulse rate (per min), rate of respiration (per min), capillary refill time and colour of the conjunctival mucous membranes were carried out in all the dogs.

All the animals were subjected to detailed ophthalmic examination and B-scans of the eyes using a 7.5 MHz linear probe. The probe was placed in the thumb compartment of a new examination glove which was filled with copious amount of coupling gel, for every scan. All of the dogs underwent trans-corneal scanning, which involved placing the probe directly on the cornea and gently applying pressure to maintain contact. Topical desensitisation was carried out prior to the scan by applying two drops of 0.5% proparacaine hydrochloride eye drops (Oproxy® (Proparacaine hydrochloride 0.5% eye drops, Ophtho Remedies Pvt. Ltd., Allahabad) spaced five minutes apart.

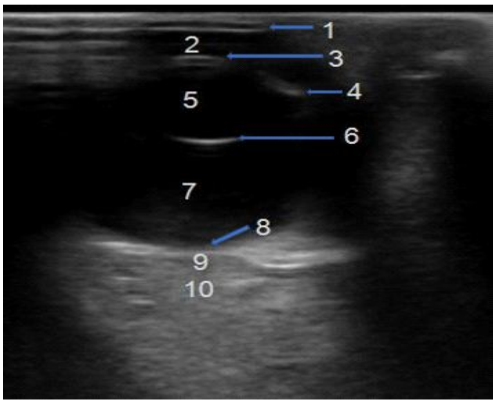
The animals were restrained manually while standing, in sternal or lateral recumbency, or both. All of the dog's eyelids were manually held open throughout the scan. Since imaging through the eye lid degrades images and introduces artefacts, it was avoided. Lesions were marked to help with delineation and calliper measurement. The transpalpebral approach, which looks through the eyelid, is used when there is corneal or scleral damage. Saline was used to rinse the eyes.

RESULTS AND DISCUSSION

In the present study, both the eyes of 123 dogs (246 eyes) were scanned by ultrasonography. A representative sonogram at 7.5 MHz was obtained in each case. Various ocular affections were detected ultrasonographically such as cataract (Cortical-16, Nuclear-41 and Morgagnian-5) in 62 (50.40%) dogs, phthisis bulbi in 20 (16.26%) dogs, retinal detachments in 16 (13.01%) dogs, vitreous haemorrhage in 10 (8.13%) dogs (Acute-7 and chronic-3), damaged eye with lens dislocation in 6 (4.88%) dogs, choroidal melanoma in 5 (4.06%) dogs and intraocular tumour in 4 (3.25%) dogs.

The sonographic appearance of the structures of the normal eye was recorded. The Cornea was the most superficially echogenic curved line and the Aqueous chamber was anechoic. Iris was represented by a thin echogenic line. The anterior and posterior boundary echoes defined the lens, but the lens itself was echo-free. Although the formation of spots and linear echoes with ageing is considered normal, the vitreous chamber is filled with a clear gel-like substance that is normally echo-free. The ciliary body appeared as a hypoechoic band. The retina appeared as an echogenic concave line. The optic disc or papilla is the circular area where the optic nerve connects to the retina, and the optic nerve is seen as a hypoechoic band surrounded by echogenic retrobulbar fat (Fig 1).

Early cataract (cortical) changes in dogs resulted in the development of hyperechoic curvilinear lines within the lens, which were posterior specular reflections on the lens surface (Fig 3A). The entire capsule was visible and the anterior and posterior cortices were echogenic in cortical cataracts (Fig 3B). Although the nucleus was always echogenically enhanced and asymmetric in cases of nuclear cataract, nearly complete nuclear cataract was also noted (Fig 3C). Lenses with reduced anterio-posterior thickness and wrinkled capsules were depicted as



Cornea (1), aqueous chamber (2), anterior lens capsule (3), iris (4), lens (5) posterior lens capsule (6), vitreous body (7), retinal rim (8), optic disc (9) and optic nerve (10).

Fig 1: Normal eye, Ultrasonographic appearance of normal eye.

Fig 2: Gross image of cataract.

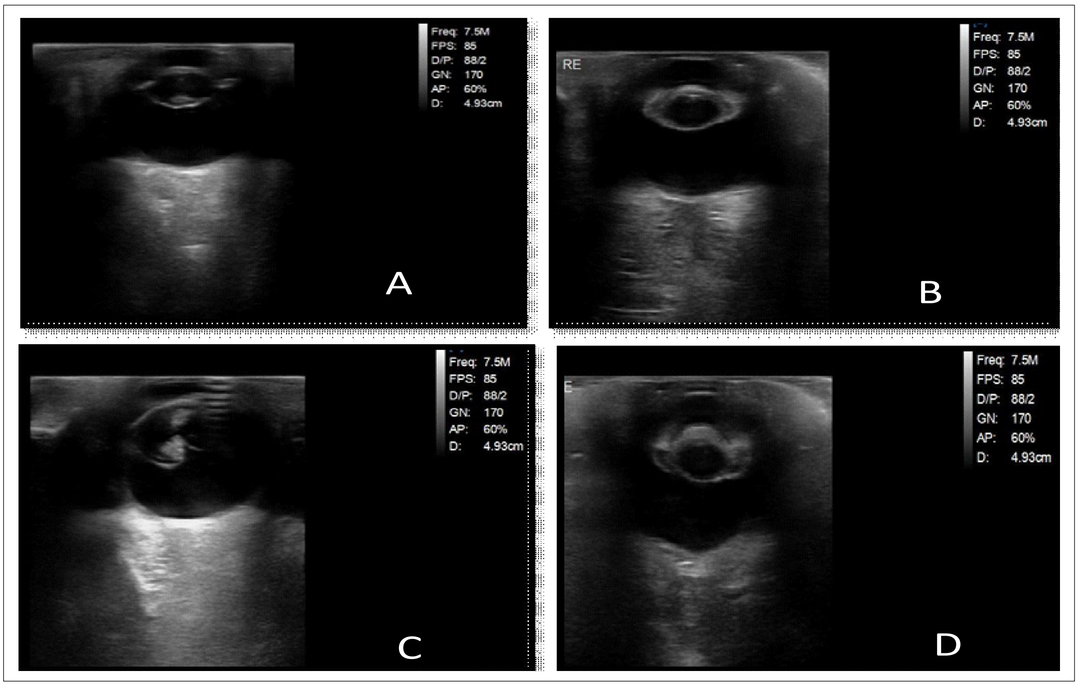


Fig 3: Cataract, Ultrasonography image (7.5 MHz linear probe). Ultrasonography image showing lens with thin hyperechoic lines indicating early cataract changes (A), ultrasonography image showing hyperechoic rim around lens representing cortical cataract. Focal hyperechoic area in lens represents incomplete cataractous involvement (B), ultrasonography image showing nucleus echogenically enhanced, which is asymmetric but nearly complete (C), and ultrasonography image showing margins of hyperechoic lens and lens with reduced thickness and wrinkled capsule due to cortical reabsorptions (D).

morgagnian cataracts. The lens's nucleus was not exactly in the centre (Fig 3D). External appearance of dog suffering with mature cataract (Fig 2).

In 20 dogs, phthisis bulbi was found (Fig 4). Phthisis bulbi was the final stage of a variety of ocular disorders, frequently observed following injury, unsuccessful surgery, and congenital ocular anomalies. The main causes in the current study were congenital ocular abnormalities [n=6, Fig 5A] and ocular trauma [n=14, Fig 5B]. The eye appeared smaller on ultrasonography, typically with calcified walls and hyperechoic fibrous tracts from the retina to the posterior lens, which can cause retinal detachment.

In 16 dogs, there was complete retinal detachment coursing from their attachment at the optic disc up to the orra serrata, displaying the typical "morning glory" sign in a longitudinal plane attached to the optic disc (Fig 7). In few dogs total retinal detachment was visualised as "seagull wings" or a V-shaped hyperechoic structure in the vitreous chamber. In most cases, the retinal membrane was thicker and more echogenic. External appearance of dog suffering with retinal detachment (Fig 6).

Lens dislocation were identified in 5 dogs (Accidental injury-3 and cataract-2), where the lens was dislocated from its own position (Fig 8 and Fig 9).

Vitreous haemorrhage were identified in 10 dogs (Fig 10). In this study ocular trauma was the main cause of acute and chronic vitreous haemorrhage. At ultrasonography subtle echogenic material that obscured the ophthalmoscopic examination was seen floating within the vitreous in acute vitreous haemorrhage (Fig 11A) and echogenic bands in the vitreous representing fibrous membranes is characteristic of chronic vitreous haemorrhage (Fig 11B).

Fig 4: Gross image of pthysis bulbi.

Choroidal melanoma (Fig 12 and 13) and Intraocular neoplasia (Fig 14 and 15) were identified in 5 (4.06%) and 4 (3.25%) dogs respectively. In this present study, gene mutation (genetic or hereditary) was observed to be the main cause of choroidal melanoma and neoplasia. Ocular melanoma arises from the melanocytes of the outer layers of the choroid. Small melanomas were dome-shaped. The cardinal ultrasonographic features of ocular melanoma

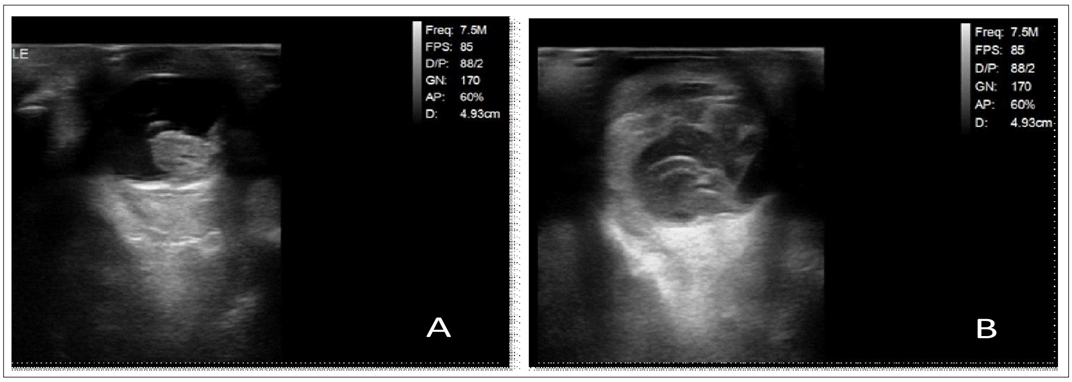


Fig 5: Pthysis bulbi, Ultrasonography image (7.5 MHz linear probe) showing congenital ocular abnormalities (A) and shrunken globe with extensive calcification and loss of the normal shape (B).

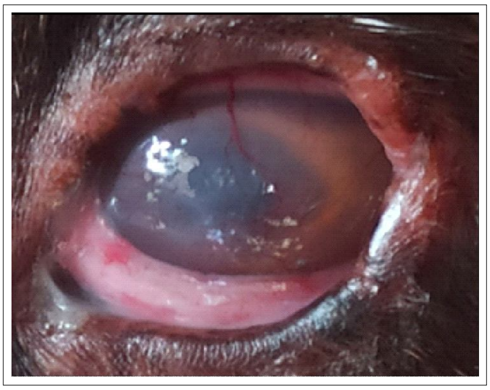


Fig 6: Gross image of retinal detachment.

Fig 8: Gross image of damaged eye with lens dislocation.

Fig 7: Retinal detachment, Ultrasonography image (7.5 MHz linear probe) showing complete Retinal detachment.

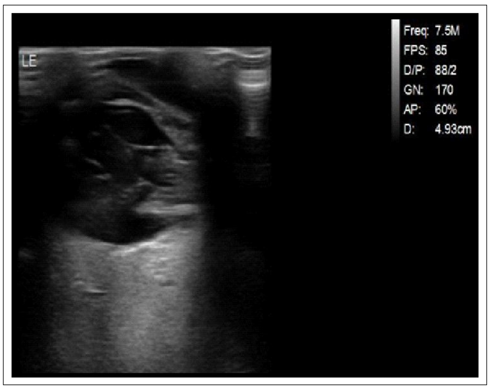


Fig 9: Damaged eye with lens dislocation.

included solid consistency, regular internal structure, dome shape with low to medium echogenicity, internal blood flow at the base, and choroidal excavation under the mass.

Even in animals where direct observation of intraocular structures is not possible, ultrasonography can be used to identify tumours, perform measurements, and compare findings to those of the contralateral eye (Gonzalez *et al.,* 2001). Ultrasonography can evaluate structures that cannot be seen with routine ophthalmologic examination techniques, such as ciliary bodies or retro-bulbar spaces (Hoffmann *et al.,* 2004). Ocular ultrasound has also been useful in the diagnosis of intraocular affections where routine ophthalmic examinations were unable to determine the extent of involvement, as evidenced by the findings in the study (Whitcomb, 2002).

All animals were scanned without sedation or general anaesthesia because these procedures make it difficult to image the subject because they cause the eye to roll downward or the third eyelid to move upward. In order to highlight various intraocular and extraocular structures the transducer was slowly panned across the globe while being angled in different directions.

Results of the present study indicated that the ocular ultrasound was useful to diagnose some diseases and its associated abnormality which could not be detected by naked eye (Gallhoefer *et al.,* 2013).

Topical anaesthesia was found to be adequate for ocular ultrasonography in dogs in this study, as reported in earlier studies (Featherstone and Heinrich, 2013; Mackay and Mattoon, 2015).

Two fluid-filled cavities (anterior chamber and vitreous chamber) appeared anechoic in the B-mode scan of the normal eye. In all of the dogs, the cornea was visible as a thin curvilinear hyperechoic line parallel to the probe. Iris was discovered in a single line, continuing with the globe and ciliary body. Normal eyes saw the lens as anechoic, with echogenic curvilinear anterior and posterior capsules Kumar, (2012). The vitreous body was seen as an anechogenic chamber filled with vitreous humour beneath the posterior margin of the lens. The vitreous was bounded anteriorly by the lens's posterior capsule and posteriorly by the eye ball's posterior wall. The optic disc could be imaged as a thick hyperechoic structure at the posterior wall of the eye ball, which was clearly more echogenic than adjacent structures. The retina, choroid and sclera were all represented by a single hyperechoic line (Toni *et al.,* 2013).

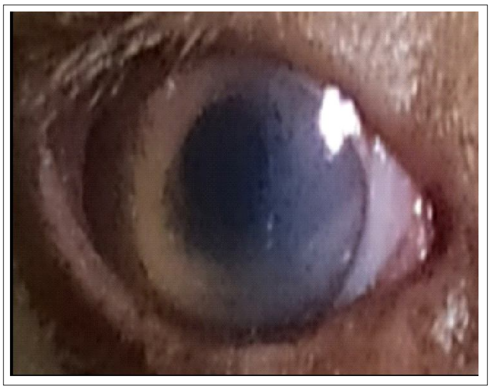


Fig 10: Gross image of vitreous haemorrhage.

Cataracts are the most common intra-ocular lesion found in small animals and are a common cause of vision loss. Cataracts are degenerative changes in the lens that cause echogenicity at various locations within an anechoic lens (Gelatt and Mackay, 2005; Spaulding, 2008); Williams, (2010). The echogenicity, size and shape of the lens can vary depending on the type of cataract and its duration. Acoustic inhomogeneities are caused by changes within a cataractous lens Spaulding, (2008). The cataracts were classified as cortical, nuclear, or morgagnian based on their location within the lens as seen in B scans Nautrup and Tobias, (2000); Pennieck and Anjou, (2008). Some cataracts are slightly wrinkled, while others are perfectly smooth. Cortical cataract is visible on ultrasound as thin hyperechoic lines around the lens. The lens in hyper mature cataracts is completely hyperechoic and smaller than normal (Spaulding, 2008). Mature cataract was the most common, followed by incipient cataract, immature cataract and hyper mature cataract (Santosh *et al.,* 2019).

Phthisis bulbi is a terminal condition caused by ocular trauma and haemorrhage. With extensive calcification, the eye is blind, small, and non-functional. The normal ocular shape is lost (David, 2002). The eyeballs showed shrunken globe with extensive calcification and loss of the normal ocular shape due to congenital abnormality and ocular trauma (Ragab and Fathy, 2018).

Retinal detachment (RD) is a common abnormality that can be detected using ultrasonography. It can be caused by either vitreoretinal traction or subretinal exudates. Detached retinas emit a continuous sheet of high-amplitude echoes that encroaches on the vitreous cavity Mcleod *et al.* (1977). Complete retinal detachment was observed coursing from their attachment at the optic disc up to the orra serrata in the current study, displaying a typical "morning glory" sign and the optic disc is attached to a longitudinal plane. When cataracts were present, retinal detachment was sometimes detected and should always be looked for when a cataract diagnosis is made. The prevalence of retinal detachment was highest in eyes with

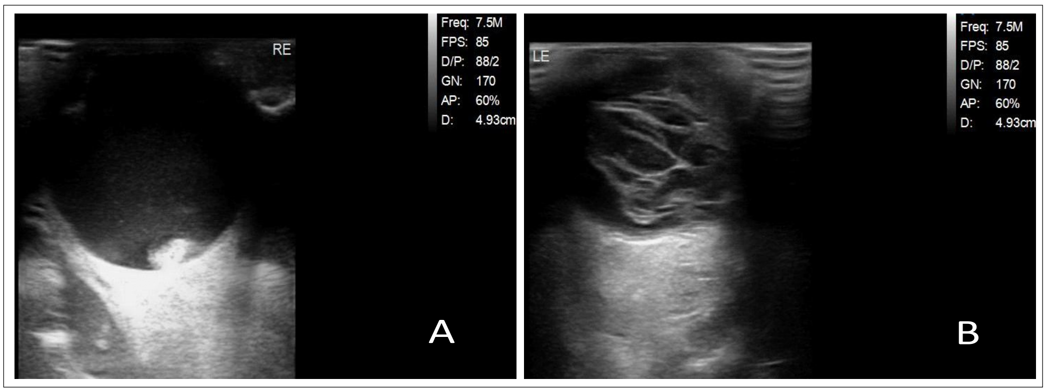


Fig 11: Vitreous haemorrhage, at ultrasonography subtle echogenic material that obscured the ophthalmoscopic examination is seen floating within the vitreous (A) and at ultrasonography shows echogenic bands in the vitreous representing fibrous membranes, characteristic of chronic vitreous haemorrhage (B).

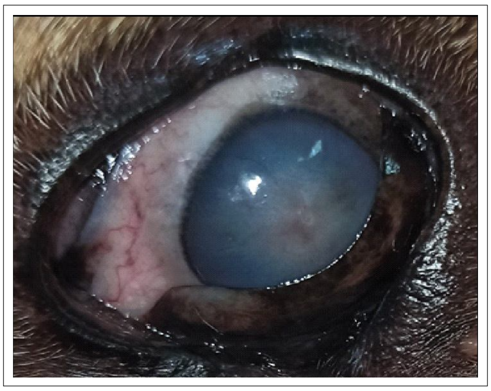


Fig 12: Gross image of choroidal melanoma.

Fig 13: Choroidal melanoma, ultrasonographic image shows a dome-shaped hypoechoic posterior mass with a smooth surface.

Fig 14: Gross image of intraocular neoplasia.

Fig 15: Intraocular neoplasia, ultrasonographic image demonstrating an extensive mass in the posterior chamber of the eye.

cataract and glaucoma maturity. In the current study, complete retinal detachment was observed coursing from their attachment at the optic disc up to the orra serrata, displaying a typical “morning glory” sign and the optic disc is attached to a longitudinal plane. Typically, the retinal membrane was thicker and more echogenic (Mcleod *et al.* 1977; Gonzalez *et al.* 2001; Spaulding 2007; Dar *et al.* 2014).

The posterior vitreous cavity showed linear and/or curvilinear convex echos of vitreous haemorrhage (Zeiss and Dubielzig 2004; Aironi and Gandage 2009). The vitreal haemorrhage seen in 10 dogs in the current study at ultrasonography revealed subtle echogenic material floating floating within the vitreous in cases of acute vitreous haemorrhage and echogenic bands in the vitreous representing fibrous membranes in cases of chronic vitreous haemorrhage, as observed by (Ragab and Fathy, 2018).

Lens dislocation was identified in 5 dogs (a ccidental injury-3 and cataract-2) where the lens was dislocated from its own position (Aironi and Gandage, 2009); Ragab and Fathy, 2018; Dar *et al.,* 2014).

Although choroidal melanoma and intraocular neoplasia were uncommon in dogs, they should be considered in the differential diagnosis of patients with uveitis and glaucoma, as well as those with discrete masses. Uveal melanoma was the most common primary intraocular tumour in both dogs and cats. Choroidal melanoma is very common in dogs (Fuchs and Belknap, 2018; Miwa *et al.,* 2005). Gene mutation is the primary cause of choroidal melanoma and intraocular neoplasia in this study, which was similar to findings mentioned in other studies of dogs (Ragab and Fathy, 2018; Fuchs and Belknap, 2018).

CONCLUSION

In conclusion, B-scan ultrasonography of the eye was a quick, safe and accurate way to examine the pathology, especially when opaque media inhibit direct examination or when exophthalmos is evident and normal anatomy of the eye. Real-time, high-quality images of the vitreous body and posterior chamber were produced by the 7.5 MHz probe. B-scan ultrasonography can also help with preoperative planning, when there is opaque ocular media, B-scan aids in the evaluation of the posterior segment. In rural centres, it is a practical choice. In many patients, this noninvasive technique enables a rapid approach to diagnosis and, as a result, the selection of appropriate therapy.

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Conflict of Interest

All authors have approved the manuscript and there is no conflict of interest.

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