B-scan ultrasonography of ocular abnormalities: a review of 182 dogs

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(Received 2 Feb 2013; revised version 22 Oct 2013; accepted 9 Nov 2013)

Summary

Ultrasonography is the only practical method for obtaining images of the posterior segment of the eye when the light-conducting media are opaque. In this study, 182 dogs with ocular abnormalities presented to the Department of Veterinary Surgery and Radiology from December 2008-August 2010 were included. All the animals were subjected to detailed ophthalmic examination and B-scan ultrasonography of the eyes with a 7.5-18 MHz linear probe. Ultrasonography revealed thin hyperechoic lines of the lens indicating early cataract changes in 40 cases. In 10 cases, thin hyperechoic rims around the lens suggestive of cortical cataract were evident. In 82 cases, the entire lens was echogenically consistent with complete cataract (nuclear cataract). In 3 cases the capsule appeared wrinkled, suggesting morgagnian cataract. To obtain images from the posterior segment of the eye, a 7.5-12 MHz linear probe was used. In two cases, there was sub-luxation of the lens, while in 14 cases, retinal detachment was observed. Complicated retinal detachments had occurred in four cases. Posterior vitreal degeneration was seen in 15 dogs. Ultrasonography revealed vitreal hemorrhage in 10 cases and asteroid hyalosis and optic nerve avulsion in one case each.

Key words: Ocular abnormalities, B-scan ultrasonography, Dog

Introduction

The eyeball's fluid content and its superficial position makes it ideally suited for ultrasonography examination. Ocular ultrasound is an effective and noninvasive technique for imaging the eye and is especially valuable for "seeing" retrobulbar and intraocular lesions when cloudy ocular media preclude their direct visualization (Fielding, 2001). Indications for diagnostic ultrasonography include localization of retinal detachments, intraocular and intraorbital tumors, foreign bodies, etc. (Aironi and Gandage, 2009).

Two dimensional ultrasonography allows for the evaluation of structures such as cornea, anterior chamber, iris, ciliary body, lens, vitreous chamber and the posterior section of the bulbar wall. A special ultrasound system with frequencies of 40-100 MHz has been created to give detailed images of the cornea, anterior and posterior chamber, lens, iris and ciliary body (Nautrup and Tobias, 2000). In the normal young eye, three cavities (anterior chamber, posterior chamber and vitreous body) with anechoic appearance and a few present reflectors can be seen. The normal posterior chamber is located between the posterior iris surface and the anterior lens surface. Curvilinear interfaces appearing at the anterior and posterior margins of the lens are due to specular reflections, when scanned perpendicularly. The optic nerve is seen as a thin linear hypoechoic structure outlined by adjacent hyperechoic fat (Boroffka *et al*., 2006).

Various conditions diagnosed by conventional B-scan ocular ultrasonography in the ophthalmic unit of the Department of Surgery and Radiology, Anand Agricultural University, Anand, Gujarat, India, during December 2008-August 2010 were studied. This pictorial assay shows B-scan images of a few ocular abnormalities.

Materials and Methods

One hundred and eighty two male and female dogs of different breeds were referred with varying symptoms of ocular abnormalities. All the animals were subjected to detailed ophthalmic examination and B-scans of the eyes using a 7.5-18 MHz linear probe (Esaote, MYLAB40VET, Netherland). The animals were scanned in sternal recumbency or sitting position with head fixations for ultrasonography. The transducer was placed in direct contact with topically anesthetized (0.5% proparacaine) cornea after the application of coupling gel (Arihant Care, Ahmedabad-380023, Gujarat, India) (Dziezyc *et al*., 1987). Imaging through the eye lid was avoided because it produces artifacts and causes image degradation. All animals were scanned without sedation or general anesthesia as these methods cause the eye to roll downward or the third eyelid to move upward making the imaging process difficult. The transducer moved slowly across the globe and angled in different

directions to highlight various intraocular and extraocular structures. Lesions were marked to delineate and measure with in-built caliper. In cases of corneal or scleral damage, the transpalpebral approach, which examines through the eyelid, was adopted. Eyes were rinsed with saline solution after each examination and a drop of lubricant was instilled.

Results

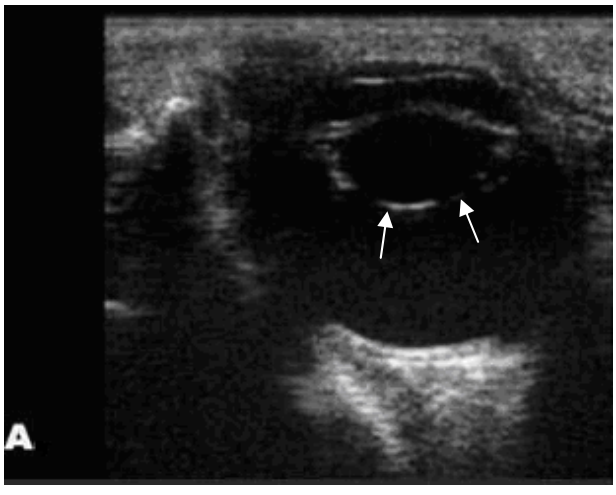
In the present study, the eyes of 182 dogs (364 right and left eyes) were scanned by ultrasonography. In each case, a representative sonogram using 7.5 MHz was obtained first.

Various ocular conditions detected by B-scan ultrasonography included early cataract changes in 40 dogs, cataract (cortical-10, nuclear-82, and morgagnian-03) in 95 dogs and sub-luxation in 2 dogs. Retinal detachments were seen in 14 dogs, while complicated retinal detachments were observed in 4. Posterior vitreal degeneration was seen in 15 and hemorrhage in 10 dogs. One case was observed for each asteroid hyalosis and optic nerve avulsion conditions.

Dogs with early cataract (cortical) changes, had hyperechoic lines within the lens, and the strong hyperechoic curvilinear line was a posterior specular reflection on the surface of the lens (Fig. 1A). In cortical cataracts, the anterior and posterior cortices were echogenic and the entire capsule was apparent (Fig. 1B). In all cases of nuclear cataract, the nucleus was echogenically enhanced with asymmetry, but nearly complete nuclear cataract was also observed (Fig. 1C). Morgagnian cataracts were visualized as lenses with reduced anterio-posteriorly thickness and wrinkled capsules. The nucleus was not exactly in the center of the lens (Fig. 1D).

Subluxated lenses were identified in 2 dogs with posterior luxation where the lens was posteriorly in the vitreal cavity.

In 14 dogs there was complete retinal detachment showing a typical “morning glory” sign in a longitudinal plane attached to the optic disc (Fig. 2A). The retinal membrane was typically thicker and more echogenic.



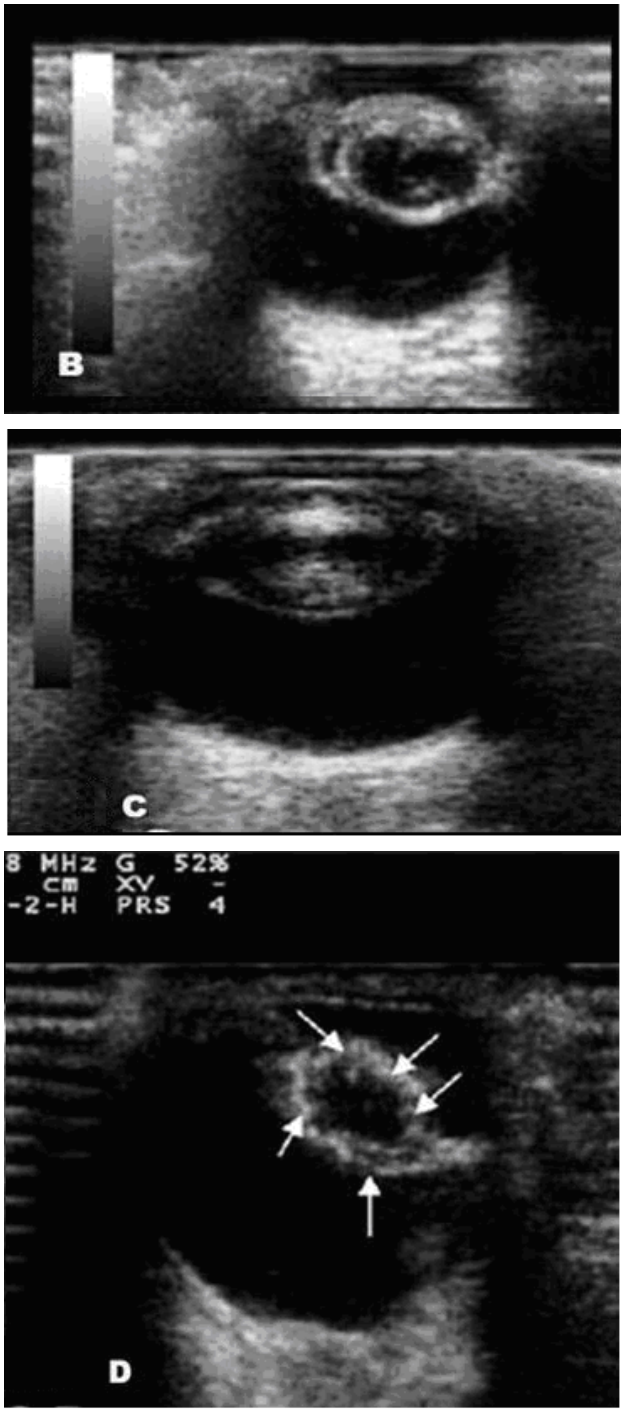


Fig. 1: Ultrasonography image. A: Ultrasonography image (18 MHz linear probe) showing lens with thin hyperechoic lines (arrows) indicating early cataract changes. B: Ultrasonography image (7.5 MHz linear probe) showing hyperechoic rim around lens representing cortical cataract. Focal hyperechoic area in lens represents incomplete cataractous involvement. C: Ultrasonography image (18 MHz linear probe) showing nucleus echogenically enhanced, which is asymmetric but nearly complete. D: Ultrasonography image (18 MHz linear probe) showing margins of hyperechoic lens and lens with reduced thickness and wrinkled capsule (arrows) due to cortical reabsorptions

Four dogs had flat retinal detachment (retinal layers remaining attached at the optic disc to the ora serrata but

separated from the adjacent choroid by fluid anywhere between them) (Fig. 2B).

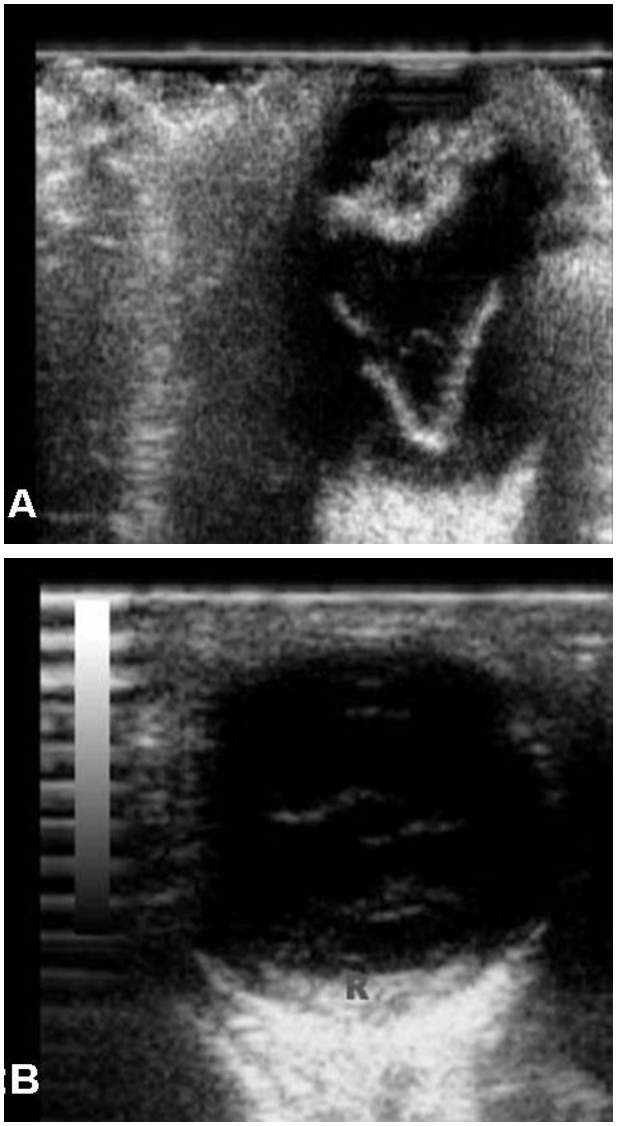


Fig. 2: Ultrasonography image. A: Ultrasonography image (12 MHz linear probe) showing complete retinal detachment coursing from their attachment at optic disc up to orra serrata. B: Ultrasonography image (10 MHz linear probe) showing flat retinal detachment (R) with vitreal degeneration (VD)

Detached vitreous had multicurved lines with varying reflectors, and was observed in all 15 dogs with posterior vitreal detachments. The vitreal membranes were typically less echogenic when compared to detached retinal membranes. This was seen frequently in cataractous eyes in the B-scans (Fig. 3). The presence of blood cells in the vitreous (Fig. 4A) gave rise to low intensity echoes. A multitude of echoes with varying appearance within the anechoic vitreal cavity, was seen in 10 dogs with vitreal hemorrhage (Fig. 4B).

In one dog with asteroid hyalosis, small foci which were discrete pinpoint reflectors were dispersed throughout the vitreous. One dog that had had a vehicular accident, had acute vision loss in the left eye. The left pupil was unresponsive to light but the right pupil reacted normally to direct light. The sclera was intact but the globe of the eye was misshapen. Posterior segment examination revealed the presence of vitreous hemorrhage inferiorly. The optic nerve head was obscured by the overlying hemorrhage. The retina was completely detached and the shape of the globe was also deformed. The optic nerve did not seem to reach the optic disc and an area of hypolucency was seen anteriorly, just posterior to the optic nerve head (Fig. 5). Thus, the case was tentatively diagnosed as optic nerve avulsion.

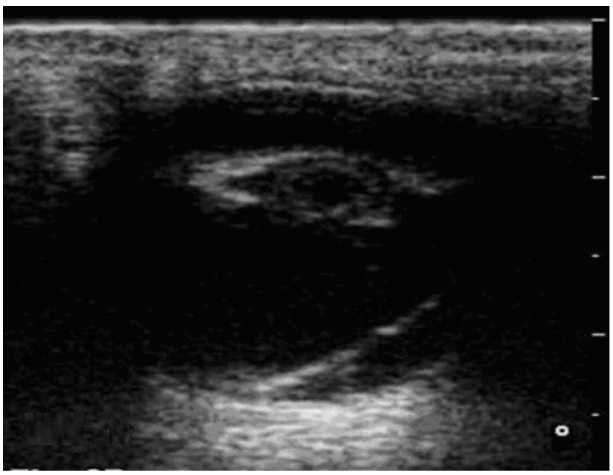


Fig. 3: Ultrasonographic image showing retraction of vitreous with intact retina and cortical cataract

Discussion

B-scan ultrasonography images of non-affected, contra-lateral eyes depicted three cavities with corneal surfaces as the first highly reflective lines (Boroffka *et al*., 2006). Similar to what was reported earlier by Grainger *et al*. (2001), in our study, the posterior chamber was not usually well visualized with ultrasonography. In normal eyes, the sclera, choroid and retina are adherent; however, under certain pathologic conditions, they may separate and form potential spaces (Spaulding, 2008).

Cataracts are degenerative changes in the lens (Gelatt and Mackay, 2005) which produce echogenicity at various locations within an anechoic lens. Echogenicity, size and shape of the lens may change with the type of cataract and its duration. Changes within a cataractous lens produce acoustic inhomogenecities (Spaulding, 2008). Based on their location within the lens, the cataracts were addressed as cortical (n=10), nuclear (n=82) and morgagnian (n=3) as visualized in the B-scans in the present study, also reported by earlier researchers (Nautrup and Tobias, 2000; Pennieck and d'Anjou, 2008). Some cataracts have a slightly wrinkled appearance whereas others are perfectly smooth (Farrow, 2003). Ultrasonographically, cortical cataract is seen as thin hyperechoic lines around the lens. In hypermature cataracts, the lens is entirely hyperechoic and smaller than normal (Spaulding, 2008).

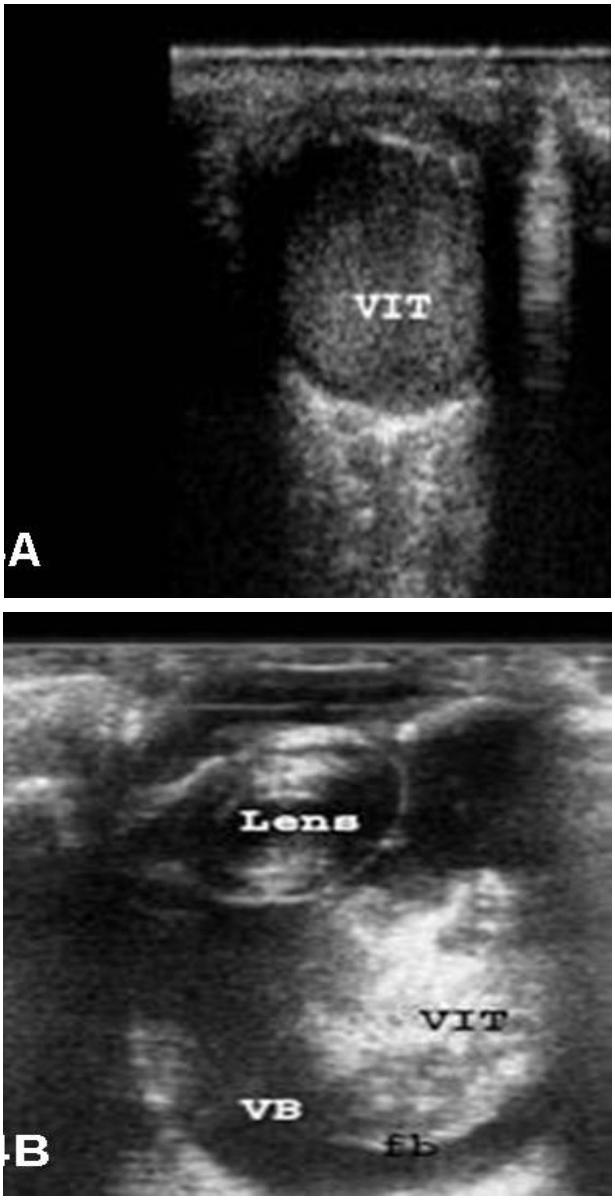


Fig. 4: Ultrasonography image (C-7.5 and D-18 MHz linear probe) showing extensive vitreal hemorrhage. A: Diffuse, multifocal evenly dispersed echoes are present in the vitreal chamber with motion on real time examination suggesting vitreal hemorrhage (VIT). Vitreal hemorrhage is organized and developed into fibrinous membranes (fb). B: Vitreous body-VB

Posterior sub-luxated lenses in two dogs can be attributed to the rupture of zonules at the peripheral ligamentous attachments.

Retinal detachment (RD) is a commonly encountered abnormality that can be diagnosed ultrasonographically. It can be caused by vitreoretinal traction due to contracting membranes or by sub retinal exudates. Detached retinas produce a regular continuous sheet of high-amplitude echoes encroaching the vitreous cavity (McLeod *et al*., 1977). The retina is usually attached firmly to the points of the ora serrata anteriorly and the optic nerve head posteriorly. Out of 18 dogs with RD, 14 had the typical "morning glory" sign, i.e. complete detached retinal membrane from the optic disc to the ora serrata (Spaulding, 2008). In 4 dogs, flat RD was diagnosed. Vitreal membrane and a detached taut retina have a similar appearance.

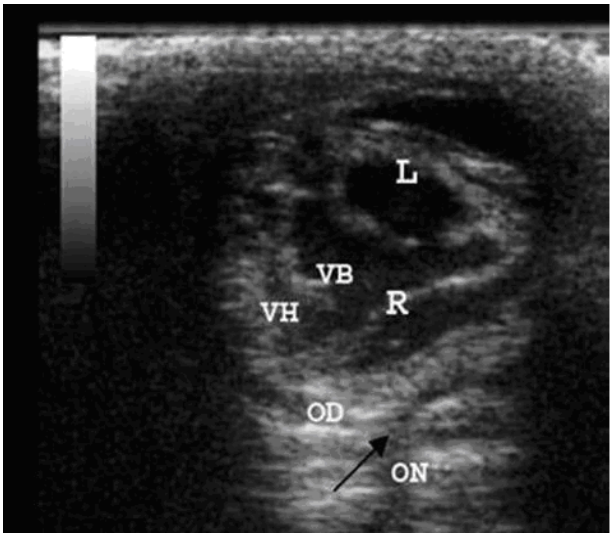


Fig. 5: Ultrasonography image (10 MHz linear probe) showing misshapen eye globe with vitreous hemorrhage (VH) inferiorly. The optic nerve head (ON) is obscured by the overlying hemorrhage. Retina (R) is completely detached. The optic nerve is not reaching the optic disc (OD) and an area of hypolucency is seen anteriorly (arrow)

In 15 dogs, detached vitreous appeared as linear and/or curvilinear convex echos in the posterior vitreous cavity. Vitreal membranes were typically less echogenic when compared to detached retinal membranes (Zeiss and Dubielzig, 2004). The scans showed reduced volumes of vitreous gel and marked mobility and elasticity of the detached vitreous. The vitreal haemorrhage seen in 10 dogs can contribute to the organization and development of fibrinous membranes (Aironi and Gandage, 2009).

Asteroid hyalosis is characterized by numerous small, refractile bodies of calcium phospholipid suspended within a relatively solid vitreous gel. Beside old age, asteroid hyalosis is also associated with chronic inflammatory and degenerative ocular disorders (Barnett *et al*., 2001). As seen in the present study, the small foci around 0.03-0.1 mm calcium-lipid complexes are discrete pinpoint reflectors and disperse throughout the vitreous (Bedi *et al*., 2006).

Optic nerve avulsion observed in one case, is a rare presentation of ocular trauma. The diagnosis of this entity is often obscured by the presence of concomitant vitreous hemorrhage, which precludes the visualization of optic head excavation (Sawhney *et al*., 2003).

In conclusion, B-scan ultrasonography of the eye is a safe, rapid and reliable method of investigating the normal anatomy of the eye and its pathology. The 7.5-12 MHz probe provided excellent quality real-time imaging of posterior and vitreous chambers and can be considered as a representative ultrasonogram. The 15-18 MHz probe provided good quality images of the lens and its pathology.

Acknowledgement

The authors would like to express their thanks to Dr. M. J. Sheth for her technical assistance.

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