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Pictorial Essay: B-Scan Ultrasonography Of Eye & Orbit

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Abstract
B-scan ultrasonography (USG) is a simple, non-invasive tool for diagnosing lesions of the posterior segment of the eyeball. Common conditions such as vitreous degeneration, retinal detachment, ocular trauma, choroidal melanoma, and retinoblastoma canbe accurately evaluated with this modality. B-scan USG is cost-effective, which is an important consideration in the rural setting. In addition, it is non- invasive and easily available and the results are reproducible.

Keywords*: B-scan; ocular pathologies; retinal detachment*

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I. Introduction

The eyeball's fluid content and its superficial position makeit ideally suited for examination with ultrasonography (USG). USG is the only practical method for obtaining images of the posterior segment of the eye when the light-conducting media are opaque. It is the most useful investigation prior to vitrectomy. In this pictorial essay, we highlight the various conditions that can be evaluatedby B-scan USG.

Normal B-scan and Anatomy (Figure 1)

The human eye, with its superficial position and its fluid- filled structure, is ideally suited for examination by USG. The eyeball has a transparent anterior segment and an opaque posterior segment containing the echo lucent vitreous. The iris diaphragm divides the anterior segment, which is filled with aqueous humour, into two chambers. The eyeball has three coats: the sclera, choroid and retina. The lens is a transparent, biconvex body situated behind the iris. On B-scan, normal clear vitreous is seen inthe posterior segment with the echo of the posterior lens capsule seen anteriorly. The axial length of the normal adulteye is 24 mm. [1,2,4]

On B-scan of the normal eyeball, the optic nerve can be seen passing through the retro bulbar fat. The retro bulbar fat is echogenic, and the optic nerve is seen as a hypoechoictubular structure extending from the posterior pole of the eyeball toward the orbital apex. [1-4] The extraocular musclescan be identified on a B-scan, especially the medial and lateral recti, on a horizontal scan.

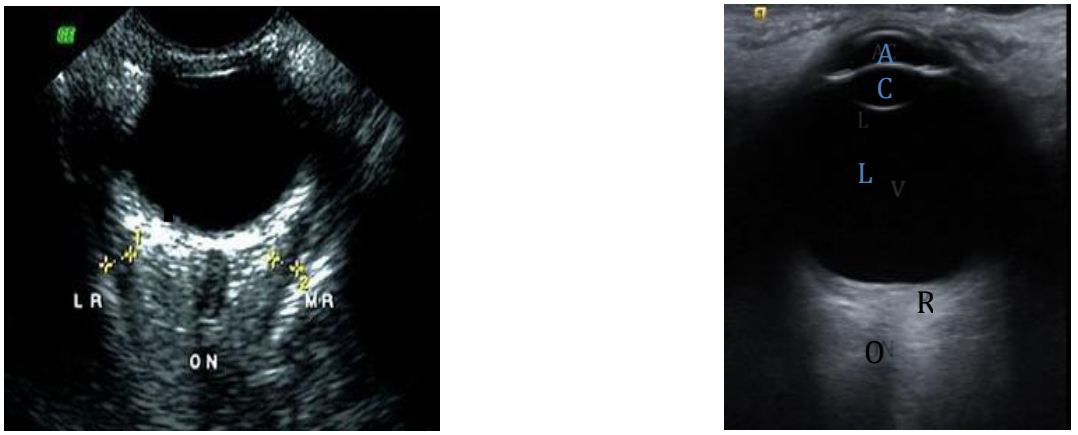

Figure 1. Normal anatomy. B scan of normal eyeball shows MR- medial rectus; LR- lateral rectus; AC- anterior chamber; L- lens; v- vitreous humour, ON-optic nerve, R-retina

II. Material And Methods

All images presented in this article were obtained using a standard USG machine (Samsung series, Wipro GE, Ahmedabad, India) equipped with a 7.5–10 MHz real- time high-frequency probe with the contact method. The probe was placed over the closed eyelid after application of coupling gel.

Various ocular conditions detected by B-scan

Vitreous degeneration

In vitreous degeneration, the liquefied vitreous contains cholesterol crystals that move with eye movements. B-scan reveals multiple hyper reflective mobile foci within the vitreous chamber that show after-movements on a dynamic scan. This is also known as synchysis scintillans. There is no reduction of visual acuity in this condition. It is often bilateral and secondary to longstanding uveitis or may follow vitreous haemorrhage. [1-4]

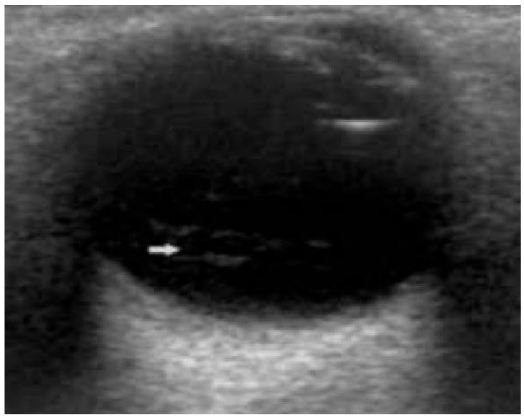

Figure 2 A 50-year-old female with known case of diabetes mellitus had vitreous degeneration in right eye. B –scan reveals multiple hyper reflective foci(arrow) within the vitreous chamber. After movements were also seen on dynamic scan.

Classic retinal detachment with choroidal detachment

Retinal detachment (RD) is usually due to a break or tear in the retina; it may also be caused by vitreoretinal traction dueto contracting membranes or because of sub retinal exudates.The detached retinaisusuallyattached to the firm anchoringpoints of the ora serrata anteriorly and theoptic nerve headposteriorly and, consequently, a total RD shows a funnelshape. Dynamic scan may reveal an undulating motionof the retinal membrane, particularly in a recent RD. WithB-scan, it is possible to diagnose RD early so that reparativesurgery can be carried out to seal the retinal tear using laseror cryotherapy.

RD sometimes seen in association with choroidal detachment. In a choroidal detachment, B-scan shows fluid in the supra-choroidal space; the choroid is attached anteriorly to the ciliary body (scleral spur) and posteriorly at the exit foramina of the vortex veins. It maybe secondary to trauma or surgery or may even occur spontaneously. [1-4]

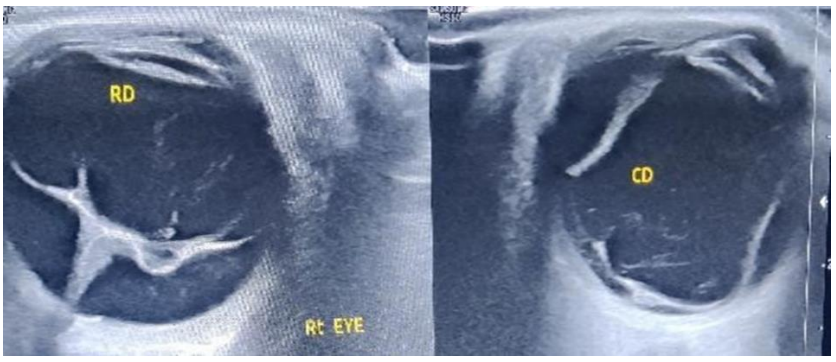

Figure 3. Retinal detachment. B- scan reveals a classic total retinal detachment(RD)in a 58-year-old man who came to loss of vision in his right eye. The retina has a funnel shaped appearance due to firm attachment at the ora serrata anteriorly and optic nerve head posteriorly. Dynamic study showed reduced retinal mobility. The retinal leaves are thick.

RD with persistent hyperplastic primary vitreous (PHPV)

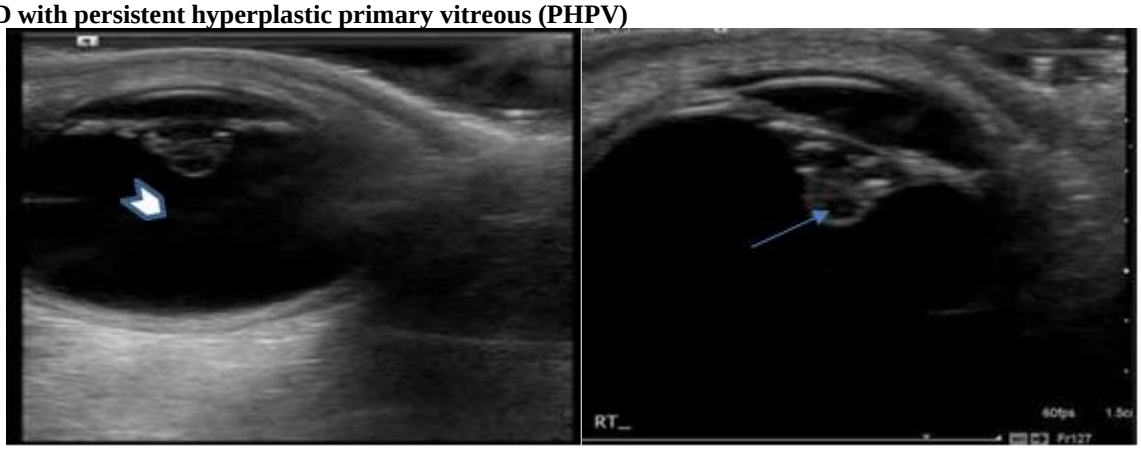

Figure 4. Retinal detachment with PHPV. B scan reveals a funnel shaped RD(arrowhead) inimage 1 along with persistent central hyaloid artery (arrow) in a 2-year-old boy in image 2.

In persistent hyperplastic primary vitreous a funnel-shaped RD seen associated with a persistent central hyaloid artery.

PHPV (Persistent hyperplastic primary vitreous).

PHPV is a serious unilateral disorder of the vitreous that is seen in childhood. It presents as leukocoria (white pupil). There is failure of regression of the primary vitreous. The primary vitreous persists in a microphthalmic eye and B-scan shows a retrolental membrane, which may be dense; there is a persistent hyaloid artery extending from the retrolental region to the optic $_{disc}$..(1-4)

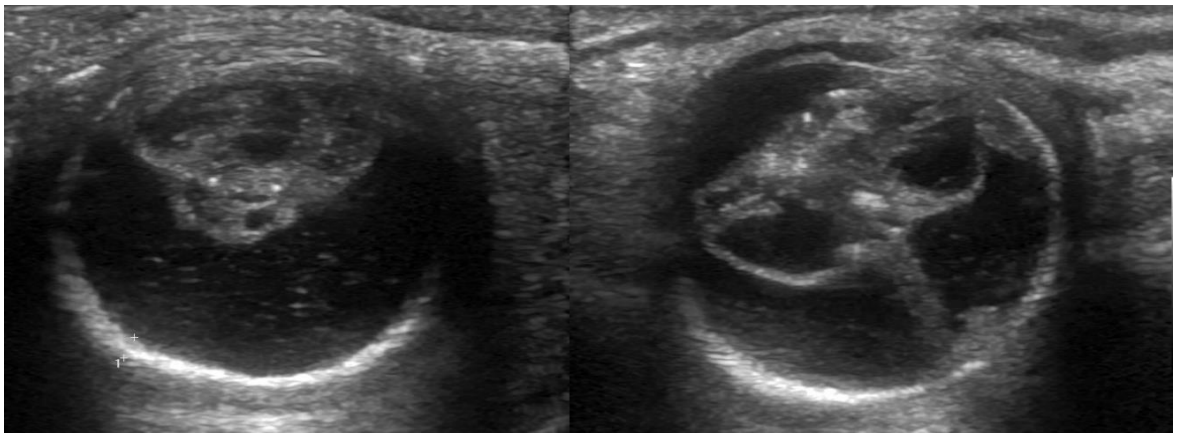

Figure 5. A 3 year old female patient came to OPD with loss of vision in right eye and we can see echogenic band seen in posterior segment extending from posterior surface of lens to optic nerve head. Internal echoes are seen in vitreous cavity.

Phpv With Calcification Of Optic Disc

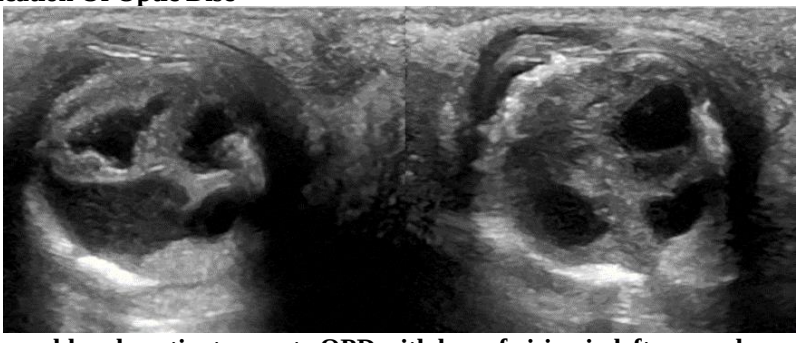

Figure 6. A 10 year old male patient came to OPD with loss of vision in left eye and we can see echogenic band seen in posterior segment extending from posterior surface of lens to optic nerve head. Internal echoes are seen in vitreous cavity. Optic disc also shows calcification.

RD with cyst formation.

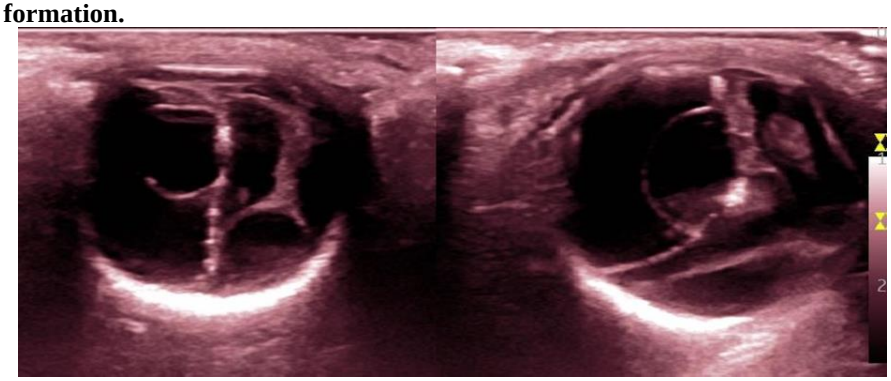

Figure 7. A 15 year old female .B mode ocular sonogram reveals retinal detachment - proliferative type with sub retinal cyst formation.

Dermoid Cyst/dacryocystocele

Dermoid cyst/ dacryocystocele are extra-conal , non-enhancing masses with smooth margins, cystic and/or solid components. They are typically heterogeneous with soft tissue, fluid and fatty (sebum) components; occasionally calcifications may be present.

Figure 8. Swelling over inner canthus of eye. USG reveals mixed echogenic lesion predominantly hypoechoic with globules of fat seen within the lesion- Dermoid cyst.

Retinopathy of prematurity

Retinopathy of prematurity is a bilateral condition that is associated with a history of prematurity and oxygen therapyin the postnatal period. Thisleads to the occurrence of retrolental fibroplasia, with development of dense retrolental membranes, a result of neovascularization from the retinal periphery leading to fibrotic changes in the anterior vitreous. The eyeballs are normal in size. [1-4]

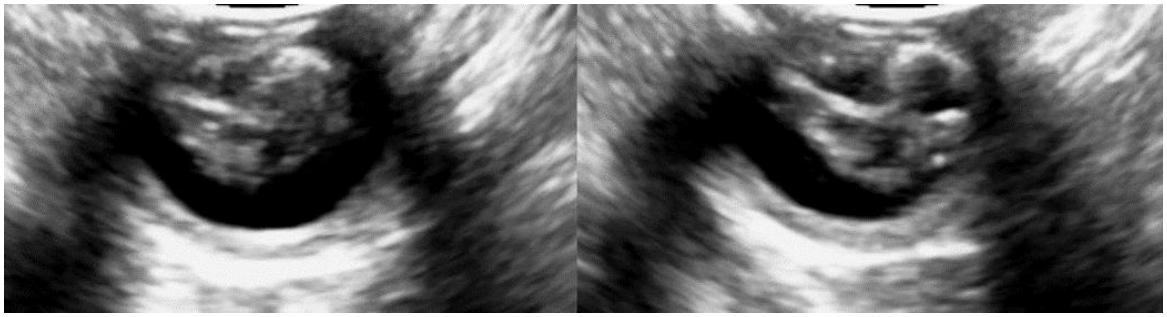

Figure 9.B-scan transverse image of eyes show bilateral small eyes with swollen, cataractous lens and symmetrical heterogeneous predominantly hypoechoic mass lesion with few echogenic foci- calcificationin posterior segment attached anteriorly to posterior surface of lens.

Choroidal melanoma

Choroidal melanoma, the commonest primary intraocular tumour in adults, arises from the choroid and ciliary body. Most of these lesions arise posterior to the equator of the eyeball. (1- 3, 6)

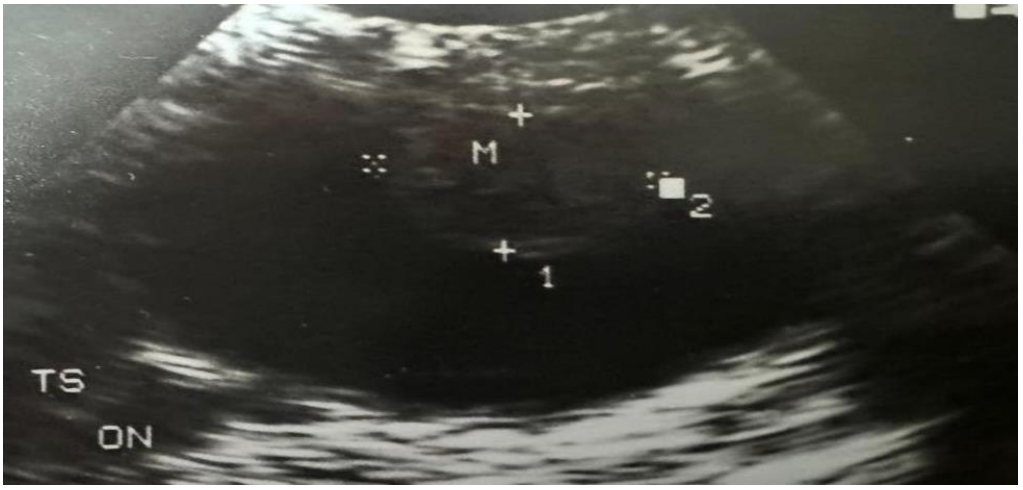

Figure 10..On B-scan, it is seen as a lenticular-shaped mass arising from the choroid. USG is used to assess scleral erosions and extraocular extension into orbital fat[] Some tumors have a collar-button or mushroom shape. Bloodflowwithin the tumour is seen on colour Doppler as pulsating channels or lakes of colour. Choroidal melanoma may be associated with retinal detachment. The tumour has a bilobed or 'cottage-loaf' appearance, which is caused by wasting as it breaks through Bruch's membrane. The tumour usuallydemonstrates choroidal excavation. Colour Doppler revealsthe vascularity of the lesion.

Retinoblastoma

Retinoblastoma is the commonest primary intraocular tumor of childhood. It arises from the embryonic retinal epithelium of the primary optic vesicle. It is usually unilateral but may be bilateral in one-third of cases. It presents in childhood as leukocoria. The tumor projects from the retina into the vitreous chamber. Some tumors produce sub retinal lesions and cause retinal detachment. Calcium deposits are commonly seen within the tumor. Thecalcium deposits, which are seen as highly reflective foci, are pathognomonic of the condition. The tumor outline is irregular. B-scan may help in the detection of optic nerve invasion resulting from extraocular spread of the tumor.(1-5,7)

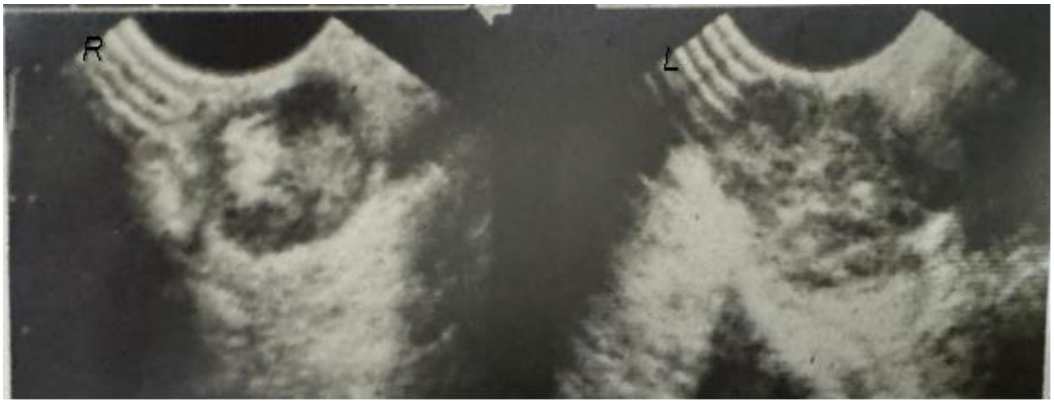

Figure 11. Retinoblastomas appear as echogenic soft-tissue masses with variable shadowing due to calcificationsand heterogeneity due to necrosis and haemorrhage 5. At diagnosis, tumors are usually vascular on Doppler examination. The vitreous may have multiple areas of "floating" debris, which may represent vitreous seeding or alternatively, necrotic debris, haemorrhage or increased globulin content 5.

Ocular trauma/Foreign body.

Ocular trauma either due to blunt injury or penetrating injury can result in vitreous haemorrhage. There may be rupture and shrinkage of globe due to loss of vitreous as aresult of a penetrating injury. There is distortion of normal ocular shape and intravitreal haemorrhage develops with or without concomitant posterior vitreous detachment. The foreign body that caused the injury may be seen within theeyeball, for example a

metallic object in a missile injury orblasts. Sometimes penetrating foreign bodies like a woodenobject or a metallic rod may be seencrossing the eyeball. Metallic foreign bodies show a posterior reverberation artefact.

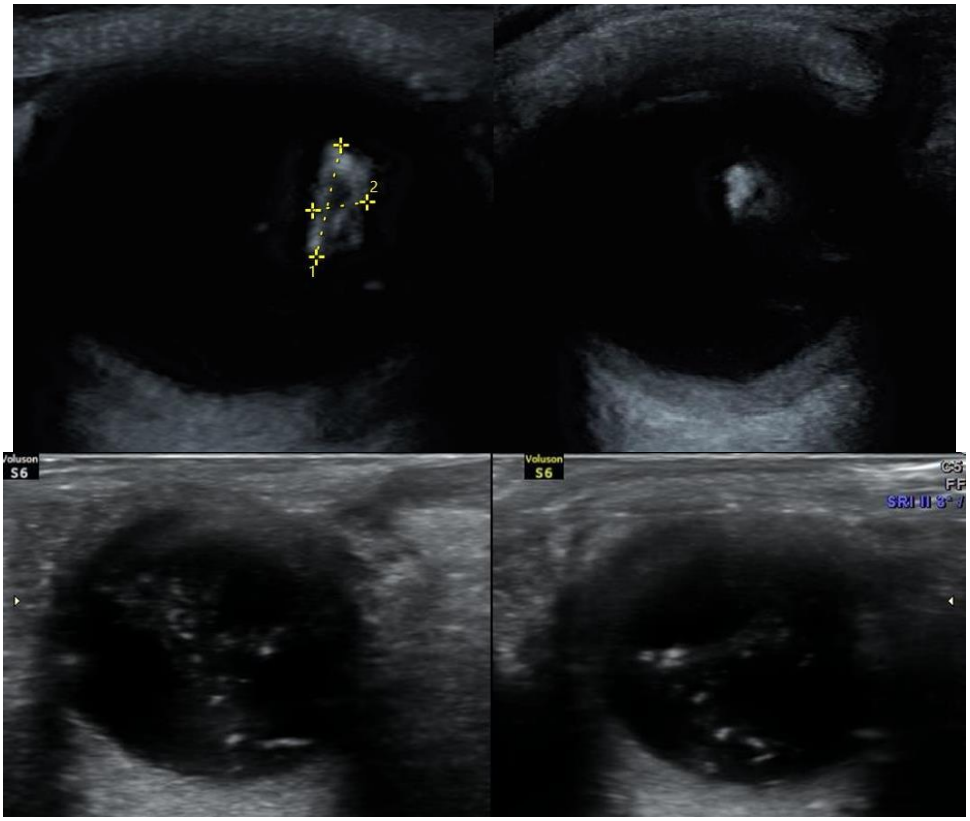

Figure 12 &13. abnormal echogenic structure with posterior acoustic shadowing may demonstrate a twinkling artefact on colour flow Doppler reverberation artefacts are common ay demonstrate location-dependent mobility.a vitreous foreign body is more likely to be mobile than one in the posterior orbital fat

Phthisis bulbi

Phthisis bulbi is an end-stage condition following ocular trauma and haemorrhage. The eye is blind, small, and non-functioning, with extensive calcification. There is loss of thenormal ocular shape.

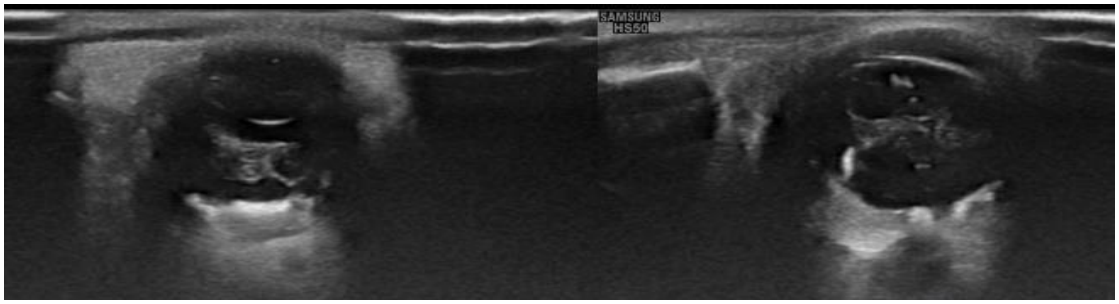

Figure 14.. Phthisis. the B scan of the left eye shows shrunken globe with extensivecalcification and loss of the normal shape. there was history of trauma.

Vitreous detachment

Vitreous detachment is seen in elderly individuals. It results from gel liquefaction and collection of fluid in the subvitreal space, which in turn, results in vitreous detachment. It is seen frequently in cataractous eyes on B-scan. B-scan shows reduced volume of vitreous gel.USG also shows marked mobility and elasticity of the detached vitreous, with a mirror image configuration whenthe eye is deviated to one side and then to the other.

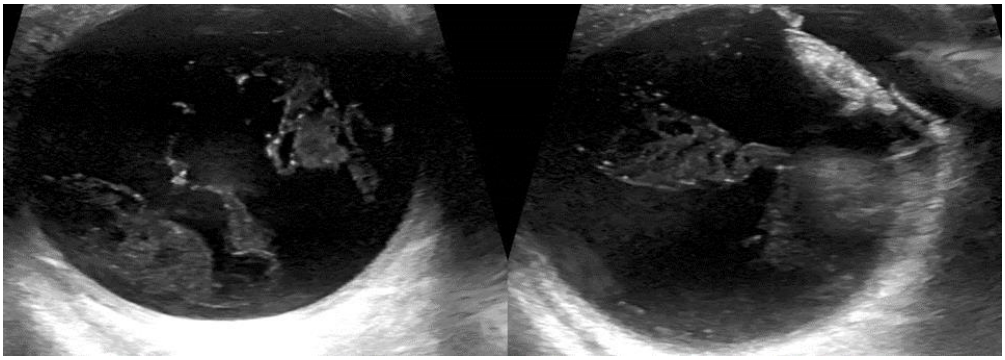

Figure 15. Vitreous detachment. B-scan shows a reduction in the volume of the vitreous gel. On movement, thevitreous shows increased mobility with a mirror image configuration, when the eye is deviated to one side and then to the other.

Vitreous haemorrhage

Vitreous haemorrhage can result from tearing due to vitreoretinal traction, diabetic retinopathy, vasculitis, subarachnoid haemorrhage, and blunt trauma to the eye. The presence of blood cells in the vitreous gives rise to low- intensity echoes. Later, the haemorrhage may organize and develop fibrinous membranes. Figure shows a B-scan of the right eye which reveals widespread low-intensity echoes in the vitreous chamber, with marked after-movement on dynamic scanning.

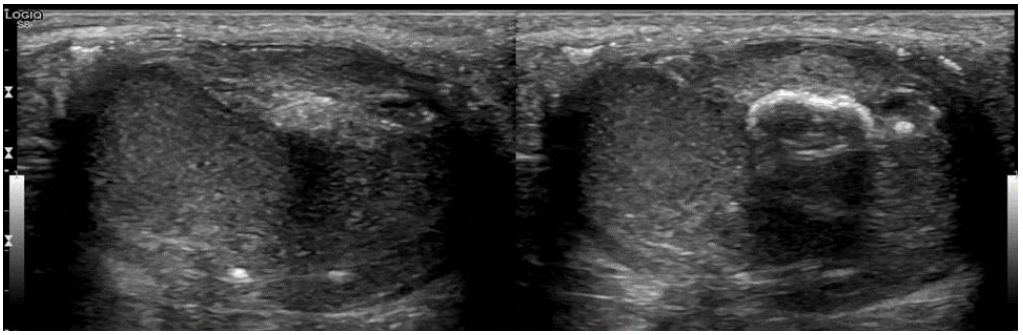

Figure 16. Small and shrunken globe with multiple foci of calcification is noted. Fibrotic scarring with irregular globe contour is noted. On colour Doppler globe shows moderately increased vascularity with vitreous haemorrhage. Thin smooth membrane is noted within vitreous with echoes, s/o retinal detachment with vitreous haemorrhage.

Cavernous Hemangioma

Although cavernous hemangiomas can be located anywhere within the orbit , over 80% are located within the intraconal compartment, most commonly in the lateral aspect.

They are usually round or oval in cross-section and although frequently abut the globe, they do not deform it, but rather are deformed by the globe, on account of their soft consistency.

Large lesions may be associated with the expansion of the bony confines of the orbit Ultrasound demonstrates a smoothly circumscribed retrobulbar lesion with regular moderate to high internal echogenicity.

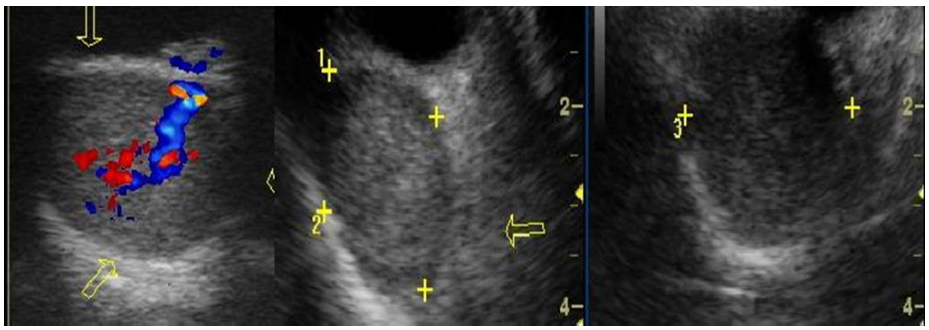

Figure 17. Ultrasound demonstrates a smoothly circumscribed retro bulbar lesion with regular moderate to high internal echogenicity 3-4. No flow can be demonstrated on Doppler scanning

Orbital Cellulitis

Orbital Cellulitis: usually associated with a sub-periosteal abscess from adjacent sinusitis or with a previous history of trauma/dental procedure.

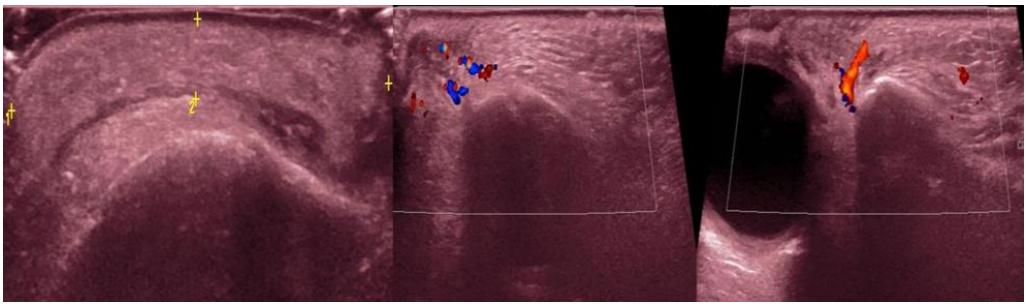

Figure 18.B SCAN mode of eye shows oedematous and thickened soft tissue.

Orbital Hydatid Cyst

Hydatid cyst seen as extra-conal cystic mass lesion. (8)

Figure 19. B SCAN mode of eye shows multi-loculated cystic lesion in extra conal compartment of right eye.

Optic Nerve Glioma

Optic nerve glioma is seen as fusiform masses of medium reflectivity.
homogenous echotexture with dilated subarachnoid space seen as cystic area anteriorly.

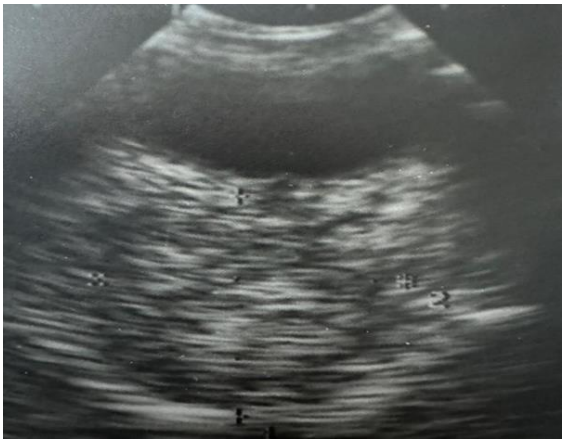

Figure 20. Optic nerve glioma-a fusiform homogenous mass with dilated subarachnoid space seen anteriorly.

Lens Implant

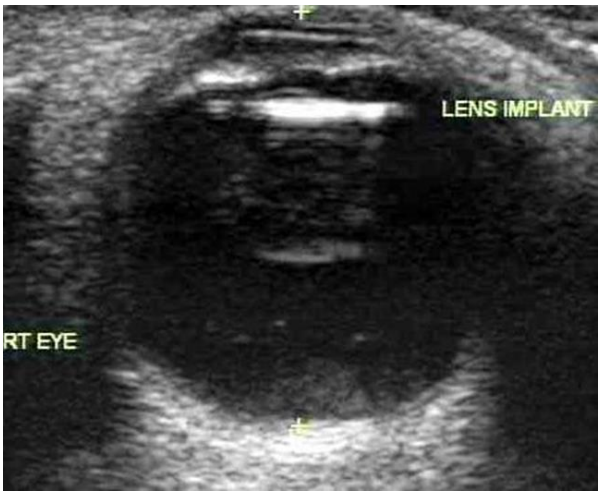

Figure 21. B SCAN mode of eye shows hyperechoic hyper- reflective lens implant is noted in right eye.

Thyroid Ophthalmopathy

Thyroid-associated orbitopathy, also known as **thyroid-associated ophthalmopathy** or **thyroid eye disease**, is the most common cause of proptosis in adults and is most frequently associated with Graves' disease. On imaging, it is characterized by bilateral and symmetrical enlargement of the extraocular muscle bellies. The typical distribution is inferior rectus muscle most commonly affected, followed by medial rectus, then superior rectus, with sparing of their tendinous insertions. .

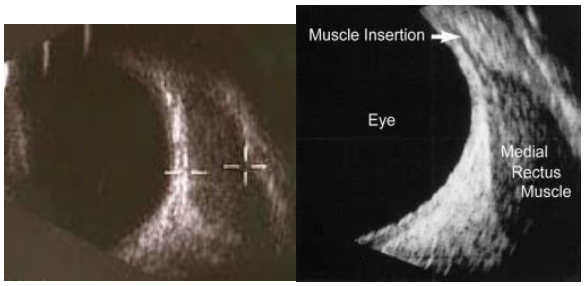

Figure 22. B-scan ultra-sonogram reveals enlargement of the extraocular muscle belly. The tendinous insertion of the extraocular muscle at the globe is not thickened, which is characteristic of thyroid-related orbitopathy.

Pseudotumor Of Orbit

Orbital pseudotumor is an idiopathic inflammatory lesion of the orbit most commonly involving the extra-ocular muscles (most commonly the lateral rectus muscle), but can involve any of the orbital contents including the retro-orbital fat and the lacrimal gland.(11)

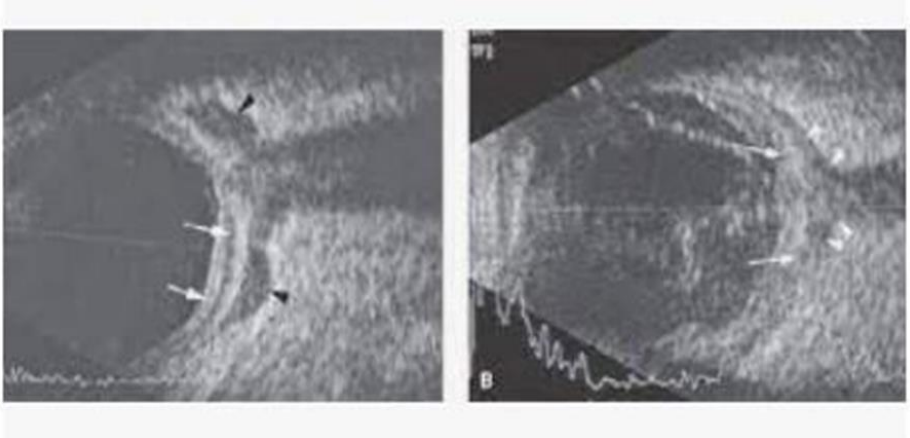

Figure 23. Thickened hypoechoic lateral rectus muscle- pseudotumor.

Choroidal metastases

Metastatic carcinoma in the choroid are retinal masses located in the posterior part of the fundus and are frequently associated with serous detachment of the retina.

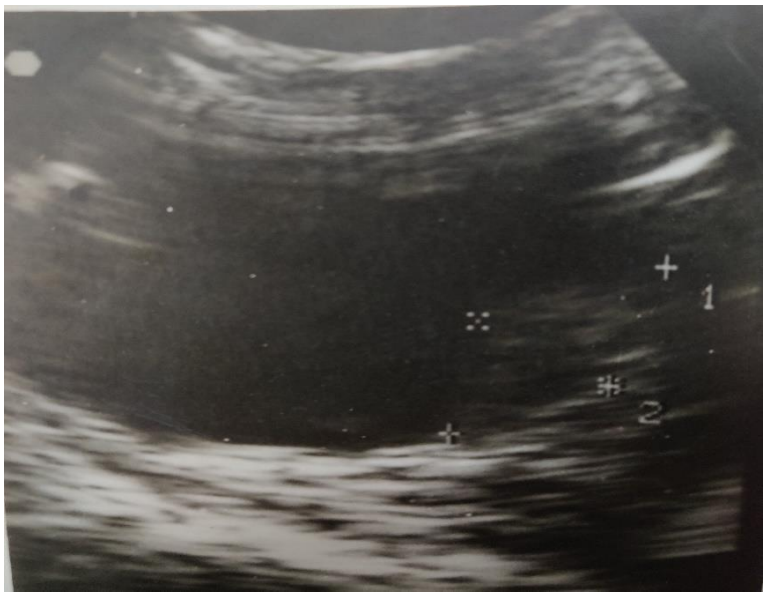

Figure 24. Broad based, echogenic relatively flattened lesion in intraocular metastasis.