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B-scan: Technical aspects and Interpretation

Introduction of USG

In 1973,Lazzaro spalanzani (Italy) discovered that bats orient themselves with the help of sound whistles while flying in darkness. This was the basis of modern ultrasound application

Two types of devices are used diagnostically, i.e A-scan and B-scan

A-scan: It is a one dimensional **amplitude** modulation scan commonly used for measurement of axial length and pachymetry.

Along with B-scan it is used to determine the ultrasonic properties such as internal reflectivity and dimensions of posterior segment masses.

B-scan: It is a two dimensional ,cross sectional **brightness** scan. Its use is primarily to evaluate posterior segment and orbital pathology when the ocular media are cloudy and direct view is not possible.

History of B-Scan

For sound to be considered ultrasound, it must have a frequency of greater than 20000 oscillations per second, or 20Khz,rendering it inaudible to human ears.

USG of the eye is an indispensible, non invasive tool in the diagnosis and management of various ocular orbital diseases.

It was first used in ophthalmology in 1956 by Mundt and Hughes as A-scan.

Baum and Greenwood introduced the first B-scan in 1958.

Coleman in the 70s developed the first commercially available B-scan.

Principle of B-Scan

Ophthalmic ultrasound uses high frequency ultrasound waves, which are transmitted from probe to eye.

Tissue penetration is directly proportional to resolution and inversely to frequency. That is why; USG probe used for ocular USG are of higher frequency(10 MHz) as it needs much less tissue penetration

As the sound waves strike intraocular structures, they are reflected back to the probe and converted into an electric signal.

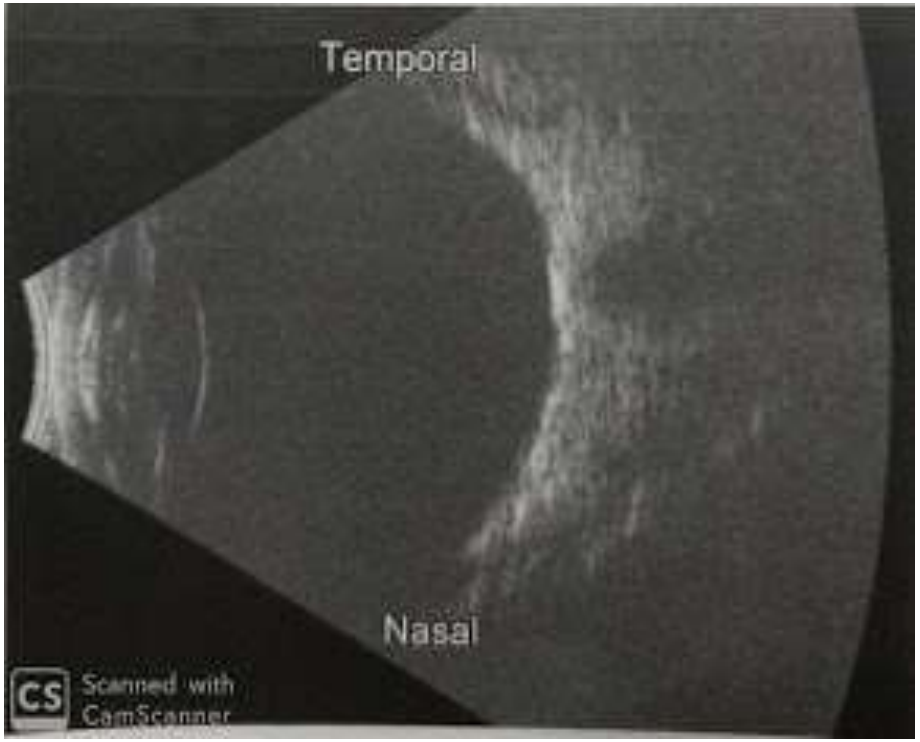
These signals are subsequently reconstructed as an image on a monitor

The ophthalmic B-scan probe has high frequencies of 10 MHz and contains piezoelectric crystal

Marker on probe helps in the understanding orientation of the image on the screen

The orientation of the marker is directly correlated to the sound beam orientation

Wherever the marker is directed on the eye represents the upper portion of the echogram and in most instances the probe is placed opposite the area of the eye to be examined



Velocity depends on the density of the medium

980 m/s	Silicone IOL
986 m/s	Silicone oil
1480 m/s	Fresh water
1532 m/s	Aqueous, Vitreous
1550 m/s	Solid tissue: Intraocular and orbital soft tissue blood
1640 m/s	Clear crystalline lens

Reflectivity is higher when the echoes are stronger and thus producing brighter dots

The angle of incidence of the probe is critical

When the probe is held perpendicular to the area of interest, more of the echo is reflected directly back into the probe tip and sent to the display screen

When held oblique to the area imaged, part of the echo is reflected away from the probe tip and less is sent to the display screen

Absorption: The density of the solid lid structure results in absorption of part of the sound wave when B-scan is performed through the close eye, thereby compromising the image of the posterior segment

Gain: When the gain in high, weaker signals are displayed, such as vitreous opacities and PVDs

When the gain is low, the weaker signals disappear and only the stronger echoes such as retina, remain on the screen.

BASIC SCREENING TECHNIQUE

Probe positions

Transverse position: Most commonly used. The probe is positioned parallel to limbus (on opposite scleral surface).

It demonstrates the lateral extent of pathology (approximately 6 o'clock hours)

Longitudinal position:

The probe is perpendicular to the limbus. It represents the radial extent of pathology and proximity to the optic nerve and demonstrates only 1 o' clock hour that represents optic nerve to the periphery

Axial position:

Patient is fixating in primary gaze, probe face centered on the cornea. Displays the lens and the optic nerve. Horizontal axial scan marker is toward the patient's nose. Vertical axial scan marker is toward the 12 0'clock position.

Oblique position:

Patient is asked to look at various gazes and probe is placed at the oblique axis

The entire globe must be examined, from the posterior pole out to the far periphery.

Using a limbus to fornix approach, the four major quadrants include the 12 o'clock, 3 o'clock, 6 o'clock and 9 o'clock positions and each centered on the right side of echogram in transverse approaches are evaluated

Macular localizing

The four methods of localizing and centering of the macula are horizontal, vertical, transverse and longitudinal

In the horizontal and vertical method, the probe is on the corneal vertex and should be aimed straight ahead to centre the macula with marker directed nasally in the horizontal while marker is in the 12 o'clock position in the vertical method

In the transverse and longitudinal method patient fixating slightly temporally and the probe is placed onto the nasal sclera with the marker at the 12 o’clock position in transverse method while toward the limbus or temporally toward the macula in the longitudinal method. These scans bypasses the lens, thereby preventing absorption or reverberation artifacts from an intraocular lens

Indications for B-scan

Opaque ocular media

Anterior segment: Corneal opacification, hyphema or hypopyon, miosis, cataract, pupillary or retrolenticular membrane

Posterior segment: Vitreous hemorrhage or inflammation

Clear Ocular Media

Anterior segment: Iris lesions, ciliary body lesions

Posterior segment: Tumors, Choroidal detachment(CD), retinal detachment(RD), optic disc abnormalities

Intraocular foreign bodies: For detection and localization

Interpretation

(1) Retinal detachment:

-Appears highly reflective, attached to the ora serrata anteriorly and the optic nerve

-It has moderate mobility and translucent subretinal space

-Maintains 100% reflectivity even on low gain

-There is a gradual separation of the membrane from the ocular wall unlike in CD

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-Attachment at the disc is broad and at the periphery of the disc

-Persists at low gain

-Thickness corresponds to PVR

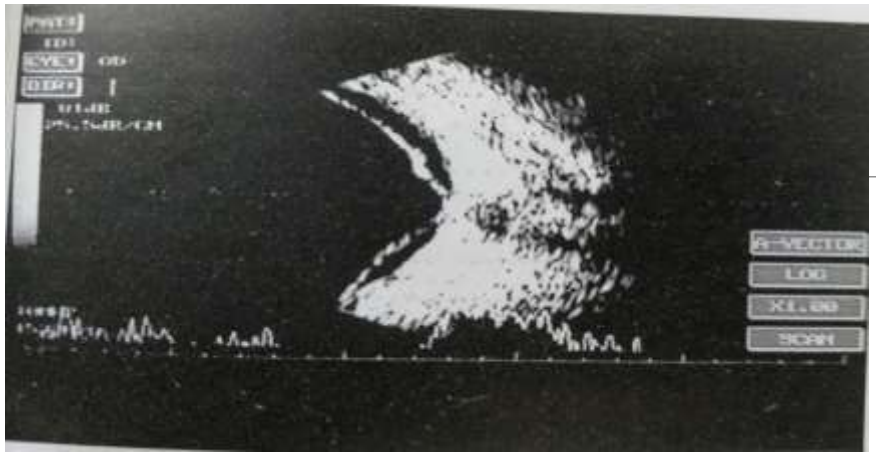
-Configuration-convex in RRD, concave in TRD, Double layer sign in GRT

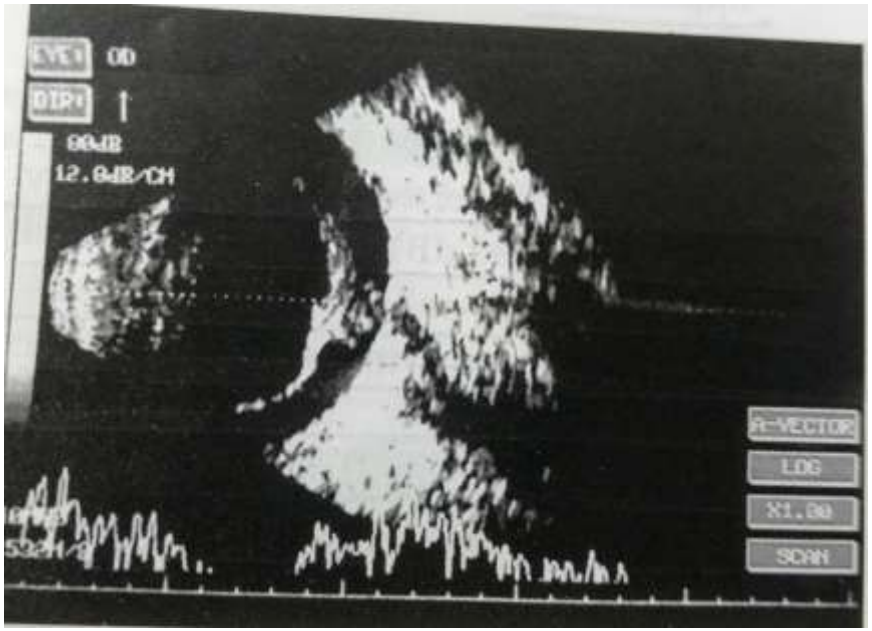
-The configuration of funnel, retinoschisis

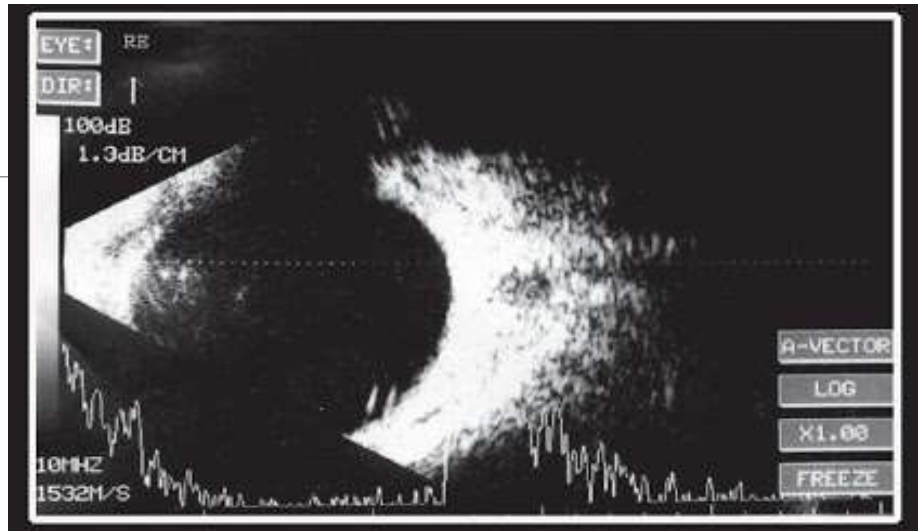
-Coexisting findings can be peripheral retinal looping, cyst formation in long standing RD

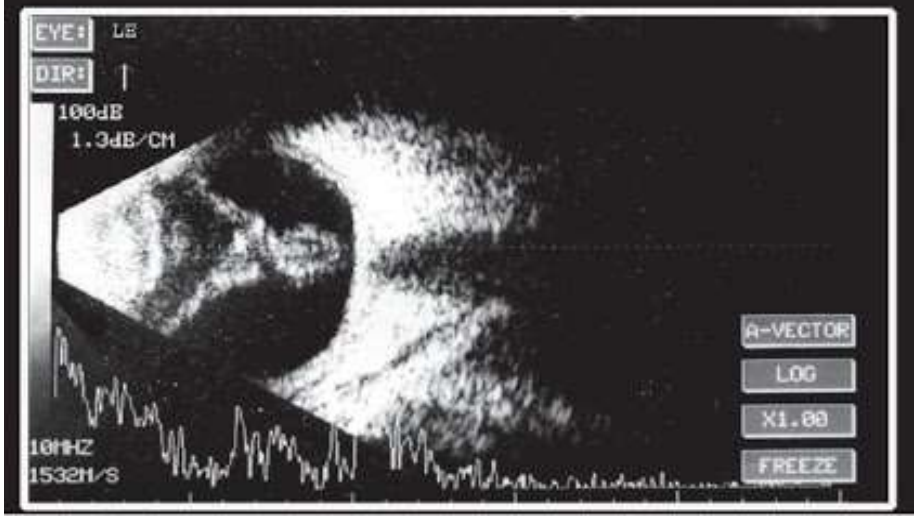
-Tractional RD common finding in vascular retinopathies caused strong adhesion and subsequent traction detached retina-Concave appearance

RD, Open funnel and closed funnel RD

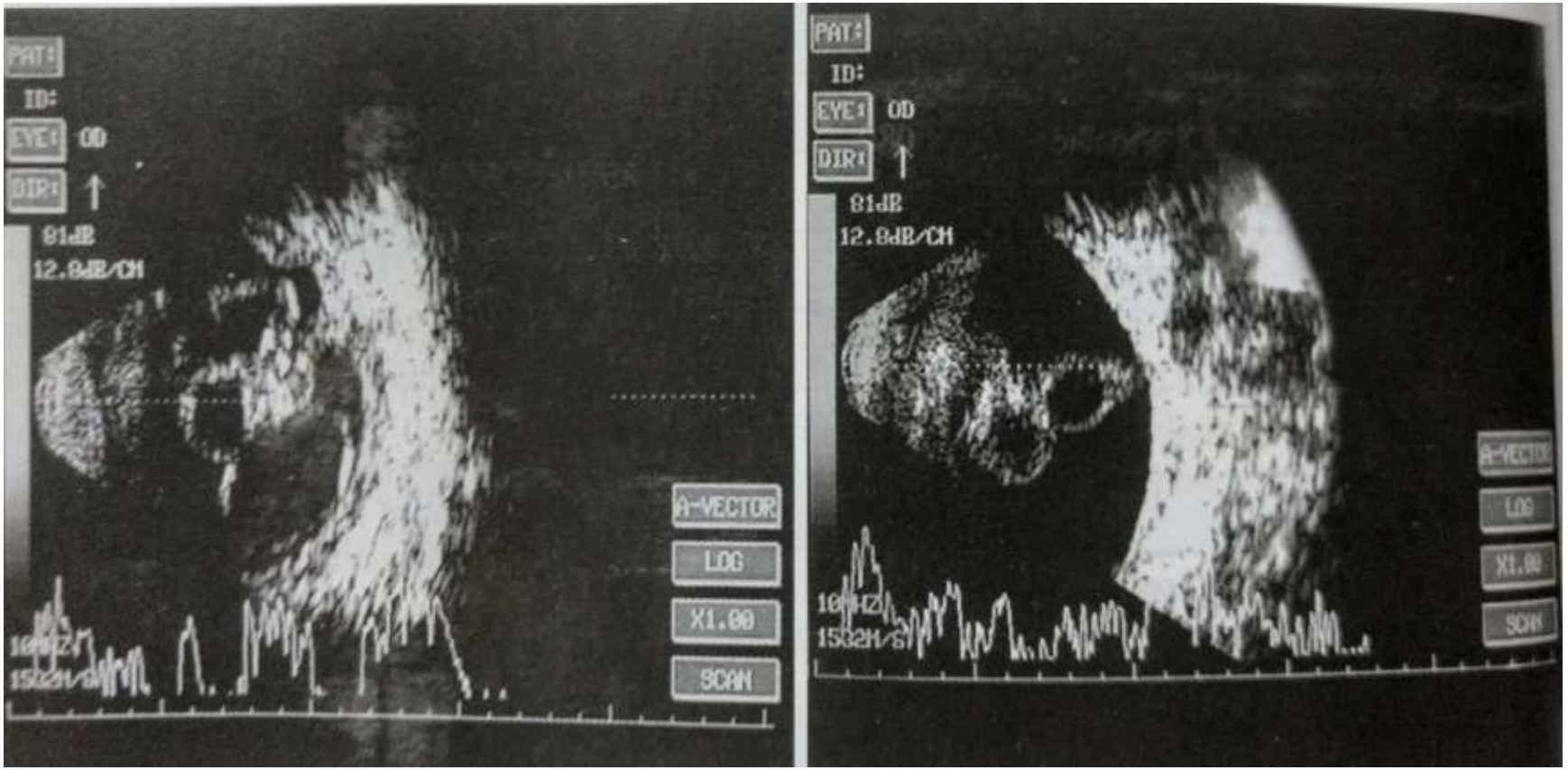








Retinal cyst in old RD



(2)Posterior vitreous detachment

In PVD with the normal eye, the reflectivity is very low, high gain(90dB) setting is required. The reflectivity disappears on lowering the gain under 70dB

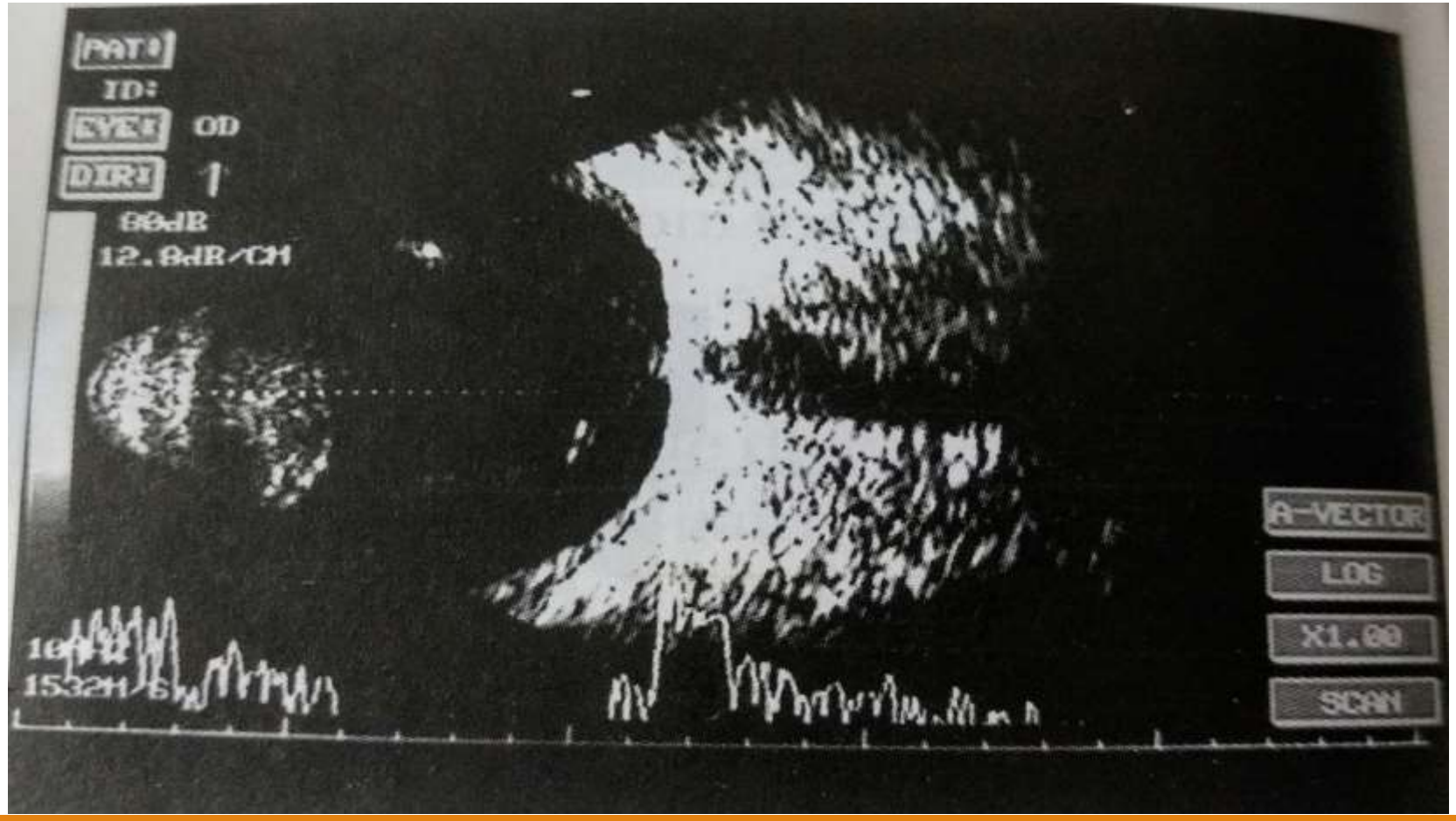
Kinetic echography shows a very undulating movement that continues after the eye movement's stop

Attachment at disc narrow or none

About 40-90% spike height decreasing anteriorly

The height of PVD generally more superiorly

Thick PVD spike may persist at low gain



How to differentiate from RD?

Measure the difference in decibels between the 50% spike height of membrane and sclera

(3)Choroidal Detachment(CD)

It is smooth, dome shaped and thick

No movement seen with eye movement

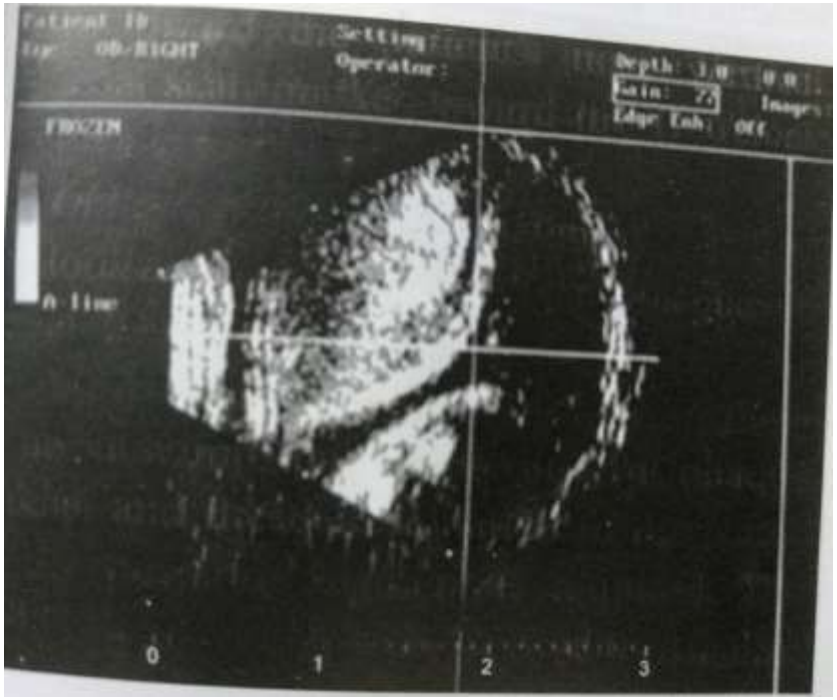
When extensive, one can see multiple dome shaped detachments, which may "kiss" in the central vitreous cavity

Serous CD has anechoic suprachoroidal space

Hemorrhagic CD has dispersed opacities

Seen as thick bright opacity even at low gain

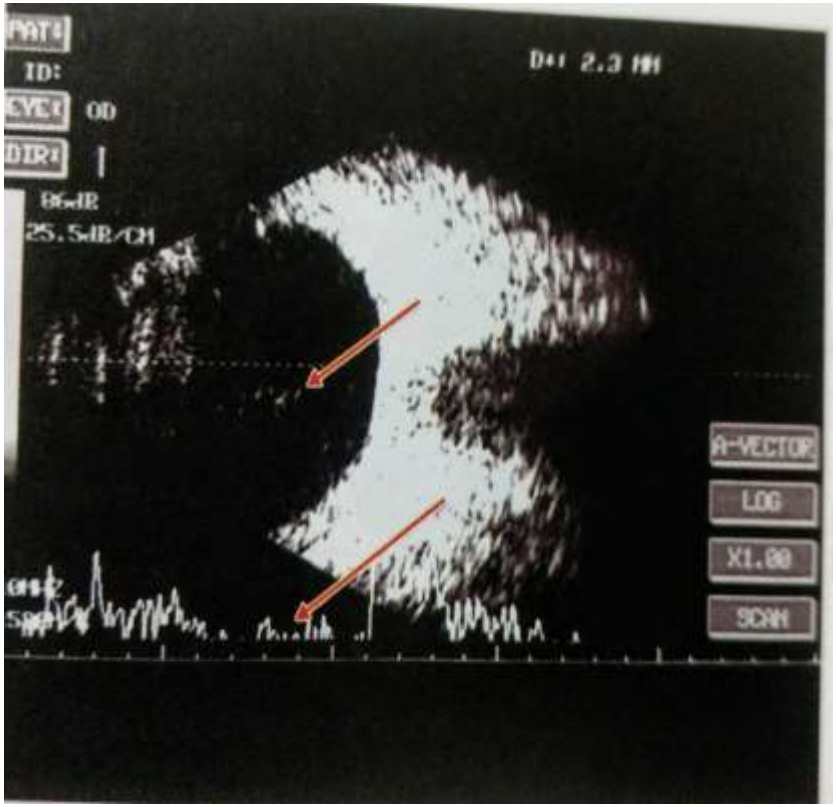
HEMORRHAGIC CD WITH KISSING CHOROIDS



(4) Vitreous Hemorrhage

A fresh mild hemorrhage appears as small dots or linear areas of low reflective mobile vitreous opacities

Old vitreous hemorrhage appears vitreous filled with multiple large opacities that are higher in their reflectivity and membranes as the blood organizes



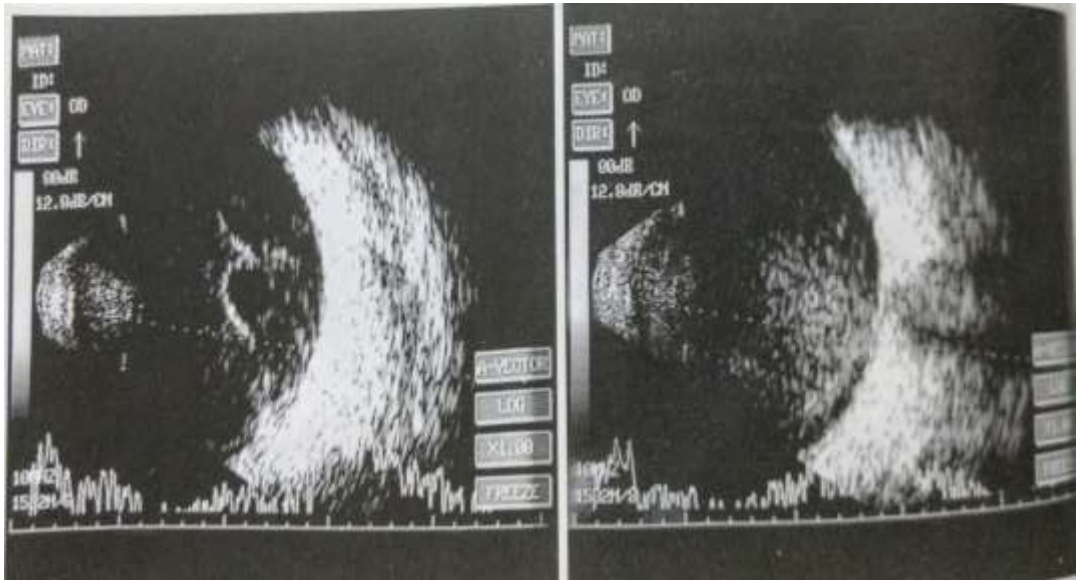
Differentiation b/w VH and Asteroid hyalosis

Asteroid hyalosis is highly echogenic and they are still visible when the gain setting is reduced upto 60dB whereas VH which usually disappears by 60dB

(5)Endophthalmitis

Low to moderate cases: Hyper reflective opacities

Severe cases: Moderate or coarse opacities with membrane formation

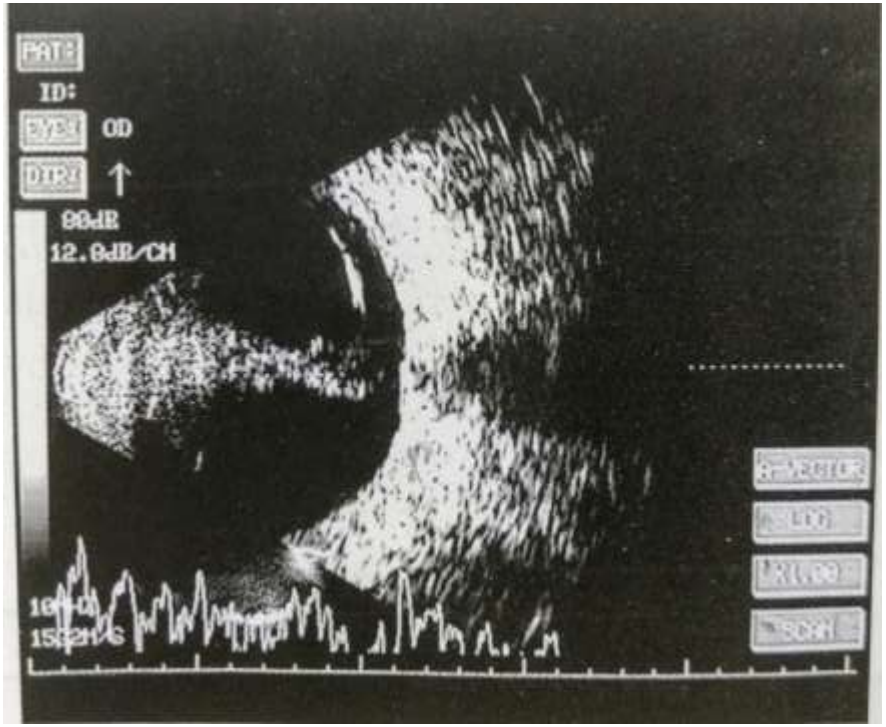


(6)Persistent fetal Vasculature

It is a congenital abnormality when the fetal hyaloid artery does not resorb.

-Very thin persistent hyaloid vessel coursing from the disc to the lens can be seen

-Globe size is usually small



(7) Intraocular foreign Body

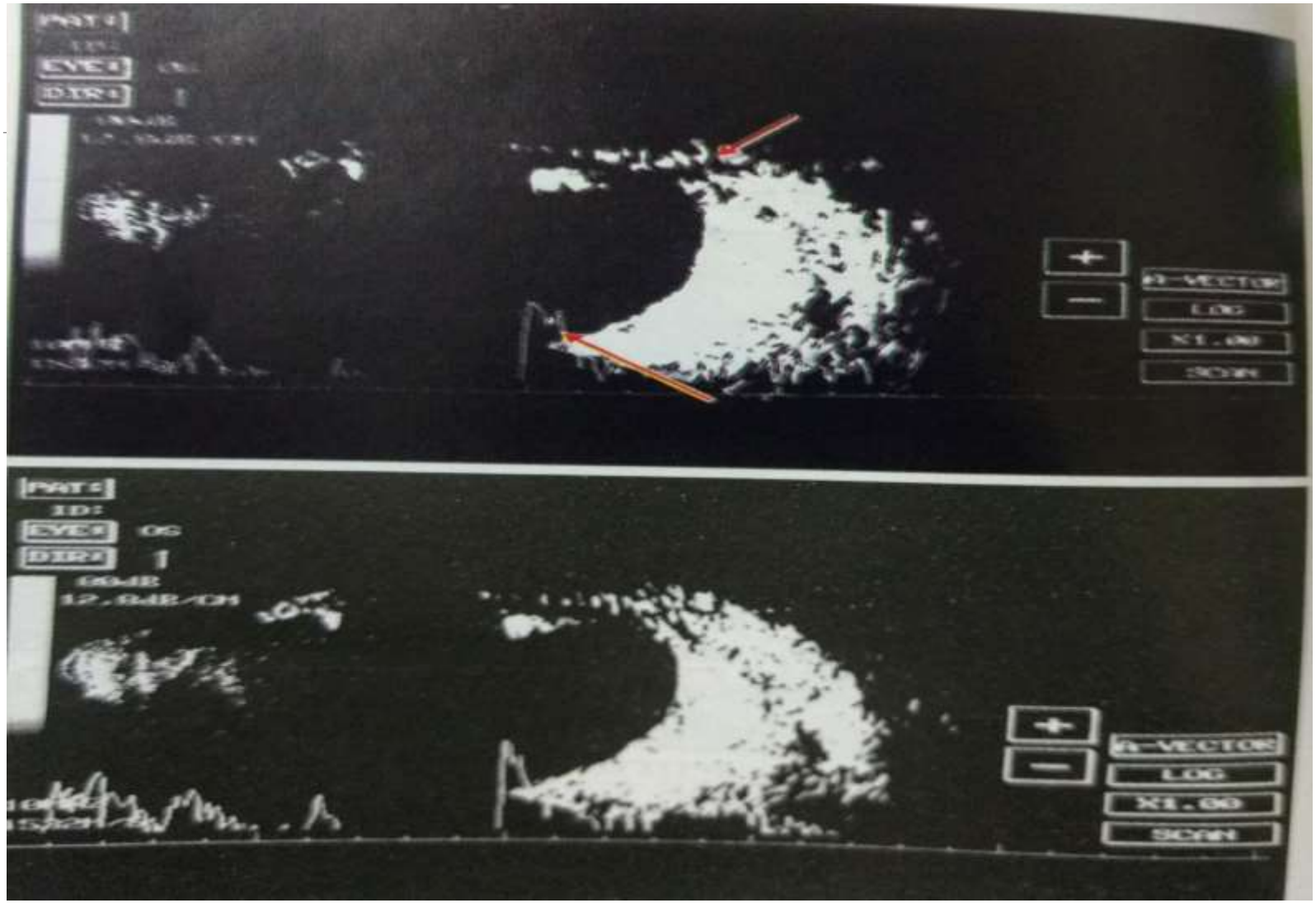
A-scan: Steeply rising wide echo spike along the base line between the initial spike and ocular wall spike

Extremely high reflectivity(100%) spike which persists on low gain

The distance between the IOFB and the adjacent sclera is accurately measured at lower system sensitivity

Sound attenuation is very strong

IOFB



B-scan: Acoustically opaque contrasting with the acoustically clear vitreous

Persists even when the system sensitivity is decreased by 20-30db

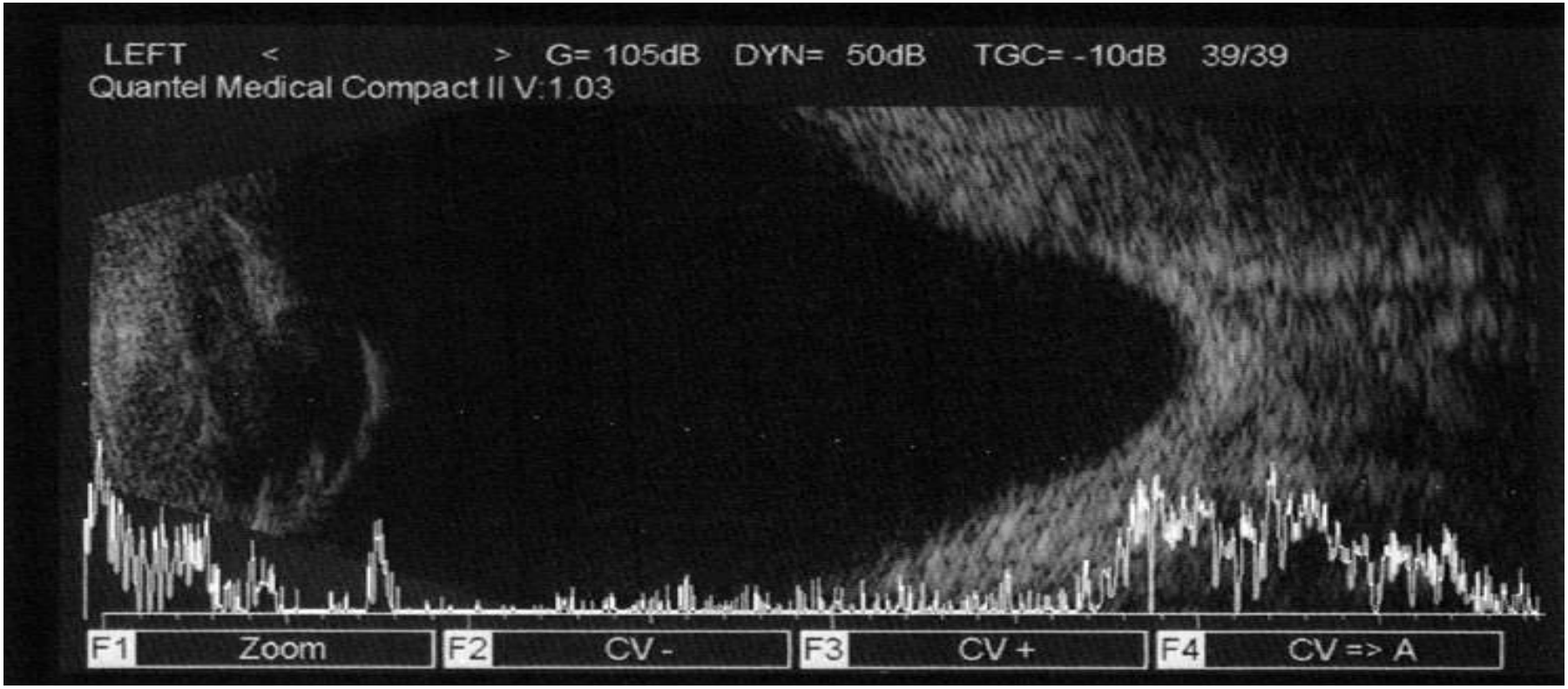
Topographic and kinetic echography will show if the foreign body is adherent to the retina or if it is floating in the vitreous

Sound attenuation is very strong

Shadowing of the ocular and orbital tissue behind it as it totally reflects the sound beams preventing its propagation within tissue behind it

(8)Posterior Staphyloma

Appears as a shallow excavation of posterior pole with smooth edges in highly myopic eyes(focal area of thinned retina)

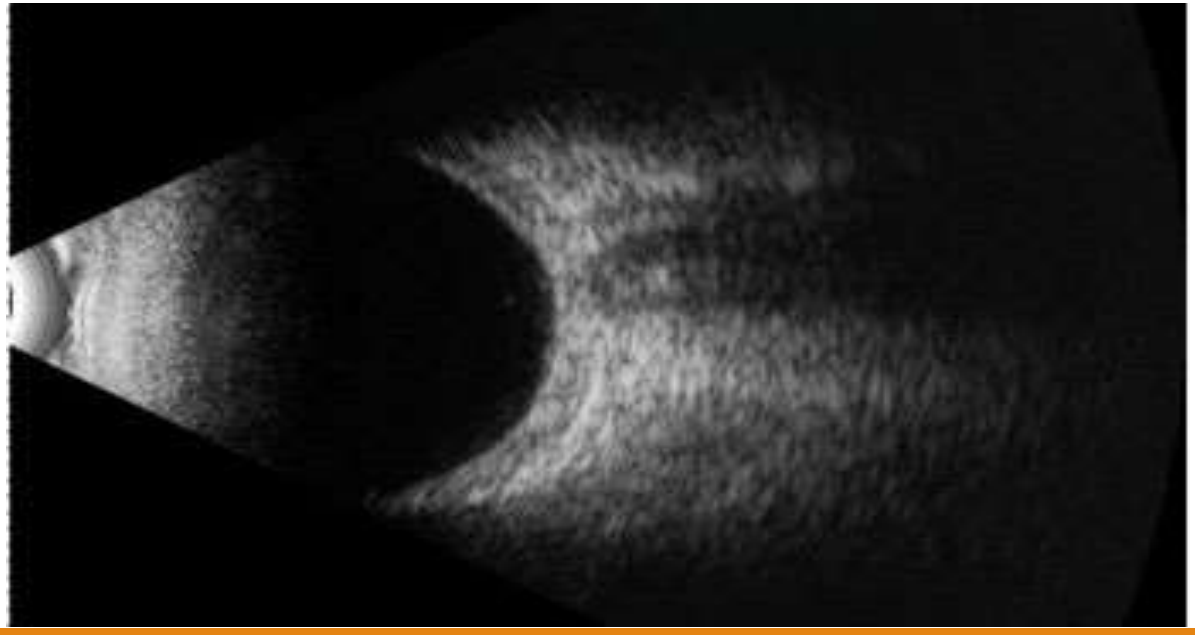


(9) Posterior Scleritis

It is commonly associated edema adjacent to the sclera

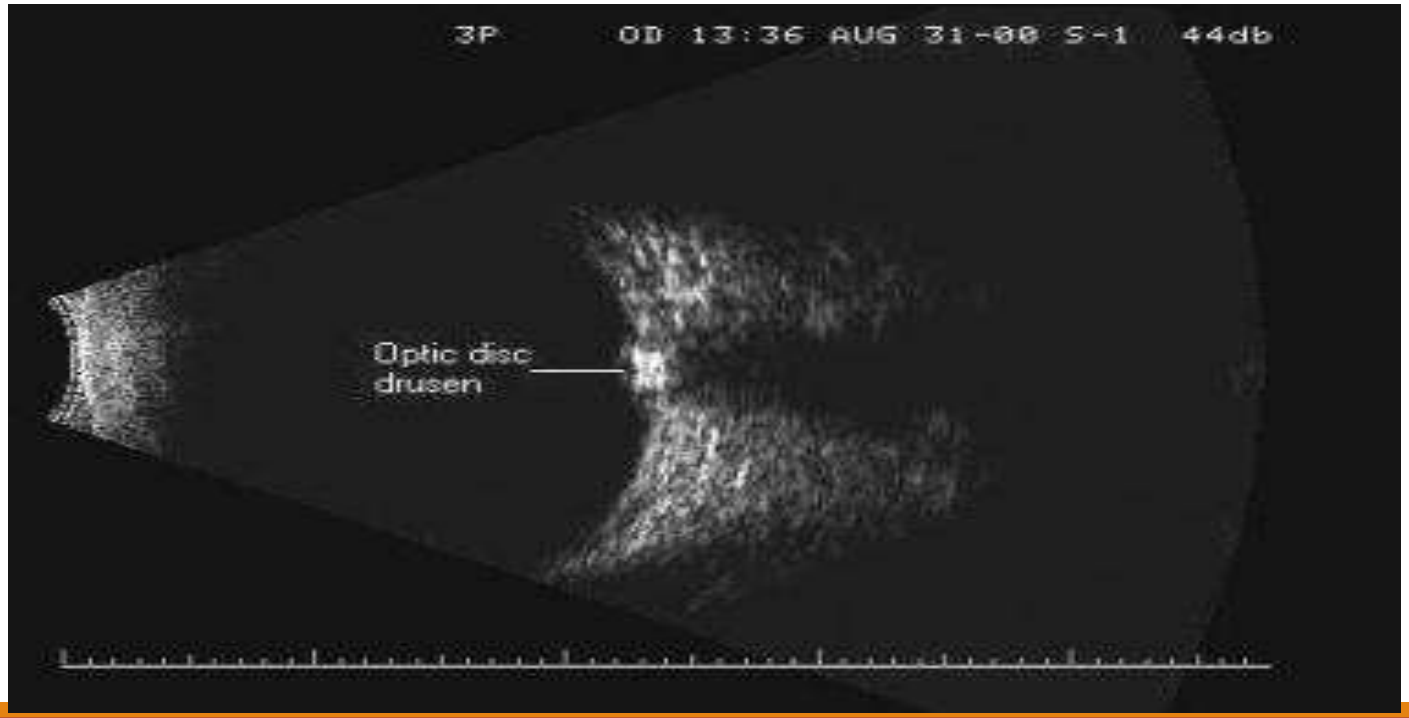
This manifests itself as an echolucent area in the tenon space, it forms a **“T-sign”**

USG is the best modality for diagnosis



(10) Optic Nerve Pathologies

Optic disc drusen: Appears as an echogenic focus within or on the surface of the optic nerve head



Astrocytic hamartomas v/s Drusen

AH seen in patients with tuberous sclerosis or neurofibromatosis

Usually unilateral

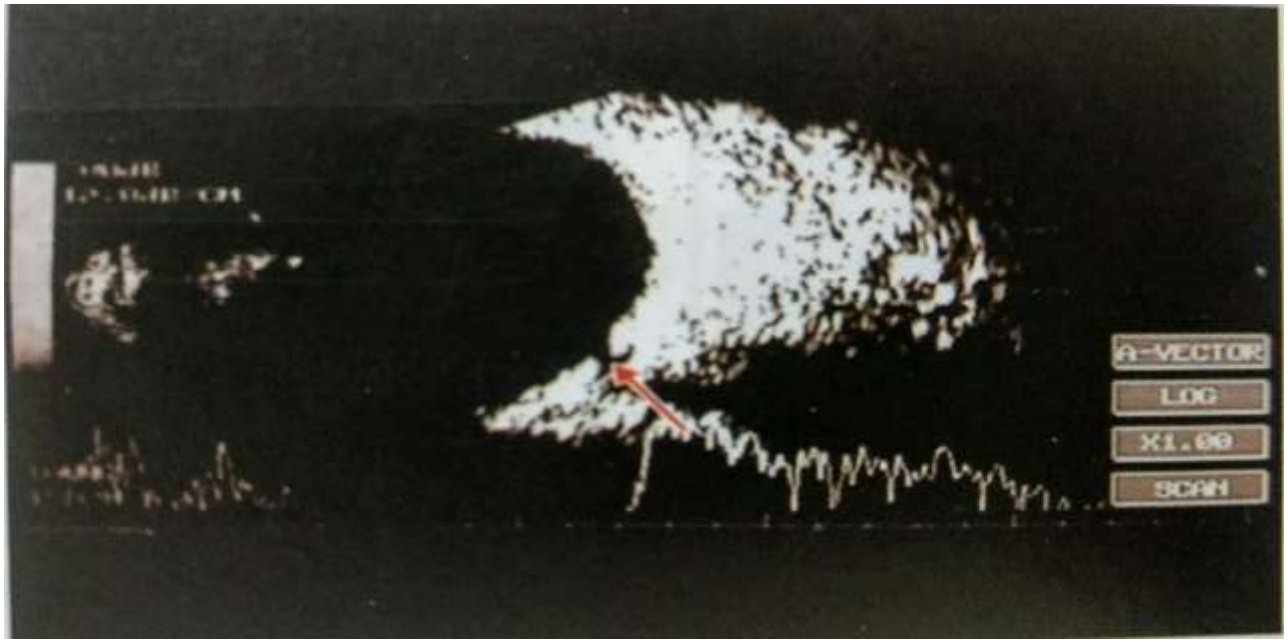
Usually larger

Associated with RD

Optic Nerve Head Cupping

Appears as an excavation of the disc

It is important to note that USG can detect cupping reliably only in advanced cases



(11) Intraocular Tumors

Choroidal melanoma:

Mushroom shaped is caused by tumor growth through a break in bruch's membrane

Choroidal excavation(produced by dome shaped fundus lesions in ultrasound beam path

Solid mass with shadowing

The scleral extension should be watched for

Choroidal Metastasis: The tumor has an irregular outline and heterogenous internal structure

Hemangioma: A scan honeycomb spikes, spikes do not touch baseline

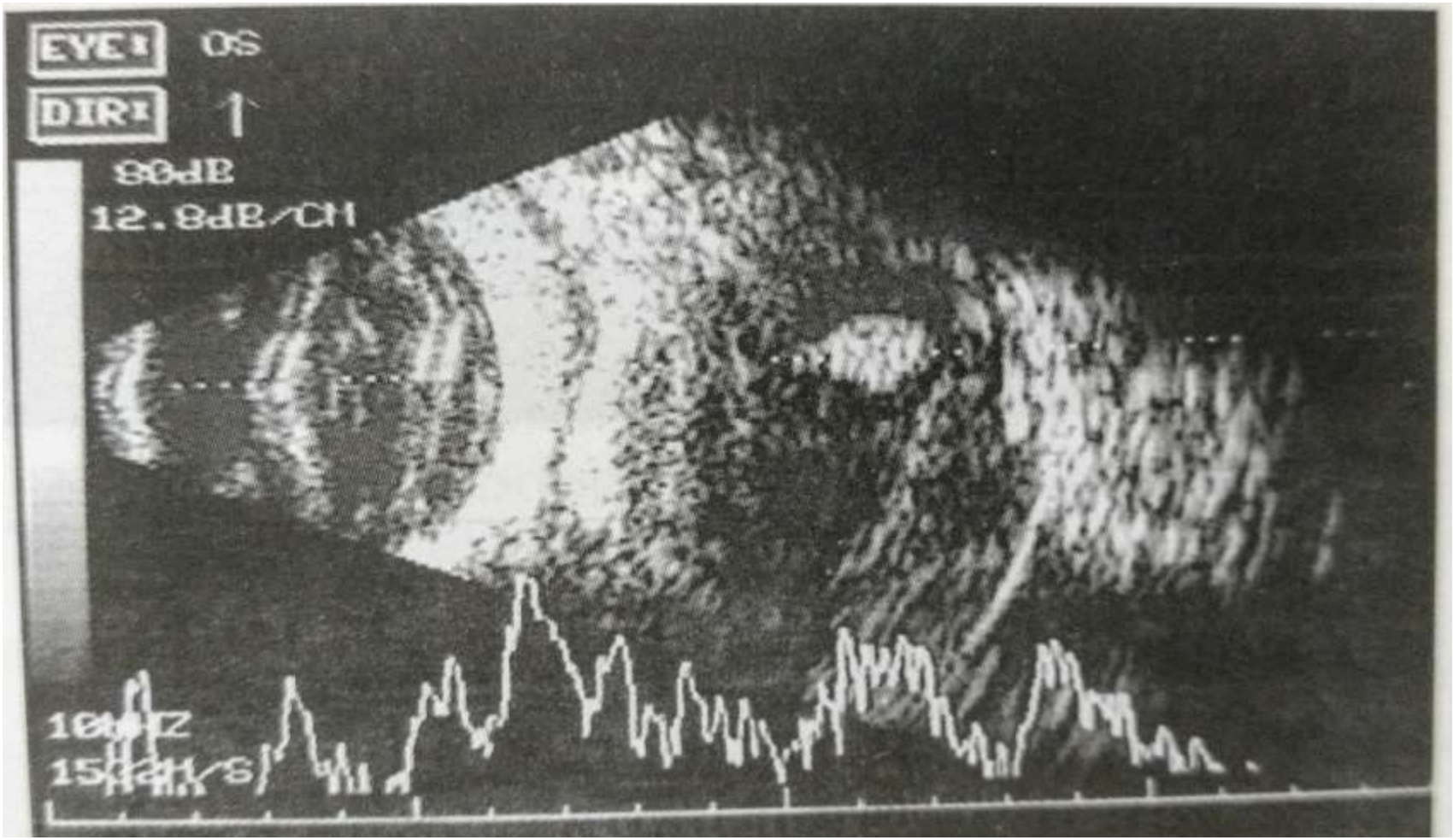
(12) Cysticercosis Extraocular Muscle

EOM cysticercosis manifests as a well demarcated cyst in relation to the right recti muscle with a central echodense, highly reflective structure within the sonolucent cyst, corresponding to the scolex

EOM involvement is the most common variety of orbital cysticercosis

The subconjunctival space is the next common site, followed by the eyelid >optic nerve>retro-orbital space> lacrimal gland

Cysticercosis EOM



(13) ROP

Multiple membranes in the periphery

RD

Focal fibrovascular fonds

Open funnel RD

Closed funnel RD

(14)Coats disease

Unilateral

RD

Turbid SRF

(15)Retinoblastoma

Solid tumor

Calcification

Moderate internal reflectivity

If necrosis, calcification-High reflectivity

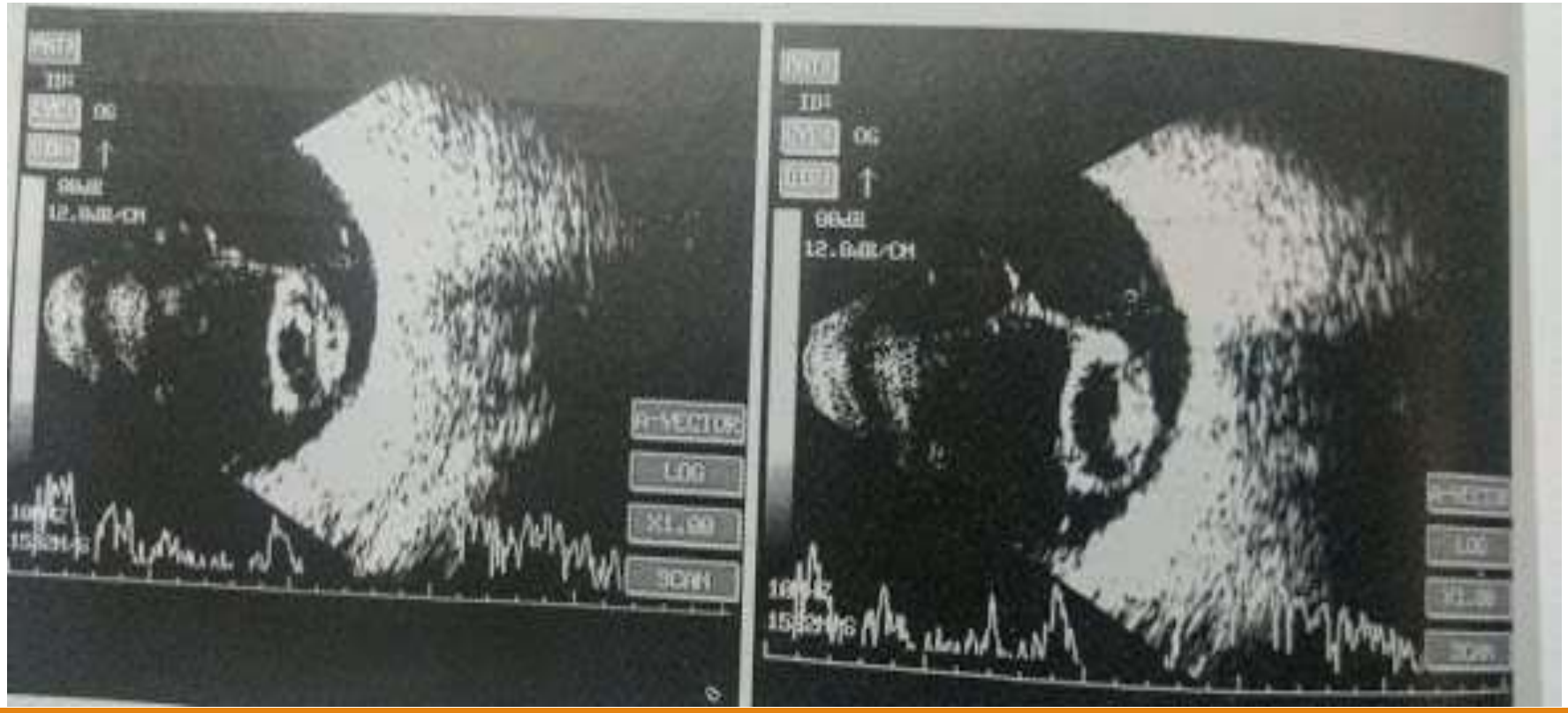
Sound attenuation moderate to high

If glaucoma: Globe enlarged

(16) Nucleus drop

Bi-convex shaped structure

Surrounding mild to moderate spikes suggesting vitritis



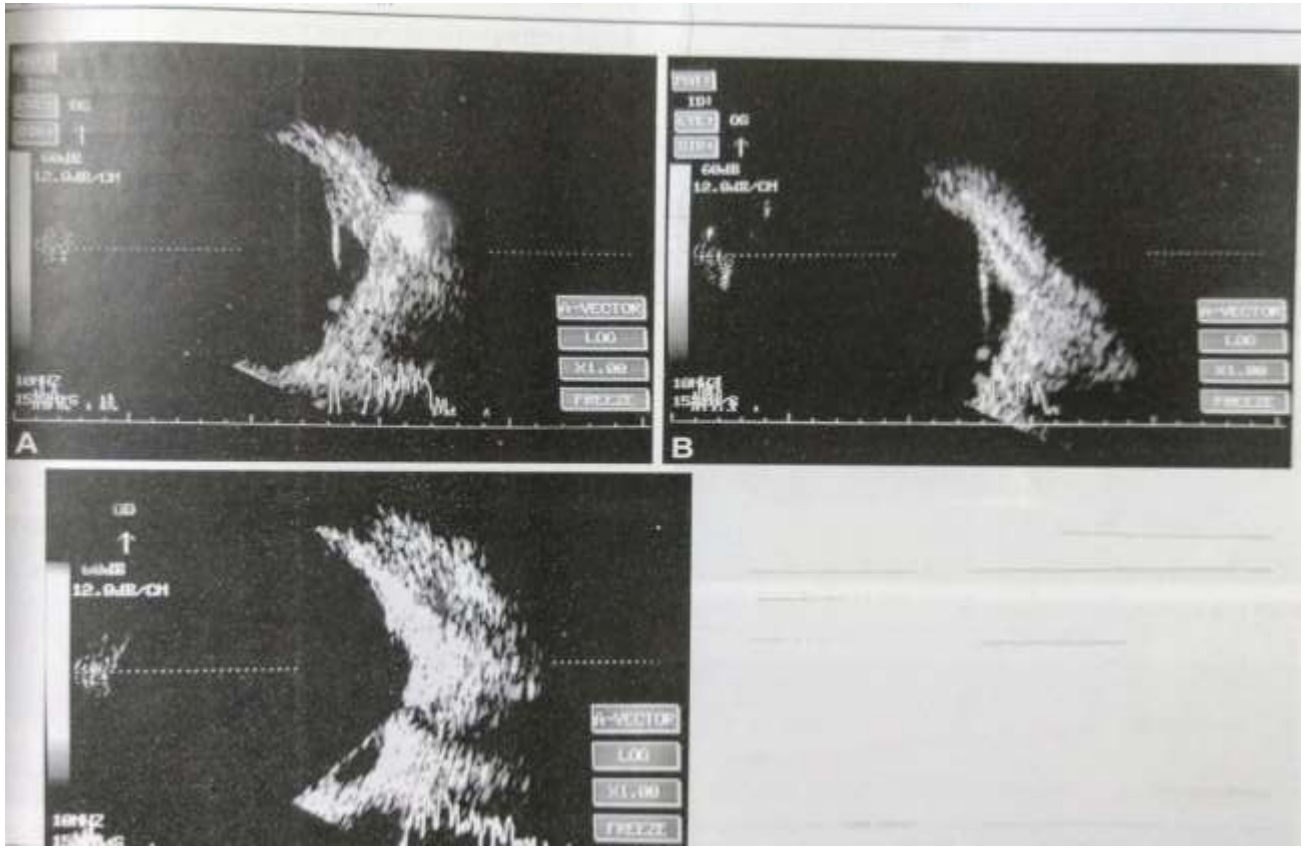
(17) Choroidal Coloboma

Excavation of posterior

Cyst

RD

Small eyeball



Thank You

Stay Home - Stay Safe

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