ULTRASONOGRAPHY (USG) INTRODUCTION ● Sound has been used clinically as an alternative to light in the diagnostic evaluation of Varity conditions. ● Advantage of sound over light is it can pass through opaque tissue. ● An important tool in terms of diagnostic and management. ols non-invasive investigation on choice to study eye in opaque media. DEFINITION ● USG is an acoustic wave that consist of oscillation of particles within a medium. ● Ultrasound Waves are acoustic waves that have frequencies more than 20KHz ● History ● In 1956 ● First time: Mundt and Hughes, American Oph. ● A-scan (Time Amplitude) to demonstrate various ocular disease ● Oksala et al in Finland ● Ultrasound Basic Principle (Pulse-Echo Technique) ● Studied reflective properties of globe In 1958, Baum and Greenwood Developed the first two-dimensional (immersion) (B-scan) ultrasound instrument for ophthalmology ● In the early 1960s, Jansson and associates, in Sweden, Used ultrasound to measure the distances between structures in the eye ● In the 1960s, Ossoinig, an Austrian ophthalmologist ● First emphasized the importance of standardizing instrumentation and technique ● Developed standardized A-scan In 1972, Coleman and associates made ● First commercially available immersion B -scan instrument ● Refined techniques for measuring axial length, AC depth, lens thickness ● Bronson in 1974 made contact B scan machine ADVANTAGES OF USG ● Easy to use ● No ionizing radiation ● Excellent tissue differentiation ● Cost effectiveness Primary uses in ophthalmology ● Posterior segment evaluation in hazy media/orbit -structural integrity of the eye but no functional integrity ● Detection and differentiation of intraocular and orbital lesions ● Location of intra ocular foreign body ● Ocular biometry for IOL power calculations ● PHYSICS .USG is an acoustic wave that consist of oscillation of particles that vibrate in the direction of the propagation Longitudinal waves Consist of compression and rarefaction molecules of media Oscillation of particles is characterized by velocity, frequency& wavelength VELOCITY ● Velocity= wavelength*frequency ● Depends on the density of the media ● Takes 33 micro sec to come back from posterior pole to transducer ● About 1500m/sec average velocity in phakic eye and 1532m/sec in aphakic eye ● SOUND WAVE VELOCITIES THROUGH VARIOUS MEDIA Medium Velocity (m/sec) Water 1,480 Aqueous/ Vitreous 1,532 Silicon Lens 1,486 Crystalline Lens 1.641 PMMA Lens 2,718 Silicon Oil 986 Tissue 1,550 Bone 3,500 FREQUENCY ● Ophthalmic ultrasonography uses frequency ranging from 6 to 20MHz ● High frequency provide better resolution ● 8 MHz in A scan ● 10 MHz in B scan ● Low frequency (1-2MHz) used in body scanning gives better penetration ● Wavelength ● Wavelength is approx. 0.2mm ● Good resolution of minute ocular & orbital structures ● REFLECTIVITY ● When sound travels from one media to another media of different density, part of the sound is back into the prob ● This known as an echo, the greater the density difference at that interface -the stronger the echo, or -the higher the reflectivity -In A-scan USG echoes are represented as spikes arising from a baseline ● The stronger the echo, the higher the spike ● In B-scan USG echoes are represented as multitude of dots that together form an images on screen ● The stronger the echo, the brighter the dot ● ABSORPTION ● Ultrasound is absorbed by every media through which passes ● The more dense the medium, the greater the amount of absorption ● Interface ● Relative difference between various tissues that the sound beam encounters ● Strong or weak echoes due to the significance of tissue interface ● For example: - The difference in interface between vitreous and fresh blood is very slight resulting in small echo - The difference between a detached retina and the

vitreous is great producing a large echo – Texture and size of interface ● Smooth surface like retina will give strong reflection ● Smooth and rounded surface scatters the beam ● Coarse surface like ciliary body or membrane with folds tend to scatter the beam without any single strong reflection Small interface produces scattering of reflection INSTRUMENTATION 1. Probe Transducer: undergoes mechanical vibration when stimulated by electrical energy from the instrument and receive returning echo .. returning waves create another mechanical vibration then produces an electrical single that transmitted to receiver and the display screen 2. Amplifier device that turns the low signals from your source equipment into a signal with enough gain. 3. Display system PROBES ASCAN PROBE Small, pencil size, easy handling No marker present Beam–parallel and non focused of 8MHz Placed at right angles to the area of interest Kept directly over the globe after putting local anaesthetic B SCAN PROBE Thick Marked present–indicates beam orientation Focus beam of 10MHz Mostly kept transpalpebrum after slightly increase of gain A scan ● Is a single dimensional acoustic display in which echoes are represented as vertical spikes and strength as a height of the spikes. ● The scan involves a local anesthetic to be dropped into the eye to be scanned. Probe is placed directly on globe ● This information is displayed on a screen and printed for your case notes. ● USES ● Axial length measurements – Intraocular and intraorbital pathologies ■ Detection ● Differentiation ■ Localization CAL PL R ● In A–scan, thin, parallel sound beam is emitted from the probe tip, with an echo bouncing back into the probe tip as the sound beam strikes each interface. ● An interface is the junction between any two media of different densities and velocities. anterior corneal surface aqueous/anterior lens surface posterior lens capsule/anterior vitreous posterior vitreous/retinal surface choroid/anterior scleral surface. The echoes received back into the probe from these interfaces are converted by the biometer to spikes arising from baseline. ● The greater the difference in the two media at each interface, the stronger the echo and the higher the spike. ● ● Average Axial Length of Normal Eye 23.06 mm ●Majority 22.0 to 24.5 mm ●Error of 0.4mm in the measurement of axial length may result in a one diopter change in calculated IOL power. ●Difference in AL measurement Between both eyes + 0.3 mm ●Applanation A–scan biometry Humphrey A DIVISION OF CARL ZEISS, INC. BIOMETRY MODE 01:42 PM PATIENT 11–24–99 LT 4.14 ACD 3.66 AL 2 3.0 6 60% GAIN PHAKIC AUTOMATIC RECORD 01 00 a: Initial spike (probe tip and cornea) b: Anterior lens capsule c: Posterior lens capsule d: Retina e: Sclera f: Orbital fat 20 30mm When echoes b through d are high and steeply rising, the ultrasound beam is most likely on visual axis. If no scleral or orbital fat echoes visible, then ultrasound beam is most likely aligned with optic nerve. procedure A probe is placed on the patient's cornea. The probe is attached to a device that delivers adjustable sound waves. The measurements are displayed as spikes on the screen of an oscilloscope (Visual monitor). The appearance of the spikes and the distance between them can be correlated to structures within the eye and the distance between them. Probe position The probe lightly touches the cornea and is positioned, such that the barrel of the probe is aligned with the optical axis or visual axis of the eye. The operator aims the probe towards the macula of the eye. Alignment with the optical axis will be indicated by high lens spikes and a high retina spike on the scan graph. Spike height is affected by the difference in density & by the angle of incidence, which is determined by the probe orientation to the visual axis. If the probe is held nonparallel, part of the echo is

diverted at an angle away from the probe tip, and is not received by the machine. A perfect high, steeply rising retinal spike may be impossible when macular pathology is present (eg, macular edema, macular degeneration, epiretinal membranes, posterior staphylomas). Corneal compression ● If pressure is applied on the cornea, the axial length measurment may be falsely too short. ● It can be monitored by observing the anterior chamber depth, read out by an instrument. ● Most eyes will have an ACD readings between 2.5 to 4.0mm. ● The corneal compression error factor can be avoided by using the immersion technique IMMERSION A–SCAN BIOMETRY ● The immersion technique is accomplished by placing a small scleral shell between the patient's lids, filling it with saline, and immersing the probe into the fluid, being careful to avoid contact with the cornea. More accurate than contact method because corneal compression is avoided. Eyes measured with the immersion method are, on average, 0.1–0.3 mm longer.