Original Article

Usefulness of B-Scan Ultrasonography in Ocular Trauma

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Purpose: To detect and differentiate the nature of various traumatic intra-ocular pathologies by B-scan Ultrasonography.

Material and Methods: This study was conducted in the department of ophthalmology, Chandka Medical College Larkana, from Oct. 2003 to Sept. 2005 and included patients with history of first time ocular trauma in association of secondary opaque ocular media were included in this study. The exclusion criteria included known anterior / posterior segment pathology and previous ocular surgery or trauma. (group A)

Results: The total patients referred to us for ocular B-scan in two years were 340. Out of these the traumatic cases were 72 (21.2%). In these, 51 (70.8%) patients had suffered from penetrating ocular trauma (group A) and 21 (29.2%) from blunt ocular trauma (group B). The major causative agents in penetrating cases were pellet 6 cases (11.8%), metallic foreign body 5 cases (9.8%), road traffic accident 5 cases (9.8%), thorn 4 cases (7.8%), scissor and grinding machine 8 cases (15.7%), followed by knife, wire, iron rod 3 cases each (17.6%), and needle, tip of pen, bird bite, fire cracker, electric wire, mirror, screw driver 2 cases each (27.5%), The major causative agents in blunt trauma were assault by fist / stick 5 cases (23.8%), cricket ball 4 cases (19%), followed by Gulli danda (Tip Cat), stone 3 cases each (28.6%), and buckle of belt, toy, corner of door 2 cases each (29.6%). The traumatic ocular findings seen on B-scan were cataract alone 11 cases (15.3%), IOFB 10 cases (13.8%) retinal detachment alone 6 cases (8.3%), vitreous haemorrhage alone 5 cases (6.9%), hyphema alone 5 cases (6.9%), and combined lenticulo-vitro-retinal abnormalities 35 cases (48.6%).

Conclusion: Ocular B-scan is safe non-invasive technique which is used easily to detect and differentiate various traumatic intra ocular pathologies and therefore help in the planning of further line of management.

The clinical use of ophthalmic ultrasound has increased dramatically over the past twenty years and has presently reached the point where it is universally regarded as an essential means of soft tissue examination of the eye and orbit[1].

Principles of Ultrasound: Ultrasound is an acoustic wave in which compressions and rarefactions occur due to changes in density within fluid and solid substances[2]. An ultrasonic wave differs from a sonic wave in that the former exhibits frequencies above 20 kilohertz (1 KHz equals one thousand cycles per second) and is thus not audible to humans. Sound waves, like light waves can be directed, focused, and reflected according to established principles. In ophthalmic ultrasound, high frequencies (about 10 megahertz, or 10 million cycles per second) and small wavelengths make detailed resolution of ocular structures possible. Sound travels in biological tissue at a rate of approximately 1,500 meters per second, and for most purposes the speed in a tissue may be considered independent of frequency. The time required for sound to travel to the rear of the eye and return is only about 33 microseconds (1 microsecond equals 1 millionth of a second)[3].

Methods of Display After the electrical energy is converted into sound energy and then reconverted into electrical energy by the crystal, the echoes can be displayed in graphic form. The three types of display are A-mode, B-mode, and M-mode. Each of this presents structural information in a unique display format.

Ultrasonic system: Transducer scanning and electronic processing are incorporated into a basic ultrasonic system to produce cross-sectional images of the eye and orbit. In A-mode the transducer is fixed in position, resulting in one-dimensional display, in B-mode the transducer undergoes a sweeping or scanning motion in any selected plane, and the resulting display is two dimensional. The word scan is loosely used in terms of A-scan and B-scan. It is inappropriate to describe A-mode as A-scan because no scanning motion of transducer takes place). The resultant two-dimensional image is composed of numerous spots, and the brightness of each spot is proportional to the sound energy reflected by the corresponding tissues boundary. This type of B-mode is also known as intensity modulated ultrasonography, and the term "gray scale" is often used to describe the relative brightness of the displayed tissue echoes. A system that incorporates a gray scale with many steps of gradations of gray, ranging from black to white, is quite desirable since the relative brightness of a displayed echo helps the examiner in identifying the corresponding tissue[4].

Examination Procedure After the patient is comfortably situated in either a lying or sitting position with eyelids closed, a coupling agent, such as methylcellulose, is applied on the scanning head or the closed lids. The procedure can also be done with probe directly over cornea. Sound waves of very high frequency, such as ophthalmic ultrasound, are not transmitted through air, and thus the probe must be coupled with closed lids. The technique causes no discomfort, so patients generally cooperate.

The examination is dynamic, and the examiner must move the scanning head over the closed lid in all directions to ensure that representative cross sections of the globe are obtained. Various recording systems are available so that each photo can be labeled as to which of the infinite cross sections it represents[5].

In a typical contact B-mode exam, the anterior portion of the eye is not visualized well. However, the posterior lens capsule may be noted behind the position of the cornea and closed lid, which is at the extreme left of the screen. Normal vitreous reflects sound poorly, and such poorly reflecting structures are termed sonolucent. They appear black as opposed to structures that reflect sound well, which appear white or shades of gray. Similarly, the optic nerve is sonolucent and appears black. The black horizontal V-shaped optic nerve is an important landmark in B-mode ultrasound. In the normal eye, the retina appears as a smooth, concave surface with a sharp acoustic boundary on the right of the screen, which disappears late as the sensitivity is reduced. This acoustically opaque concave surface results from echoes arising from the vitreo-retinal interface and is inseparable from the choroid and sclera. If a sheet like membrane is observed in the vitreous, the sensitivity should be reduced to estimate its relative acoustic density. If the echo persists at low sensitivity, the membrane is more likely to be retina, whereas if it disappears early, a vitreal membrane is the more likely diagnosis[6].

MATERIAL AND METHODS

Prospectively we studied ocular B-scan of 83 traumatized eyes of 72 patients aged between 15 months and 58 years, from October 2003 to September 2005, at the department of ophthalmology, Chandka Medical College and Hospital Larkana. In each case, patients name, age, sex, occupation, address, detailed history of trauma i.e. nature, duration, cause, place, site and ocular clinical examination was noted on a specific performa.

Patients with first time history of ocular trauma showing secondary ocular changes i-e. hyphema, cataract, and vitreo-retinal pathology were included in this study. The exclusion criteria included known anterior or posterior segment pathology, history of previous ocular surgery or trauma. All 72 patients were divided into two main groups on the basis of nature of trauma. Group A comprised 51 (70.8%) patients who came with history of Penetrating ocular trauma (Table 1), and the group B comprised 21 (29.16%) patients who presented with history of blunt ocular trauma (Table 2).

RESULTS

In Group A out of 51 patients with history of penetrating ocular trauma 38 (74.5%) were males and 13 (25.5%) were females. Eight (15.7%) patients were presented with history of bilateral ocular trauma and 43 (84.3%) patients with unilateral ocular trauma in which right eye was involved in 22 (51.2%) cases, and left eye was involved in 21 cases (48.8%) (Table 1). In Group B out of, 21 patients with history of blunt ocular trauma, 16 (76.2%) were males and 5 (23.8%) were females. Three (14.3%) patients presented with history of bilateral ocular trauma and 18 (85.7%) patients with unilateral ocular trauma in which right eye was involved in 13 (72.2%) cases and left eye was involved in 5 (27.7%) cases (Table 2). The causes of penetrating ocular trauma are shown in table 3, and the causes of blunt ocular trauma are shown in table 4. The traumatic ocular findings on B–scan ultrasonography are shown (table 5).

Table 1: Age, sex, & laterality distribution of group A patients with penetrating ocular trauma

Age in years	No. of patients n=51 (70.8%)	Male n=38 (74.5%)	Female n=13 (25.5%)	Laterality Bilateral n = 8(15.7%) Unilateral n = 43(84.3%)
1 – 10	7	5	2	Bil=1, Rt=4, Lt=2
11 – 20	11	8	3	Bil=2, Rt=5, Lt=4
21 – 30	15	12	3	Bil=3, Rt=5, Lt=7
31 – 40	8	6	2	Bil=2, Rt=3, Lt=3
41 – 50	7	5	2	Rt=4, Lt=3
51 – 60	3	2	1	Rt=1, Lt=2

n = Number, Rt = Right, Lt = Left, Bil = Bilateral

Table 2: Age, sex, & laterality distribution of group B patients with blunt ocular trauma.

Age in years	No: of patients n=21 (29.2%)	Male n=16 (76.2%)	Female n=5 (23.8%)	Laterality Bilateral n = 3(14.3%) Unilateral n = 18(85.7%)
1 – 10	2	1	1	Rt=1, Lt=1
11 – 20	4	3	1	Bil=1, Rt=1, Lt=2
21 – 30	7	5	2	Bil=1, Rt=4, Lt=2
31 – 40	5	4	1	Bil=1, Rt=4
41 – 50	2	2	0	Rt=2
51 – 60	1	1	0	Rt=1

DISCUSSION

Traumatic patients with opaque light conducting media were the main cause of referral. In hyphema, B-scan shows echoes in the anterior chamber (Fig. 1). The normal lens produces extremely low internal reflectivity, whereas dense cataract often produces highly reflective echoes indicates. Lens subluxation or dislocation presence of increased echoes of lens contour at abnormal site (Fig. 2). Mostly traumatic cataracts are associated with vitreoretinal abnormalities. We have noticed 11.1% prevalence of vitreoretinal abnormalities associated with traumatic cataract, which is less as reported 20-30% by Kaskalogu M[8]. In fresh mild vitreous hemorrhage, dots and short lines are displayed on B-scan. But when the haemorrhage spreads diffusely, it creates scattered low amplitude echoes (Fig. 3). Organization of blood creates interfaces that may have a pseudomembranous appearance. On B-scan, detached vitreous is usually smooth and may be thick posteriorly when blood is layered along its surfaces (Fig. 4). Retinal detachment typically appears as a bright, continuous smooth and some what folded membrane within the vitreous, which is reflective and freely moving on real time imaging. The movements become less pronounced in long standing detachments. If total and extensive, the detached retina gives a typical triangular funnel shape appearance with insertion into the optic disc and ora serrata (Fig.5).

Table 3: Penetrating causative agents

Penetrating object	No. of Patients n = 51 (%)
Pellet	6(11.8)
Metallic foreign body	5(9.8)
Road traffic accident	5(9.8)
Thorns, scissor, grinding machine	12(23.5)
Knife, wire, iron rod	9(17.6)
Needle, tip of pen, bird bite, fire cracker, electric wire, mirror, screw driver (2 each)	14(27.5)

Table 4:. Blunt causative agents

Blunt objects	No. of Patients n = 21 (%)
Assault by fist / wooden stick	5(23.8)
Cricket Ball	4(19)
Gulli Danda (Tip Cat), stone (3 each)	6(28.6)
Buckle of belt, plastic toy, corner of door (2 each)	6(28.6)

The tractional retinal detachment appears as a tented or tabletop configuration with the vitreous band connected to anterior surface (Fig. 6). The choroidal detachment typically appears as smooth, thick, dome-shaped membrane in the periphery with little after-movement on kinetic evaluation (Fig. 7). Blunt trauma can lead to posterior scleral rupture that may be difficult to detect clinically and

Table 5: Ocular traumatic findings on B–scan ultrasonography

Findings	No. of Patients n = 72 (%)
Hyphema alone	3(4.2)
Hyphema + cataract	5(6.9)
Hyphema + cataract + vitreous haemorrhage + retinal detachment	1(1.4)
Dense cataract alone	11(15.3)
Cataract + vitreous haemorrhage	4(5.65)
Cataract + anterior and posterior lens capsule rupture	4(5.6)
Cataract + vitreous haemorrhage + retinal detachment	3(4.2)
Subluxation of lens + vitreous haemorrhage	2(2.8)
Dislocation of natural ocular lens	4(4.2)
Subluxation of lens	1(1.4)
Posterior dislocation of implanted intraocular lens	1(1.4)
Vitreous haemorrhage alone	5(6.9)
Vitreous haemorrhage + posterior vitreous detachment	3(4.2)
Vitreous haemorrhage + Retinal detachment	3(4.2)
Subhyaloid haemorrhage	2(2.8)
Intraocular foreign body in the iris	1(1.4)
Intraocular foreign body in the Lens	2(2.8)
Intraocular foreign body in the vitreous	4(5.6)
Intraocular foreign body in the retina	3(4.2)
Retinal detachment alone	6(8.3)
Peripheral retinal tear	2(2.8)
Peripheral retinal dialysis	1(1.4)
Posterior scleral rupture	1(1.4)

Table 6: Occupational ocular trauma

Type of Occupational Trauma	Occupation	No. of Patients n = 23 (%)
Industrial	Lathe machine worker	3(13)
	Tool grinders	1(4.3)
	Welders	2(8.7)
	Carpenter	2(8.7)
	Marble grinder	1(4.3)
	Gold smith	1(4.3)
Agriculture	Iron & steel worker	1(4.3)
	Farmer	3(13)
	Harvester	2(8.7)
Electrical	Electrician	2(8.7)
Cooker	Hot cooking oil	1(4.3)
Laborer	Brick / Stone	4(17.4)

with ultrasonography, although the affected area may show irregular contour and decreased reflectivity (Fig. 8). However, such a rupture should be suspected when few of the following or all indirect signs like: incarceration of vitreous and vitreous hemorrhage with PVD; demonstra-tion of folds and traction bands that extend in the direction of rupture; thickening or detachment of retina or choroids; haemorrhage in episcleral space closest to the site may co-exist. B-scan offers advantages in determining the foreign body's position and distance from ocular structures. The major value of B-scan in detecting foreign bodies is its independence from radio-opacity. Softer materials, which are only intermediately reflective (wood and vegetative materials) are more difficult to detect. Metal or glass foreign bodies deflect or absorb sound so that they produce an anechoic area posterior to the body. If the foreign body is not visible clearly due to echoes from nearby tissues then gain should be reduced so that echoes from less reflective tissues are obliterated and the foreign body stands out clearly (Fig. 9a and b). Plain radiograph (Fig. 9 c) and C.T. Scan are superior for detecting foreign bodies, specially if they are multiple, although ultrasound contributes to their exact location with respect to other ocular structures[7-10].

In our study, the non occupational traumatic cases were 49 (68.1%) on the other hand occupational traumatic cases were 23 (31.9%) (Table 6 & 7). Because of outdoor activities, the ocular trauma is more common in males than females. The prevalence of ocular trauma in young males was 83% (45 cases) which is comparable with those reported by Mirza Shafique et al 91% (90 cases)[11].

Because of having a rural and non industrial catchment area, the occupational ocular traumatic cases in our study were 31.9% (Table 6), which are less as compared with other national studies carried out by Uzma Fasih et al – 72%[12] and butt NH et al – 54%[13].

Table 7: Non Occupational Ocular Trauma

Object	No. of Patients n = 49 (%)
Pellet	6(12.2)
Road traffic accidents	5(10.2)
Assault by fist/stick	5(10.2)
Cricket ball	4 (8.2)
Thorn	4(8.2)
Gulli danda (Tip Cat)	3(6.1)
Stone	3(6.1)
Knife	3(6.1)
Mirror	2(4.1)
Fire cracker	2(4.1)
Bird bite	2(4.1)
Tip of pen / pencil	2(4.1)
Needle	2(4.1)
Buckle of belt	2(4.1)
Toy	2(4.1)
Corner of door	2(4.1)

In international studies of Bakers S, et al[14] and Fong LP et al[15], the occupational ocular traumatic cases were 14.3% – 15% of all the ocular injuries, which are significantly less than our national studies[12,13]

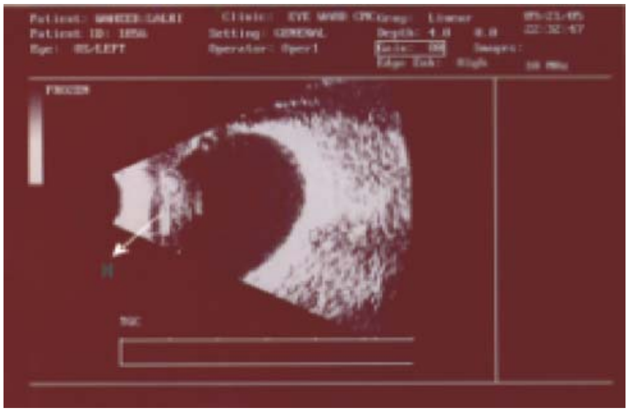

Fig. 1: Left eye B-Scan of Master Waheed Ali, 8 years old showing anterior chamber hyphema (H) after blunt trauma by Gulli Danda.

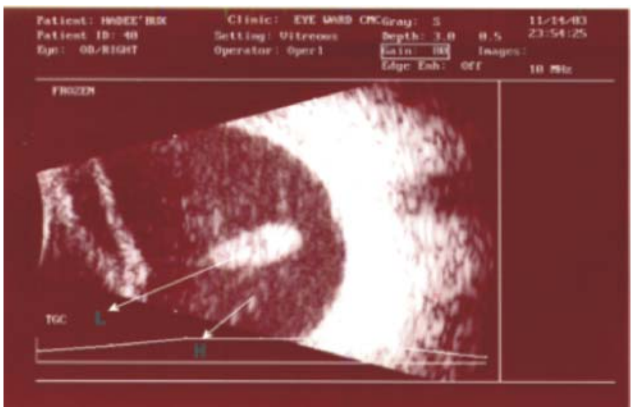

Fig. 2: Right eye B-Scan of Mr. Hadee Bux 58 years old showing posteriorly dislocated natural lens (L) with surrounding vitreous haemorrhage (H) after blunt trauma by corner of door.

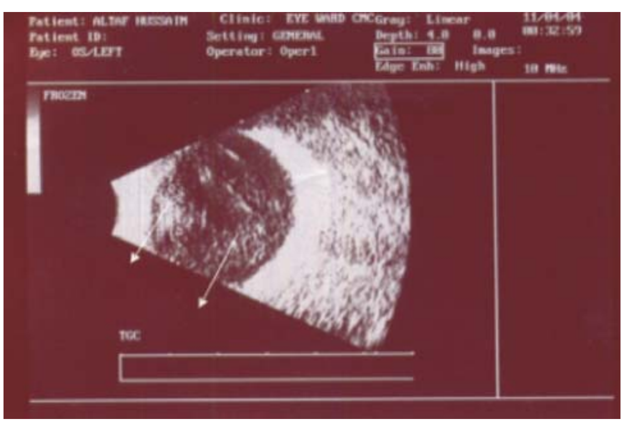

Fig. 3: Left eye B-Scan of Mr. Altaf Hussain 32 year old showing cataract (C) and vitreous haemorrhage (H) after blunt trauma by buckle of belt.

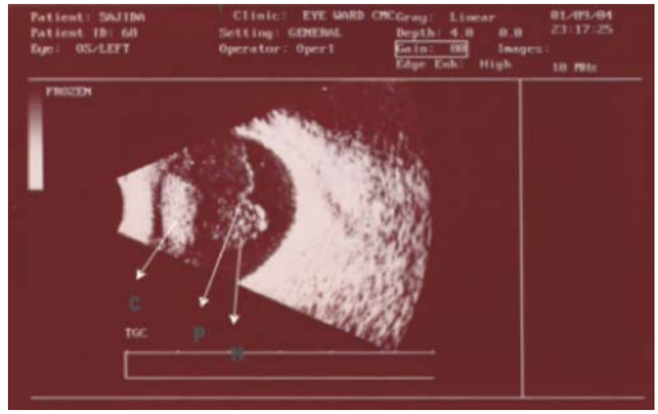

Fig. 4: Left eye B-Scan of Miss Sajida 17 year old showing cataract (C), vitreous haemorrhage (H) and Posterior vitreous detachment (P) after blunt trauma by fist.

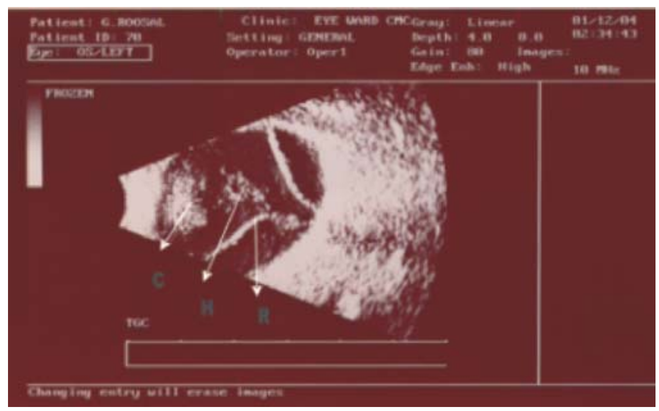

Fig. 5: Left eye B-Scan of Mr. Ghulam Rasool 52 years old showing cataract (C), vitreous haemorrhage (H) and total retinal detachment (R) after blunt trauma by cricket ball.

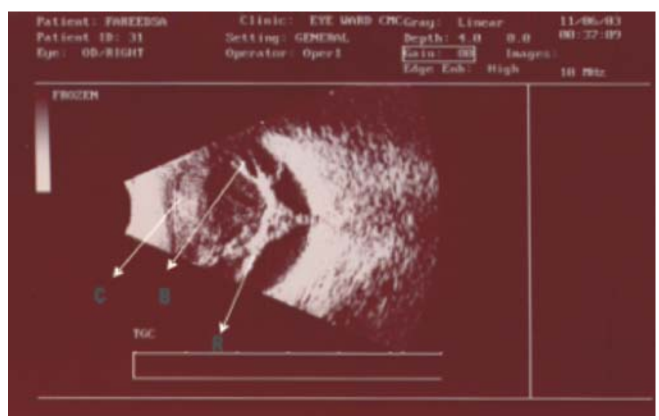

Fig. 6: Right eye B-Scan of baby Fareeda 6 years old showing cataract (C), vitreoretinal tractional bands (B) and tractional retinal detachment (R) after blunt trauma by Toy.

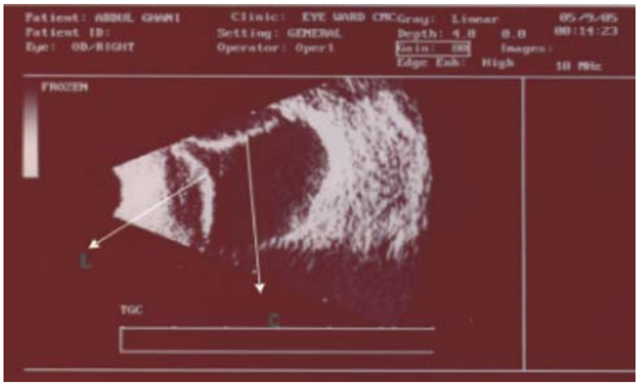

Fig. 7: Right eye B-Scan of Mr. Abdul Ghani 55 years old showing posterior chamber intra ocular lens (L) and choroidal detachment (C) after blunt trauma by stone.

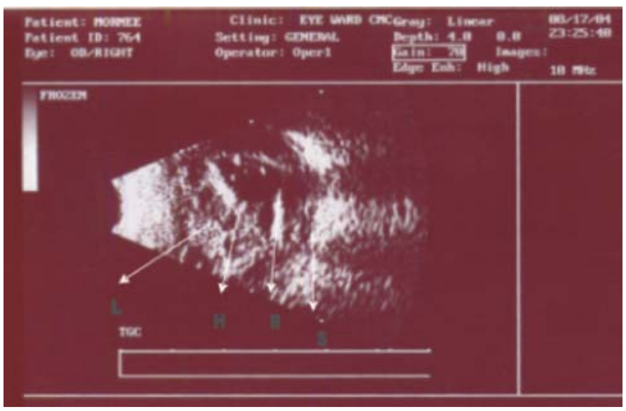

Fig. 8: Right eye B-Scan of baby Mornee 4 years old showing lens rupture (L), vitreous haemorrhage (H), retinal detachment (R), posterior scleral rupture (S) after penetrating trauma by drip set needle.

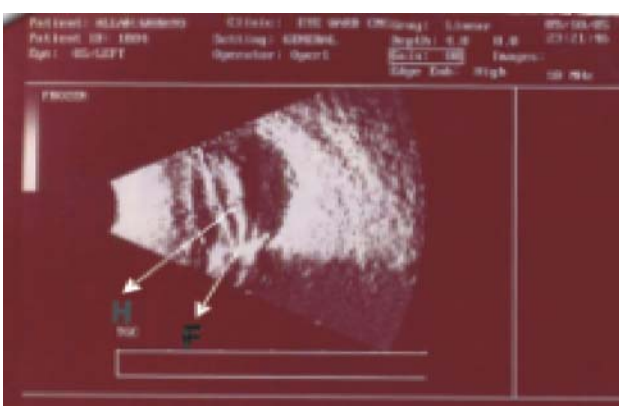

Fig. 9a: Left eye B-Scan of Allah Warayo 58 years old showing vitreous haemorrhage (H) and intra ocular foreign body (F) on the retina after penetrating trauma by fire arm.

Fig. 9b: B-Scan of same patient showing prominence of intra ocular foreign body (F) and obliteration of echoes from near by tissues on decreasing the gain of B-Scan

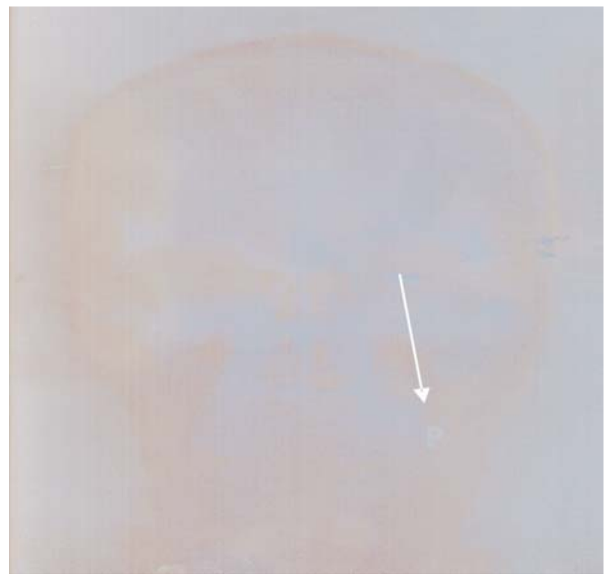

Fig. 9 c: Plain X-ray orbit P.A view of same patient showing multiple pellets(P) on the left side and few on the right side

showing 54% - 72%, due to the modernization of most industries and the proper adaptation of protective measures by the workers in various occupations.

CONCLUSION

Ocular trauma is important cause of morbidity and visual loss in children to middle aged males, which can be prevented by adopting safety measures especially in children and occupational individuals. Early to diagnose posterior segment pathology by B-Scan will lead the surgeon to plan surgical procedure in advance or refer to another tertiary care center.

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