Original Article

Imaging in Ocular Trauma Optimizing the Use of Ultrasound and Computerised Tomography

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Purpose: This study was conducted to identify the role of ultrasound (US) and computerized tomography (CT) scan in diagnosis of common ocular traumatic lesion.

Material and Methods: A cross sectional observational study was conducted over one year period simultaneously at the Jinnah Postgraduate Medical Center (JPMC), Karachi and the PNS SHIFA hospital, Karachi. Fifty patients with traumatic ocular injuries who were referred by the ophthalmologist for radiological evaluation were included in the study. Data regarding five common traumatic lesions namely intraocular foreign body, vitreous hemorrhage, lens dislocation, retinal detachment and choroidal detachment was analyzed.

Results: The age of subjects included in this study ranged from 08 years to 60 years (mean age was 28 $\pm$ 1 year). Ultrasound was able to detect the pathologies in 93% of the patients when compared with CT scan. CT scan showed higher accuracy compared to ultrasound in detecting intraocular foreign body (25 patients out of which 24 cases were diagnosed by ultrasound) vitreous hemorrhage (26 patients out of which 22 cases were diagnosed on ultrasound) and lens dislocation (04 patients out of which 02 cases were diagnosed on ultrasound). However ultrasound showed higher accuracy compared to CT scan in detecting retinal detachment (20 patients out of which only 06 cases were diagnosed on CT scan) and choroidal detachment (08 patients while CT was unable to detect any case of choroidal detachment).

Conclusion: In the setting of acute ocular trauma CT scan is more accurate in detecting intraocular foreign body, vitreous hemorrhage and lens dislocation whereas ultrasound is superior in diagnosing retinal detachment and choroidal detachment. Combined use of these imaging modalities is recommended in diagnosis and management of post traumatic patients with ocular injuries.

Ocular trauma is common and may lead to vision threatening pathologies. It has been estimated that world-wide ocular injuries are responsible for blindness in approximately 1.6 million people, bilateral visual impairment in 2.3 million and unilateral visual loss in about 19 million people annually[1]. Approximately half of all patients who present to an eye casualty department are suffering from ocular trauma[2].

Ocular injuries are usually associated with injuries to head and neck or limb structures and definitive diagnosis of ocular trauma in the acute setting may be challenging. Missed ocular injuries in polytrauma patients may lead to serious morbidity later on, necessitating the need of high index of suspicion and employment of appropriate imaging techniques to accurately define the extent and type of ocular injury.

Various imaging modalities exist to aid in the initial and subsequent evaluation of trauma involving the eye and orbit. However, the best modality for the initial evaluation of eye trauma remains indirect ophthalmoscopy. In the first few hours after a severe injury, the first examiner can obtain information with a level of detail that no other imaging method can provide. Although the early view may not always be the best one, often the first look into a traumatized eye is the only look. Direct visualization of intraocular structures however may become difficult or impossible when the eye lids are swollen after injury. The use of imaging modalities like ultrasonography and CT scanning can be useful adjuncts in the management of such patients. Standard roentgenography, computed tomography (CT), magnetic resonance imaging (MRI), and ultrasonography have been employed in managing ocular trauma patients and all have their strengths and weaknesses[3-5]. This study explores the role of ultrasound and CT scanning in the management of ocular trauma.

MATERIAL AND METHODS

After appropriate technical and ethical approval from the relevant review boards this cross sectional observational study was conducted simultaneously at the Jinnah Postgraduate Medical Center (JPMC), Karachi and the PNS SHIFA hospital, Karachi. Sampling technique was non-probability convenience. The sample comprised fifty patients with traumatic ocular injuries who were referred by the ophthalmologist for radiological evaluation. Data regarding five common traumatic lesions namely intraocular foreign body, vitreous hemorrhage, lens dislocation, retinal detachment and choroidal detachment were analyzed. Period of study was 01 year from 31st January 2009 to 30th January 2010. All the patients were examined by ultrasound in supine position with linear high frequency transducer of 7.5 MHZ on single ultrasound machine (GEVoluson 730), using closed eye technique with water soluble gel followed by orbital CT scan. Spiral CT of patients was performed on Toshiba Asteion 16 slices CT scanner. Axial slices were obtained with 120 KV and 250MA. The CT protocol included pitch of 1.0 slices thickness 1.0mm and reconstruction interval 5.0 mm. Reformatted coronal and sagital images were also obtained. In all selected patients the findings seen on Ultrasound and CT scan were collected and proforma were filled for each patient.

RESULTS

In this study there were 34 (68%) male patients and 16 (32%) were female patients. The mean age of patients in our study was 28± 1 year (SD 14.5).

After ultrasound all patients underwent CT scanning. Overall ultrasound was able to detect the pathologies in 93% of the patients when compared with CT scan results. Data analysis for five individual pathologies as shown in tables 1 and 2 was carried out and it revealed that CT scan diagnosed foreign body in 25 patients out of which 24 cases were correctly diagnosed on Ultrasound. CT scan diagnosed vitreous hemorrhage in 26 patients out of which 22cases were correctly diagnosed on Ultrasound. CT scan diagnosed lens dislocation in 04 patients out of which 02 cases were correctly diagnosed on Ultrasound. Ultrasound diagnosed retinal detachment in 20 patients out of which 06 cases were correctly diagnosed on CT scan. Ultrasound diagnosed choroidal detachment in 08 patients, none of these were picked up by CT scan.

The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of ultrasound and CT scan for different ocular pathologies included in this study are shown in table 3.

Disease distribution include frequency of foreign body 25 (30%), vitreous hemorrhage 26 (31%), retinal detachment 20 (24%), choroidal detachment 8(10%) and lens dislocation 4 (5%).Chi square test was applied to check association between categorical variables ($p<0.00$).

DISCUSSION

Traumatic ocular emergencies can present in isolation or as part of poly trauma. It is difficult to perform a physical examination on a severely injured patient. The eye may be swollen shut or there may be intraocular bleeding rendering fundoscopic examination impossible. The patient may be unable to cooperate or respond, making it difficult to evaluate for visual acuity or ocular movement. Since these lesions can lead to exceptional morbidity in the form of vision loss they warrant a high index of suspicion and prompt and judicious use of imaging modalities to obtain an accurate diagnosis and initiate appropriate management at an early stage.

Studies have shown that ultrasound and CT scan are highly accurate in detection of ocular pathologies.[6] Computed tomography is considered as having advantage due to its ability of performing multiplanar reformation, evaluating intraorbital structures with simultaneous imaging the bony orbit for fractures and any herniations of orbital contents[7].

Our study includes both children and adults with history of ocular trauma. Mean age of patients was 28 ±1 year in our study while in study done by Deramo et al it was 36 years[7].

In this study ocular sonography was done using a single machine (GE Voluson 730)and a standardized technique similar to that used by other researchers (e.g. by Hoffman) using close eye technique with linear 7.5 – 10 MHz probe in sagittal and transverse plane[8]. Ultrasound was followed by CT scanning done by similar protocol as described by Kazuhiro et al.[9] Axial slices were obtained from above the orbit to below the orbit, the field of view included the cavernous sinus and anterior brain stem with 120 KV and 100-160 MA, pitch of 1.5, slices thickness 1.0mm and reconstruction interval 1.0 mm. All CT scans done were on Toshiba Asteion 16 slice CT scanner.

Blaivas et al[4] evaluated the accuracy of ultrasound for the diagnosis of ocular pathology in patients with ocular trauma and findings were confirmed by thin slices CT scanning. The results showed 100% sensitivity and 97.2 % specificity. While in our study the sensitivity is 97.3% and specificity is 94.4%.

Table 1: Patient gender distribution based on pathology

Pathology	Female	Male	Total patients
Intraocular foreign body	09	16	25
Vitreoushae morrhage	04	18	26
Ectopialentis	02	02	4
Retinal detachment	04	16	20
Choroidal detachment	04	04	8

Table 2: Ultrasound VS CT scan diagnostic breakdown based on different pathologies

Pathology	Correctly diagnosed on Ultrasound	Correctly diagnosed on CT scan	Incorrectly diagnosed on Ultrasound	Incorrectly diagnosed on CT scan	Total
Intraocular foreign body	24	25	01	0	25
Vitreous haemorrhage	22	26	4	0	26
Ectopialentis	2	4	2	0	4
Retinal detachment	20	6	0	14	20
Choroidal detachment	8	0	0	8	8

Table 3: Sensitivity, specificity, PPV (Positive Predictive Value), NPV (Negative Predictive Value) of ultrasound and Ct Scan For Different Ocular Pathologies

Pathology	Ultrasound				Ct Scan			
	Sensitivity %	Specificity %	PPV %	NPV %	Sensitivity %	Specificity %	PPV %	NPV %
Intraocular foreign body	96	92.8	92.3	96.2	100	96.15	96.15	100
Vitreous haemorrhage	84.6	96.5	95.6	87.5	96.29	92.3	92.85	96
Ectopialentis	75	97.9	66.6	96	80	95.8	66.6	96
Retinal detachment	95.2	90.9	86.9	96.7	30	95.6	75	75.8
Choroidal detachment	80	97.7	88.8	91.6	0	98	0	86.2

Fig. 1: Oculr ultrasound with linear probe

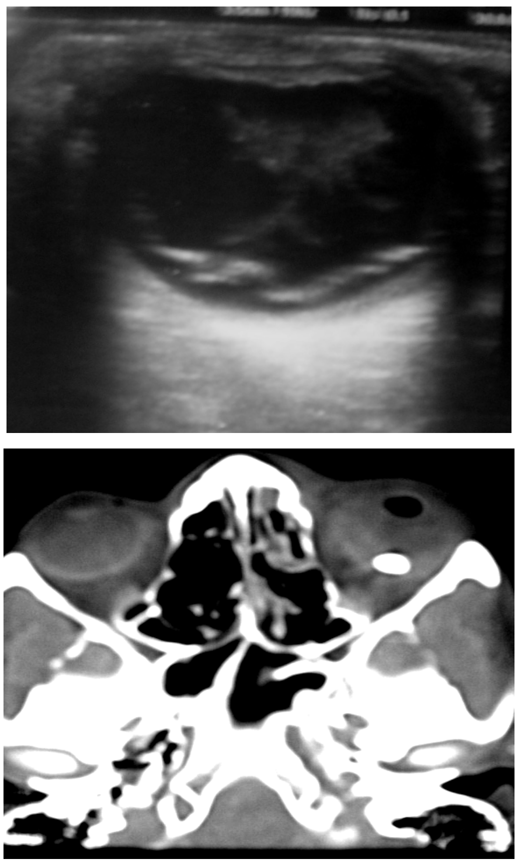

Fig. 2: 22-year male patient with vitreous hemorrhage, retinal detachment and foreign body.

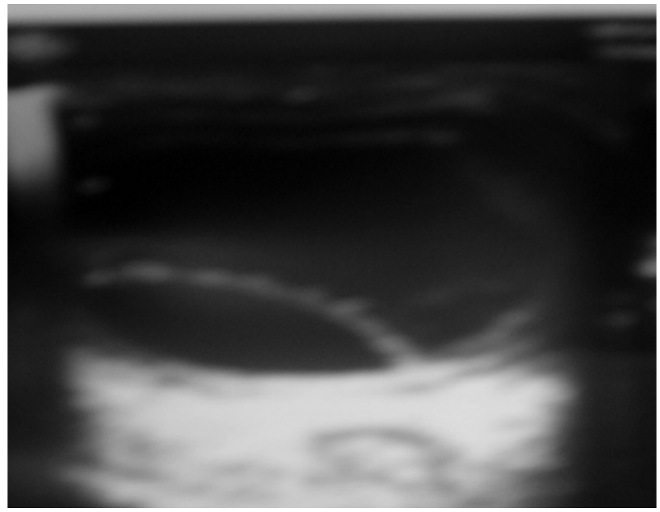

Fig. 3: 30-year female presented with history of blunt trauma. Ultrasound image reveals retinal detachment.

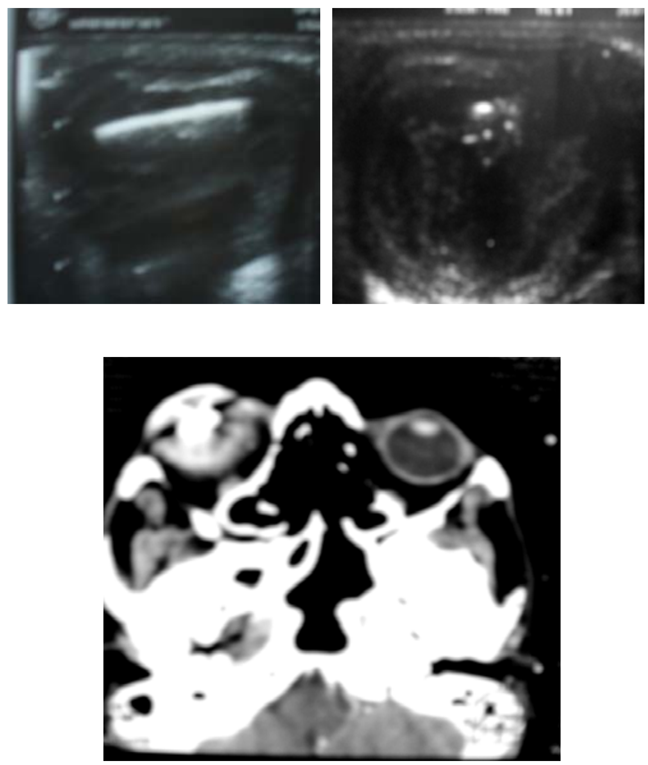

Fig. 4: 60-year-old male patient presented with oculartrauma during iron working,Ultrasound and CT images show largeforeign body, vitreous hemorrhage and retinal detachment.

Fig. 5: 21 year old female patient presenting with trauma. Imaging reveals Lens dislocation

Shiver et al[3] stated the sensitivity of ultrasound for detecting foreign body to be 87.5% and specificity to be 95.8 %. In our study the sensitivity for foreign body detection was 96 % and specificity was 92.8%.

CT is considered the most sensitive method for detection of intraocular foreign body reaching more than 95% detection rate[10] while in our study the CT sensitivity for diagnosis of intraocular foreign body reached 100%.

Ultrasonography is an excellent method to detect all kinds of intraocular foreign bodies with an overall detection rate for metallic and non metallic foreign body reaching 93% stated by Khan & Khan et al[11].

In our study the sensitivity of ultrasound for the diagnosis of retinal detachment is 95.2% & specificity is 90.9% in comparison with Dhakshina et al the sensitivity is 92.3 % and specificity is 100%[12] hence retinal detachment is well demonstrated by ultrasound as well as sometimes by CT as a 'V' or a 'sunset sign[13].

In our study the sensitivity of ultrasound for the diagnosis of vitreous hemorrhage is 84.6% and specificity is 96.5 % in comparison with S. Kim S. Lee et al sensitivity is 73% and specificity 90%[14].

Gilbert et al stated that sensitivity of CT for the diagnosis of lens dislocation is 100% and specificity is 96% [15]while in our study the sensitivity of CT is 80 % and specificity is 95.8%. Dislocation of lens into opaque media is a perfect indication for ultrasound. The abnormally placed lens is easily detected because of its shape and strong reflectivity. Munk et al (1991) demonstrated lens fragmentation with individual fragments distinctly discernible on ultrasound[16].

The slight difference of results in my study in comparison with other studies was possibly due to incorporation of patients and operator dependency of ultrasound and CT scan done with 3-5 mm slice thickness due to patient load and time limitation rather than 1.0mm, which is used in other studies[9].

Ultrasound provides good visualization of ocular anatomy that allows evaluation of intraocular foreign body and related lesions such as vitreous hemorrhage and retinal detachment[17].Ultrasound is inexpensive and readily available in most Radiology departments. On the other hand it is operator dependent technique. The examination of the globe is exhaustive and patient is asked to perform ocular movements to find the exact ultrasound incidence angle to visualize the foreign body[18], however ultrasound is useful in detecting small, nonmetallic posteriorly located foreign bodies that may not be detected by other methods[19,20].

CT is accurate in detecting and localizing intraocular, metallic, glass and stone foreign bodies,[21] CT imaging offers short examination time and has the ability to obtain diagnostically useful coronal and sagittal reconstruction images[21] on the other hand there is radiation dose delivered to the lens. In the presence of significant facial trauma it is very difficult to determine the cause of decreased visual acuity. Significant vitreous hemorrhages, intraocular foreign bodies, chorioretinal detachment, lens dislocation and others all result in visual loss and require imaging for diagnosis.

CONCLUSION

This study shows that ultrasound has high sensitivity and specificity in diagnosing traumatic ocular diseases and is superior to CT scan in diagnosing retinal detachment and choroidal detachment, while CT scan detects foreign body, vitreous hemorrhage and lens dislocation more accurately than ultrasound.

The results of this study support the combined use of ultrasound and CT scan imaging in managing patients with traumatic ocular injuries who are referred for radiological evaluation. However keeping in view the common availability, cost effectiveness and acceptably high sensitivity and specificity of ultrasound in detecting ocular traumatic pathologies the authors strongly propose liberal use of ultrasound in managing these patients. The importance of incorporating ocular ultrasound training for all radiologists, ophthalmologists and emergency department physicians cannot be overemphasized.

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