Evaluation of the result of diagnostic of Spiral computed tomography comparing with Cone Beam computed tomography in diagnostic of foreign body in the orbit

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Abstract: Background and aim: Foreign bodies are common findings in the orbit, most commonly the result of accidents. Knowing the potential damage to the eye and its associated imagery are required for a quick and accurate radiological diagnosis. **Materials and method:** The most common foreign bodies found in six different materials were chosen, including metal, glass, plastic, stone, wood and graphite. Each material was were prepared in 4 sizes and scanned with a Somatom Spiral CT and Newtom VG Cone Beam CT. **Result:** Cone-beam computerized tomography (CBCT) are not suitable for low density foreign bodies. **Conclusion**: CBCT devices with lower radiation doses and lower costs can be used for detecting the orbit foreign bodies and localizing its position in cases of limited access to CT scan. CT scan
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1. Introduction

Trauma to the eye accounts for about 3% of visits to emergency departments in the United States (Bord and Linden, 2008). Knowing the potential damage to the eye and its associated imagery are required for a quick and accurate radiological diagnosis in the eye injury after trauma (Kuhn, 2002). Accurate detection and localization of intraocular foreign bodies is a critical factor in the presurgical ophthalmologic treatment and treatment design before surgery (Kubal, 2008). The most common traumatic injuries include trauma to the anterior chamber of the eye, damage to the lens, open globe injuries and ocular attachments, intraocular foreign bodies, carotid cavernous fistula, damage to the optic nerve.

Radiographic examination of the eye is rarely performed today. Radiography has a sensitivity of 64-78% for fractures, but its sensitivity for orbital soft tissue damages is low (De Santana Santos, 2011).

While Ultrasonography (US) is very useful for evaluating the globe and its contents, its use is controversial in globe ruptures. US transducers used to study injured eye is not suitable because of their need to direct contact or indirect contact with the eyes via a water bath system (Williamson, 1989).

MRI is hardly done in emergency cases and is controversial in metallic foreign bodies, MRI is not recommended for orbit primary assessment (Kubal, 2008).

Cone-beam computerized tomography (CBCT) is a new imaging technique that is used for maxillofacial imaging.There is a divergent or cone shaped source of ionizing beam and a tow dimensional surface detector that is fixed to a rotating gantry. Multiple sequential projection images is obtained in a full scan of the surrounding the area of interest (White and Pharoah, 2009). These obtained pictures produce a series of three dimensional data which is used to reconstruction of primary pictures in three orthogonal planes (Axial, Sagittal and Coronal)(De Vos, 2009).

Published reports indicate that the effective dose (International Committee on Radiation Protection in 2005) for different CBCT devices in the range 52 to 1025 Microsieverts (μSV) depending on the type and model of equipment. CBCT dose produces reduction in range between 96% to 51%

compared with the conventional CT (range 1400 to 2100 µSV) provides (White and Pharoah, 2009).

The aim of this study was to evaluate CBCT compared with Spiral CT in the detection of foreign bodies in the orbit is invitro model.

2. Material and Methods

Foreign bodies: the most common foreign bodies found in six different materials were chosen, including metal, glass, plastic, stone, wood and graphite. Each material was prepared in 4 sizes of 3 mm and 2 mm and 1 mm and half-millimeter. Hounsfield unit HU of foreign bodies and their surrounding was measured in spiral CT images. (Table 1).

Sample size (sheep's head): The foreign bodies were visualized in an in vitro model. Sheep's head was used for this study, the obtained samples were used one day after the death and all pictures were taken in the same day. Sex heads was considered for evaluating the materials.

Table 1: Radio opacity of the investigated foreign bodies and their surroundings

	HU
Metal	4000
Glass	2407
Wood	60
Stone	1876
Plastic	193
Graphite	742
orbit	42

Foreign body in the orbit: the foreign body was placed in the sheep's orbit. Blade was used to cut the tissue around the eye and the body was pushed vertically into the hole

Imaging: The samples were scanned with a Somatom Spiral CT and Newtom VG Cone Beam CT. NewTom VG Cone Beam CT (Verona / Italy) with Cone X-Ray Beam and 1920x 1536 Pixels flat panel detector, 15 cm x15 cm detector size, 360 degree rotation, 18s scan time and 120 KVP.

Slices were prepared Kvp 110 at scan time of 18s and the minimum slice thickness of one millimeter. Initial and final reconstruction was produces using NNTViewer version 2.17 software.

Somatom Sensation 16 (Siemens /Forcheim Germany) with matrix size of 512*512 and 0.4 mm resolution and 140 KVP. Scan was done in the KVP110, MA 110 and minimum slice thickness of 0.6mm was used for this evaluation. The reconstruction was done using Synngo CT 2009E software and was assessed with Leonardo Work Station.

Analysis:

Obtained Images was observed by three general radiologists who were aware of the orbital foreign body. Observers expressed their opinion about the foreign bodies in images using the scale below (Table 2).

3. Results

Kappa coefficients of agreement between observers were 0.8. The agreement coefficient was above the 0.7 so the agreement was high between the observers. The metal and stone foreign bodies were clearly observed in two devices with all sizes. Wood was not found in any of the sizes.

Table 2-Basic criteria used for image interpretation

Grade	Assessment	Definition
++++	Excellent image	Excellent resolution of details and excellent visibility, good demarcation from surrounding
+++	Good image	Good resolution of details, demarcation from surrounding, clear visibility
++	Fair image	Insufficient resolution of details, insufficient visibility, insufficient demarcation
+	Bad image	Details not resolved, bad demarcation from surrounding, bad visibility
0	No image	Invisible

Plastic was not observed in half millimeter size in the CT and was hardly detected in CBCT .Plastic with sizes more than half millimeter was seen In CT scan with better quality. Glass was easily observed in both devices. Graphite was found with slightly better quality on CT in half millimeter and other sizes were similar in both sets of conditions (Figures1-6), (Table 3).

Table 3- Image quality of foreign bodies in orbit observed via computed tomography (CT) and cone beam computed tomography (CBCT)

	CT				CBCT			
Size	0.5 mm	1 mm	2mm	3mm	0.5 mm	1mm	2mm	3mm
Metal	++++	++++	++++	++++	++++	++++	++++	++++
Wood	0	0	0	0	0	0	0	0
Plastic	0	++	+++	+++	+	+	++	++
Stone	++++	++++	++++	++++	++++	++++	++++	++++
Glass	+++	+++	++++	++++	++++	++++	++++	++++
Graphite	++	+++	++++	++++	+++	+++	++++	++++

4. Discussions and conclusion

Computerized tomography is an imaging technique that produces cross-sectional images of the body in the axial plane. Because of high contrast CT images, this device is a standard method for the detection of foreign bodies (De Santana Santos, 2011; de Santana Santos, 2011; Holmes, 2005; Popescu, 2011).

Plain radiography due to its low cost and availability is usually the first additional examination that is required.

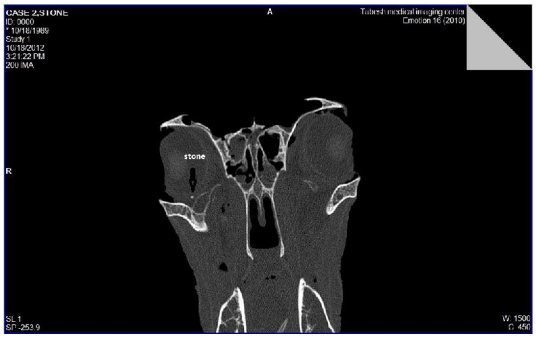

Figure 1. Spiral CT image of stone 0/5mm intraocular foreign body

It is a useful method for the detection and localization of foreign bodies in the eye(Stockmann, 2005; Martins, 2005; Dourado, 2008). Achievement to a detection rate of 69% to 90% for metallic foreign bodies and 71% to 77% of glass foreign bodies are a high achievement, but in organic foreign bodies such as wood (0-15%) is a low rate. (santanaA) CT scan is required in many complex cases, CT scan has many advantages comparing to the plain radiography film and tomography.

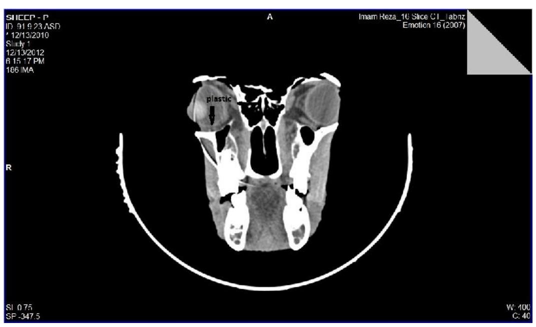

Figure 2. Spiral CT image of plastic 1mm intraocular foreign body

CT scan is reported to be the modality of choice in the detection of metallic foreign bodies; MRI should be avoided because there is a possibility of moving metal objects due to the magnetic field. Wood has a density similar to air in the CT scan which had made it difficult to diagnose, however, some authors suggest the use of MRI (Krimmel, 2001).

In this study we evaluated a novel imaging technique named CBCT (cone beam computerized tomography) to assess the ability of this system in detecting the foreign bodies of the orbit. The results of this study show that high density materials can easily be detected in both devices and materials with low density and smaller sizes were better seen with CT scan comparing to the CBCT. Woody materials with lowest density were seen hypodense in both devices.

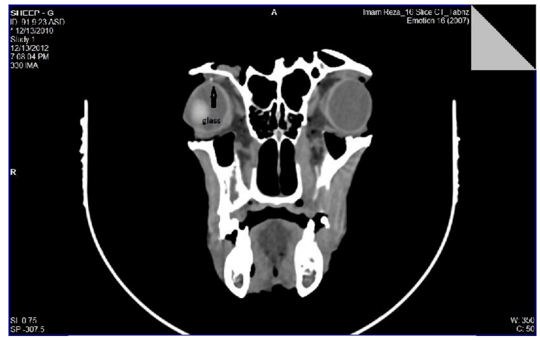

Figure 3. Spiral CT image of glass 0/5mm intraocular foreign body

Arrs and his colleague with placing foreign objects made of glass in three sizes of half a millimeter, one millimeter and a half millimeters in the eyes of pigs and scanning by CT, MRI and us came to the conclusion that CT delivers the most sensitive modality of imaging for the detection of glass in the orbit and sensitivity is influenced by the size and position of foreign bodies (Gor, 2001).

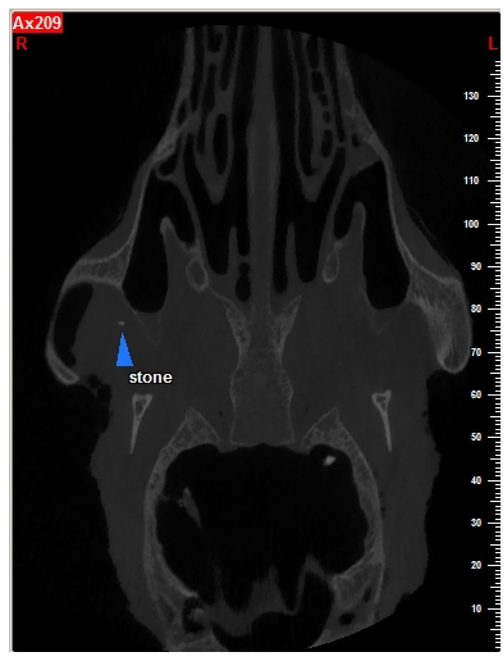

Figure- 4 Cone Beam CT image of stone 0/5mm intraocular foreign body

In our study with foreign bodies sized similar to the study above, CBCT was similar to Spiral CT scan and images showed the position of the foreign body very clearly.

Figure 5. Cone Beam CT image of plastic 1mm intraocular foreign body

In the studies of Stuehmer, shnider and dalili which CBCT and CT scan was used for the detection of metallic materials, they concluded that artifact can interfere in detecting the position of the metallic materials and CBCT with three dimensional images has less metallic artifacts comparing to the CT scan. In our study all sizes of metallic foreign bodies was seen clearly(Stuehmer, 2008; Schnider, 2012; Dalili, 2012; Eggers, 2007; Eggers, 2005).

Figure- 6 Cone Beam CT image of glass 0/5mm intraocular foreign body

Krimell has introduced the CT as the basic imaging modality and the MRI as the second modality of choice .Woody materials are seen as low signal with MRI and are described as air bubbles in CT images which is taken immediately after the insertion of foreign body and its attenuation increases with water absorption with delayed imaging. In our study the woody materials was scanned after insertion and was seen hypodens by both methods.

Conclusion

We can hereby express that CBCT devices with lower radiation doses and lower costs can be used for detecting the orbit foreign bodies and localizing its position in cases of limited access to CT scan. CT scan and CBCT are not suitable for low density foreign bodies, in these cases MRI or sonography can be recommended.

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