RADIOLOGIC EXAMINATION OF THE EYE AND ORBIT: A REVIEW

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Abstract

Background: The value of radiologic examination of the eye and orbit in evaluating ocular, orbital or peri-orbital trauma, foreign bodies and tumors cannot be over-emphasized. This review aims to analyze the different radiologic techniques available.

Methods: Information for this review article was sourced from journal articles, internet explorer, Google, Google Scholar, Yahoo, msn, Firefox, AJOL, Medline and Pubmed search engines. The search words include ocular injuries, foreign bodies, orbital fractures, trauma, radiologic modalities, and about 50 publications reviewed.

Results: Several techniques have been recognized as components of radiologic examination of the eye and orbit; these have been grouped into plain radiography, conventional tomography, ocular sonography, computerized axial tomography, magnetic resonance imaging.

Conclusion: Improvements and change in the management of ocular pathologies will depend on the availability of various imaging modalities which were discussed in the review.

Key words: Radiology, Eye, Orbit

INTRODUCTION

The initial and subsequent assessment of the eye and orbit can be done using various radiologic modalities, but the best imaging modality remains the indirect ophthalmoscopy. Thus, the ophthalmologists usually diagnose most ocular and orbital disorders without the aid of radiologic imaging.1,2,3 However, radiologic studies of the eye and orbit are invaluable in evaluating ocular, orbital or peri-orbital injuries, foreign bodies and tumors.4,5,6 The number of structures present in a relatively small orbital space makes the management of orbital trauma a difficult and exacting evaluation. This makes radiologic examination useful adjuncts in the management of ocular and orbital injuries. Ocular pathologies such as retinal detachment can also be evaluated by radiological techniques especially when there are opacities in the media such as hyphaema, cataract and vitreous opacities.5,6 Eye injuries in association with major trauma can pose diagnostic difficulties, as patients with reduced consciousness may not report visual symptoms, and assessment of the eye can be awkward in a supine patient.1 Orbital and ocular injuries may be associated with facial injuries and in patients with peri-orbital hematomas and swelling, it may not be possible to see the eye properly at the initial examination.7,8,9 Treating life threatening injuries will be the immediate priority in a patient with multiple injuries, but the potential for vision loss due to ocular trauma should not be forgotten.

Intraocular tumors may not be readily appreciated as a solid mass using standard examination techniques. Optic nerve and other orbital tumors may be masked by other opacities in the media and by hyphaema. Radiological examination may reveal such solid masses.1,5,6

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ANATOMY

Before beginning the review on the various radiologic modalities for ocular evaluation, a brief revision of orbital anatomy is given. The orbit is a conical or four-sided pyramidal cavity, with the apex aimed postero-medially and the base opening onto the face (Figure 1). It is made up of 7 bones and consists of a base, an apex and four walls divided into the roof, lateral wall, medial wall, and the floor. The bones are intended to protect the eye from mechanical injury.

The base opens into the face and has four borders, namely the superior margin made by the frontal bone, inferior margin by the maxilla and zygomatic bones, medial margin by the frontal, lacrimal and maxilla bones with the lateral margin by the zygomatic and frontal bones. The apex lies near the medial end of the superior orbital fissure and contains the optic canal which communicates with the middle cranial fossa. The roof or superior wall is formed by the orbital plate of the frontal bone and the lesser wing of sphenoid. The orbital surface presents medially by trochlear fovea and laterally by the lacrimal fossa. The floor or inferior wall is formed by the orbital surface of the maxilla, orbital surface of the zygomatic bone and the orbital process of the palatine bone. Medially near the orbital margin is located the groove for the naso-lacrimal duct. Near the middle of the floor, located in the infra-orbital groove is the infra-orbital foramen. The floor is separated from the lateral wall by the inferior orbital fissure, which connects the orbit to the pterygo-palatine and infra-temporal fossa.

The medial wall is formed by the frontal process of maxilla, lacrimal duct, orbital plate of ethmoid and a small part of the body of the sphenoid bones. The lateral wall is formed by the orbital process of the zygomatic bone and the orbital plate of the greater wing of the sphenoid. The bones meet at the zygomatico-sphenoid suture. The lateral wall is the thickest wall of the orbit. The optic foramen, which contains the optic nerve, and the large ophthalmic artery, is at the nasal side of the apex. A larger superior orbital fissure contains veins and twigs for non-visual sensations such as pain.

RADIOLOGICAL VIEWS AND PROJECTIONS

PLAIN ANTERIO-POSTERIOR VIEW

Plain radiographs are relatively inexpensive, universally available and can reveal a lot of information and are indispensable in cases in which a patient cannot co-operate for longer scanning procedures. However, there is poor soft tissue definition. They are particularly indicated in bony lesions. They are of little value in soft tissue injuries of the eye. X-ray studies of the orbits are more difficult than x-rays of other parts of the body because of super-imposition of other bones of the skull. Antero-posterior radiograph of the skull provides an overview of the size and shape of the orbit, the floor of the orbit, zygomatico-frontal suture and lamina papyracea. The patient is placed on the radiographic table, usually in the prone position. The head may be adequately adjusted and immobilized by a clamp devise, head-band, or sand bags. Several variations of the position as well as tomographic techniques may be used to localize a particular depth.
2. LATERAL VIEW

The lateral skull radiograph demonstrates the sella turcica, anterior and posterior clinoids, anterior and posterior wall of the frontal sinus, sphenoid sinus and naso-pharyngeal soft tissues. The lateral view is useful for the localization of foreign bodies. The patient lies on the side and the outer canthus of the orbit of interest is placed against the film. The x-rays are directed vertically through the canthus.\textsuperscript{13,14}

![Figure 2: Lateral skull radiograph](image)

3. CAUDWELL VIEW

This is a modified postero-anterior projection of the orbit, with a 15° caudal tilt. The patient is in prone position with the fore-head and nose resting on the table. This position the petrous ridges are projected downward and there is a clear visualization of the orbital rim and roof. The greater wing of the sphenoid is easily detected as it forms the larger part of the lateral wall. The orbital section of the lesser wing of the sphenoid is projected close to the medial wall. The superior orbital fissure is clearly seen between the greater and lesser wings of the sphenoid bone. The foramen rotundum is projected under the inferior rim of the orbit. It is however important to note that plain radiographs do not show any detail of intra-cranial injury.\textsuperscript{13,14}

![Figure 4: Caudwell’s view or modified postero-anterior projection of the orbit, with a 15° caudal tilt.](image)

4. WATER’S VIEW

The occipito-oral or Water’s view provides the best projection of the maxillary antra and inferior orbital rim. Basically, it is a postero-anterior radiograph which allows additional visualization of the orbital and peri-orbital structures. The patient is again prone with the head extended so that the chin lies on the table and the tip of the nose approximately 4cm from the table. The water’s view allows clear visualization of maxillary antrum separate from the super-imposed petrous bones. The petrous ridge is projected downwards. The antral contours are complete and not deformed. Visualization of the maxillary antrum is used in revealing orbital pathology. The inferior orbital rim, lateral wall, zygomatic arch and frontal with ethmoidal sinuses are all demonstrated in this view.\textsuperscript{13,14}
7. OBLIQUE VIEWS

The oblique views demonstrate the shape and diameter of the optic canal which has a normal range of 4.4-6.0mm in diameter. Oblique views are used for visualization of the outer wall of the orbit and should be taken from both sides. The patient rests with the cheek, nose and brow of the side of interest resting against the cassette. The x-rays are projected through the occiput and exit through the center of the orbit of interest. The technique obtains better visualization of the outer rim of the orbit and is of particular interest if an orbital rim fracture is suspected.13,14

8. RHEESE’S VIEW

This is a modified oblique view useful for demonstration of the optic canal. The patient is prone with head adjusted so that the zygoma, nose and chin rest on the cassette. In this radiographic view, the optic canal is demonstrated in the lateral quadrant of the orbit. The ethmoidal air cells, the lesser wing of the sphenoid and the superior orbital rim are demonstrated. If the patient is unable to lie prone, this film may be taken supine.13,14

9. SUBMENTOVERTICAL, BASAL, AXIAL OR HIRTZ’ PROJECTION

This plain radiographic view demonstrates the sphenoidal, ethmoidal sinuses, nasopharynx, nasal cavities, and the zygomatic arch. The vertex is placed against the table top, with the neck in extension; the Frankfort plane should be parallel to the film. The central ray is centered between the angles of the jaw. This projection gives a good view of the mandibular arch and condyles, the skull base, sphenoid sinus and the posterior ethmoid cells.13,14

10. COMBERG’S MODIFIED LATERAL METHOD

This is also known as the limbal-ring method. It is the most simple and commonest technique employed. A metallic ring of the corneal diameter is stitched at the limbus and x-rays are taken. One exposure is taken in the antero-posterior view and three exposures are taken in the lateral view while the patient is looking straight, upwards and downwards respectively. The position of the foreign body is estimated from its relationship with the metallic ring in different postions.13,14

11. POSSIBLE FINDINGS ON PLAIN RADIOGRAPHS

1. BLOW-OUT FRACTURES

The orbital bones are very delicate and the thickness in the orbital floor and medial wall comparable to that of an eggshell, these are the weakest regions of the bony orbit. Orbital wall fractures therefore, most often, occur in these areas. The proximity of the para-nasal sinuses, nerves, vessels, extra-ocular muscles, globe and other orbital structures predispose them to a wide variety of possible collateral damage from injury producing orbital fractures. Blow-out fractures occur when a non-penetrating force to the anterior peri-orbital region compresses the orbital contents and causes a sudden increase in intra-orbital pressure. This transmits the force outward to the weakest orbital segment along the vector of injury. An orbital blow out fracture is defined as a fracture of the orbital floor, usually without involvement of the orbital rim. With complex orbital fractures, the rim also can be fractured.14,15,16 The impacting object typically has a diameter that is larger than that of the orbital...
opening. Examples include a fist, tennis ball, baseball, snowball and door knob.\textsuperscript{15,16}

Research carried out in cadaver experiments that these fractures typically occur in the middle third of the orbital floor. The infra-orbital nerve normally traverses this region via the inferior orbital canal and thus is prone to injury there. With inferior displacement of the floor fracture fragment, intra-orbital soft-tissues, such as fat and even extra-ocular muscle, not infrequently herniate into the maxillary antrum. Entrapment of the inferior rectus muscle is a serious possible complication to be anticipated. Other authors have proposed that the soft-tissue glove of orbital fat, ligamentous and fascial tissue, and extra-ocular muscles protects the globe by absorbing considerable energy during impact.\textsuperscript{15,16} Fracture fragments are then displaced into the frontal sinus or even into the anterior cranial fossa. Orbital emphysema is most frequently seen with fractures of the medial wall. Orbital contents can, in rare instance, prolapse into the ethmoid sinus if the fracture is large enough. Also entrapment of the medial rectus muscle is uncommon. If the trochlea of the orbit is involved, the superior rectus muscle would be compromised.\textsuperscript{15,16}

2. BLOW-IN FRACTURES

Orbital blow-in fractures are produced by blunt trauma, usually against the frontal bone or the maxilla, with energy consequently transmitted toward the orbital roof or floor, respectively. The fracture fragments are characteristically displaced toward the orbital space. The posterior portion of the orbital roof near the optic canal and superior orbital fissure is especially weak, and the optic nerve is vulnerable at this fracture point. Inwardly displaced orbital roof fragments can impress into the superior rectus and levator palpebrae muscles. Of interest, 14-29\% of reported orbital roof blow-in fractures are associated with an intraocular (globe) injury. In the skull cavity, associated injuries include frontal lobe contusion, dural tear, and even formation of acquired encephalocele in the fracture defect.\textsuperscript{17,18}

Blunt trauma to the anterior maxilla is a typical cause of inferior blow-in fractures of the orbit. Upwardly displaced bone fragments may impinge on the inferior rectus and inferior oblique muscles. Medial blow-in fractures have been described, typically resulting from a direct blow and fragmenting the nasal bones and medial orbital wall.\textsuperscript{17,18}

3. Lé FORT FRACTURES

Post-acceleration or deceleration injury, motor vehicle collisions, and violent crimes result in a myriad of orbital and mid-facial fractures. Along the visual pathways, trauma is divided into 4 major locations: intra-orbital, intra-orbital, infra-canalicular, and infra-cranial. In 1901, Renée Lé Fort provided the earliest classification system of maxillary fractures. His model described “great lines of weakness in the face” caused by low-velocity impact forces directed against cadaver skulls.\textsuperscript{17,18}

The Lé Fort I, or transverse, fracture extends through the base of the maxillary sinuses above the teeth apices, essentially separating the alveolar processes, palate, and pterygoid processes from the facial structures above them. This transverse fracture across the entire lower maxilla separates the alveolus as a mobile unit from the rest of the mid-face. Segments of the alveolus may be dislocated as a result of this fracture. High-energy injuries may cause a Lé Fort I fracture and a split along the palate’s midline.

A Lé Fort II fracture, also termed a pyramidal fracture of the maxilla, begins laterally, similar to a Lé Fort I fracture, but medially diverges in a superior direction to include part of the medial orbit as well as the nose. The fracture across the nose may be variable; in some cases it involves only the nasal cartilage, and in other, more extensive cases, the naso-frontal suture. The fracture extends diagonally from the pterygoid plates through the maxilla to the inferior orbital rim and up the medial wall of the orbit to the nose. This fracture separates the maxillary
alveolus, medial wall of the orbit, and nose into separate pieces.

A Lé Fort III fracture, or cranio-facial disjunction, denotes a complete separation of the mid-face or facial bones from the cranium. This fracture transverses the zygomatico-frontal suture, continues through the floor of the orbit, and finally passes through the naso-frontal suture. The bones of the orbit are separated through the lateral wall, floor, and medial wall. This fracture rarely results in a single segment of bone; more commonly, the break is comminuted, making up any of a variety of combinations of zygomatic, naso-ethmoid, and orbital fractures. The fractures on the 2 sides may not be symmetrical, and minimal mobility may be present.17,18

4. FRACTURES OF THE ZYGOMATICOMAXILLARY COMPLEX (ZMC)

A pure tripod fracture entails separation of the zygoma from the face. The zygomatic arch is disrupted laterally, and there is simultaneous disruption at or near the sutures of the zygoma with the frontal and maxillary bones. Fractures involving the orbital apex are associated with anterior skull base fractures. The optic nerve is particularly prone to injury there.17,18

CONVENTIONAL ORBITAL TOMOGRAPHY

Body section radiography or conventional tomography is a method whereby the examiner may blur the super-imposed surrounding structures and clearly visualize a given area at a given depth. During exposure, the x-ray table is moved in one direction above the object and the film is moved in the opposite direction, the table adjusted so that the fulcrum point is at the level of anatomic interest. The plane will then be shot focused against the blurred anatomic structures around it. Tomography is of use particularly in localizing small fractures, as well as determining the extent of linear fractures and the presence of orbital tumors. In conjunction with specialized routine views, tomograms are believed by some radiologists as informative as computerized axial tomography scans. However, the speed and demonstration of detailed regional anatomy of computerized axial tomography scans makes them the procedure of choice at most institutions.17,19

OTHER RADIOGRAPHIC VIEWS

This includes the lateral skull radiographs. The foreign body is demonstrated when the patient looks upwards, the intra-ocular foreign body if anteriorly located, will appear to be located superiorly. When the patient looks downwards and the intra-ocular foreign body is posteriorly located, it will appear to be located superiorly and vice versa. Caldwell view demonstrates the superior/lateral orbital rims, medial wall, ethmoidal and frontal sinuses. Water’s view is used to demonstrate the orbital floor and diagnosis of roof (blow-out fractures).

COMPUTERIZED AXIAL TOMOGRAPHY (CT) SCANS

Computed tomography is a mathematical algorithm reconstruction of data obtained from multiple radiographic projections of an object. The physics of a CT scan involves an x-ray source and an array of x-ray detectors mounted in a CT gantry. The x-ray beam is projected through the object placed on the CT couch with the array of detectors measuring the attenuation of the x-ray beam. The process is repeated several times and the multiple projections are summed, using the computed mathematical algorithm, and converted to shades of gray densities recorded as the CT image.20,21 The relative attenuation of the x-ray beam is expressed as Hounsfield Units (HU), in honor of the inventor of the computed tomographic scanner. Modern CT scanners include the helical or spiral CT scanners depending on the arrangement of the array of detectors. The result is better spatial resolution per slice thickness and shortened scan time which reduces the patient motion artifact.22,23

Indications for computerized axial tomography of the orbits include, but are not limited to congenital anomalies, proptosis, fibro-osseous disease, orbital and ocular neoplasms and trauma. Others are infections and inflammation,
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thyroid orbitopathy, follow-up after surgery, chemotherapy, or radiation therapy and radiation therapy treatment planning. Foreign body, diplopia, loss of vision, and complications of sinusitis and sinus surgeries are also indications.\textsuperscript{23,24}

The standard examination should consist of image acquisition in the axial plane, and reconstructed coronal and sagittal planes, when utilizing a multi-detector scanner. Direct cranial coronal and axial images can be performed in the absence of this ability or for problem solving in the case of subtle fracture. In the absence of any contraindications, intravenous contrast should be administered when evaluating neoplasm, inflammatory disorders and vascular lesions. Pre-contrast imaging is necessary when attempting to identify calcium in entities such as retinoblastoma. Studies should be reconstructed in soft tissue and bone windows. Tilting the patient’s head backwards or coronal images with or without Valsalva maneuvers may elucidate some vascular lesions.\textsuperscript{24,25} The CT scan’s ability to delineate tissue of varying density makes it an invaluable diagnostic tool. Routine CT scans are usually multiple axial cuts of 10mm, 8mm, 5mm, 2mm and even 1mm apart depending on the lesions being evaluated and the type of multi-slice CT scan employed, starting at the skull base and going to the skull vertex.\textsuperscript{22,24,25}

A wide variety of ocular injuries resulting from concussive or blunt and penetrating trauma can be diagnosed by CT. Frequently, traumatic tissue damage or ocular media opacities such as traumatic cataracts or intraocular hemorrhage prevent adequate direct ophthalmologic evaluation. The ophthalmologic surgeon must then rely on available radiologic imaging techniques for the detection of intra-ocular foreign bodies.\textsuperscript{23,24} Helical CT scanning is considered the diagnostic method of choice for the detection of intraocular foreign bodies and is preferred over both MR imaging and sonography.\textsuperscript{23} CT scan can show intra-orbital and intra-ocular emphysema, hemorrhage, lens dislocation and subluxation, globe rupture associated with corneal and sclera lacerations, retinal and choroidal detachment, optic nerve injury and extra-ocular muscle injury. CT scan can also localize foreign bodies and identify injuries caused by them as well as determine their nature. Not only will CT provide useful information when clinical ocular trauma is suspected, it may identify unsuspected ocular injuries in patients with multiple trauma.\textsuperscript{22,23,24,25} It is imperative that orbital contents be scrutinized carefully on both soft tissue and bone windows of all head and face CT scans in order that clinically significant ocular injuries not be over-looked. Helical CT scan with multi-planar re-construction is accurate at detecting and localizing intra-ocular and orbital metallic, glass and stone foreign bodies. This imaging method aids the surgeon in choosing the surgical approach to retained intra-ocular or orbital foreign bodies.\textsuperscript{26,27}

Figure 3: Axial cranial computed tomography at the level of the orbits.

ULTRASONOGRAPHY (US)

Ultrasound is defined as high frequency sound waves greater than 20kHz and medical ultrasound frequencies range between 2MHz to 50MHz. The lower the frequency, the better the penetration
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The physics consists of application of an electrical potential to a transducer made from a piezo-electrical crystal or synthetic ceramic. The electrical potential resulting in mechanical contraction and relaxation of the crystal and an ultrasonic pulse wave is emitted. The pulse waves or echoes are received by the transducer and converted back into electrical impulses which are amplified and converted into a display on the ultrasound monitor or screen. The display is in two formats which are amplitude (A-mode) and brightness (B-mode) modulations.\textsuperscript{28,29,30}

B-scan ultrasonography is an important adjunct when after trauma, the presence of opaque media due to hemorrhage or cataract may make evaluation of the posterior segment difficult or impossible thus preventing visualization of the ocular fundus. Hyphema or vitreous hemorrhage obscures the fundal view.\textsuperscript{29-30} Traumatic cataract may develop within hours and this prevents visualization of the fundus of the eye. Although clinical findings may suggest a complication such as retinal detachment, the ophthalmologist may have to rely on ultrasound examination for a thorough evaluation of the posterior segment. The study is generally performed by a radiologist who is able to differentiate between hemorrhage, fibrin, membranes and a retinal detachment. Ultrasonography is operator-dependent and therefore requires significant experience with this imaging modality.\textsuperscript{29,30} Information gained from this technique can play important roles in surgical decision making. A-scan ultrasonography can be utilized to measure the axial length of an eye if penetrating injury involves the lens, and consideration is being given to primary intraocular lens placement at the time of urgent surgical intervention. Often in the setting of ocular trauma, measurements must be obtained from the contra-lateral eye to calculate intraocular lens power.\textsuperscript{31,32,33}

B-scan ocular ultrasonography is generally the imaging technique of choice while A-scan has a corroborative and correlative role. Ultrasonography is carried out as a sterile procedure if the eye is has a penetrating injury or a wound has been recently closed. Probes should be sterile or they may be placed in sterile rubber sleeves. In case of a ruptured globe, it is highly recommended that primary closure should be performed before ultrasonographic examination. If ultrasonography is performed prior to primary closure, it should be performed with the least possible trauma.\textsuperscript{32,33,34} The small A-scan probe may be gently placed on the conjunctiva in an area away from the wound, or the probe may be placed on closed lids with copious sterile methylcellulose applied for optimal sound penetration.\textsuperscript{31,33,34}

Ultrasound biomicroscopy (UBM) is an imaging technique that utilizes high-frequency (50-MHz) sound waves to produce high-resolution, 2-dimensional cross-sectional images of the anterior segment to a depth of approximately 5 mm. It has been used to study anterior segment structures and tumors, to determine anterior chamber angle depth, and to define the various mechanisms of glaucoma. Ultrasound biomicroscopy has also been used to evaluate peripheral posterior segment conditions, such as the anterior margin of peripheral choroidal tumors, cilio-choroidal detachment, and pars planitis.\textsuperscript{35,36,37,38}
Figure 3: Transverse image of a normal B-mode ocular scan

MAGNETIC RESONANCE IMAGING TECHNIQUE (MRI)

The general physics of the magnetic resonance imaging is nuclei of the hydrogen atoms become aligned when placed in a magnetic field. A pulse of radio-frequency (RF) energy is then applied to these nuclei which results in a shift of the net magnetic vector of 90 or 180 and results in absorption of RF energy. When the RF pulse is terminated, the nuclei of the hydrogen atoms in human tissue will relax or realign themselves with the magnetic field. However in the process, the relaxing nuclei emit RF energy which is measured by the MRI scanner receptors. Gadolinium which is a paramagnetic contrast agent may be given intravenously to enhance the vascular anatomy of the human tissue studied. MRI takes too much time to obtain images and interferes with monitoring of an unstable patient, especially if the monitoring equipment are made from ferro-magnetic materials. Nonmetallic objects that are difficult to visualize on CT are better visualized with MRI.

However, MRI is contraindicated when a ferromagnetic foreign body is present, because the strong magnetic field can move the foreign body, severely damaging the eye. An initial CT or plain film radiograph is needed to exclude the presence of a metallic foreign body. Additionally, MRI is expensive, not always readily available, and more sensitive to motion artifact than other forms of imaging. It has been suggested that MRI should be carried out if CT and conventional ultrasonography are negative, but suspicion of a retained foreign body in the patient’s eye remains high.

MRI is the imaging modality of choice for evaluation of ocular lesions, the optic nerve apparatus, cranial nerve palsies, and retro-bulbar disease with potential intracranial extension. Intraocular tumors such as uveal melanoma (because of superior delineation of the extent of the disease and unique paramagnetic signal characteristics of melanin) are easily detected. In comparison with computed tomography, MRI allows more accurate depiction of extension of optic nerve or sheath tumors into the optic chiasm, optic tracts and lateral geniculate bodies of thalami. As a predictor of multiple sclerosis, MRI can help to prognosticate the development of multiple sclerosis after optic neuritis. It should be noted that once plain radiographs or CT scan of the orbit has screened metallic fragments, MRI is valuable in the examination of the optic nerve and globe for injury and hence useful adjunct in the assessment of orbital injury.

The advantages MRI are provision of superior soft tissue resolution in comparison with other radiologic imaging modalities and ability to distinguish the layers of the globe partially (sclera is separated from the uvea and retina), MRI allows for the visualization of anterior chamber structures which is not seen on CT. However, the limitations include the possibility of a ferro-magnetic foreign body within the orbit, which is an absolute contraindication because of potential for movement of a ferromagnetic foreign body within the fluctuating magnetic fields of a MR machine. This could result in blindness. Again, with MRI, there is poor visualization of the cortical bone.

LOCALIZATION OF INTRAOCULAR FOREIGN BODIES USING PLAIN X-RAYS

Plan X ray are easily available and cheap and is able to detect shape and number of radio-opaque intra-ocular foreign body. It localizes orbital wall fracture and or sinus disease. The various radiographic views for localization include the posterior-anterior and lateral views, Water’s view or Bellows’ modified lateral view and bone free dental x-rays of anterior segment. Others include placing a radio-opaque marker using limbal ring/contact lens called the Comberg’s technique. The radio opaque ring is sutured to the limbus and plain radiographs are acquired, the distance of the intra-ocular foreign body is then measured from that point noting that the axial length of an emmetropic eye is about 24mm.
SWEET’S LOCALIZATION METHOD

This is a radiographic technique for locating a foreign body in the eye based on mathematical calculations from radiographs of the different positions of the eye taken at different angles which is done by taking two radiographic films of the eye while the patient’s head is immobilized. A small metal ball and a cone are placed at precise distances from the center of the cornea as register marks while lateral and perpendicular radiographic views of the eye are made. A three-dimensional view of the eye is constructed from the two films, and, guided by the positions of the ball and cone, the location of the foreign body in the eye is plotted from the intersection of lines through the ball and cone.16,43

LOCALIZATION OF INTRAOCULAR FOREIGN BODIES USING COMPUTERIZED AXIAL TOMOGRAPHY SCAN

CT scan provides axial images as well as reconstructed coronal and sagittal sections of traumatized globe and therefore retained intraocular foreign body of sufficient size and radio sensitivity can easily be localized. Other advantages include the ability to distinguish soft tissue and bony changes from trauma using the Hounsfield’s Unit or HU. CT scan examination can be performed in a known or presumed ferro-magnetic intra-ocular foreign body and in patients with pacemakers or external life support, unlike magnetic resonance imaging. It is also quicker, less expensive than MRI and requires no contact with the eye.25,26,27

LOCALISATION OF INTRAOCULAR FOREIGN BODIES USING MAGNETIC RESONANCE IMAGING

Magnetic resonance imaging provide better image quality of most soft tissues lesions such as vascular and intracranial lesions, intraocular tumors, cavernous sinus thrombosis and lesions of optic nerve. MRI does not asses bone, bony lesions and fracture very well. However, it provides coronal, axial and oblique sections without repositioning the patient, post-image acquisition processing or image reconstruction. MRI is however contraindicated in eyes with ferro-magnetic intra-ocular foreign body, cochlear implants, intraocular magnetic vascular clips and cardiac pacemakers.44,45,46

LOCALIZATION OF INTRAOCULAR FOREIGN BODIES USING OCULAR ULTRASOUND

As stated earlier, ultrasonographic examination of the eye is useful where there is presence of a cloudy media. It localizes intra-ocular foreign body relative to the ocular coat and can be used to determine magnetic intra-ocular foreign body. Ultrasonography can detect globe rupture, vitreal or retinal hemorrhages and is very helpful in planning surgical repair. Ultrasonography is cost effective, movable and available but operator dependent.47,48,49,50

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