Imaging of Orbital Trauma and Emergent Non-traumatic Conditions

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KEYWORDS

- Orbital emergencies • Orbital trauma • Facial fractures • Open globe injury
- Intraocular foreign body • Orbital infection • Orbital inflammation • Carotid–cavernous fistula

KEY POINTS

- Multidetector computed tomography (MDCT) has become a crucial component in the assessment of orbital trauma.
- MDCT allows for accurate characterization of the orbital fractures, orbital soft tissue injuries, and assessment of orbital foreign bodies.
- Nontraumatic orbital emergencies often present a challenge to clinical diagnosis due to overlapping symptomatology necessitating radiological evaluation.
- Contrast-enhanced MR imaging allows for detailed evaluation of the orbital soft tissues and differentiation of the multiple causes of nontraumatic orbital emergencies.
- Conventional angiography is useful for the diagnosis and treatment of vascular orbital emergencies, such as carotid–cavernous fistulae.

INTRODUCTION

Radiological imaging evaluation is crucial in the aid of clinical assessment in patients with orbital trauma or nontraumatic orbital emergencies. In the setting of orbital trauma, clinical assessment of the orbits may be hindered by extensive facial soft tissue injury, decreased level of consciousness, or life-threatening injuries to the remainder of the body. Multidetector computed tomography (MDCT) is the modality of choice in the assessment of orbital trauma[1] because of its many advantages over other imaging modalities. MDCT is superior to conventional radiography due to its faster acquisition; it may be performed concomitantly with CT imaging of additional body parts frequently obtained in the setting of multi organ injuries. Additionally, it only requires 1 head position, and it allows for the assessment of the orbital soft tissues, is more sensitive for detection of fractures, and may be reformatted in multiple projections and in 3 dimensions. Ultrasound is user dependent and contraindicated in the setting of suspected open globe injury. MR imaging cannot be performed in the setting of potential intraorbital metallic foreign body.

Patients also seek emergency care for many nontraumatic orbital conditions causing a multitude of presenting symptoms to include: vision loss, scotoma, eye pain, ophthalmoplegia, diplopia, orbital bruit, proptosis, or enophthalmos. Cross-sectional imaging with either contrast-enhanced MR imaging or MDCT is helpful in differentiating the numerous etiologies of disease states that present with these symptoms. MR imaging is particularly useful in the setting of nontraumatic emergencies due to its superior evaluation of the orbital soft tissues with respect to MDCT. In addition, conventional

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angiography may be indicated in select cases in which a vascular abnormality affecting the orbit is suspected, such as carotid–cavernous fistulae. Although invasive, conventional angiography has advantages over CT angiography (CTA) and magnetic resonance angiography (MRA), as it consists of real-time imaging and allows for endovascular treatment when appropriate.

ORBITAL SKELETAL TRAUMA

Orbital Blowout Fracture

Orbital blowout fracture is a displaced fracture of an orbital wall directed away from the orbit, which may be characterized as pure, if the orbital rim is spared, or impure, if the orbital rim is involved in the fracture (**Fig. 1**). The 2 mechanisms of the orbital blowout fracture are termed the hydraulic and the bone conduction mechanisms, which both have shown to result in orbital blowout fractures in experimental models with key differences (**Box 1**).[2] The inferior orbital wall is most frequently affected by the blowout fracture, followed by the medial orbital wall. Although the medial orbital wall (lamina papyracea) is thinner than the inferior orbital wall, it is supported by osseous struts of the ethmoid sinuses, likely increasing its durability against fracture. Complications that advocate for early surgical repair include extraocular muscle entrapment and enophthalmos, which are typically seen in fracture fragments of greater than 1 cm in size.[3–5] Internal fixation of orbital blowout fracture typically results in the placement of mesh material to restore orbital volume and provide a barrier against the herniation of intraorbital contents.

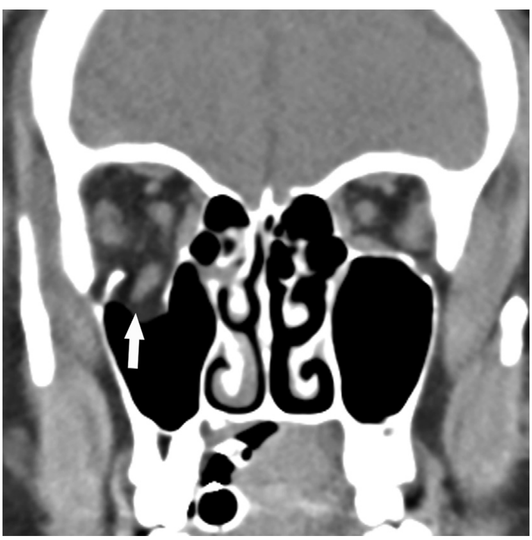

Fig. 1. Orbital blowout fracture. Coronal CT image demonstrates the inferiorly displaced fracture of the right orbital floor with herniation of intraorbital fat and inferior rectus muscle into the defect (*arrow*). Clinical correlation for entrapment should be performed.

Box 1
Mechanisms of orbital blowout fractures

- Hydraulic mechanism—posteriorly oriented force to the orbit causes an acute increase in intraorbital pressure with subsequent fracture of the weakest orbital wall to relieve this pressure.
  - Larger fracture defect
  - May affect the medial orbital wall
  - Commonly results in herniation of orbital contents
- Bone conduction mechanism—a force applied to the orbital rim is transmitted posteriorly until eventual buckling of the affected wall occurs.
  - Smaller, anterior fracture defect
  - Never involves medial wall
  - Rarely results in herniation

A special type of the orbital blowout fracture is the trapdoor fracture. The trapdoor fracture is an inferior orbital blowout fracture in which the inferior rectus muscle or infraorbital fat herniates through the fracture defect into the underlying maxillary sinus with return of the fracture fragment back to its original position; thus, the fracture fragment acts like a trapdoor. These patients will present with signs of entrapment caused by extraocular muscle restriction, resulting in diplopia. On coronal CT imaging, the inferior rectus muscle or extraconal fat herniates inferior to the orbital floor through a nondisplaced inferior orbital wall fracture.

Superior Orbital Wall Fracture

The superior orbital wall or orbital roof is the only wall that forms a partition between the anterior cranial fossa and intraorbital contents. Fractures through the orbital roof are typically a result of a direct blow to the forehead and usually displace into the orbit, termed orbital blow-in fracture (**Fig. 2**). Associated frontal sinus fracture is a common finding. Potential complications include proptosis, diplopia, orbital emphysema, dural tear with resultant cerebrospinal fluid (CSF) leak or brain herniation, cerebral contusion, and extension of fracture to the orbital apex. Repair of these potential complications may require both intracranial and extracranial approaches.[6] The fractures are best visualized on coronal reformatted CT images.