Blunt and penetrating facial injury and its associated injuries

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Learning objectives

• To examine basic approach to the facial injuries along with common mechanisms of injury.
• To illustrate assorted cases of blunt and penetrating facial trauma.
Facial trauma presenting to emergency departments require urgent assessment leading to accurate diagnosis, as various fractures leading to injuries to the head and neck region may lead to life-threatening situations. Facial fractures commonly present alone or in combination with other serious injuries[1], leading to a significant portion of emergent admission to plastic surgery[2] and about 2% of all hospital admissions in the United States[3]. Mandibular fractures occur most frequently, followed by zygomaticomaxillary, orbital floor, and nasal fractures. As much as one third of the patients presenting with facial injury have multiple facial fractures. Intracranial injuries are seen more often than cervical spine injuries, which accompany facial fractures in about 1.3% of all facial fractures and 5.3% of those resulting from motor vehicle accidents[1]. Incidence of severe and panfacial fractures has decreased with combined use of airbags and seatbelts, while incidence due to interpersonal violence has been increasing[2]. Often complex in nature, facial injuries may lead to serious cosmetic and functional sequelae, including death in rare instances[4]. Patients with facial fractures need to be carefully evaluated for brain injury, as facial fractures serve as a marker for an increased risk of injury to the brain. A ten-fold increased risk of intracranial hemorrhage and doubled risk of any traumatic brain injury including a concussion in bicyclists when combined with a facial injury suggest that the presence of enough force leading to facial fractures is likely to lead to brain damage as well [5]. Therefore, one must distinguish the signs and symptoms of facial fractures from those of soft tissue injury.

In spite of their clinical significance, facial fractures are often poorly diagnosed due to the complexity of cranial anatomy and the relatively little emphasis made on facial fractures during medical school training[1], resulting in inaccurate or delayed initial diagnosis and management, and consequent morbidity[3]. Assessment of facial trauma comprises of taking history to discover the mechanism of the injury and the specific symptoms, performing a physical examination, and imaging[1]. As the capacity to do a proper physical exam becomes limited with the overlying edema, hemorrhage, and soft-tissue injury in patients with trauma to the head and neck region[3] as well as with decreased compliance due to frequent incidence of intoxication[6], the role of imaging in making an accurate and timely diagnosis becomes pivotal.

Presently, the widespread availability, and the rapid and accurate imaging capability of CT leave less and less room for conventional films in assessment [3, 6]. CT is valuable in the assessment and management of acute facial trauma, offering the greatest benefit for assessing mid-face injuries [4, 8]. In many cases, interpreting conventional radiographs may be difficult due to the superimposition of complex bony landmarks in the head and neck region, especially in demonstrating complex structures associated with massive comminution, displaced fragments, and soft tissue lesions. As such, multiple studies have emphasized the advantage of CT over conventional radiographs with respect to
diagnostic accuracy and preoperative planning[10]. When the CT scans the brain of the patients with any suggestion of facial trauma to rule out intracranial injury, the scan should continue down to the inferior border of the mandible for optimal efficiency [6]. Another benefit that CT offers is that it may allow the injured patients to be positioned in a less potentially hazardous way than required by conventional radiography[3]. While CT scan is more sensitive than a panorex in picking up mandibular fractures, it is limited in evaluating dental anatomy[6]. Due to the insensitivity to fractures, MRI plays a limited role in the evaluation of facial trauma. However under specific circumstances such as associated traumatic aneurysms and carotid cavernous sinus fistula, MRI may provide complementary information[3].
At our centre, protocol for facial bones is the following.

<table>
<thead>
<tr>
<th>Scan Type</th>
<th>Spiral</th>
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<tbody>
<tr>
<td>Scan Direction</td>
<td>Head</td>
</tr>
<tr>
<td>KV/mAs/Rotation Time</td>
<td>129Kv/120mAs/1sec</td>
</tr>
<tr>
<td>CARE Dose</td>
<td>off</td>
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<tr>
<td>Detector Collimation</td>
<td>64x0.6</td>
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<tr>
<td>Slice Thickness</td>
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</tr>
<tr>
<td>Pitch</td>
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Coronal and sagittal reformats reconstructed at 2mm/2mm increments/spacing on B70 temporal bone kernel. Axial and coronal mediastinal kernel at 2mm/2mm increments/spacing.

Through retrospective review of our PACS database, assorted cases of blunt trauma and penetrating trauma were selected for discussion.

**Case 1**

53-year-old male involved in MVA with a blunt trauma to the face.

**Figure 1 - 3:** Axial, coronal and sagittal CT facial bones with right mandibular fracture through base of coronoid process. Mandibular condyles are enlocated.

**Figure 4 - 8:** Axial CT through orbits on bone windows and soft tissue demonstrate a comminuted, mildly depressed right zygomaticomaxillary complex fracture is with extension up to involve the orbital roof. A small bony fragment (arrow) is displaced into the anterior cranial fossa above the orbital roof.

**Figure 9 - 12:** Coronal reformats: The orbital floor is depressed, without evidence of entrapment or distortion of the infrarectus muscle. A small subperiosteal hematoma is suspected along the lateral wall of the orbit adjacent to the lateral rectus. The fracture extends superiorly into the temporal squamosa and frontal bone with minimal depression.
Figure 13: Sagittal reformat image demonstrates intracranial extension of the orbital fracture.

Figure 14 - 16: There is a small amount of hemorrhagic and nonhemorrhagic contusion surrounding the bony fragments superior to the right orbital roof and a small extra-axial hematoma in the right middle cranial fossa.

Case 2

70-year-old male patient presents with self-inflicted nail gun injury.

Figure 17 - 18: AP and lateral view of the skull demonstrating two nails in the right temporo-frontal region, and one nail in the left temporo-frontal region.

Figure 19 - 24: Axial and coronal CT through the middle cranial fossa on bone window (Fig 19) and axial and sagittal brain windows(Fig 20, 21) demonstrate the three nails penetrating temporal squama and traversing the inferior frontal lobes bilaterally. No large intra or extraaxial collection noted. Subsequent CT angiogram in coronal MIP and VRT reformats do not demonstrate any injury to intracranial vasculature.

Case 3

30-year-old patient with the blow to the face.

Figure 25: Coronal, sagittal and coronal soft tissue reformats demonstrate right orbital floor blow-out fracture with herniation of the right inferior rectus muscle through the fracture defect and presumed entrapment.

Case 4

25-year-old male fell and hit his head on a metal pole

Figure 26: A nondisplaced fracture of the right orbital floor is shown with involvement to the infra orbital foramen. No herniation of orbital content noted. Also fracture to the lateral wall of the maxillary sinus on the right side is noted.

Case 5

70-year-old male with a nail in the left orbit
**Figure 27 - 30:** Long linear metallic foreign body is demonstrated extending through the left globe just lateral to the superior ophthalmic vein, through the orbital roof and into the left frontal lobe. The tip lies directly adjacent to the anterior horn of the left lateral ventricle. Moderate surrounding metallic artifact is demonstrated, which degrades the images slightly, however no large associated intraparenchymal hemorrhage is demonstrated.

**Figure 31:** On the CT angiogram, the tip and trajectory of the nail do not appear to impact any major arteries.

**Case 6**

Left temporal squama fracture and dural sinus disruption.

**Figure 32 - 34:** Axial noncontrast facial bones CT demonstrate left temporal squamosa fracture which is seen to extend into the left sphenoid triangle. It remains non-displaced.

**Figure 35:** Non-contrast axial CT head shows extensive subarachnoid hemorrhage with a predominance for the left sylvian fissure and right middle cranial fossa. Subdural hematoma is also seen in the lateral aspect of the left middle cranial fossa.

**Figure 36:** Coronal MIP reformats from CTA showing irregularity in the posterior portion of the left sphenoparietal dural venous sinus with a hypo-attenuation particularly reflecting sinus disruption and a source of hemorrhage.

**Case 7**

60-year-old female with fall with raccoon eyes.

**Figure 37 - 42:** Fractures are seen extending through both the medial and lateral pterygoid plates on the left and the right. There is a transverse-oriented fracture involving the base of the frontal sinus extending to involve the anterior wall of the frontal sinus and roofs of both orbits. The inner table of the frontal sinus is intact. The nasal septum is fractured and slightly deviated to the left. Fractures are seen involving the medial walls of the maxillary sinuses bilaterally. Compatible with a Le Fort II fracture on the right and a Le Fort I fracture on the left. A mildly comminuted fracture is seen involving the hard palate to the right of midline.
Fig. 1: Axial cut showing fracture through right mandible.

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Fig. 2: Sagittal view of the mandible showing previously demonstrated mandible fracture.

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Fig. 3: Coronal section of the same patient.

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**Fig. 4:** Axial cut through the orbit demonstrating right zygomaticomaxillary fracture.

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**Fig. 5:** Axial cut through the orbit demonstrating right zygomaticomaxillary fracture

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Fig. 6: Axial cut through the orbit demonstrating right zygomaticomaxillary fracture

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Fig. 7: Axial cut through the orbit demonstrating right zygomaticomaxillary fracture

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Fig. 8: Axial cut, soft tissue window revealing a small bony fragment (arrow) is displaced into the anterior cranial fossa above the orbital roof.

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**Fig. 9:** Coronal reformats showing the depressed orbital floor without evidence of entrapment or distortion of the infrarectus muscle.

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Fig. 10: Coronal reformats showing the depressed orbital floor without evidence of entrapment or distortion of the infrapectus muscle.

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**Fig. 11:** Coronal reformats showing the depressed orbital floor without evidence of entrapment or distortion of the infrarectus muscle.

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Fig. 12: Coronal reformats showing the depressed orbital floor without evidence of entrapment or distortion of the infrarectus muscle.

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Fig. 13: Sagittal reformat image demonstrates intracranial extension of the orbital fracture

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Fig. 14: CT of the brain demonstrating a small hemorrhagic contusion posterior to the intracranial extension of the fracture.

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Fig. 15: Head CT showing a small extra-axial hematoma in the right middle cranial fossa.

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Fig. 16: Sagittal reformat showing the intracranial extension of the fracture, and its associated extra axial hemorrhage.

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**Fig. 17:** AP View of the skull showing two nails in the right temporo-frontal region and one in left temporo-frontal region.

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**Fig. 18:** Lateral view of the same patient.

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Fig. 19: Axial CT through the middle cranial fossa on bone window showing previously seen nails.

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Fig. 20: Coronal reformat in bone window showing previously seen nails.

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Fig. 21: Sagittal view in brain window showing two nails penetrating frontal lobe.

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**Fig. 22:** Axial cut in brain window showing two nails on both side of the frontal lobe.

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Fig. 23: Subsequent CT angiogram in coronal Maximal Intensity Projection reformat does not demonstrate any injury to intracranial vasculature.

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Fig. 24: CT angiogram in coronal Volume-Rendering Technique reformat confirming intact intracranial vasculature.

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Fig. 25: Coronal, sagittal and coronal soft tissue reformats demonstrate right orbital floor blow-out fracture with herniation of the right inferior rectus muscle through the fracture defect and presumed entrapment.

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Fig. 26: A nondisplaced fracture of the right orbital floor is shown with involvement to the infra orbital foramen. No herniation of orbital content noted. Also fracture to the lateral wall of the maxillary sinus on the right side is noted.

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**Fig. 27:** Lateral scout view demonstrating a metallic rod penetrating through the orbit into anterior fossa.

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**Fig. 28:** Coronal reformat showing the nail in the orbit lateral to the superior ophthalmic vein (blue arrow).

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**Fig. 29:** CT of the brain demonstrating the nail penetrating into the left frontal lobe.

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Fig. 30: Sagittal reformat showing the nail penetrating into left frontal lobe.

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**Fig. 31:** CTA showing that the nail is not compromising any major intracerebral arteries.

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Fig. 32: Axial image showing fracture in the left temporal squama.

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Fig. 33: Axial image showing the fracture in the left temporal squama.

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**Fig. 34:** Axial image showing the fracture in the left temporal squama extending into sphenoidal triangle.

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**Fig. 35:** Non-contrast axial CT scan showing extensive subarachnoid hemorrhage, and subdural hematoma in the lateral aspect of the middle cranial fossa.

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Fig. 36: Coronal MIP reformat showing irregularities in the posterior portion of left sphenoparietal sinus.

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**Fig. 37:** Axial CT scan showing maxillary fracture involving bilateral maxillary sinuses and nasal septal fracture with leftward deviation.

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**Fig. 38:** Axial CT image showing a mildly comminuted fracture is seen involving the hard palate to the right of midline.

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**Fig. 39:** Again shown is the nasal septum fracture and fractures of the lateral pterygoid plate bilaterally.

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Fig. 40: Coronal reformat showing a transverse-oriented fracture involving the base of the frontal sinus extending to involve the anterior wall of the frontal sinus and roofs of both orbits.

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**Fig. 41:** Coronal reformat showing fracture of medial and lateral pterygoid plate bilaterally.

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**Fig. 42:** Coronal reformat showing fractures of lateral pterygoid plates bilaterally.

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Conclusion

Blunt and penetrating injury to the face can present with complex radiological picture. There can be multiple fractures as shown by the cases, and intracranial injury and other life-threatening injuries must be ruled out with each case. Also, knowledge of the anatomy and of the implication of different injuries is crucial for patient management and disposition in the setting of facial trauma.
References


