Types of Bone Fractures — Imaging and Management

See online here

Bones constitute the supportive skeleton of the body. They are composed of an organic component of type-1 collagen with calcium, phosphate and hydroxyl ions deposited in hydroxyapatite. Bones are covered with a thin layer of periosteum which provides blood supply to help the healing of bone fractures. Bone fractures are the result of damage to the integrity of normal bones due to direct force or pathological processes.

Definition of Bone Fractures

A fracture refers to a break in a bone that results from accidents, falls or sports injuries.

Note: Fractures are a disruption in the cortex of a bone.
Sometimes fractures may arise spontaneously in:

- Weakened bones such as bones of low bone density and osteoporotic bones.
- Overuse and stress fractures.

Other important terms include:

- Dislocation which represents a complete or persistent displacement of a joint.
- Subluxation which is the partial displacement of a joint.

Epidemiology of Fractures

Trauma is the 4th leading cause of death in the world. It is the leading cause of death in people aged 1—44 years. The injuries may be fatal injuries such as those high-speed road traffic accidents or non-fatal injuries such as those sustained during contact sports. The

male to female ratio for fatal injuries is 2:1 while that of non-fatal injuries in 1.3:1. These ratio changes to 1:1.3 with advanced age beyond 65 years.

Classification and Types of Bone Fractures

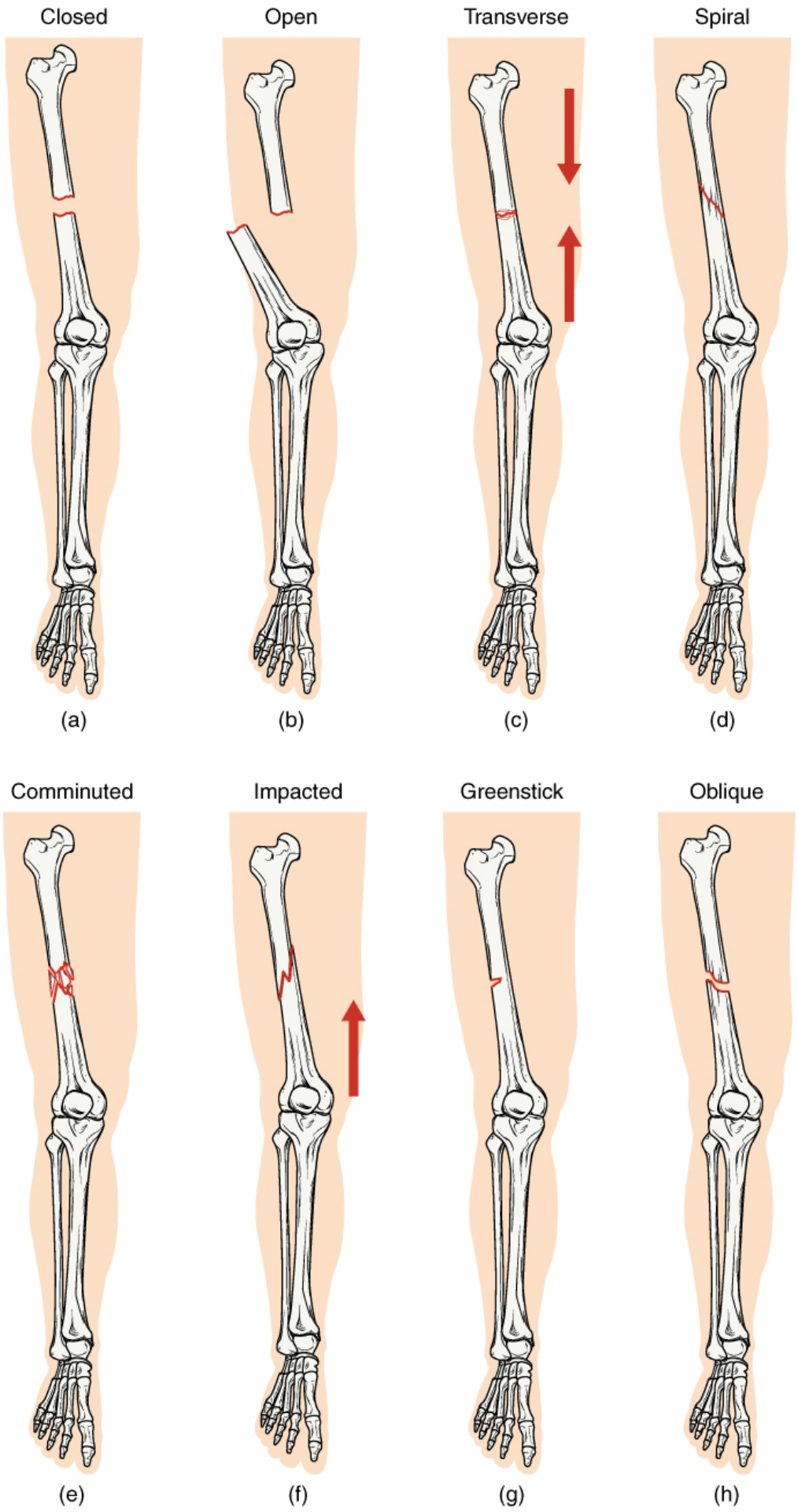

Image: “Bone with different types of fractures: (a) closed fracture, (b) open fracture, (c) transverse fracture, (d) spiral

fracture, (e) comminuted fracture, (f) impacted fracture, (g) greenstick fracture and (h) oblique fracture," by OpenStax College. License: CC BY 4.0

Various methods have been used to classify fractures to allow for communication between the team managing patients and accordance of universal care.

Based on integrity of the skin

Fractures can be classified based on the integrity of the skin above the fracture as:

Closed fracture

These are fractures with intact skin over the broken bone. If the patient does not have any life-threatening emergencies, then it is never an emergency, but fixation is needed to allow for easier and more accurate healing.

They are further classified as per the AO classification depending on the specific bone involved.

Open fracture

These are fractures with disrupted overlying skin. They are more susceptible to infection from the external environment and need special management and prolonged recovery. This is an orthopedic emergency requiring debridement, irrigation in the OR and broad-spectrum antibiotic prophylaxis.

They are further classified by the Gustillo & Anderson classification into:

- Gustillo I
- Gustillo II
- Gustillo III

Based on the extent of the fracture line

Fractures are also classified based on the extent of the fracture line into:

Complete	Incomplete
Fracture extends through the entire cortex.	Fracture extends through part of the cortex.
• **Transverse:** Fracture line is perpendicular to the long axis of the bone. • **Oblique:** Fracture line diagonal with respect to the long axis of the bone. • **Spiral:** Fracture is caused by a twisting force. • **Comminuted:** Fracture that produces more than two fragments.	• Buckle • Greenstick • Occur in soft bones • Most commonly seen in the pediatric population

Based on the orientation

Transverse

Oblique

Spiral fractures

Spiral fractures present as two long fracture lines at two different directions caused by a severe rotatory force.

Comminuted fractures

Comminuted fracture occurs when there are multiple fracture segments that separate into small bone fragments which might pierce the skin.

Segmental fractures

Segmental fractures occur with two fracture lines and three or more large bone segments that separate from the original bone.

The Healing Process

The healing of bones is similar to the healing process in other injured tissues but without scar formation. New bone is formed to preserve the function of skeleton support. The healing process depends on the patient's age, peripheral circulation, comorbidities, medications, e.g., steroids, alcohol, smoking, and associated infection or complications. **Healing starts with the inflammatory phase then moves into the reparative phase and finishes with remodeling.**

It is crucial to stabilize the fractured bone segment in the first two phases to allow for the formation of new blood vessels.

The inflammatory phase lasts for a few weeks and is **characterized by a hematoma collection at the fracture line** with resorption of the bone edges that lost their blood supply. It is similar to classic inflammation with swelling, tenderness and redness, all powered by cytokine release. Multipotent mesenchymal cells undergo transformation into osteoprogenitor cells which start bone formation.

The next phase is **characterized by callus formation which is invaded by newly formed blood vessels**. This phase continues for months with cartilage and bone formation. The callus is formed by cartilage, which ossifies and hardens later on, and the endochondral bone at the fracture site covers the callus. The clinical union is achieved in this phase as the pain with movement of the affected limb disappears and the stabilization of the bone segment with movement occurs.

With the achievement of a clinical union, remodeling starts. It lasts for years while the bone is brought back to its original size and shape. The remodeling phase is **characterized by ossification of the cartilaginous callus**.

Clinical Picture of Bone Fractures

Careful history-taking and assessment of the mechanism of injury is extremely important to help with fracture evaluation and exclude other injuries.

Examination of Bone Fractures

Gentle palpation of the injured area is necessary to determine if there is displacement and to exclude other injuries. The examination should **involve the fracture site, the distal and proximal joint and any possible other injuries**. Sensory and motor examination of the injured limb is performed to evaluate the neurovascular supply after the fracture and following reduction.

Imaging of Bone Fractures

Plain X-ray

It is considered the primary imaging modality of choice for fracture diagnostics.

Note: Most fractures can be diagnosed using two orthogonal views of a plain radiograph.

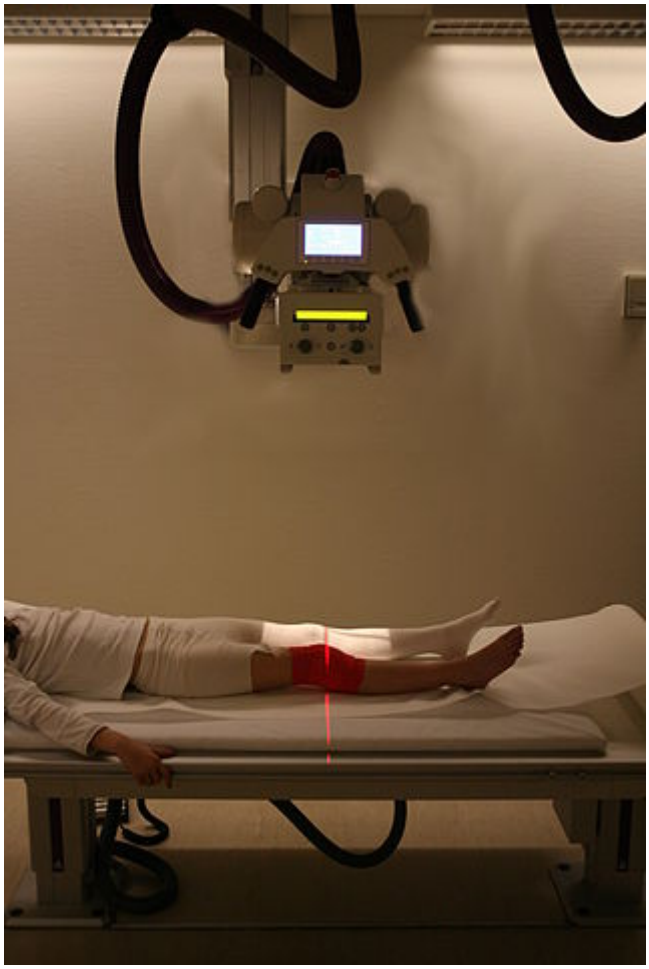

Image: “Radiography of knee in modern x-ray-machine at Sandnessjøen Hospital, Norway. The patient’s knee is examined to check for possible bone fractures after an injury.” by Thomas Bjørkan.

Some other fractures may need another view, e.g., scaphoid view for scaphoid fractures. X-ray radiographs **may fail to reveal fracture lines in some specific fractures,** e.g., stress fractures, scaphoid fractures, and hip fractures.

In this case, CT or MRI is better able to reveal the fracture line. Otherwise, the case should be managed with fixation and follow-up radiographs must be performed after one or two weeks to evaluate for a fracture line.

Other important rules of 2s to consider during the X-ray include:

- The X-ray should visualize at least two joints i.e. one above and one below.
- The X-rays could be done at two occasions if no changes noted in the first.
- In pediatric populations, two sides of the same part of the body are needed for comparison as they are anatomically different from adults.

Ultrasound

Ultrasound has high sensitivity and specificity and can be safely **used in the emergency department or sports facilities** without ionizing radiation.

CT and MRI are more beneficial, especially in stress fractures or spinal fractures, as they provide good visualization of the fracture site and reveal possible displacement.

Management of Bone Fractures

A thorough evaluation for associated injuries using advanced trauma life support is the first step in trauma patients. Evaluation starts with **airway maintenance, breathing support and circulation support**. Adequate pain management is also necessary for all patients. Pain management can be achieved by the application of ice, immobilization of the injured limb, analgesic medications and regional nerve block.

For fracture immobilization, splinting is the initial step, unless the neurovascular supply distal to the fracture is interrupted. Immobilization is performed on the scene, before the patient is transported, to reduce the pain and prevent complications of displacement and soft tissue injury. Reduction of the fractured bone should be attempted first in case of absent peripheral pulses, altered sensation or change of the skin color distal to the fracture.

Open fractures require **vigorous irrigation with saline solution followed by surgical debridement of necrotic tissues, tetanus prophylaxis, and intravenous antibiotics**.

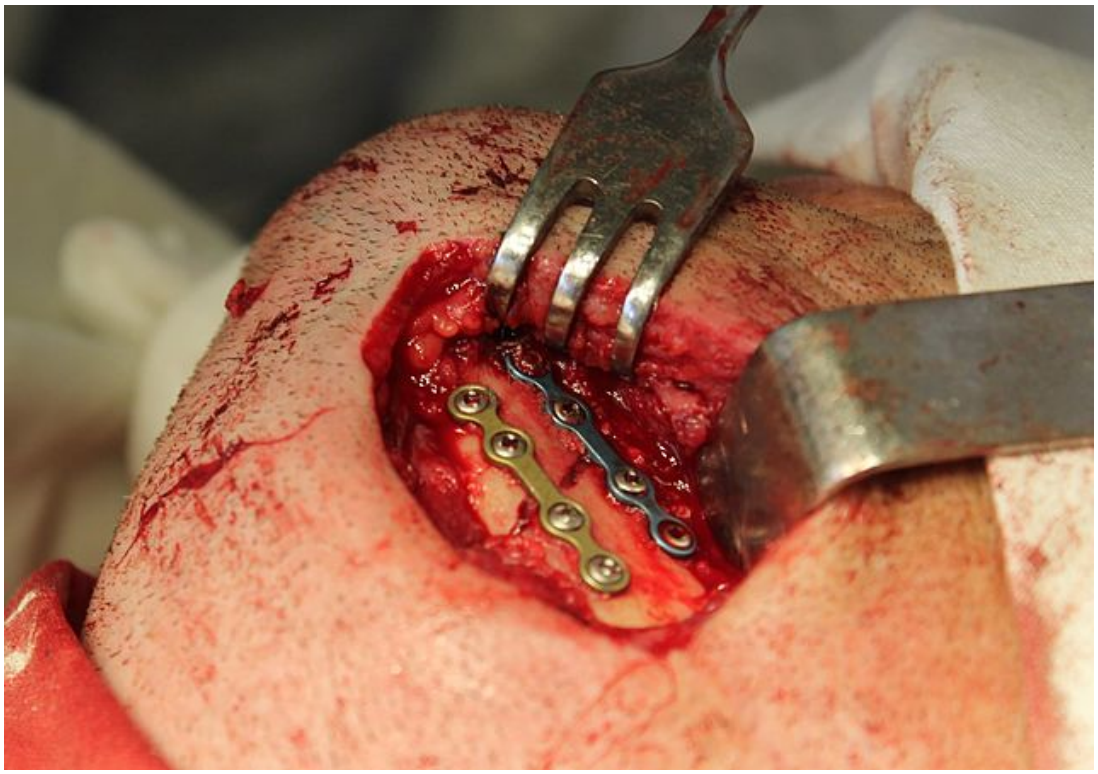

Image: “The patriotic open osteosynthesis.” by Katia&Lena. License: CC BY-SA 4.0

Complications of Bone Fractures

Acute onset complications following fractures can include neurovascular injury, fat embolism, deep venous thrombosis, and compartment syndrome.

Neurovascular injury

Arterial injuries can be fatal in places that can accommodate plenty of blood loss. Femur fractures and pelvic fractures are particularly common with an injury of major blood vessels leading to enormous bleeding. Arterial injury can also **lead to interruption of blood supply distal to the fracture**.

The **immediate reduction** is crucial when absent peripheral pulses follow fractures. Angiography is the definitive way for diagnosis of arterial injury even with intact clinical evaluation. Nerve injury can be acute following the fracture or delayed, thus complicating casting.

Abnormal sensation distal to the fracture with the administration of adequate analgesia is a sign of nerve injury. It can range from neuropraxia, **characterized by only physiological interruption of the nerve signals** which heals in about two months, to neurotmesis, characterized by anatomic disruption of the nerve fibers.

Deep vein thrombosis is a common complication following fractures which can progress to fatal pulmonary embolism. Adequate prophylaxis is indicated in all patients with prolonged immobilization to avoid thromboembolic events.

Fat embolism

It occurs **most commonly in the lower limb with a fracture of the femoral shaft**. Patients present with dyspnea, tachypnea, hypoxemia, and a petechial rash. It may progress to a fatal respiratory failure or neurological complications.

Compartment syndrome

It is **characterized by increased pressure in enclosed muscle tissue following fractures due to bleeding, edema or tight casting**. It is common with fractures of the tibia and radius. Complications can progress to gangrene. It is characterized by pain which increases out of proportion to the fracture. The pain can be elicited with passive movement or stretching of the muscles. When suspected, casts and bandages should be removed immediately, and fasciotomy should be planned to save the limb.

Long-term complications

Long-term complications include Osteomyelitis, nonunion which is common with scaphoid fracture and femoral neck fractures, premature osteoarthritis and complex regional pain syndrome.

References

General principles of fracture management: Bone healing and fracture description via uptodate.com

General principles of acute fracture management via uptodate.com

General principles of fracture management: Early and late complications via uptodate.com

Notes