GENERAL PRINCIPLES OF FRACTURES

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OBJECTIVES

• Structure and function of bone.
• Histology of bone
• Types of bone
• Definition of fracture.
• Types of fracture
• **Bone** is a specialized type of connective tissue. It has a unique histological appearance, & carry out its numerous functions.
 FUNCTIONS OF BONES

• **Haematopoiesis**: the formation of blood cells from haematopoietic stem cells found in the bone marrow.

• **Lipid and mineral storage**: bone is a reservoir holding adipose tissue within the bone marrow and calcium within the hydroxyapatite crystals.

• **Support**: bones form the framework and shape of the body.

• **Protection**: especially the axial skeleton which surrounds the major organs of the body.
COMPONENTS OF BONE

Like any connective tissue, its components can be divided into **cellular components** and the **extracellular matrix**.

**Cellular Components:**

There are three types of cells in bone:

- **Osteoblasts**: synthesize uncalcified/unmineralised extracellular matrix called osteoid. This will later become calcified/mineralized to form bone.

- **Osteocytes**: the osteoblasts become between lamellae in lacunae where they mature into osteocytes. They then monitor the minerals and proteins to regulate bone mass.
• **Osteoclasts**: Derived from monocytes and resorb bone by lysosomal enzymes. They are large and multinucleated cells.

• The balance of osteoblast to osteoclast activity is important in the maintenance of the tissue’s structural integrity. It also plays a role in conditions such as **osteoporosis**.
EXTRACELLULAR MATRIX

- provide biochemical and structural support to the cells.

- In addition to collagen and the associated proteins usually found in connective tissue, bone is impregnated with mineral salts, in particular calcium hydroxyapatite crystals. These crystals associate with the collagen fibres, making bone hard and strong. This matrix is organized into numerous thin layers, known as lamellae.
CHEMICAL COMPOSITION OF BONE

BONE

RESISTS EFFECT OF PULLING-TENSION

ORGANIC
35%

MATRUX

INORGANIC
65%

CELLS

MAINLY HYDROXYAPATITE

RESISTS BENDING AND COMPRESSION

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Structure of Bone

- Under the microscope, bone can be divided into two types:
- **Woven bone** (primary bone) – Appears in embryonic development and fracture repair. It consists of osteoid (unmineralised ECM), with the collagen fibres arranged randomly. It is a temporary structure, soon replaced by mature lamellar bone.

- **Lamellar bone** (secondary bone) – The bone of the adult skeleton. It consists of mineralised osteoid. This organised structure makes it much stronger than woven bone. Lamella bone itself can be divided into two types – compact and spongy.
• In both types of bone, the external surface is covered by a layer of connective tissue, known as the **periosteum**.

• A similar layer, the **endosteum** lines the cavities within bone (such as the medullary canal, Volkmann’s canal and spongy bone spaces).
Lamellar bone can be divided into two types. The outer is known as **compact bone** – this is dense and rigid. The inner layers of bone are marked by many interconnected cavities, and is called **spongy bone**.
COMPACT BONE (CORTICAL)

• Compact bone forms the outer ‘shell’ of bone. In this type of bone, the lamellae are organised into concentric circles, which surround a vertical Haversian canal (which transmits small neurovascular and lymphatic vessels). This entire structure is called an osteon, and is the functional unit of bone.

• The Haversian canals are connected by horizontal Volkmann’s canals – these contain small vessels that anastomose the arteries of the Haverisan canals

• The Volkmann’s canals also transmit blood vessels from the periosteum.

• Osteocytes are located between the lamellae, within small cavities (known as lacunae). The lacunae are interconnected by a series of interconnecting tunnels, called canaliculi.
SPONGY BONE (CANCELLOUS)

- Spongy bone makes up the interior of most bones, and is located deep to the compact bone. It contains many large spaces – this gives it a honeycombed appearance.

- The bony matrix consists of a 3D network of fine columns, which crosslink to form irregular trabeculae. This produces a light bone, that is strong against multidirectional lines of force. The lightness afforded to spongy bone is crucial in allowing the body to move. If the only type of bone was compact, they would be too heavy to mobilize.

- The spaces between trabeculae are often filled with bone marrow. Yellow bone marrow contains adipocytes and red bone marrow consists of haematopoietic stem cells.

- This type of bone does not contain any Volkmann-s or Haversian canals.
STRUCTURE OF MATURE BONE.
TYPES OF BONE:

- 1) Long bones
- 2) Short bones (bones of the wrist and ankle)
- 3) Flat bone (sternum, and most skull bones)
- 4) Irregular bones (vertebrae and carpel bone and tarsal bone and hip bones)
- 5) Sesamoid bones (patella)
DEFINITION OF FRACTURE:

- A fracture is a soft tissue injury associated with break in the bone or a break in the structural continuity of bone. It may be crack, a crumpling or a splintering of the cortex.
- The resulting bone fragments may be displaced or undisplaced.
- If the overlying skin remains intact => closed fracture.
- If the skin or a body cavities is breached => open/compound fracture.
PATHOLOGY OF FRACTURES

• Fractures result from:
  
  • (1) traumatic incident >> most common
  
  • (2) repetitive stress of normal degree persisting to the point of mechanical fatigue
  
  • or (3) normal stress acting on abnormally weakened bone (a so-called ‘pathological’ fracture).
HOW IS FRACTURE HAPPENED?

• Bone have special criteria >> resistancy which mean that when bone exposed to truma it will change it’s shape in minimal degree to absorb the shock.(shock absorbent).

• Truma is a Relationship between magnitude of truma and ability of bone to resist the truma so if magnitude of truma> resistance of bone = fracture.

• If resistance of bone > magnitude of truma = no fracture

• 1)Magnitude of truma could be out of sudden ,big ,large happened at once to bone and its exceeded the ability of bone to absorb it >> fracture will occur even in normal bone.(so large magnitude of truma ,normal bone)

• 2)Sometimes the ability of bone to resist that truma is minimal so Fracture will happened( easily )even in weak force/truma (low magnitude of truma in week bone ),,,could be generalize like osteoporosis, osteogenesis imperfecta or metabolic bone disease or localize such as bone cyst a metastasis or primary bone tumor.

• 3) low magnitude of truma but in repetitive pathway in normal bone like dancer.
FRACTURE DUE TO INJURY

• **Direct force >>** Bone breaks at the point of impact, soft tissues are also damaged. - A direct blow usually splits the bone transversely or ‘butterfly’ fragment. - Damage to the overlying skin is common >>> **Always** there but in different degree [Fracture >> swelling due to soft tissue inflammation so soft tissue here always damaged but in different degree.] From simple contusion to very severe damage.

• **Indirect force >>** Bone breaks at a distance from where the force is applied; soft-tissue damage at the fracture site is not common. Most fractures are due to a combination of forces

  • Twisting >> spiral fracture (rotational force) • Compression >> short oblique fracture. • Bending >> triangular ‘butterfly’ fragment. • Tension >> transversely.

• Binding with compression >> betterfly

• Binding , compression with twisting >> short oblique fracture.
The bone is exposed to repetitive minor trauma, each one is not enough to break bone, because it's repetitive the force will accumulate in the bone to reach its maximum ability to resist the trauma >> finally fracture.

Most common site of fracture >> second and fifth metatarsals, proximal tibia and neck of femur,

FATIGUE or STRESS fractures

occur in normal bone which is subjected to repeated heavy loading.

creates minute deformations that initiate the normal process of remodeling

combination of bone resorption & bone formation

repeated and prolonged exposure to stress and deformation

bone resorption occurs faster than replacement

leaves the area liable to fracture.

Typically in:
- Athletes
- Dancers
- Military personnel
A similar problem exists in people who are on medication that alters the normal balance of bone resorption and replacement; stress fractures are increasingly seen in patients with chronic inflammatory diseases who are on treatment with steroids or methotrexate.
3) Pathological fractures

- Fractures may occur even with normal stresses if the bone has been weakened by 1) a change in its structure (e.g. in osteoporosis, osteogenesis imperfecta or Paget’s disease) or 2) through a lytic lesion (e.g. a bone cyst or a metastasis).
Did the bone break through the skin?

**Open**
- a fractured bone that **breaks through the skin**
- **Also called “Compound Fx”**

**Closed**
- a fractured bone that **does NOT penetrate through the skin (skin remains intact)**
- **Also called “Simple Fx”**
Is the bone: completely broken or part of it?

**Complete Fracture:**
the fracture completely **separates** the bone in two

**Incomplete Fracture:**
the fracture **does NOT break the bone all the way through**
Details (pattern) of the fracture? Continued...

Spiral

the fracture **twists around the bone shaft**
(can be from a twisting injury)
Details (pattern) of the fracture?

**Greenstick**
- one side of the bone is bent while the other is broken
- incomplete type of fracture
- (most common in pediatric patients)

**Comminuted**
- the bone is *broken into many fragments (3 or more)*
Details (pattern) of the fracture?

- Transverse:
  - The fracture is straight across the bone shaft.

- Oblique:
  - The fracture is slanted across the bone shaft.
TYPES OF FRACTURE

• COMPLETE FRACTURES:
  • The bone is split into two or more fragments.
  • The fracture pattern helps to tell how the fracture occurred and how it is likely to behave after reduction.
Complete fractures

- If the fracture is **transverse**, the fragments usually remain in place after reduction.
- If it is **oblique** or **spiral**, they tend to slip and re-displace even if the bone is splinted.
- In an **impacted** fracture, the fragments are jammed tightly together and the fracture line is indistinct.
- Double fractures in a long-bone diaphysis, leaving an isolated segment between the breaks, is called a **segmental fracture**.
- A **comminuted fracture** is one in which there are multiple fragments; because there is poor interlocking of the fragments, these fractures are unstable.
TRUMA IN ORTHPRIODICS

• Important to know machinism of truma >> we will suspect where the injury will happen
• Positioned of pt in the accident.
Transverse  Stress  Oblique, Displaced  Greenstick  Comminuted
Impacted Fracture

A **impacted fracture** happens when the impact on the bone is from one of the ends and the force runs straight up the bone.

The bone breaks and the two ends of the fracture are pushed into each other.

This is a common arm fracture in children.
SEGMENTAL FRACTURE – A TYPICAL HIGH-ENERGY INJURY;

C: Comminution / Pattern

- Segmental
  - Bone broken in 2+ separate places; Fx lines do not connect
C: Commination / Pattern

- Comminuted
  - Broken, splintered, or crushed into >3 pieces
TRANSVERSE FRACTURE
OBLIQUE FRACTURE

C: Comminution / Pattern
- Oblique (Simple)
- Spiral (Simple)
  - Oblique in 2+ views
SPIRAL FRACTURE, DUE TO A TWISTING FORCE – A TYPICAL LOW-ENERGY FRACTURE
• INCOMPLETE FRACTURES

• The bone is incompletely divided and the periosteum remains in continuity.

• eg:- greenstick fracture where the bone is bent, seen in children more than adults.
INCOMPLETE (‘GREENSTICK’) FRACTURE OF THE ULNA
TYPES ON INCOMPLETE

• **Stress fractures** also may be incomplete, with the break initially appearing in only one part of the cortex; nevertheless, they take just as long to heal as complete fractures.

• **Compression fractures** This is seen most typically in the vertebral bodies.

• **Green stick**
COMPRESSION FRACTURE, TYPICALLY OF AN OSTEOPOOROTIC LUMBAR VERTEBRA

C: Comminution / Pattern

- Compression
- Impacted
  - (e.g. “Buckle / Torus”)
SIGNS AND SYMPTOMS OF FRACTURE (BROKEN)

- **B**>> brusing with pain or swelling.
- **R**>> reduced movement.
- **O**>> odd appearance.
- **K**>> krackling sound (from bone fragments).
- **E**>> edema or erythema.
- **N**>> neurovascular impairments
FRACTURE DISPLACEMENT

• After a complete fracture the fragments usually become displaced, partly by the force of the injury, partly by gravity and partly by the pull of muscles attached to them.

• Displacement is usually described in terms of translation, alignment, rotation and altered length.
• Translation (shift): the fragments may be shifted sideways, backwards or forwards in relation to each other, such that the fracture surfaces lose contact. The fracture will usually unite even if apposition is imperfect, and sometimes even if the bone ends lie side by side with the fracture surfaces making no contact at all.
• **Alignment (angulation):**

- the fragments may be tilted or angulated in relation to each other. If malalignment is marked the bend in the limb may be obvious; small degrees of malalignment are detected only by x-ray.
• **Rotation (twist):** long-bone fragments may be rotated in relation to each other; the bone looks straight but the limb ends up with a torsional deformity

• **Length:** the fragments may be distracted and separated, or they may overlap, due to muscle spasm, causing shortening of the bone.
SOFT-TISSUE DAMAGE

- Low-energy (low-velocity) fractures cause only moderate soft-tissue damage; the classic example is a closed spiral fracture.

- High-energy (high velocity) fractures cause severe damage; examples are segmental and comminuted fractures, no matter whether open or closed.
• The state of the enveloping soft tissues has a significant effect on fracture healing.

• A full description of the fracture should therefore include comment on the soft tissues.
Thank you