Bone Grafting and Reconstruction
Introduction

- **Historical background:**
  - Surgeons have gained their experience in reconstruction from the numerous wars.
  - Civilian injuries produce the largest number and the most extensive tissue loss almost indistinguishable from war injuries.
Introduction

- It started in WW I and concentrated around reconstruction of the mandible but without antibiotic support

- In WW II distant bone blocks were transplanted from the ilium, rib and tibia with routine use of antibiotic
  - No cancellous cellular marrow
Introduction

- Mowlem in 1944, introduced the concept of “Iliac cancellous bone chips” beginning the evolution of predictable bony reconstruction of the jaw bone.

- Boyne brought about the “use of particulate bone and cancellous marrow” with metallic trays splinted to large acellular cortical bone.
Biology of bone grafting

- Three biological mechanisms are involved:
  - **Osteogenesis:**
    - Is the production of new bone by proliferation, osteoid production and mineralization
  - **Osteoconduction:**
    - Is the production of new bone and migration of local osteocompetent cells along a conduit e.g. fibrin, blood vessel or even certain alloplast material like hydroxyapatite
    - Originate from the endostium or residual periostium of the host bone
  - **Osteoinduction:**
    - Is the formation of bone by stem cells transforming into osteocompetent cells by BMP
    - Induct the recipient tissue cells to form periostium and endostium
The Rib
Surgical anatomy

- The first, eleventh and twelfth ribs are atypical.
- A typical rib has a head, a neck and a shaft.
  - The shaft slopes down and laterally to an angle and then curve forward.
  - The upper border is blunt and lateral to the angle the lower border form a sharp ridge sheltering a costal groove.
- This feature identify right from left ribs.
Surgical anatomy

A Typical rib:

- **The head:**
  - Bevelled by two articular facets that slope away from a dividing ridge.
  - The lower one is vertical and articulate with the upper border of its own vertebra.
  - The upper facets faces up and articulate with the lower border of the vertebra above.
  - Each form a synovial joint separated by a ligament attached to the ridge.
Surgical anatomy

**The Rib**

- **The neck:**
  - Is flattened with its upper border curving into a thin, prominent ridge, the crest

- **The tubercle:**
  - Shows two small facets lying medial and lateral
  - The medial one is covered with hyaline cartilage and form synovial joint with the transverse process of its vertebra
  - The lateral facet is smooth surfaced and receive the costotransverse ligament
Surgical anatomy

The Rib

Costal cartilages:
- They form a primary cartilaginous joints at the extremities of all twelve ribs.
- The first is short and articulate with the manubrium and the clavicle.
- They increase in length below and the seventh has the longest.
- They are bent from a downward slope with the rib to upward slope toward the sternum.
Surgical anatomy

The Rib

- Rib harvesting:
  - Indicated for costochondral graft to restore pseudoarticulation of the TMJ, or to replace a missing part of the anterior mandible to reconstruct a functional articulation
  - The rib is usually 5th or 6th typical one
  - Incision is placed in the infra-mammary crease, to hide the scar
Surgical anatomy

The Rib

- Right rib is always preferred because:
  - It could be contoured to fit either side of the mandible or facial bones
  - Postoperative pain is less likely to be confused with cardiogenic pain
- The 6th rib is where the distal origin of the pectoralis major muscle, dissection transect the muscle minimally
- Sharp dissection is carried through full thickness of skin, subcutaneous tissues and the muscle, to expose the rib periostium, the chest wall cortex
Surgical anatomy

The Rib

- The periostium is incised from 1 cm onto the rib cartilage to the full desired length, the anterior border of the latissimus dorsi muscle, about 12 cm.

- Reflected carefully from the chest wall cortex around the inferior and superior rib edges to the pleural cortex periostium, using a maxillofacial surgery periosteal elevator rather than Doyen rib stripper.
Surgical anatomy

The Rib

- This is to avoid creating pleural tear, because of the irregularities and bony projection to which periostium and lung pleura are firmly attached, leading to pneumothorax.

- A releasing incision made at right angle to the rib incision carried to the rib edges help in reflecting the perichondrium and gaining access to the cartilage.
Surgical anatomy

The Rib

- The cartilage is separated first by scalpel blade and the proximal part is cut with a saw or rib cutter after lifting the rib and carefully separating any adherent periosteal membrane from the pleural cortex.

- The closure is layered, peristium, subcutaneous tissue, dermis and lastly skin.

- Drain is not necessary.
Surgical anatomy

**The Rib**

- The length of the cartilage is related to the growth of the graft not to the prevention of bony ankylosis
  - Disadvantages:
    - Longer length create a longer lever arm, promoting separation (2-3 mm)
    - Associated with overgrowth
  - Incorporation of the perichondrium or periostium sleeve, in the graft does not enhance survival or stability of the graft
    - In children the cartilage is easily separated from bone, sleeve reduce the chance of separation
    - In adult the cartilage is firmly incorporated to bone
    - Increases the probability of pneumothorax
Surgical anatomy

The Rib

- It is recommended, a 2 – 3 mm of cartilage length without adherent periostium of perichondrium for both costochondral growth grafts in children and articulation graft in adult
The Iliac crest
Surgical Anatomy: **Iliac crest**

- **Hip Bone:**
  - Made of three bones fused in a Y-shaped epiphysis involving the **acetabulum**, (hip joint socket), a concave hemisphere,
  - Pubis and ischium form incomplete bony wall for pelvic cavity, their outer surface gives attachment to the thigh muscles
  - The *ilia* forms a brim between the hip joint and the joint with the sacrum
Surgical Anatomy: **Iliac crest**

- The anterior 2/3 is thin bone forming the iliac fossa, posterior abdominal wall.
- The posterior 1/3 is thick bone and carries the articular surface for the sacrum.
- The ilium is nearly at right angle to the other two bones.
Surgical Anatomy: **Iliac crest**

- The outer surface rises wedge-shaped along an anterior border to the anterior superior iliac spine.
- Behind the acetabulum, it passes up as a thick bar of weight-bearing bone and curve back to the posterior superior iliac spine.
- It is the attachment of the muscles of the buttock, Gluteus minimus, medius and maximus.
Surgical Anatomy:  **Iliac crest**

- The upper border between the anterior and posterior superior iliac spines, the iliac crest, has a bold upward convexity and curve from front backward in a sinuous bend.
- The anterior part is curved outwards and it’s external rim has a more prominent convexity behind the anterior superior iliac crest spine, the iliac tubercle.
Surgical Anatomy: **Iliac crest**

- The gluteal surface:
  - Convex in front, concave behind, conforming to the curvature of the iliac crest
- The anterior border:
  - Shows a gentle S-shaped bend
  - Sartorius muscle is attached a finger breadth below the anterior spine
- The posterior part of the crest is thicker than the rest
Surgical Anatomy: Iliac crest

- The inner surface:
  - The iliac fossa, shows a gentle concavity and is paper thin in its deepest part
  - The lower 2/3 is bare bone
  - The iliacus muscle and fascia are attached to the inner lip of the crest over the whole area
Surgical Anatomy: **Iliac crest**

- **Bone harvesting:**
  - The lateral approach to the anterior ilium affect the gait the most
  - The medial anterior approach involve the large iliacus muscle which is not necessary for normal gait but large medial haematoma might produce gait disturbances
Surgical Anatomy:  

Iliac crest

- Surgical access:
  - Incision should be placed 1 cm posterior to the anterior superior spine and extend to the iliac tubercle
  - It should be placed lateral to the bony prominence to prevent irritation by tight cloths or belt
  - Proceed down to bone medial to the muscles, tensor fascia lata and gluteus medius and lateral to the iliacus and the external abdominal muscles
Surgical Anatomy: *Iliac crest*

- Cancellous bone is available in the anterior ilium within the upper 2 – 3 cm and between the tubercle and the anterior superior spine, *Iliac crest graft*.
- “Trap door” is one of the most common osteotomy used for anterior ilium harvest.
- During closure, strict attention should be followed in order to reorient and reposition the muscles in their original positions.
- A drain is required to because of the dead space and should be placed within the bony cavity.
The tibia
Surgical Anatomy:  \textit{The tibia}

- Is the largest and medial bone of the lower leg, has a large upper end and a smaller lower one.
- The shaft is vertical and triangular in cross-section.
- Its anterior and posterior borders with the medial surface between them are \textit{subcutaneous}.
Surgical Anatomy: The tibia

- The anterior border is sharp above and blunt below where it continue with medial malleolus.
- The posterior border is blunt and run down into the posterior border of the medial malleolus.
- On the fibular side it has a sharp interosseous border.
Surgical Anatomy:  The tibia

- The upper end:
  - Expand widely with prominent tuberosity projecting anteriorly from its lower part
  - The surface bone is a very thin compact-type which is fragile around the margins
Surgical Anatomy: **The tibia**

- The superior articular surface or plateau shows a pair of condylar concavity to articulate with meniscus and the condyle of the femur.

- Between the condylar surfaces, the plateau is elevated into intercondylar eminence and grooved by the medial and lateral tubercles.
Surgical Anatomy: The tibia

- The lower end:
  - Is rectangular in section
  - Medially, it is subcutaneous, anteriorly, it is bare bone
  - Laterally, the surface is triangular and articulate with the fibula

- The extensive subcutaneous surface of the tibia makes it an accessible donor site for bone grafts
Surgical Anatomy:  *The tibia*

- **Bone harvesting:**
  - The tibial plateau is an excellent reservoir for cancellous bone.
  - It can provide up to 40 cc of bone without affecting the structural support of the tibia.

- Indication:
  - Small bony defects:
    - Non-union,
    - Osteotomy defects
    - Dentoalveolar defects
    - Sinus lift procedure
Surgical Anatomy: The tibia

- Surgical access:
  - Could be done under local anaesthesia and conscious sedation
  - Incision over the lateral tubercle best accomplished by flexing the leg at the knee joint
  - It is 6 – 10 mm from the skin and dissection is made through the thin subcutaneous tissue
  - Sharp dissection to reflect the tensor fascia lata band and make 1 cm opening into the cortex and the cancellous bone could be harvested lateral and inferior to the midline to avoid damage to the knee