MEDICAL EDUCATION RESOURCE

Bones: Hip Bone,Ilium,Pubis,Ischium,Acetabulum ,Obturator Foramen

Bones – Introduction

- The **bones of the lower limb** are larger, stronger, and heavier than those of the upper limb because they support the **body weight** and are adapted for **locomotion**.
- They are arranged in four main parts:
    1. **Hip bone** – forms the pelvic girdle.
    2. **Femur** – bone of the thigh.
    3. **Tibia and Fibula** – bones of the leg.
    4. **Tarsal, Metatarsal, and Phalangeal bones** – form the foot.
- The **pelvic girdle** connects the lower limbs to the trunk and transmits the body weight to the lower extremities.

Hip Bone

Introduction

- The **hip bone** (also called **coxal bone** or **innominate bone**) forms the **lateral part of the pelvis**.

- It is a large, irregular, flat bone formed by the fusion of **three parts**:
    1. **Ilium** (upper large part)
    2. **Ischium** (posteroinferior part)
    3. **Pubis** (anteroinferior part)
- The three parts meet and fuse at the **acetabulum**, a deep cup-shaped cavity for articulation with the **head of the femur**.

Anatomical Position

To place the hip bone in **anatomical position**:

- The **acetabulum** should face **laterally**.
- The **obturator foramen** should lie **inferomedially**.
- The **symphysial surface** (pubic symphysis) should face **medially**.

Features

- The bone has **two surfaces**, **four borders**, and **three main parts** (ilium, ischium, pubis).
- The **pelvic surface** is smooth and concave.
- The **gluteal surface** is convex and roughened by lines for muscular attachment.
- The **acetabulum** is directed laterally, downward, and forward.
- The **obturator foramen** is a large opening bounded by pubis and ischium.

Ilium

General Features

- The **ilium** is the **upper expanded part** of the hip bone.
- It forms the **superior two-fifths** of the acetabulum.
- It consists of a **body** and an **ala (wing)**.

Body

- Forms the **upper part of the acetabulum**.
- Contributes to the **acetabular fossa** and **acetabular margin**.
- Gives attachment to the **rectus femoris** from the **anterior inferior iliac spine (AIIS)**.

Ala (Wing)

- The broad, fan-shaped portion above the body.
- Presents **three surfaces**:
    1. **Gluteal surface** – convex; has **three gluteal lines** (posterior, anterior, inferior) that mark muscle attachments:
        - *Gluteus maximus* between posterior and anterior lines.
        - *Gluteus medius* between anterior and inferior lines.

- *Gluteus minimus* below inferior line.

2. **Iliac fossa** – smooth concavity on internal surface for *iliacus muscle*.
3. **Sacropelvic surface** – medial aspect with:
    - *Auricular surface* for sacroiliac joint articulation.
    - *Iliac tuberosity* above it for ligaments.

Borders and Spines

1. **Anterior border:**
    - Has **ASIS (anterior superior iliac spine)** and **AIIS (anterior inferior iliac spine)**.
    - ASIS gives attachment to *inguinal ligament*, *sartorius*, and *tensor fasciae latae*.
2. **Posterior border:**
    - Has **PSIS (posterior superior iliac spine)** and **PIIS (posterior inferior iliac spine)**.
    - Between PIIS and ischial spine lies the **greater sciatic notch**.
3. **Superior border (Iliac crest):**
    - Curved ridge forming the upper margin of ilium.
    - Divided into *outer lip*, *intermediate zone*, *inner lip*.
    - Attachments:

        - Outer lip – *tensor fasciae latae* (anteriorly), *latissimus dorsi* (posteriorly).
        - Intermediate zone – *internal oblique*.
        - Inner lip – *transversus abdominis* and *quadratus lumborum*.
4. **Medial border:**
    - Forms part of the **linea terminalis** (arcuate line).

Clinical Anatomy

- The **iliac crest** is used as a landmark for:
    - **Bone marrow biopsy** and **lumbar puncture** (level of L4 spine).
- **ASIS** is palpable and used to locate **McBurney's point** and **inguinal ligament**.
- **Iliac tuberosity and auricular surface** are involved in **sacroiliitis** (painful inflammation of sacroiliac joint).

Pubis

General Features

- The **pubis** forms the **anteroinferior part** of the hip bone.
- It consists of:
    1. **Body** – flattened and medially placed.

2. **Superior ramus** – extends laterally from body to join ilium and ischium.

3. **Inferior ramus** – passes downward and laterally to join the ischial ramus.

Important Landmarks

- **Pubic crest:** Anterior border of the body of pubis; ends medially as the **pubic tubercle**.
    - *Attachments:* Inguinal ligament and rectus abdominis.
- **Pubic symphysis:** Medial surface articulates with opposite pubic bone by fibrocartilage.
- **Pectineal line (pecten pubis):** Ridge on superior ramus forming part of the **pelvic brim**; gives attachment to *pectineus muscle*.
- **Obturator crest:** Located below pectineal line; gives attachment to *obturator membrane*.
- **Obturator groove:** Becomes the **obturator canal** for passage of *obturator nerve and vessels*.
- **Inferior ramus:** Joins ischial ramus to form the **ischiopubic ramus**, bounding the **obturator foramen**.

Clinical Anatomy

- **Fracture of pubic rami** may injure **urinary bladder** or **urethra**.
- **Pubic symphysis diastasis** can occur during childbirth due to hormonal softening of ligaments.
- **Pubic tubercle** serves as a palpable landmark for the *superficial inguinal ring*.

Ischium

General Features

- The **ischium** forms the **posteroinferior part** of the hip bone.
- It contributes the **posterior two-fifths** of the acetabulum.
- It consists of:
    1. **Body** – upper thick part joining the ilium and pubis.
    2. **Ramus** – thinner part projecting forward to unite with the inferior ramus of pubis (forming the *ischiopubic ramus*).

Body

- Forms **part of the acetabulum** and gives attachment to several muscles and ligaments.
- On its **posterior surface**, a strong **ischial spine** projects medially and posteriorly.
    - **Above the spine** ? *Greater sciatic notch*.
    - **Below the spine** ? *Lesser sciatic notch*.
- The **ischial spine** gives attachment to:
    - *Sacrotuberous ligament* (partly).

- *Coccygeus muscle*.
- *Levator ani (iliococcygeus part)*.
- *Superior gemellus muscle*.

Ischial Tuberosity

- Large, roughened projection below the lesser sciatic notch.
- It bears the **weight of the body when sitting**.
- It gives origin to:
  - *Semimembranosus* (upper lateral facet).
  - *Biceps femoris (long head)* and *semitendinosus* (upper medial facet).
  - *Adductor magnus* (inferior surface).
- Provides attachment for the *sacrotuberous ligament* at its posterior margin.

Ischial Ramus

- Extends **anteriorly and medially** to unite with the **inferior ramus of pubis**, forming the **ischiopubic ramus**.
- The **outer surface** gives origin to the *adductor magnus*, *gracilis*, and *obturator externus* muscles.
- The **inner surface** is part of the wall of the **ischiorectal fossa**.

Important Notches

1. **Greater Sciatic Notch**
    - Lies above the ischial spine.
    - Converts into **greater sciatic foramen** by the *sacrospinous ligament*.
    - Structures passing through:
        - *Piriformis muscle*.
        - *Sciatic nerve*.
        - *Superior and inferior gluteal vessels and nerves*.
        - *Pudendal nerve* and *internal pudendal vessels* (they exit here and re-enter through the lesser foramen).
2. **Lesser Sciatic Notch**
    - Lies below the ischial spine.
    - Converted into **lesser sciatic foramen** by the *sacrospinous* and *sacrotuberous ligaments*.
    - Transmits:
        - *Tendon of obturator internus*.
        - *Nerve to obturator internus*.
        - *Internal pudendal vessels* and *pudendal nerve* (entering the perineum).

Clinical Anatomy

- **Avulsion fractures** of the ischial tuberosity occur in athletes due to strong hamstring pull.
- The **ischial spine** is used as a **landmark in obstetrics** to measure the **station of the fetal head**.
- Tenderness over the **ischial tuberosity** is seen in *weaver's bottom* (ischial bursitis).

Acetabulum

General Features

- The **acetabulum** is a **deep cup-shaped cavity** on the lateral surface of the hip bone.
- It articulates with the **head of the femur** to form the **hip joint**.
- Formed by the fusion of:
    - **Ilium** – upper two-fifths.
    - **Ischium** – posterior two-fifths.
    - **Pubis** – anterior one-fifth.

Structure

- **Acetabular margin (rim):**
    - Incomplete inferiorly due to **acetabular notch**.

    - Gives attachment to the **acetabular labrum**, a fibrocartilaginous rim that deepens the cavity.

- **Acetabular fossa:**
    - Central non-articular depression; lodges a **fat pad** and attachment of **ligamentum teres (ligament of head of femur)**.

- **Lunate surface:**
    - Crescentic articular part covered by **hyaline cartilage**.
    - Articulates with the **head of femur**.
    - Thicker superiorly where body weight is transmitted.

- **Acetabular notch:**
    - Located inferiorly between the two ends of the lunate surface.
    - Converted into a foramen by the **transverse acetabular ligament**.

Clinical Anatomy

- **Congenital dislocation of the hip** results from shallow or defective acetabulum.
- **Fracture of acetabular wall** may accompany posterior dislocation of the femoral head in accidents.
- The **acetabular fossa** serves as a useful landmark during hip replacement surgery.

Obturator Foramen

General Features

- A large, oval opening in the **anteroinferior part of the hip bone**.
- Bounded by:
    - **Pubis** (superiorly and medially).
    - **Ischium** (inferiorly and laterally).
- Covered by the **obturator membrane**, a thin fibrous sheet closing the foramen except for a small **obturator canal** at its upper part.

Obturator Canal

- Formed between the **obturator membrane** and the **groove on the inferior surface of the superior ramus of pubis**.
- Transmits:
    - **Obturator nerve**.
    - **Obturator artery**.
    - **Obturator vein**.

Functions

- The obturator membrane gives **origin** to:

- *Obturator externus* (external surface).
- *Obturator internus* (internal surface).

- It strengthens the **anterior pelvic wall** and reduces unnecessary weight of the bone by maintaining a light but strong structure.

Clinical Anatomy

- **Obturator hernia**: Protrusion of abdominal contents through the obturator canal, common in elderly thin females.
- The **obturator nerve** may be compressed, causing **pain in the medial thigh**.
- The **obturator vessels** are important in pelvic hemorrhage control during surgery.

Ossification of Hip Bone

Primary Ossification Centres

- **Three primary centres** appear during the **8th–9th week of intrauterine life**, one for each component:
  1. **Ilium** – appears first (around the 8th week).
  2. **Ischium** – appears about the **3rd month**.
  3. **Pubis** – appears around the **4th–5th month**.
- These parts remain separate at birth but are joined by **cartilage at the acetabulum**.

Secondary Ossification Centres

Appear around **puberty (14–15 years)** and fuse by **20–25 years**:

1. **Iliac crest centre** – appears near the anterior part of the crest.
2. **Anterior inferior iliac spine centre** – gives additional strength to the spine.
3. **Ischial tuberosity centre** – appears around 16 years.
4. **Pubic symphysis centre** – appears near the crest of pubis.
5. **Acetabular centre** – appears at the **Y-shaped cartilage** within the acetabulum where the three bones meet.

- **Fusion pattern:**
  - Begins at the acetabulum and spreads outward.
  - Complete fusion of ilium, ischium, and pubis occurs between **20–25 years** of age.

Timeline Summary

CENTRE	APPEARS	FUSES
Ilium	8th week IU	20–25 yrs
Ischium	3rd month IU	20–25 yrs
Pubis	4th–5th month IU	20–25 yrs
Iliac crest (secondary)	14 yrs	20–25 yrs

CENTRE	APPEARS	FUSES
Ischial tuberosity (secondary)	16 yrs	20–25 yrs
Pubic symphysis (secondary)	15 yrs	20–25 yrs
Acetabular Y-cartilage	Puberty	20–25 yrs

Clinical Anatomy of the Hip Bone and Its Parts

1. Hip Bone as a Whole

- **Pelvic Fractures** usually occur at **weak points**:
  - *Pubic rami*, *acetabular walls*, or *sacroiliac joint area*.
- Because the bones form a ring, a single break is rare — usually **two fractures or a fracture with dislocation** occur.
- **Fall injuries** can cause:
  - **Acetabular fractures** (posterior wall commonly).
  - **Pubic rami fractures** — often from anterior-posterior compression.
  - **Ischial tuberosity avulsion** — due to hamstring pull.

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2. Ilium

- **Iliac crest** is used for:

    - *Bone marrow aspiration and grafting*.
    - *Landmark for lumbar puncture* (L4 vertebral level lies between both crests).
- **ASIS** serves as a surface landmark to locate *inguinal ligament*, *McBurney's point*, and *femoral artery pulsation line*.
- **Sacroiliitis** (inflammation of sacroiliac joint) causes *buttock pain radiating to posterior thigh*.

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3. Ischium

- **Ischial tuberosity** is the **weight-bearing point when sitting**.
    - *Bursitis (Weaver's bottom)* results from prolonged sitting on hard surfaces.
- **Avulsion fracture** occurs in athletes during violent contraction of hamstrings.
- **Ischial spine** is an important obstetric landmark — indicates the **station of the fetal head** during vaginal delivery.

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4. Pubis

- **Fracture of pubic rami** may injure the **urinary bladder or urethra** (especially in males).
- **Diastasis of pubic symphysis** can occur in pregnancy and childbirth due to *relaxin-induced ligament softening*.
- **Pubic tubercle** is used as a landmark for *superficial inguinal ring* and *inguinal hernia surgery*.

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5. Acetabulum

- **Congenital dislocation of hip** results from a **shallow or malformed acetabulum**, leading to lateral displacement of femoral head.
- **Posterior dislocation** (from dashboard injury) may fracture posterior wall of acetabulum and damage **sciatic nerve**.
- During **total hip replacement**, correct alignment of the *acetabular cup* is vital to prevent limb shortening and instability.

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6. Obturator Foramen

- **Obturator hernia** is rare but serious, often seen in *elderly, thin females*; causes *bowel obstruction*.
- **Obturator nerve compression** in this hernia produces **pain along medial thigh**.
- **Obturator artery** is a potential source of pelvic bleeding during *hernia repair or hysterectomy*.

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7. Forensic & Radiological Importance

- The **pelvic inlet and outlet shape** help in determining **sex**:
    - *Female pelvis*: broader, shallow, wide subpubic angle.
    - *Male pelvis*: narrow, deep, acute subpubic angle.
- **Iliac crest ossification centres** help in estimating **age of adolescents** in forensic radiology.

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8. Developmental Defects

- **Congenital acetabular dysplasia** – shallow socket, leading to early hip dislocation.
- **Failure of fusion of pubic bones** ? *epispadias or exstrophy of bladder*.
- **Failure of obturator membrane closure** ? *obturator foramen anomalies*.

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9. Surface Landmarks (Palpable Points)

- **ASIS** – most anterior projection on the iliac crest.
- **Pubic tubercle** – 2.5 cm lateral to midline, palpable beneath skin.
- **Ischial tuberosity** – felt in flexed hip, important for gluteal injections landmarking.
- **Iliac crest level** – corresponds to **L4 vertebra** (spinal tap reference).
- **Greater trochanter** – lateral landmark for *hip joint level*.