5 Oblique popliteal ligament (Fig. 12.11).
6 Arcuate popliteal ligament.
7 Anterior cruciate ligament (Fig. 12.12).
8 Posterior cruciate ligament (Fig. 12.12).
9 Medial meniscus (Fig. 12.11).
10 Lateral meniscus (Fig. 12.11).
11 Transverse ligament.

**Fibrous (Articular) Capsule**

The fibrous capsule is very thin, and is deficient anteriorly, where it is replaced by the quadriceps femoris, the patella and the ligamentum patellae.

**Femoral attachment:** It is attached about half to one centimeter beyond the articular margins. The attachment has three special features.
1. Anteriorly, it is deficient.
2. Posteriorly, it is attached to the intercondylar line.
3. Laterally, it encloses the origin of the popliteus.

**Tibial attachment:** It is attached about half to one centimeter beyond the articular margins. The attachment has three special features.
1. Anteriorly, it descends along the margins of the condyles to the tibial tuberosity, where it is deficient.
2. Posteriorly, it is attached to the intercondylar ridge which limits the attachment of the posterior cruciate ligament.
3. Posteroslately, there is a gap behind the lateral condyle for passage of the tendon of the popliteus.

Some terms applied to parts of the capsule are as follows.

**Coronary ligament:** The fibrous capsule is attached to the periphery of the menisci. The part of the capsule between the menisci and the tibia is sometimes called the coronary ligament.

**Short lateral ligament:** This is a cord-like thickening of the capsule deep to the fibular collateral ligament. It extends from the lateral epicondyle of femur, where it blends with the tendon of popliteus, to the medial border of the apex of the fibula.

The capsular ligament is weak. It is strengthened anteriorly by the medial and lateral patellar retinacula, which are extensions from the vastus medialis and lateralis laterally by the iliotibial tract; medially by expansions from the tendons of the sartorius and semimembranosus; and posteriorly, by the oblique popliteal ligament.

**Openings**

The capsule has two constant gaps.
1. One leading into the suprapatellar bursa.
2. Another for the exit of the tendon of the popliteus.

Several other gaps that communicate with the bursae deep to the medial head of the gastrocnemius and deep to the semimembranosus.

---

**Ligamentum Patellae**

This is the central portion of the common tendon of insertion of the quadriceps femoris; the remaining portions of the tendon form the medial and lateral patellar retinacula. The ligamentum patellae is about 7.5 cm long and 2.5 cm broad. It is attached above to the margins and rough posterior surface of the apex of the patella, and below to the smooth, upper part of the tibial tuberosity. The superficial fibres pass in front of the patella. The ligamentum patellae is related to the superficial and deep infrapatellar bursae, and to the infrapatellar pad of fat (Fig. 12.12).

**Tibial Collateral or Medial Ligament**

This is a long band of great strength. Superiorly, it is attached to the medial epicondyle of the femur just below the adductor tubercle. Inferiorly, it divides into anterior and posterior parts.

The anterior or superficial part is about 10 cm long and 1.25 cm broad, and is separated from the capsule by one or two bursae. It is attached below to the medial border and posterior part of the medial surface of the shaft of the tibia. It covers the inferior medial genicular vessels and nerve, and the anterior part of the tendon of the semimembranosus, and is crossed below by the tendons of the sartorius, gracilis and the semitendinosus (Fig. 12.11).

---

**Fig. 12.12:** Sagittal section through the knee joint of right side seen from the medial aspect to show the reflection of the synovial membrane (note the cruciate ligaments)
The posterior (deep) part of the ligament is short and blends with the capsule and with the medial meniscus. It is attached to the medial condyle of the tibia above the groove for the semimembranosus.

Morphologically, the tibial collateral ligament represents the degenerated tendon of the adductor magnus muscle.

**Fibular Collateral or Lateral Ligament**

This ligament is strong and cord-like. It is about 5 cm long. Superiorly, it is attached to the lateral epicondyle of the femur just above the popliteal groove. Inferiorly, it is embraced by the tendon of the biceps femoris, and is attached to the head of the fibula in front of its apex. It is separated from the lateral meniscus by the tendon of the popliteus. It is free from the capsule. The inferior lateral genicular vessels and nerve separate it from the capsule (Fig. 12.11).

Morphologically, it represents the femoral attachment of the peroneus longus.

**Oblique Popliteal Ligament**

This is an expansion from the tendon of the semimembranosus. It runs upwards and laterally, blends with the posterior surface of the capsule, and is attached to the intercondylar line and lateral condyle of the femur. It is closely related to the popliteal artery, and is pierced by the middle genicular vessels and nerve, and the terminal part of the posterior division of the obturator nerve (Fig 12.13).

**Arcuate Popliteal Ligament**

This is a posterior expansion from the short lateral ligament. It extends backwards from the head of the fibula, arches over the tendon of the popliteus, and is attached to the posterior border of the intercondylar area of the tibia.

** Cruciate Ligaments**

These are very thick and strong fibrous bands, which act as direct bonds of union between tibia and femur, to maintain antero-posterior stability of knee joint. They are named according to the attachment on tibia.

Anterior cruciate ligament begins from anterior part of intercondylar area of tibia, runs upwards, backwards and laterally and is attached to the posterior part of medial surface of lateral condyle of femur. It is taut during extension of knee (see Fig. 2.12).

Posterior cruciate ligament begins from the posterior part of intercondylar area of tibia, runs upwards, forwards and medially and is attached to the anterior part of the lateral surface of medial condyle of femur. It is taut during flexion of the knee.

These are supplied by middle genicular vessels and nerves (see Figs 2.26 and 12.13).

**Menisci or Semilunar Cartilages**

The menisci are two fibrocartilaginous discs. They are shaped like crescents. They deepen the articular surfaces of the condyles of the tibia, and partially divide the joint cavity into upper and lower compartments. Flexion and extension of the knee take place in the upper compartment, whereas rotation takes place in the lower compartment (Fig. 12.11).

Each meniscus has the following:

- **Two ends**: The anterior and posterior ends of meniscus is vascularised and is innervated. The remaining part of the meniscus receives its nutrition from the synovial fluid. Therefore, movement is important for cartilage nutrition since movement causes diffusion of nutrients from synovial fluid to the cartilage.

**Functions of menisci**

- They help in making the articular surfaces more congruent. Because of their flexibility they can adapt
their contour to the varying curvature of the different parts of the femoral condyles, as the latter glide over the tibia.

2. The menisci serve as shock absorbers.
3. They help in lubricating the joint cavity.
4. Because of their nerve supply, they also have a sensory function. They give rise to proprioceptive impulses.

Transverse Ligament
It connects the anterior ends of the medial and lateral menisci (Fig. 12.13).

Lateral
1. A bursa deep to the lateral head of the gastrocnemius.
2. A bursa between the fibular collateral ligament and the biceps femoris.
3. A bursa between the fibular collateral ligament and the tendon of the popliteus.
4. A bursa between the tendon of the popliteus and the lateral condyle of the tibia.

Medial
1. A bursa deep to the medial head of the gastrocnemius.
2. The anserine bursa is a complicated bursa which separates the tendons of the sartorius, the gracilis and the semitendinosus from one another, from the tibia, and from the tibial collateral ligament (see Fig. 8.14).
3. A bursa deep to the tibial collateral ligament.
4. A bursa deep to the semimembranosus.

Relations of Knee Joint

Anteriorly
Anterior bursae (see Fig. 3.6), ligamentum patellae (Fig. 12.12), and patellar plexus of nerves.

Posteriorly
1. At the middle: Popliteal vessels, tibial nerve.
2. Posterolaterally: Lateral head of gastrocnemius, plantaris, and common peroneal nerve.
3. Posteromedially: Medial head of gastrocnemius, semitendinosus, semimembranosus, gracilis, and popliteus at its insertion (Fig. 12.13).

Medially
1. Sartorius, gracilis and semitendinosus (see Fig. 8.14).
2. Great saphenous vein with saphenous nerve.
3. Semimembranosus (Fig. 12.13).

Laterally
Biceps femoris, and tendon of origin of popliteus.

Blood Supply
The knee joint is supplied by the anastomoses around it. The chief sources of blood supply are:
1. Five genicular branches of the popliteal artery.
2. The descending genicular branch of the femoral artery.
3. The descending branch of the lateral circumflex femoral artery.
4. Two recurrent branches of the anterior tibial artery.
5. The circumflex fibular branch of the posterior tibial artery (see Fig. 6.10).

As many as 12 bursae have been described around the knee—four anterior, four lateral, and four medial. These bursae are as follows.

Anterior
1. Subcutaneous prepatellar bursa (see Fig. 3.6).
2. Subcutaneous infrapatellar bursa.
3. Deep infrapatellar bursa.
4. Suprapatellar bursa.
Nerve Supply
1. Femoral nerve, through its branches to the vasti, especially the vastus medialis.
2. Saphenous nerve, through the genicular branches of the tibial and common peroneal nerves.
3. Obturator nerve, through its posterior division.

MOVEMENTS AT THE KNEE JOINT

DISSECTION
Clean the articular surfaces of femur, tibia and patella on the soft specimen and on dried bones. Analyze the movements on them. Try all these movements on yourself and on your friends as well.

Features
Active movements at the knee are flexion, extension, medial rotation and lateral rotation (Table 12.2). Flexion and extension are the chief movements. These take place in the upper compartment of the joint, above the menisci. They differ from the ordinary hinge movements in two ways.
1. The transverse axis around which these movements take place is not fixed. During extension, the axis moves forwards and upwards, and in the reverse direction during flexion.
2. These movements are invariably accompanied by rotations or conjunct rotation. When the foot is on the ground, while standing erect, medial rotation of femur occurs during last 30 degrees of extension as in position of “attention” by the vastus medialis. It is called conjunct rotation. During the position of “stand at ease”, there is lateral rotation of femur, during initial stages of flexion, by popliteus muscle.

Medial rotation of the femur occurs during the last 30 degrees of extension, and lateral rotation of the femur occurs during the initial stages of flexion.

When the foot is off the ground as while sitting on a chair the tibia rotates instead of the femur, in the opposite direction.

Table 12.2: Muscles producing movements at the knee joint

<table>
<thead>
<tr>
<th>Movement</th>
<th>Principal muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Extension (from sitting on a chair to standing)</td>
<td>Quadriceps femoris (four heads)</td>
</tr>
<tr>
<td>B. Locking (standing in “attention”)</td>
<td>Vastus medialis</td>
</tr>
<tr>
<td>C. Unlocking (standing “at ease”)</td>
<td>Popliteus</td>
</tr>
<tr>
<td>D. Flexion</td>
<td>1. Biceps femoris</td>
</tr>
<tr>
<td>E. Medial rotation of flexed leg</td>
<td>2. Semimembranosus</td>
</tr>
<tr>
<td>F. Lateral rotation of flexed leg</td>
<td>3. Semitendinosus</td>
</tr>
<tr>
<td></td>
<td>1. Popliteus</td>
</tr>
<tr>
<td></td>
<td>2. Semimembranosus</td>
</tr>
<tr>
<td></td>
<td>3. Semitendinosus</td>
</tr>
<tr>
<td></td>
<td>Biceps femoris</td>
</tr>
</tbody>
</table>
Rotatory movements at the knee are of a small range. Rotations take place around a vertical axis, and are permitted in the lower compartment of the joint, below the menisci. Rotatory movements may be combined with flexion and extension or conjunct rotations, or may occur independently in a partially flexed knee or adjacent rotations. The conjunct rotations are of value in locking and unlocking of the knee.

During different phases of movements of the knee, different portions of the patella articulate with the femur. The lower pair of articular facets articulates during extension; middle pair during beginning of flexion; upper pair during midflexion; and the medial strip during full flexion of the knee (see Figs 2.21 and 12.10).

**Locking and Unlocking of the Knee Joint**

Locking is a mechanism that allows the knee to remain in the position of full extension as in standing without much muscular effort.

Locking occurs as a result of medial rotation of the femur during the last stage of extension. The anteroposterior diameter of the lateral femoral condyle is less than that of the medial condyle. As a result, when the lateral condylar articular surface is fully ‘used up’ by extension, part of the medial condylar surface remains unused. At this stage the lateral condyle serves as an axis around which the medial condyle rotates backwards, i.e. medial rotation of the femur occurs, so that the remaining part of the medial condylar surface is also ‘taken up’. This movement locks the knee joint. Locking is aided by the oblique pull of ligaments during the last stages of extension. When the knee is locked, it is completely rigid and all ligaments of the joint are taut. Locking is produced by continued action of the same muscles that produce extension, i.e. the quadriceps femoris, especially the vastus medialis part.

The locked knee joint can be flexed only after it is unlocked by a reversal of the medial rotation, i.e. by lateral rotation of the femur. Unlocking is brought about by the action of the popliteus muscle.

Accessory or passive movements can be performed in a partially flexed knee. These movements include:

a. A wider range of rotation.
b. Anteroposterior gliding of the tibia on the femur.
c. Some adduction and abduction.
d. Some separation of the tibia from the femur.

**Morphology of Knee Joint**

1. The tibial collateral ligament is the degenerated tendon of the adductor magnus.
2. The fibular collateral ligament is the degenerated tendon of the peroneus longus.

3. Cruciate ligaments represent the collateral ligaments of the originally separate femorotibial joints.
4. Infrapatellar synovial fold indicates the lower limit of the femoropatellar joint.

### CLINICAL ANATOMY

- **Osteoarthritis** is an age related cartilage degeneration of the articular surfaces. It is characterized by growth of osteophytes at the articular ends, which make movements limited and painful. However, osteoarthritis may set in at an early age also due to underlying congenital disorders or fractures around the knee joint.

- Structurally, the knee is a weak joint because the articular surfaces are not congruent. The tibial condyles are too small and shallow to hold the large, convex, femoral condyles in place. The femoropatellar articulation is also quite insecure because of the shallow articular surfaces, and because of the outward angulation between the long axis of the thigh and of the leg.

  The stability of the joint is maintained by a number of factors:

  a. The cruciate ligaments maintain anteroposterior stability.
  b. The collateral ligaments maintain side to side stability.
  c. The factors strengthening the capsule have been enumerated earlier (see page 142, col. 1).
  d. The iliotibial tract plays an important role in stabilizing the knee (see Fig. 38).

- **Deformities of the Knee**: The angle between the long axis of the thigh and of the leg may be abnormal and the leg may be abnormally abducted (genu varum or knock knee) or abnormally adducted (genu varum or bow knee). This may occur due to rickets, and posture, or as a congenital abnormality (Fig. 12.14).

- **Diseases of the Knee**: The knee joint may be affected by various diseases. These include osteoarthritis and various infections. Infections may be associated with collections of the fluid in the joint cavity. This gives rise to swelling above, and at the sides of the patella. The patella appears to float in the fluid. Aspiration of fluid can be done by passing a needle into the joint on either side of the patella. Bursae around the joint may get filled with fluid resulting in swellings.

- **Injuries to the Knee**:
  a. **Injuries to menisci**: Strains in a slightly flexed knee, as in kicking a football, the meniscus may get separated from the capsule, or may be torn longitudinally (bucket-handle tear) or transversely (see Fig. 2.18).
The medial meniscus is more vulnerable to injury than the lateral because of its fixity to the tibial collateral ligament, and because of greater excursion during rotatory movements. The lateral meniscus is protected by the popliteus which pulls it backwards so that it is not crushed between the articular surfaces.

Injuries to cruciate ligaments are also common. The anterior cruciate ligament is more commonly damaged than the posterior. It may be injured in violent hyperextension of the knee or in anterior dislocation of the tibia. The posterior ligament is injured in posterior dislocation of the tibia. The injury may vary from simple sprain to complete tear. Tear of the ligaments leads to abnormal anteroposterior mobility (Figs 12.15a and b).

Injuries to collateral ligaments are less common, and may be produced by severe abduction and adduction strains (Figs 12.16a and b).

Mal-alignment of patella: Ideally the patella is resting in the centre of the width of the femur in a relaxed standing position. However, the patella position may be altered congenitally or due to tightness of surrounding structures which may lead to painful conditions of the patello-femoral joint.

Semimembranosus bursitis is quite common. It causes a swelling in the popliteal fossa region on the posteromedial aspect (see Fig. 7.5).

Baker’s cyst is a central swelling, occurs due to osteoarthritis of knee joint. The synovial membrane protrudes through a hole in the posterior part of capsule of knee joint.

Hip joint and knee joint may need to be replaced if beyond repair.

In knee joint disease vastus medialis is first to atrophy and last to recover (see Fig. 3.27).

Figs 12.15a and b: Rupture of: (a) Anterior, and (b) posterior cruciate ligaments.

Figs 12.16a and b: Injury of: (a) Medial, and (b) lateral collateral ligaments.

### ANKLE JOINT

**DISSECTION**

Define the margins of both extensor retinacula, one flexor retinaculum and both peroneal retinaculum. Identify the tendons enclosed in synovial sheaths, nerves and blood vessels passing under them. Displace these structures without removing them.

Clean and define the strong medial and lateral ligaments of ankle joint. Also demarcate the thin anterior and posterior parts of the capsule of the joint.

**Type**

This is a synovial joint of the hinge variety.

**Articular Surfaces**

The upper articular surface is formed by:

1. The lower end of the tibia including the medial malleolus.
2. The lateral malleolus of the fibula, and
3. The inferior transverse tibiofibular ligament. These structures form a deep socket (Fig. 12.18).
   The inferior articular surface is formed by articular areas on the upper, medial and lateral aspects of the talus.

   Structurally, the joint is very strong. The stability of the joint is ensured by:
   a. Close interlocking of the articular surfaces.
   b. Strong collateral ligaments on the sides.
   c. The tendons that cross the joint, four in front, and three on posteromedial side and two on posterolateral side (Fig. 12.17).

   The depth of the superior articular socket is contributed by:
   a. The downward projection of medial and lateral malleoli, on the corresponding sides of talus.
   b. By the inferior transverse tibiofibular ligament that bridges across the gap between the tibia and the fibula behind the talus (Fig. 12.18). The socket is provided flexibility by strong tibiofibular ligaments and by slight movements of the fibula at the superior tibiofibular joint.

   There are two factors, however, that tend to displace the tibia and fibula forwards over the talus. These factors are:
   a. The forward pull of tendons which pass from the leg to the foot.
   b. The pull of gravity when the heel is raised. Displacement is prevented by the following factors:
      i. The talus is wedge-shaped, being wider anteriorly. The malleoli are oriented to fit this wedge.
   ii. The posterior border of the lower end of the tibia is prolonged downwards.
   iii. The presence of the inferior transverse tibiofibular ligament.
   iv. The tibiocalcaneal, posterior tibiotalar, calcaneofibular and posterior talofibular ligaments pass backwards and resist forward movement of the tibia and fibula.

**Ligaments**

The joint is supported by:
   a. Fibrous capsule.
   b. The deltoid or medial ligament.
   c. A lateral ligament.

**Fibrous Capsule**

It surrounds the joint but is weak anteriorly and posteriorly. It is attached around the articular margins with two exceptions:
1. Posteromedially, it is attached to the inferior transverse tibiofibular ligament.
2. Anteroinferiorly, it is attached to the dorsum of the neck of the talus at some distance from the trochlear surface.

   The anterior and posterior parts of the capsule are loose and thin to allow hinge movements. On each side, however, it is supported by strong collateral ligaments.

   The synovial membrane lines the capsule. The joint cavity ascends for some distance between the tibia and the fibula.

**Deltoid or Medial Ligament**

This is a very strong triangular ligament present on the medial side of the ankle. The ligament is divided

---

**Fig. 12.17:** Anterior view of coronal section through the right ankle joint to show its relations
The suprascapular ligament: It converts the scapular notch into a foramen. The suprascapular nerve passes below the ligament, and the suprascapular artery and vein above the ligament (Fig. 10.3).

The spinoglenoid ligament: It is a weak band which bridges the spinoglenoid notch. The suprascapular nerve and vessels pass beneath the arch to enter the infraspinous fossa.

**SHOULDER JOINT**

**DISSECTION**

Having studied all the muscles at the upper end of the scapula, it is wise to open up and peel into the most mobile shoulder joint.

Identify the muscles attached to the greater and lesser tubercles of humerus. Deep to the acromion look for the subacromial bursa.

Identify coracoacromial, acromion process and triangular coracoacromial arch binding these two bones together.

Trace the supraspinatus muscle from supraspinous fossa of scapula to the greater tubercle of humerus. On its way it is intimately fused to the capsule of the shoulder joint. In the same way, tendons of infraspinatus and teres minor also fuse with the posterior part of the capsule.

 Inferiorly trace the tendon of long head of triceps brachii from the infraglenoid tubercle of scapula.

Cut through the subscapularis muscle at the neck of scapula. It also gets fused with the anterior part of capsule of the shoulder joint as it passes to the lesser tubercle of humerus.

Having studied the structures related to shoulder joint, the capsule of the joint is to be opened.

A vertical incision is given in the posterior part of the capsule of the shoulder joint. The arm is rotated medially and laterally. This helps in head of humerus getting separated from the shallow glenoid cavity.

Inside the capsule, the shining tendon of long head of biceps brachii is visible as it traverses the intertubercular sulcus to reach the supraglenoid tubercle of scapula. This tendon also gets continuous with the labrum glenoidale attached to the rim of glenoid cavity.

**Type**

The shoulder joint is a synovial joint of ball and socket variety.

The articular surface, ligaments, bursae related to this important joint are explained below.

**Articular Surface**

The joint is formed by articulation of the glenoid cavity of scapula and the head of the humerus. Therefore, it is also known as the glenohumeral articulation.

Structurally, it is a weak joint because the glenoid cavity is too small and shallow to hold the head of the humerus in place (the head is four times the size of the glenoid cavity). However, this arrangement permits great mobility. Stability of the joint is maintained by the following factors:

1. The coracoacromial arch or secondary socket for the head of the humerus (see Fig. 6.8).
2. The musculotendinous cuff of the shoulder (see Fig. 6.7).
3. The glenoidal labrum (Latin lip) helps in deepening the glenoid fossa. Stability is also provided by the muscles attaching the humerus to the pectoral girdle, the long head of the biceps brachii, the long head of the triceps brachii.

Atmospheric pressure also stabilises the joint.

**Ligaments**

1. The capsular ligament: It is very loose and permits free movements. It is least supported inferiorly where dislocations are common. Such a dislocation may damage the closely related axillary nerve (see Fig. 6.12).

Medially, the capsule is attached to the scapula beyond the supraglenoid tubercle and the margins of the labrum.

Laterally, it is attached to the anatomical neck of the humerus with the following exceptions:

- Inferiorly, the attachment extends down to the surgical neck.

- Superiorly, it is deficient for passage of the tendon of the long head of the biceps brachii.
Anteriorly, the capsule is reinforced by supplemental bands called the superior, middle and inferior glenohumeral ligaments. The area between the superior and middle glenohumeral ligament is a point of weakness in the capsule (Foramen of Weitbrecht) which is a common site of anterior dislocation of humeral head.

The capsule is lined with synovial membrane. An extension of this membrane forms a tubular sheath for the tendon of the long head of the biceps brachi.

2. The coracohumeral ligament: It extends from the root of the coracoid process to the neck of the humerus opposite the greater tubercle. It gives strength to the capsule.

3. Transverse humeral ligament: It bridges the upper part of the bicipital groove of the humerus (between the greater and lesser tubercles). The tendon of the long head of the biceps brachii passes deep to the ligament.

4. The glenoidal labrum: It is a fibrocartilaginous rim which covers the margins of the glenoid cavity, thus increasing the depth of the cavity.

Bursae Related to the Joint

1. The subacromial (subdeltoid) bursa (see Figs 6.7 and 6.8).
2. The subscapularis bursa, communicates with the joint cavity.
3. The infraspinatus bursa, may communicate with the joint cavity.

The subacromial bursa and the subdeltoid bursae are commonly continuous with each other but may be separate. Collectively they are called the subacromial bursa, which separates the acromion process and the coracoacromial ligaments from the supraspinatus tendon and permits smooth motion. Any failure of this mechanism can lead to inflammatory conditions of the supraspinatus tendon.

Relations

- **Superiorly:** Coracoacromial arch, subacromial bursa, supraspinatus and deltoid (Fig. 10.4).
- **Inferiorly:** Long head of the triceps brachii, axillary nerves and posterior circumflex humeral artery.
- **Anteriorly:** Subscapularis, coracobrachialis, short head of biceps brachii and deltoid.
- **Posteriorly:** Infraspinatus, teres minor and deltoid.
- **Within the joint:** Tendon of the long head of the biceps brachi.

Blood Supply

1. Anterior circumflex humeral vessels.
2. Posterior circumflex humeral vessels.
3. Suprascapular vessels.
4. Subscapular vessels.

Nerve Supply

1. Axillary nerve.
2. Musculocutaneous nerve.
3. Suprascapular nerve.

Movements of Shoulder Joint

The shoulder joint enjoys great freedom of mobility at the cost of stability. There is no other joint in the body which is more mobile than the shoulder joint. This wide range of mobility is due to laxity of its fibrous capsule, and the four times larger size of the head of the humerus as compared with the shallow glenoid cavity. The range of movements is further increased by

---

**Fig. 10.4:** Schematic sagittal section showing relations of the shoulder joint

- Acromion
- Supraspinatus
- Infraspinatus
- Posterior fibres of deltoid
- Teres minor
- Glenoidal labrum
- Long head of triceps brachii
- Axillary nerve and posterior circumflex humeral vessels
- Teres major
- Subacromial bursa
- Coracoacromial ligament
- Anterior fibres of deltoid
- Tendon of long head of biceps brachii
- Coracoid process
- Capsule of shoulder joint
- Cephalic vein
- Coracobrachialis
- Short head of biceps brachii
- Pectoralis major
- Subscapularis
- Brachial vessels
concurrent movements of the shoulder girdle (Figs 10.5a and b and 10.6a to f).

However, this large range of motion makes the glenohumeral joint more susceptible to dislocations, instability, degenerative changes and other painful conditions specially in individuals who perform repetitive overhead motions (cricketers).

Movements of the shoulder joint are considered in relation to the scapula rather than in relation to the sagittal and coronal planes. When the arm is by the side (in the resting position) the glenoid cavity faces almost equally forwards and laterally; and the head of the humerus faces medially and backwards. Keeping these directions in mind, the movements are analysed as follows.

1. Flexion and extension: During flexion the arm moves forwards and medially and during extension the arm moves backwards and laterally. Thus flexion and extension take place in a plane parallel to the surface of the glenoid cavity (Figs 10.6a and b).

2. Abduction and adduction: take place at right angles to the plane of flexion and extension, i.e. approximately midway between the sagittal and coronal planes.

Figs 10.6a to f: Movements of the shoulder joint: (a) Flexion, (b) extension, (c) abduction, (d) adduction, (e) medial rotation, (f) lateral rotation
coronal planes. In abduction, the arm moves anterolaterally away from the trunk. This movement is in the same plane as that of the body of the scapula (Figs 10.6c and d).

3 **Medial and lateral rotations** are best demonstrated with a midflexed elbow. In this position, the hand is moved medially across the chest in medial rotation, and laterally in lateral rotation of the shoulder joint (Figs 10.6e and f).

4 **Circumduction** is a combination of different movements as a result of which the hand moves along a circle. The range of any movement depends on the availability of an area of free articular surface on the head of the humerus.

Muscles bringing about movements at shoulder joint are shown in Table 10.1. Abduction has been analysed.

### Analysis of the overhead movement of the shoulder

The overhead movements of flexion and abduction of the shoulder are brought about by smooth and coordinate motion at all joints of the shoulder complex: glenohumeral, sternoclavicular, acromioclavicular, and scapulothoracic. Only glenohumeral joint motion cannot bring about the 180 degrees of movement that takes place in overhead shoulder movements. The scapula contributes to overhead flexion and abduction by rotating upwardly by 50–60 degrees. The glenohumeral joint contributes 100–120 degrees of flexion and 90–120 degrees of abduction to the total 170–180 degrees of overhead movements. This makes the overall ratio of 2 degrees of motion of shoulder to 1 degree of scapulothoracic motion and is often referred to as "Scapulo-humeral Rhythm". This for every 15 degrees of elevation, 10 degrees occur at shoulder joint and 5 degrees are due to movement of the scapula.

The humeral head undergoes lateral rotation at around 90 degrees of abduction to help clear the greater tubercle under the acromion. Although deltoid is the main abductor of the shoulder, the rotator muscles, namely the supraspinatus, infraspinatus, teres minor and the subscapularis play a very important role in providing static and dynamic stability to the head of the humerus. Thus, the deltoid and these four muscles constitute a "couple" which permits true abduction in the plane of the body of the scapula.

In addition, the scapular muscles such as trapezius, serratus anterior, levator scapulae and rhomboids provide stability and mobility to the scapula in the coordinated overhead motion.

Serratus anterior is chiefly inserted into the inferior angle of scapula. It rotates this angle laterally. At the same time, trapezius rotates the medial border at root of spine of scapula downwards. The synergic action of these two muscles turns the glenoid cavity upwards increasing the range of abduction at the shoulder joint.

### Table 10.1: Muscles bringing about movements at the shoulder joint

<table>
<thead>
<tr>
<th>Movements</th>
<th>Main muscles</th>
<th>Accessory muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Flexion</td>
<td>• Clavicular head of the pectoralis major</td>
<td>• Coracobrachialis</td>
</tr>
<tr>
<td></td>
<td>• Anterior fibres of deltoid</td>
<td>• Short head of biceps brachii</td>
</tr>
<tr>
<td></td>
<td>• Posterior fibres of deltoid</td>
<td>• Teres major</td>
</tr>
<tr>
<td></td>
<td>• Latissimus dorsi</td>
<td>• Long head of triceps brachii</td>
</tr>
<tr>
<td>2. Extension</td>
<td>• Pectoralis major</td>
<td>• Sternocostal head of the pectoralis major</td>
</tr>
<tr>
<td></td>
<td>• Latissimus dorsi</td>
<td>• Teres major</td>
</tr>
<tr>
<td></td>
<td>• Short head of biceps brachii</td>
<td>• Coracobrachialis</td>
</tr>
<tr>
<td>3. Adduction</td>
<td>• Long head of triceps brachii</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Both initiate abduction and are involved</td>
<td>• Subscapularis</td>
</tr>
<tr>
<td></td>
<td>throughout the range of abduction from 0°–90°</td>
<td></td>
</tr>
<tr>
<td>4. Abduction</td>
<td>• Serratus anterior 90°–180°</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Upper and lower fibres of trapezius 90°–180°</td>
<td></td>
</tr>
<tr>
<td>5. Medial rotation</td>
<td>• Pectoralis major</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Anterior fibres of deltoid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Latissimus dorsi</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Teres major</td>
<td></td>
</tr>
<tr>
<td>6. Lateral rotation</td>
<td>• Posterior fibres of deltoid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Infraspinatus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Teres minor</td>
<td></td>
</tr>
</tbody>
</table>
3) **Distal radio-ulnar joint**: It is a *pivot joint* ([PGL^83]) (a synovial joint) between the head of ulna and ulnar notch of radius.

- **Movements at radioulnar joints are pronation and supination** ([ATOS, AHMS^86]).

<table>
<thead>
<tr>
<th>Movement</th>
<th>Muscles causing movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pronation</td>
<td>Pronator quadratus (strong pronator), Pronator teres (Rapid pronator).</td>
</tr>
<tr>
<td>Supination</td>
<td>Supinator (when elbow is extended), Biceps (when elbow is flexed).</td>
</tr>
</tbody>
</table>

**Radiocarpal (wrist) and midcarpal joints**

- Wrist is a biaxial ellipsoid joint ([UP^85]) formed proximally by distal end of radius and articular disc articular disc distally with scaphoid, lunate and triquetral bones ([UP^85]). Midcarpal joint is formed between proximal and distal carpal bones.

<table>
<thead>
<tr>
<th>Movement</th>
<th>Joint involved</th>
<th>Muscles causing movements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>Radiocarpal and midcarpal</td>
<td>Flexor carpi radialis, flexor carpi ulnaris, and palmaris longus assisted by flexor digitorum superficialis and profundus, and flexor pollicis longus (muscles of anterior compartment of forearm).</td>
</tr>
<tr>
<td>Extension</td>
<td>Wrist</td>
<td>Extensor carpi radialis longus and brevis, and extensor carpi ulnaris, assisted by extensor digitorum, extensor pollicis longus.</td>
</tr>
</tbody>
</table>
Scapular-humeral mechanism

- Movement at shoulder joint occurs not only at gleno-humeral joint, but is also contributed by rotation of scapula on thoracic wall. In abduction, out of total 180° elevation, humerus moves 120° at the shoulder joint and the remaining 60° is done by rotation of scapula. In every 15° elevation, shoulder joint contributes 10° and scapular rotation 5°, in the ratio of 2:1. Rotation of scapula is facilitated by movements at sternoclavicular and acromioclavicular joints. In higher ranges of abduction there is lateral rotation of humerus. Lateral rotation of scapula increases the range of humeral elevation.

- Abduction is initiated by supraspinatus, which is responsible abduction upto 15° (Aims 93). After that deltoid (acromial or middle fibers) is the major abductor upto 90° of abduction. These two muscles, supraspinatus and deltoid are the prime movers for abduction. Overhead abduction (> 90°) is caused by trapezius (DPG 03, PGI 83) and serratus anterior (DPG 82, PGI 83), which act by causing upward rotation of glenoid cavity.

Applied Anatomy

- Painful arc syndrome is characterized by pain during mid range of abduction (60° to 120°) with freedom from pain during the initial and terminal stages. This can be produced by (i) minor (partial) tear of supraspinatus; (ii) supraspinatus tendon inflammatory degeneration (supraspinatus tendinitis); (iii) calcific deposits in supraspinatus tendon; (iv) subacromial bursitis; and (v) Greater tuberosity fracture.

- Shoulder joint is the commonest joint in human body to dislocate. Anterior dislocation is most common. Complete tear of supraspinatus is characterized by inability to initiate abduction (PGI 97), but further abduction is possible if limb is abducted passively to 15°.
### Muscles producing movements

<table>
<thead>
<tr>
<th>Movement</th>
<th>Main muscles</th>
<th>Accessory muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>i) Clavicular head of pectoralis major</td>
<td>i) Corachobrachialis</td>
</tr>
<tr>
<td></td>
<td>ii) Anterior fibers of deltotid</td>
<td>ii) Short head of biceps</td>
</tr>
</tbody>
</table>
|                |                                                   | iii) Sternocostal head of pectoralis major |}
| Extension      | i) Posterior fibres of deltotid                  | i) Teres major                        |
|                | ii) Latissimus dorsi                              | ii) Long head of triceps              |
| Adduction      | i) Pectoralis major                               | i) Teres major                        |
|                | ii) Latissimus dorsi                              | ii) Corachobrachialis                 |
| Abduction      | i) **Deltoid** *(PGI 97, AI 95)* (middle or acromial fibers) | iii) Short head of biceps              |
|                | ii) **Supraspinatus** *(PGI 97, AI 95)*            | iv) Long head of triceps              |
|                | iii) **Serratus anterior** *(PGI 97, AI 95)*       |                                         |
|                | iv) Upper and lower fibers of trapezius           |                                         |
| Medial rotation| i) Pectoralis major                               |                                         |
|                | ii) Anterior fibers of deltotid                  |                                         |
|                | iii) Latissimus dorsi                             |                                         |
|                | iv) Teres major                                   |                                         |
| Lateral rotation| i) Posterior fibres of deltotid                  | i) Subscapularis                      |
|                | ii) **Infraspinatus**                             |                                         |
|                | iii) Teres minor                                  |                                         |
**Sterno-clavicular joint**

- It is a saddle type of synovial joint. It is formed by sternal end of the clavicle and clavicular notch of sterni. The joint cavity is completely subdivide by a fibrocartilagenous articular disc which fuses with the anteriorly and posteriorly.

**Acromioclavicular joint**

- It is a plane synovial joint. Bone forming the joint are the lateral end of the clavicle and clavicular facet on the margin of the acromian process of scapula. The main bond of union is coracoclavicular ligament, which part, conoid (medial) and trapezoid (lateral). The weight of the upper limb is transmitted to the medial to of the clavicle and thence to the axial skeleton through the coraco-clavicular ligment.

**Movement of the shoulder girdle**

- Both acromio-clavicular and sternoclavicular joints allow gliding (translatory) and rotatory movements of the scapula.

The scapular gliding includes elevation, depression, protraction and retraction. The scapular rotation forward or backward as expressed by the movements of inferior angle of scapula.

<table>
<thead>
<tr>
<th>Movements of scapula</th>
<th>Muscles causing movements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation</td>
<td>Trapezius (upper part), levator scapulae</td>
</tr>
<tr>
<td>Depression</td>
<td>Pectoralis minor, serratus anterior</td>
</tr>
<tr>
<td>Protraction</td>
<td>Serratus anterior, pectoralis minor</td>
</tr>
<tr>
<td>Retraction</td>
<td></td>
</tr>
<tr>
<td>Forward rotation of inferior angle</td>
<td>Rhomboideus major ( \text{AIIMS 10, AMU 87} )</td>
</tr>
<tr>
<td>(for overhead abduction)</td>
<td>Rhomboideus minor ( \text{AIIMS 10, AMU 87} ), Trapezius ( \text{AIIMS 10, AMU 87} )</td>
</tr>
<tr>
<td>Backward rotation</td>
<td>Trapezius (upper fibers), serratus anterior (lower fibers)</td>
</tr>
<tr>
<td></td>
<td>Levator scapulae, rhomboideus major and minor</td>
</tr>
</tbody>
</table>
CLINICAL ANATOMY

- The clavicle may be dislocated at either of its ends. At the medial end, it is usually dislocated forwards. Backward dislocation is rare as it is prevented by the costoclavicular ligament.
- The main bond of union between the clavicle and the manubrium is the articular disc. Apart from its attachment to the joint capsule the disc is also attached above to the medial end of the clavicle, and below to the manubrium. This prevents the sternal end of the clavicle from tilting upwards when the weight of the arm depresses the acromial end (Fig. 10.1).
- The clavicle dislocates upwards at the acromioclavicular joint, because the clavicle overrides the acromion.
- The weight of the limb is transmitted from the scapula to the clavicle through the coracoclavicular ligament, and from the clavicle to the sternum through the sternoclavicular joint. Some of the weight also passes to the first rib by the costoclavicular ligament. The clavicle usually fractures between these two ligaments (Fig. 10.1).

Dislocation: The shoulder joint is more prone to dislocation than any other joint. This is due to laxity of the capsule and the disproportionate area of the articular surfaces. Dislocation usually occurs when the arm is abducted. In this position, the head of the humerus presses against the lower unsupported part of the capsular ligament. Thus, almost always the dislocation is primarily gleno-humeral. Dislocation endangers the axillary nerve which is closely related to the lower part of the joint capsule.

Optimum attitude: In order to avoid ankylosis, many diseases of the shoulder joint are treated in an optimum position of the joint. In this position, the arm is abducted by 45–90 degrees.

Shoulder tip pain: Irritation of the peritoneum underlying diaphragm from any surrounding pathology causes referred pain in the shoulder. This is so because the phrenic nerve carrying impulses from peritoneum and the supraclavicular nerves (supplying the skin over the shoulder) both arise from spinal segments C3, C4 (Figs 10.7a and b).

The shoulder joint is most commonly approached (surgically) from the front. However, for aspiration the needle may be introduced either anteriorly through the deltopectoral triangle (closer to the deltoid), or laterally just below the acromion (Fig. 10.8).

Frozen shoulder: This is a common occurrence. Pathologically, the two layers of the synovial membrane become adherent to each other.

Clinically, the patient (usually 40–60 years of age) complains of progressively increasing pain in the shoulder, stiffness in the joint and restriction of all movements particularly external rotation, abduction and medial rotation. As the contribution of the gleno-humeral joint is reduced, the patient shows altered scapulo-humeral rhythm due to excessive use of scapular motion while performing overhead flexion and abdution. The surrounding muscles show disuse atrophy. The disease is self-limiting and the patient may recover spontaneously in about two years and much earlier by physiotherapy.

Shoulder joint disease can be excluded if the patient can raise both his arms above the head and bring the two palms together (Fig. 10.9). Deltoid, biceps, and axillary nerve are likely to be intact.

DANCING SHOULDER

When one flexes the arm at shoulder joint, there is one small point which you must remember; whether it is July or November there is a gamble of two muscles—Pectoralis major and Anterior deltoid in the tussles.

To Teres major, Latissimus dorsi was happily married but while extending, these got joined with Posterior deltoid.

In adduction of course, the joint decided a better course.

It went off with two majors (Pectoralis major and Teres major),

On the way they stopped for some gazers,

The two majors danced with Subscapularis during medial rotation,

Even Anterior deltoid and Latissimus dorsi, soon joined the happy flirtation

If one wants the joint to laterally rotate, then there is difference in the rate.

Posterior deltoid dances with Infraspinatus, Even Teres minor comes and triangulates.

When just abduction is desired, Supraspinatus and Mid-deltoid are required.

But if Kapil Dev has to do the bowling come Trapezius and Serratus anterior following.

Small muscles provide stability

Large ones give it mobility

And shoulder joint dances, dances and dances.
Figs 10.7a and b: (a) Shoulder tip pain. Other sites of referred pain also shown, and (b) anatomical basis of pain.
TESTIS
- Testis is the male gonad. It is suspended in the scrotum by spermatic cord. Left testis is slightly (1 cm) lower than the right one. The average testicular dimensions are 5 cm (length), 2.5 cm (breadth), 3 cm (anteroposterior diameter or thickness) and 10.5-14 gms (weight). The epididymis is attached to it is posterolateral surface. Vas (ductus) deferens arises from lower pole of epididymis. Lateral part of epididymis is separated from testis by an extension of cavity of tunica vaginalis, called sinus of epididymis. There is small oval body attached to upper pole of testis called appendix of testis, a remnant of paramesonephric duct.
- Testis is covered by three coats: (i) tunica vaginalis (which has a parietal and a visceral layer); (ii) tunica albuginea, and (iii) tunica vasculosa. Outside these three coats, there are layers of scrotum.

Structure
- Testis consists of 200-300 lobules. Each lobules consists of 2-3 seminiferous tubules (where spermatozoa are formed). Seminiferous tubules join at the apex of lobules to form straight tubules, which anastomose with each other to form rete testis. Which emerge from upper pole and enter the epididymis. Each tubule becomes highly coiled to form a lobe of the head of epididymis. All tubules end in a single duct which is coiled on itself to form the body and tail of the epididymis. It is continuous with ductus deferens.
- Arterial supply: Testes are supplied by testicular artery, a branch of abdominal aorta, arises at L2 vertebral level.
- Venous drainage: The veins emerging from the testis and epididymis form the pampiniform plexus. Anterior part of the plexus is arranged around the testicular artery, middle part around ductus deferens and its artery, and posterior part is isolated. The plexus condenses into 4 veins at the superficial inguinal ring and 2 veins at the deep inguinal ring. Ultimately, one vein is formed which drains into inferior vena cava on the right and into left renal vein on the left.
- Lymphatic drainage: Lymphatics from the testis run back with the testicular artery at the level of origin of testicular arteries (L2 vertebra).

EPIDIDYMS AND DUCTUS DEFERENS
- Epididymis is a firm structure, attached behind the testis. Its upper end is called head. Head is made up of highly coiled efferent ductules coming for upper end of testis. The middle part is called body and lower part is called tail. The body and tail are made up of a single duct, the duct of the epididymis which is highly coiled on itself. At the lower end of tail, this duct becomes continuous with the ductus deferens.
- Ductus deferens (Vas deferens) is a direct continuation of the canal of the epididymis. It is a thick-walled muscular tube with a narrow lumen except at the terminal dilated part called the ampulla. It enters the spermatic cord, passes through the inguinal canal, and enters the peritoneum behind the bladder. The part lying behind the bladder is dilated to form ampulla and there is no intervening peritoneum between bladder base and ductus deferens. At the base of prostate it is joined by the duct of seminal vesicle to form ejaculatory duct.
- The epididymis is supplied by testicular artery, a branch of descending aorta. Ductus deferens is supplied by artery to ductus deferens, a branch of superior vesical artery, occasionally artery to ductus deferens may arise from inferior vesical artery.

SPERMATIC CORD
- The spermatic cord consists of a tubular sheath extending from the deep inguinal ring to the upper part of posterior border of testis. Constituents of spermatic cord are:
  i) Ductus deferens (Vas deferens)
  ii) Arteries: Testicular artery, cremasteric artery, artery to ductus deferens.
  iii) Veins: Pampiniform plexus.
  iv) Nerves: Genital branch of genitofemoral nerve, sympathetic plexus around arteries.
- Others: Lymphatics, remains of the processus vaginalis.
- Covering of spermatic cord, from within outwards, are: (i) internal spermatic fascia, (ii) cremasteric fascia and (iii) external spermatic fascia.

PROSTATE
- It is an accessory gland of the male reproductive system. Its average dimensions are 4 cm (transverse diameter), 3 cm (vertical diameter or length), 2 cm (thickness or anteroposterior diameter). It has an apex, a base and four surfaces: anterior, posterior and two interlateral. Apex rests on urogenital diaphragm. Base is related to bladder neck. Posterior surface is separated from rectum by the fascia of Denonvilliers which is the obliterate...
The male reproductive organs include:

- **External genitalia**: Penis, scrotum, testis, epididymis, and part of ductus deferens.
- **Internal genitalia**: Part of ductus deferens, seminal vesicle, ejaculatory ducts and prostate.

**PENIS**

- **Penis** is the male organ of copulation. The penis has a root and a body.
- **The root of penis** is situated in the superficial perineal pouch, attached to the inferior surface of the perineal membrane. It consists of three masses of erectile tissue: bulbus penis and two crura. Each crus continues forward to become the corpus cavernosum (in the body) and bulb is the posterior end of the corpus spongiosum (of the body).
- **Body of penis** is the free portion of the penis. It is composed of three elongated masses of erectile tissues: right and left corpora cavernosa, and median corpus spongiosum. Corpora cavernosa are enveloped by tunica albuginea and corpus spongiosum is also surrounded by tunica albuginea. The urethra runs through the whole length of the corpus spongiosum from the bulb to the back to the terminal expanded part of corpus spongiosum, called glans penis.
- **The superficial fascia of penis** differentiates into an outer loose areolar tissue and an inner well-defined membrane known as fascia penis or buck’s fascia. The aerolar tissue is devoid of fat, extends into the substance of the prepuce and contains on the dorsal surface an unpaired superficial dorsal vein of the penis. Membranous layer (fascia penis) is a prolongation of Colle’s fascia of perineum. Membranous layer (fascia penis) extends up to neck of penis where it blends with the fibrous sheath of the corpora cavernosa and corpus spongiosum. Proximally it is continuous with fascia scara of anterior abdominal wall and dartos muscle of scrotum.

**Blood supply and lymphatic drainage**

- **Arterial supply** of the penis comes from following two arteries:
  1. **Internal pudendal artery**: Through its three branches: (i) deep artery of penis, (ii) dorsal artery of penis and (iii) artery of the bulb of the penis.
  2. **Femoral artery**: Through is branch superficial external pudendal.
- **Lymphatics** from glans drain into the deep inguinal nodes. From rest of the penis lymph drains into the superficial inguinal nodes.

**Nerve supply**

1. **Somatic supply**: Skin of the penis is supplied by pudendal nerve (via dorsal nerve of penis and posterior scrotal nerve). A small area on the dorsum of proximal penis (root) is supplied by ilioinguinal nerve (via perineal branch of pudendal nerve).
2. **Parasympathetic**: It is responsible for erection and is derived from pelvic splanchnic nerves (nervi erigentes); S2, S3, S4). Parasympathetic stimulation causes vasodilation (via NO) and increased blood flow to the cavernous tissue of all three corpora (right and left corpora cavernosa and corpus spongiosum). This results in erection.
3. **Sympathetic**: It is responsible for ejaculation (initial part) and is derived from L1 segment via superior and inferior hypogastric plexus.

**SCROTUM**

- The scrotum is a cutaneous bag containing the right and left testes, the epididymis and the lower parts of spermatic cords. The left half of the scrotum hangs a little lower than the right. The layers of scrotum from outside to inside are:
  - **Skin**
  - **Dartos muscle** (smooth muscle layer) continuous with Colle’s fascia of perineum posteriorly and Scarpa’s fascia anteriorly.
  - **The external spermatic fascia**, external oblique.
  - **The cremaster muscle**, continuous with fascia from internal oblique.
  - **The internal spermatic fascia**, continuous with fascia from transversalis.
- **Anterior one-third of scrotum** is supplied by ilioinguinal nerve (L1) and genitofemoral nerve (L1, L2). **Posterior two-third of scrotum** is supplied by posterior scrotal nerves (S1) and perineal branch of posterior cutaneous nerve of thigh (S2). The dartos muscle is supplied by the genitofemoral nerve.
- **Hydrocele** is a condition in which fluid accumulates in the process vaginalis of peritoneum. Tapping of hydrocele involves removing the excess fluid from tunica vaginalis. The layers penetrated (from outside in) are: **Skin, dartos muscle, external spermatic fascia, cremasteric muscle and fascia, internal spermatic fascia and parietal layer of tunica vaginalis**.
GENITAL ORGANS [177]

Notes of Dr. Ravindra Goswami (IAS-2015, AIR-153)

Eckovation App
Group Code: 873541

rectovesical pouch of peritoneum. Posterior surface is palpated on per rectum examination (PRP). Anterior surface lies behind the pubic symphysis and is separated from it by extraperitoneal fat in retropubic space (cave of Retzius). Interlateral surfaces are related to side wall of pelvis, levator ani, retropubic space and fat structures.

- The prostate is incompletely divided into five lobes. The anterior lobe lies in front of the urethra and devoid of glandular tissue hence adenoma seldom occurs here. The Median lobe (Middle lobe) is situated between prostatic urethra and ejaculatory duct. Its upper part is related to trigone bladder. It contains glandular tissue and is most common site of benign prostatic hyperplasia (BPH) and adenoma. The posterior lobe is situated behind the urethra and below the ejaculatory duct. It also contains glandular tissue and is the most common site for prostatic carcinoma. The right and left lateral lobes lie on either side of urethra. Lateral lobe contains many glands.

Mc Neal's classification
- According to Mc Neal, the gland is divided into:
  1. Peripheral zone (70%) - Lies posteriorly (corresponds to posterior lobe) and most common zone for carcinoma.
  2. Central zone (25%) - Lies posterior to urethra and above ejaculatory duct (corresponds to median lobe).
  3. Periurethral transition zone (5%) - Corresponds to anterior and lateral lobes.

Histological features
- In section, the glandular tissue of the prostate is seen in the form of numerous follicles that are lined by columnar epithelium. The follicles drain into 12 to 20 excretory ducts that open into the prostatic urethra. The ducts are lined by a double layered epithelium. The superficial (luminal) layer is columnar and the deeper layer is cuboidal. Small rounded masses of uniform or lamellated structure are found within the lumen of the follicles. These are called corpora amylacea or amyloid bodies. They are more abundant in older individuals and consist of glycoprotein. They may be calcified.
- Prostate is surrounded by a true capsule and a false capsule. Prostatic venous plexus lies between true and false capsules.
- During prostatectomy both capsules (true and false) are left behind as prostatic venous plexus lies between true and false capsule (in contrast during thyroidectomy false capsule is left behind and thyroid is removed along with true capsule as venous plexus lies deep to true capsule).

Arterial supply
- Blood supply is through:
  - Inferior vesical artery
  - Middle rectal artery
  - Internal pudendal artery

Venous drainage
- The veins form a prostatic plexus in the space between the true and false capsule. The plexus communicates with vesical plexus and internal pudendal vein. It receives deep dorsal vein of penis in front. Finally it drains into internal iliac vein and vesical vein. There is valveless communication between prostatic plexus and vertebral venous plexus through which prostatic carcinoma can spread to vertebral column and skull.

FEMALE REPRODUCTIVE ORGANS

- Female reproductive organs include external and internal genital organs. External genital system is also known as Vulva, includes mons pubis, labia majora, labia minora, clitoris, vestibule of vagina, bulbs of vestibule and great vestibular glands (Bartholin's gland).
- Internal genital organs comprise ovaries, uterine (fallopian) tube, uterus (including cervix) and vagina.

The ovaries are female gonads. Each ovary lies in the ovarian fossa on the lateral pelvic wall which is bound anteriorly by obliterated umbilical artery and posteriorly by ureter and internal iliac artery. Each ovary has two poles (upper and lower), two borders (anterior and posterior) and two surfaces (medial and lateral).
- Upper pole (tubal end) is related to ovarian fimbra of fallopian tube and external iliac artery. Suspensory ligament of ovary (infundibulopelvic ligament) connects it with pelvic brim.
- Lower pole (uterine end) is connected with lateral angle of uterus by ligament of the ovary, just posterior to the attachment of fallopian tube.
- Lateral surface is related to ovarian fossa and is covered with peritoneum which separates it from Obturator vessels and nerve.
- Medial surface is related to fallopian tube and is separated by a peritoneal recess, called ovarian bursa.
- Anterior border (mesovarian border) is straight and related to fallopian tube and obliterated umbilical artery. It is attached to posterior surface of broad ligament of uterus by mesovarium and forms the hilus of ovaries.
- Posterior border (free border) is convex and is related to fallopian tube and ureter.