

# Core Surgical Sciences course for the Severn Deanery

## Surgical Anatomy: Lower Limb - detailed learning objectives/stations

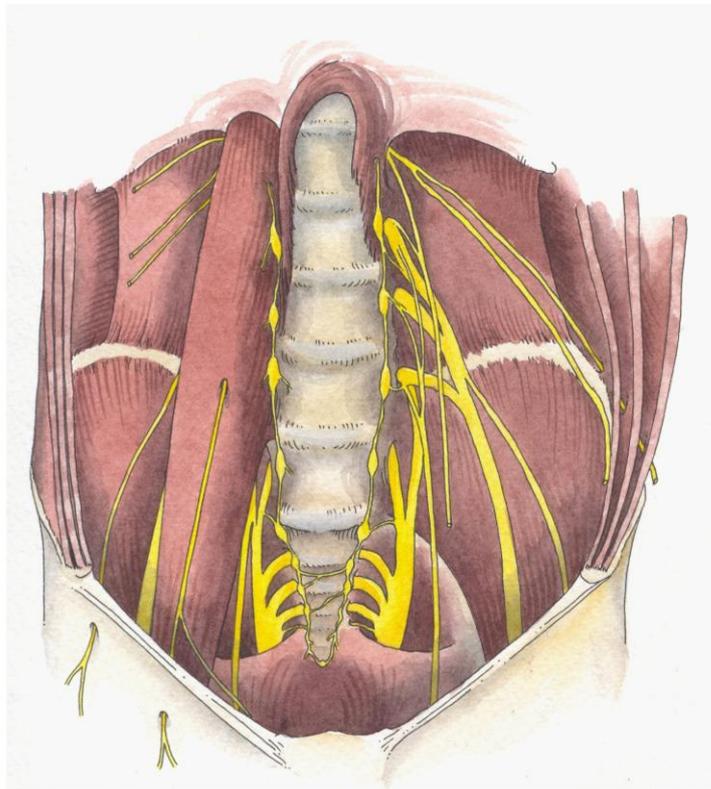
The session will be taught in small groups, with examination of prosections, and three rotating stations: lumbar plexus, hip and femoral triangle; thigh, knee and popliteal fossa; leg, ankle and foot.

### 1. Lumbar plexus, hip and femoral triangle

You should be able to:

Describe and identify the lumbar plexus and its branches:

- Formed by the ventral primary rami of spinal nerves L1 to L4
- Lies between anterior and posterior masses of psoas major
- L1 ventral primary ramus divides to form the iliohypogastric and ilioinguinal nerves: the iliohypogastric nerve supplies a branch to the upper buttock, then pierces through the anterolateral abdominal muscles to supply the skin of the suprapubic area; the ilioinguinal nerve pierces internal oblique to enter the inguinal canal, running underneath the spermatic cord to the superficial inguinal ring - supplies a small area of skin on the upper thigh, skin over root of the penis/mons pubis and the anterior third of the scrotum/labia majora
- The genitofemoral nerve (L1,2) provides a genital branch, which passes through the deep inguinal ring, into the spermatic cord to supply cremaster muscle, and a femoral branch which passes under the inguinal ligament to supply sensation to a small area of skin in the femoral triangle
- The lateral femoral cutaneous nerve (L2,3) emerges lateral to psoas, passes under inguinal ligament, to supply cutaneous sensation to the lateral thigh
- The femoral nerve (L2, 3 and 4, posterior divisions) emerges lateral to psoas muscle, passes under the inguinal ligament, to supply pectineus and the musculature of the anterior compartment of the thigh, the skin of the anterior and lower medial thigh, and (via saphenous nerve) the skin of the medial side of the leg and ankle
- The obturator nerve (L2, 3 and 4, anterior divisions) emerges medial to psoas muscle, runs just below pelvic brim to pass through the upper part of the obturator foramen, to supply the adductors and skin of the medial thigh
- The lumbosacral trunk (L4,5) emerges medial to psoas and descends into pelvis to reinforce the sacral plexus.



Describe and identify the sacral plexus and its branches:

- Ventral primary rami of spinal nerves L4 to S3 (the tiny coccygeal plexus, from S4, S5 and the coccygeal nerve, supplies skin over the coccyx)
- Sacral plexus roots lie on piriformis, under internal iliac vessels
- Segmental branches supply piriformis, levator ani and coccygeus; pelvic splanchnic nerves from S2,3,4 supply pelvic viscera, via inferior hypogastric (pelvic) plexus
- Branches of the sacral plexus leave the pelvis via the greater and lesser sciatic foramina
- The superior gluteal nerve (L4,5,S1) passes out of the pelvis through the greater sciatic foramen, above piriformis, to supply gluteus medius and minimus, and tensor fasciae latae.
- The inferior gluteal nerve (L5,S1,2) passes out through the greater sciatic foramen, below piriformis, to supply gluteus maximus.
- The sciatic nerve (L4,5, S1,2,3) also emerges into the buttock inferior to piriformis (intramuscular injections should be given in upper outer quadrant of buttock)
- The nerve to quadratus femoris (L4,5,S1) – which supplies that muscle and the inferior gemellus - lies deep to the sciatic nerve and the posterior femoral cutaneous nerve (S1,2,3) – which has branches supplying the perineum, lower buttock, and skin of the posterior thigh – lies superficial to the sciatic nerve.
- The nerve to obturator internus (L5,S1,2) leaves the greater sciatic foramen beneath piriformis, loops around the ischial spine to supply obturator internus and the superior gemellus.
- The pudendal nerve (S2,3,4) exits the pelvis through the greater sciatic foramen, loops around the sacrospinous ligament, and re-enters the pelvis through the lesser sciatic foramen, to lie in the pudendal (Alcock's) canal, providing branches to the anal canal and perineum.
- The perforating cutaneous nerve (S2,3) pierces the sacrotuberous ligament to supply the skin of the lower buttock.

Describe, identify and side the femur:

- head (with fovea for attachment of the ligament of the femoral head)
- anatomical and surgical neck
- greater and lesser trochanters
- shaft and linea aspera
- adductor tubercle
- medial and lateral condyles, intercondylar fossa

Describe and identify the hip joint:

- Synovial, ball and socket joint
- Acetabular labrum and transverse ligament deepen socket; ligament of the head of the femur
- Capsule of the hip joint - strengthened by iliofemoral, pubofemoral and ischiofemoral ligaments

Muscles acting on the hip joint (identify, describe their actions and nerve supply)

- Flexors: psoas major and iliacus, rectus femoris and sartorius
- Extensors: gluteus maximus, hamstrings
- Abductors (and medial rotators): gluteus medius and minimus, and tensor fascia lata
- Adductors (in medial compartment of thigh): pectineus; gracilis; adductors longus, brevis and magnus
- Lateral rotators: piriformis, obturator internus, quadratus femoris and obturator externus

*Hip pathology*

- Dislocation rare - only with considerable force, and often with associated fracture of the acetabulum
- Blood supply to the head of femur derives from diaphyseal and retinacular vessels (and via vessels in the ligament of the head of the femur in children); the retinacular supply may be preserved in intertrochanteric (extracapsular) fractures of the neck of femur, allowing treatment with a dynamic hip screw (DHS), but the blood supply is disrupted in the more common intracapsular fractures, necessitating an arthroplasty.
- Trauma to the hip in children may cause slipped femoral epiphysis
- Normal angulation of femoral neck is around 120 degrees; coxa vara is a decrease in this angle, and coxa valgus an increase.
- Groin injuries or 'pulls' are commonly tears in adductor tendons
- Hamstring injuries are common in athletes: as long muscles crossing 2 joints, these muscles are at risk of tearing
- The hip is a large weight-bearing joint, and a common site for osteoarthritis

Describe the boundaries of the femoral triangle:

- Inguinal ligament above, medial border of sartorius laterally, *medial* border of adductor longus laterally
- Roofed by fascia lata
- Floored by iliacus, psoas, pectineus, adductor longus

Describe the contents of the femoral triangle:

- Femoral artery and vein, and lymph node of Cloquet, within the femoral sheath
- Femoral nerve lateral to femoral sheath

Identify and describe the femoral artery

- Main artery of lower limb
- Derives from external iliac artery as it passes under inguinal ligament; runs through femoral triangle, into adductor canal (with vein and saphenous nerve) and passes through adductor hiatus to become popliteal artery
- Surface anatomy: enters thigh midway between pubic symphysis and ASIS
- Early branches of femoral artery: superficial epigastric artery; superficial circumflex iliac artery; superficial and deep external pudendal artery
- Profunda femoris (arises 3.5cm below inguinal ligament; spirals posteriorly behind femoral artery)
- supplies all thigh muscles (adductors and hamstrings supplied via perforating arteries, and provides medial and lateral circumflex femoral arteries)

*Anastomoses linking branches of femoral artery to branches of the internal iliac*

- Cruciate anastomosis, level with lesser trochanter, is formed from branches of: medial and lateral circumflex femoral arteries, first perforating artery, and inferior gluteal artery
- Anastomosis between external and internal pudendal arteries

*Anastomoses linking external to femoral artery (eg: bypassing ligated proximal femoral artery)*

- Deep and superficial circumflex iliac arteries
- Deep circumflex iliac artery with branches of profunda femoris

NB. Perforating arteries also anastomose with popliteal artery below; anastomotic chain on posterior thigh – linking gluteal arteries, circumflex femoral arteries, perforating arteries, popliteal arteries

Identify and describe the femoral vein

- Commences at adductor hiatus as continuation of popliteal vein
- Receives deep vein (running with profunda femoris), and great saphenous vein (pierces cribriform fascia over saphenous opening in fascia lata)

Describe the inguinal lymph nodes

- Around 10 superficial nodes lie below inguinal ligament and around greater saphenous vein – drain superficial lymphatics of lower limb and lymph from buttock and trunk below umbilicus
- About 4 deep nodes lie deep to fascia lata – drain deep lymphatics and glans penis/clitoris
- Inguinal nodes drain to external iliac nodes

## 2. Thigh, knee and popliteal fossa

Describe, identify and side the patella:

- Sesamoid bone in quadriceps tendon
- Apex inferior
- Lateral articular facet larger than medial (corresponds with relative prominence of lateral condyle of femur – discourages lateral dislocation of patella, along with medial patellar retinaculum and low fibres of vastus medialis, inserting into patella)

Describe, identify and side the tibia:

- Tibial plateau and intercondylar eminence
- Medial and lateral condyles
- Tibial tuberosity
- Medial malleolus

Describe, identify and side the fibula:

- Head, shaft and lateral malleolus (note posterior groove on lateral malleolus for peroneus longus)

NB. The superior tibiofibular joint is synovial joint, whilst the inferior is fibrous; only very slight movement occurs at these joints.

Identify and describe the knee joint:

- Synovial, modified hinge joint – compound joint comprising two tibiofemoral joints and patellofemoral joint
- Joint capsule attaches to margins of femoral and tibial condyles, communicates with suprapatellar and popliteal bursae; attached to rims of menisci; strengthened posteriorly by oblique and arcuate popliteal ligaments
- Medial and lateral menisci – maintain congruence of joint during complex movements
- Anterior and posterior cruciate ligaments
- Tibial and fibular (cord-like) collateral ligaments
- Popliteus muscle
- Patella, quadriceps tendon and patellar ligament, infrapatellar fat pad
- 12 bursae around knee, including suprapatellar, prepatellar, subcutaneous and deep infrapatellar bursae anteriorly; bursae deep and superficial to collateral ligaments on each side, four bursae posteriorly, under the heads of gastrocnemius, semimembranosus and popliteus tendon.

Identify and describe the muscles acting on the knee joint (attachments, actions, nerve supply):

- Popliteus elicits lateral rotation of femur on tibia to 'unlock' knee;
- Extensors: quadriceps femoris
- Flexors - hamstrings: semimembranosus, semitendinosus and biceps femoris; sartorius

### *Knee pathology*

- The prepatellar bursa is most commonly affected by inflammation (from acute or recurrent minor injuries): prepatellar bursitis ('Housemaid's knee')
- Normal knees possess a valgus angle of 10-15 degrees: there is a tendency for the patella to dislocate laterally; the valgus angle of the knee is decreased in genu varum and increased in genu valgum
- The medial meniscus is more liable to damage than the lateral, as it is less mobile.
- Rotation and impact injuries may damage the anterior cruciate ligament; the stronger posterior cruciate ligament is less frequently damaged; assessment by drawer tests
- Osteoarthritis at the knee is more common than at the hip

Describe the boundaries of the popliteal fossa:

- Bounded by semimembranosus and semitendinosus above, heads of gastrocnemius below
- Roofed by fascia lata
- Floored by popliteal surface of femur, knee capsule and popliteus

Describe the contents of the popliteal fossa:

- Popliteal artery (deepest) – muscular and genicular branches
- Popliteal vein – receives deep tributaries running with popliteal artery, and small saphenous vein
- Tibial nerve (running straight down through fossa); branches: muscular branches to plantaris, gastrocnemius, soleus, popliteus; sural nerve, genicular nerves
- Common peroneal nerve (along the edge of biceps); branches: sural communicating nerve, lateral cutaneous nerve of calf, genicular nerves
- Popliteal lymph nodes – around small saphenous vein; receive lymph from above heel

## **2. Leg, ankle and foot**

Describe, identify and side the bones of the feet:

- Tarsal bones: talus, calcaneum, navicular, cuboid, cuneiforms (The metatarsus is relatively immobile compared with the metacarpus)
- Metatarsals
- Phalanges

Note the transverse, medial and lateral longitudinal arches – maintained by bony shape, ligaments and especially tendons.

### *Foot injuries*

- Fractures of talar neck often interrupt the blood supply to the posterior part of the bone (the body) causing avascular necrosis
- Midfoot fractures are uncommon; usually caused by dropping a heavy object on the foot (or kicking a football hard)

Identify and describe important ligaments in the foot:

- Long and short plantar ligaments – help to stabilize the lateral longitudinal arch
- Sustentaculum tali and the plantar calcaneonavicular (spring) ligament – help to stabilize the medial longitudinal arch

Identify and describe the ankle joint:

- A synovial hinge joint between talus, tibia and fibula
- Stabilised by collateral ligaments: deltoid ligament medially; calcaneofibular, anterior and posterior talofibular ligaments laterally – inversion/eversion injuries may tear the collateral ligaments (ankle sprains), and may even cause fractures to the malleoli

Identify and describe the subtalar and transverse tarsal joints:

- Inversion and eversion occur at these joints (*not* at the ankle joint)
- Tibialis anterior and posterior act to produce inversion
- Peroneus longus, brevis and tertius act to produce eversion

NB. A bunion is a valgus deformity at the first MTP joint, which may be caused by ill-fitting shoes and osteoporosis. Surgery may be necessary in advanced cases.

Identify and describe the leg muscles (attachments, actions, nerve supply)

*Anterior (extensor) compartment*

- Tibialis anterior, extensor hallucis longus, extensor digitorum longus, peronius tertius

*Lateral compartment*

- Peroneus longus and brevis

*Posterior (flexor) compartment*

- Superficial calf muscles: gastrocnemius, plantaris, soleus
- Deep calf muscles: flexor digitorum longus, flexor hallucis longus, tibialis posterior

*Leg pathology*

- Increased pressure within the compartments of the leg (eg: following tibial fracture) may cause microvascular compromise – ‘compartment syndrome’
- ‘Shin splints’ is exercise-induced pain in mid-leg, which may be caused by periostitis around muscle origins
- Achilles tendon rupture tends to occur with gastrocnemius and soleus at maximum stretch (knee extended, ankle dorsiflexed), particularly in weekend athletes

Identify and describe the long tendons and intrinsic muscles in the foot (attachments, actions, nerve supply):

*Dorsum of the foot*

- Extensor digitorum brevis – tendons run deep to extensor digitorum longus to insert into dorsal extensor expansions of the toes

### *Sole of the foot*

- (Plantar aponeurosis lies deep to subcutaneous tissue - helps to stabilise the foot medially, and can be affected by repetitive strain causing inflammation and heel pain (plantar fasciitis)
- First layer: flexor digitorum brevis, abductor hallucis, abductor digiti minimi
- Second layer: flexor hallucis longus tendon; flexor digitorum longus, flexor accessorius and lumbricals
- Third layer: flexor hallucis brevis, adductor hallucis, flexor digiti minimi brevis
- Fourth layer: interosseous muscles; tendons of peroneus longus and tibialis posterior

Identify and describe nerves in the leg and foot, including root value, areas of supply, and causes and consequences of damage:

### *Tibial nerve*

- Leaves the popliteal fossa by passing deep to the converging heads of gastrocnemius, dives under the fibrous arch of soleus to lie between the superficial and deep groups of calf muscles, supplying both groups
- Runs down to the ankle with the posterior tibial artery; passes midway between the the medial malleolus and tendo calcaneus at ankle, lying between the posterior tibial artery (anteriorly) and the tendon of flexor hallucis longus (posteriorly)
- As it passes under the flexor retinaculum, it divides into its terminal branches: the medial and lateral plantar nerves, which pass into the sole to supply the intrinsic muscles and the skin of the sole

### *Common peroneal nerve*

- The common peroneal nerve runs laterally and anteriorly to plunge into peroneus longus, where it lies against the neck of the fibula, and divides into deep and superficial parts
- The superficial peroneal nerve supplies peroneus longus and brevis in the lateral compartment of the leg, then emerges anterior to the tendon of peroneus longus as medial and lateral branches which run over the dorsum of the foot to the toes, supplying most of the skin in this area
- The deep peroneal nerve spirals around the fibula, to lie anteriorly on the interosseous membrane, with the anterior tibial vessels, between extensor digitorum longus and tibialis anterior; it supplies the muscles of the anterior compartment; it then crosses the ankle joint anteriorly, with dorsalis pedis artery, and supplies the skin of the first toe cleft.

Identify and describe the vasculature of the leg and foot

- The popliteal artery divides into anterior and posterior tibial branches, inferiorly in the popliteal fossa
- The posterior tibial artery passes under the fibrous arch of soleus with the tibial nerve, gives off peroneal artery and nutrient artery to tibia, and runs down the ankle, where it wraps behind the medial malleolus, runs under the flexor retinaculum and divides into medial and lateral plantar arteries
- The peroneal artery runs lateral to the fibula, providing branches to the muscles of the lateral compartment and to the fibula itself
- The anterior tibial artery passes through the interosseous membrane, and runs anteriorly on the membrane, supplying the anterior compartment, down to the ankle, where it becomes dorsalis pedis artery
- The dorsal venous arch of the foot drains into the small and great saphenous veins; deep veins run with arteries as venae comitantes