ANAT3008

Upper Limb

» Function of the Upper Limb

Major Functions of the Upper Limb

- **Manipulation** – lever with hand on the end
  - If an action is made on the external environment or an object in the external environment and the object is effected, it is manipulation.
  - However if the body moves, it is locomotion.
- **Sensation**
- **Communication** (e.g. hand gestures)
- **Cosmetic** (e.g. body image)

Evolutionary Considerations

- **Analogies**.
  - Across species, a variety of structures perform the manipulation function of the upper limb (e.g. beaks, jaws, tails, limbs front and back).
  - Structures that have a similar function are said to be analogous (e.g. hand and bird's beak)
- **Homologies**.
  - The upper (anterior) limb across species is involved in many different sorts of locomotor and manipulative functions. Mostly used in locomotion: many forms, flight, swimming, climbing.
  - Structures that have a similar developmental origin are said to be homologous (e.g. hand and bird's wings).
    - Upper and lower limbs are serially homologous: each is composed of parts which are repeated in the other, i.e. shared properties due to comparable development
    - Humerus and femur are serially homologous
- **Primates**.
  - In primate evolution the initial adaptation of the upper limb is arboreal (climbing trees)
  - Later, and in particular with hominid (humans and their immediate ancestors) evolution, the upper limb shows an increasing specialisation for precision manipulation.

The Upper Limb in Human Development

- **Locomotion**.
  - In adult humans the upper limb is not habitually used in locomotion, however for a brief period in infancy it is, crawling.
  - However in some occupational and sporting activities, the upper limb is utilised in a locomotory way e.g. swimming.
- **Grasp Development**.
  - In the development of manipulative skills, the power grip (fist) develops earlier than the precision grip (writing grip).
  - Both are co-ordinated with the development of other limb and body movements, in particular eye movements (eye hand co-ordination).

Contribution of Individual Regions to Manipulation

- **Heirarchy of upper limb function**: reach, force transfer, movement, grip/grasp
- **Reach**.
  - Arm length determines reach, maximum length, and effective length.
- **Force Transfer**.
  - Stability is the lack of deformity or movement in a structure when force is applied it.

Larger Nerves of the Upper Limb

NERVE	ORIGIN	SPINAL CORD SEGMENTS	DESTINATION	MUSCLES	SKIN	TEST
Musculocutaneous	Lateral cord	C5,6,7	Mixed	Anterior arm	Lateral forearm	Elbow flexion
Axillary	Posterior cord	C5,6	Mixed	Deltoid, teres minor	Upper lateral arm	Shoulder abduction
Radial	Posterior cord	C5,6,7,8,T1	Mixed	Posterior arm, posterior forearm	Posterior arm and forearm, lateral dorsum of hand, part of thenar eminence	Elbow extension, wrist extension
Median	Lateral and medial cords	C5,6,7,8,T1	Mixed	Anterior forearm (except FCU and medial part of FDP), 3 thenar muscles, lumbricals 1-2	Anterior lateral hand	Radioulnar pronation, wrist flexion, thumb opposition
Ulna	Medial cord	C7,8,T1	Mixed	FCU, medial part of FDP, hypothenar, lumbricals 3-4, interossei, adductor pollicis	Anterior and posterior medial hand	Abduction and adduction of medial 4 digits at MCP joints

- ***Courses of larger nerves***

NERVE	SHOULDER	ARM	ELBOW	FOREARM	WRIST	HAND
Musculocutaneous	Passes through coracobrachialis in axilla	Anterior compartment between biceps and brachialis	In lateral roof of cubital fossa	Lateral side (as lateral antebrachial cutaneous nerve)		
Axillary	Exits axilla through quadrangular space					
Radial *Branches:* • *muscular* • *posterior brachial and antebrachial cutaneous*	Exits axilla on latissimus dorsi	Posterior compartment in radial groove, between lateral and medial head of triceps	In lateral cubital fossa between brachialis and brachioradialis	**Deep** (muscular) branch passes in supinator to posterior compartment and becomes posterior interosseous nerve **Superficial** (cutaneous) branch	Superficial branch crosses roof of lateral hand region	Superficial branch supplies lateral dorsum of hand via dorsal digital nerves

- Laterally (behind lateral malleolus):
  - 2 muscles: Fibularis longus and brevis
  - 1 vein: short saphenous vein (outside superior peroneal retinaculum)
  - 1 nerve: sural nerve (outside superior peroneal retinaculum)
- Medially (behind medial malleolus):
  - 3 muscles: Tibialis posterior, flexor digitorum longus, flexor hallucis longus
  - 1 artery: posterior tibital artery
  - 1 nerve: tibial nerve

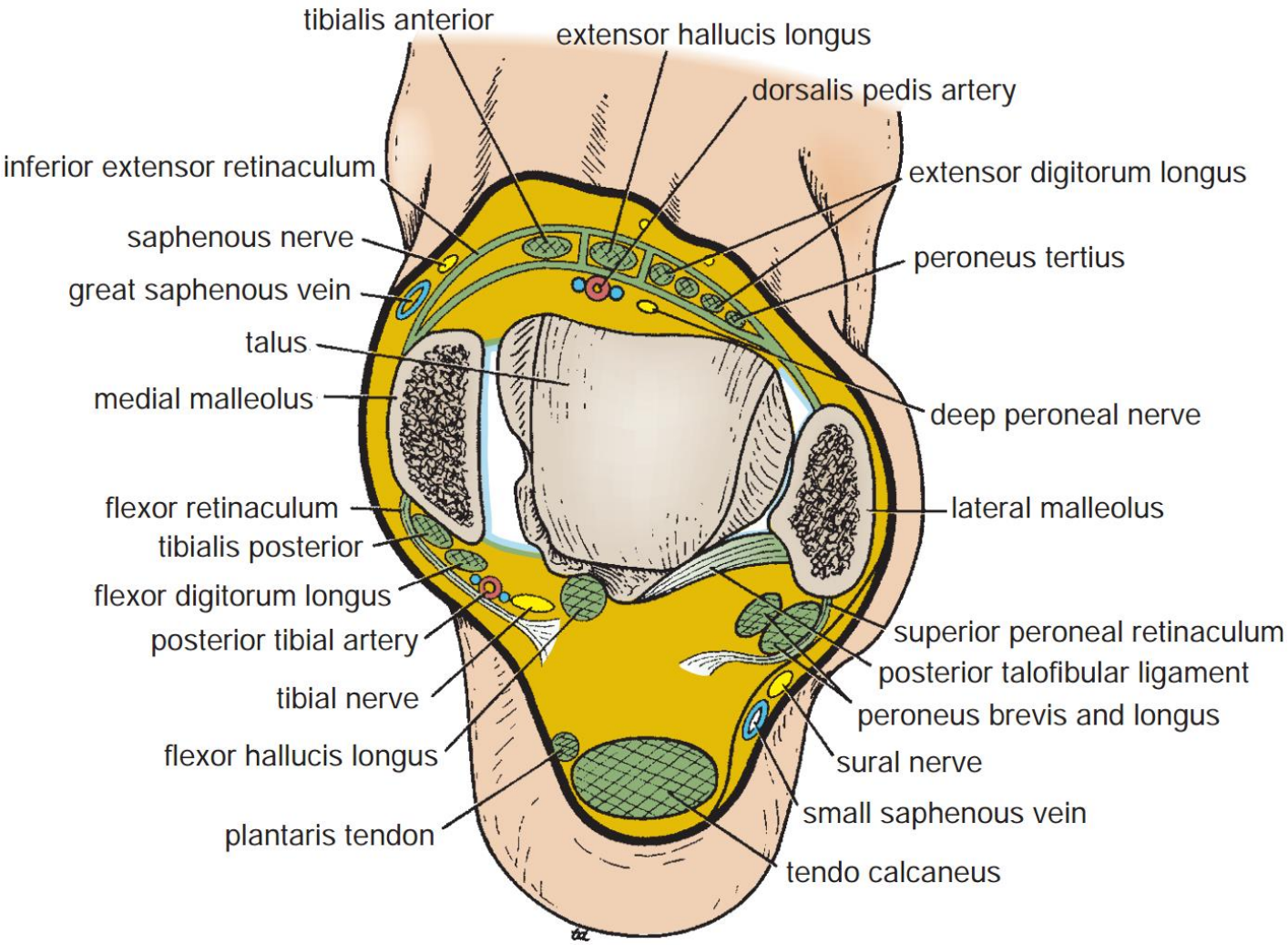

FIGURE 10.48 Relations of the right ankle joint.

- **Tarsal tunnel**
  - A space behind and below the medial malleolus.
  - Roof: flexor retinaculum.
  - Contents: tibialis posterior, flexor digitorum longus, posterior tibial artery (with its venae commitantes), tibial nerve and flexor hallicus longus.
    - NB: In the lower limb, venae commitantes tend to exist only below the knee, not above.

Leg & Ankle in Bipedal Standing & Walking

- **Standing**
  - Force transfer in the leg is through the tibia and ankle joint.
  - The axis of centre of gravity passes just in front of the ankle joint, forcing it into dorsiflexion.
  - Action of the posterior leg muscles (mainly gastrocnemius, soleus, flexor hallucis longus) are required to stabilise the joint by plantarflexing it
  - The ankle joints are close to the midline making balance more difficult but reduces sideways movement when correcting balance from a two foot to a one foot situation

- **Femoral Vein**
  - Deep
  - A continuation of the popliteal vein
  - Located in the adductor canal and the femoral triangle.
  - In the popliteal fossa, it is superficial and lateral to the femoral artery.
  - In the triangle, it is deep and medial to the femoral artery.
  - It becomes the external iliac vein when it passes beneath the inguinal ligament
  - Receives the profunda femoris and long saphenous veins in the femoral triangle.

» Nerves of the Lower Limb

Lumbosacral Plexus

The nerves of the anterior portion of the lower limb are derived from the lumbar plexus; those of the posterior portion from the sacral plexus.

- **Lumbar plexus**
  - The lumbar part of the lumbosacral plexus forms from the anterior/ventral primary rami of lumbar spinal cord segments 2–5.
  - It is located on the posterior wall of the abdominal cavity partly within the substance of psoas major.
  - The **anterior divisions** give rise to the:
    - **Obturator nerve** (L2–4)
    - **Lumbosacral trunk** (L4–5)
  - The **posterior divisions** give rise to the:
    - **Lateral femoral cutaneous nerve** (L2–3)
    - **Femoral nerve** (L2–4)
  - The femoral nerve travels on the lateral side of psoas initially and enters the femoral triangle of the thigh by passing under the inguinal ligament.
  - The obturator nerve is initially on the medial side of psoas, then enters the pelvic cavity passing over the alar of the sacrum. It then passes along the lateral wall of the pelvis and enters the medial thigh via the obturator foramen.
  - The lumbosacral trunk is also initially on the medial side of psoas, then passes over the alar of the sacrum into the pelvic cavity where it joins (and contributes to) the sacral plexus on the posterior wall of the pelvic cavity.
- **Sacral plexus**
  - The sacral part of the plexus forms from the lumbosacral trunk and the anterior primary rami of the sacral spinal cord segments 1–3.
  - It is located on the posterior wall of the pelvic cavity anterior to the muscle piriformis.
  - The **anterior divisions** give rise to the:
    - **Tibial nerve** (L4–5, S1–3)
    - Part of the **posterior femoral cutaneous nerve** (S2–3)
  - The **posterior divisions** give rise to the:
    - **Superior gluteal nerve** (L4–5, S1)
    - **Inferior gluteal nerve** (L5, S1–2)
    - **Common peroneal nerve** (L4–5, S1–2)
    - Part of the **posterior femoral cutaneous nerve (**S1–2)
  - Other nerves arise from the plexus. Sacral plexus nerves enter the lower limb via the gluteal region and the greater sciatic foramen. The tibial nerve and common peroneal nerve are initially joined together as the sciatic nerve.

Limb Derivatives from the Trilaminar Embryo	
Ectoderm	• Epidermis • Peripheral Nerves – Motor from Neural Tube (i.e. somatic motor neurons) – Sensory from Neural Crest (i.e. somatic sensory neurons)
Paraxial Mesoderm	• Skeletal Muscle Fibres.
Intermediate Mesoderm	N/A
Somatopleuric Lateral Mesoderm	• Cartilage • Bones • Joints • Dermis • Hypodermis • Blood Vessels • Connective Tissue
Splanchnopleuric Lateral Mesoderm	N/A
Endoderm	N/A

- Cephalisation: Concentration of sensory and neural organs at the anterior end
- Postcranial Segmentation
  - The post cranial part of the embryo gradually develops a set of bilateral, longitudinally repeated, segmented units.
  - These segments which particularly involve the ectoderm and mesoderm correspond to structures such as the spinal nerves, somites, dermatomes and myotomes.
- Somites
  - The somites are visible morphological divisions of the paraxial mesoderm in the region either side of the neural tube.
    - They define the segmental nature of the embryo
  - **Somites** subsequently develop into:
    - **Sclerotomes** (medial part of each somite), which migrate around the neural tube and give rise to the **vertebral column**
    - Dermomyotomes, which further divide to form:
      - × **Dermatomes**, which become the dermis of the **skin**
      - × **Myotomes**, which differentiate into segmental masses of skeletal **muscle**

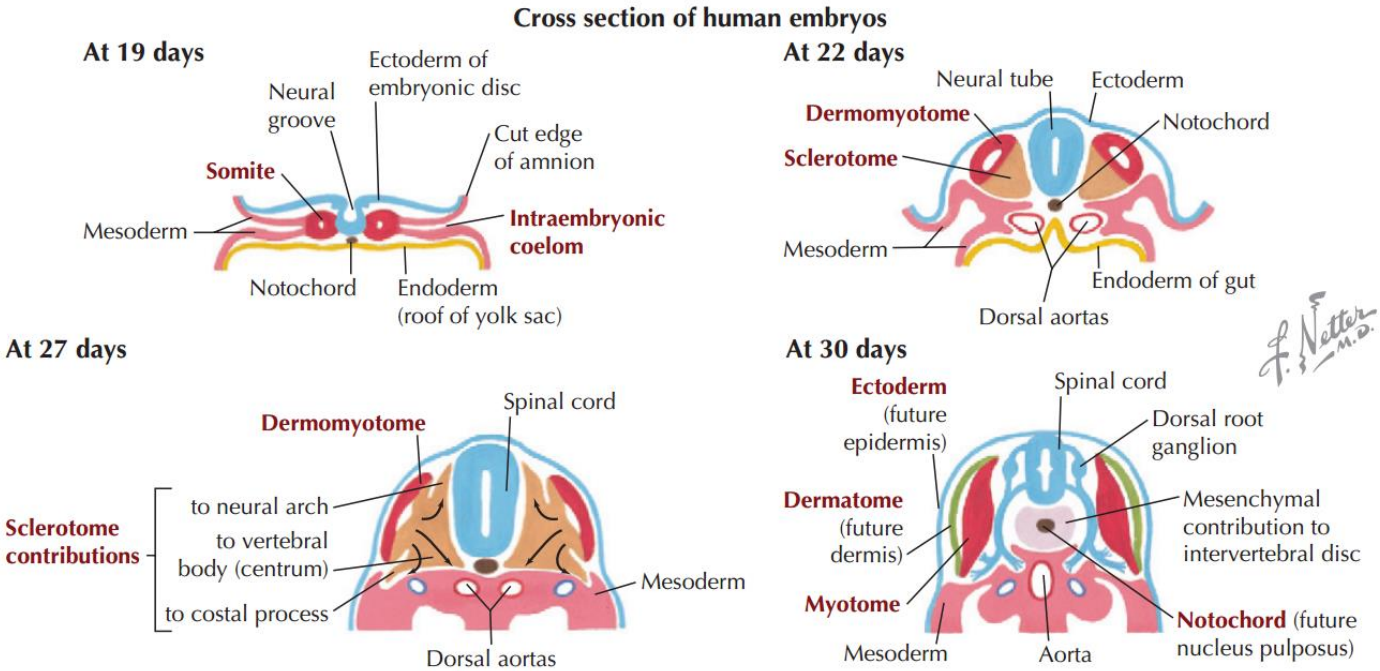

FIGURE 2-21 Somite Formation and Differentiation.