Ascending and Descending Tracts

Aims:
• To describe the spinal cord and major fibre tracts within it
• To note some effects of lesions of the cord

Objectives:
• Give an account of the structure of the spinal cord including the ascending and descending fibre tracts
• Describe and explain why lesions in particular regions of the cord have the effect they do

The spinal cord is of vital importance as it:

• Receives afferent fibres from sensory receptors of the trunk and limbs
• Controls movements of the trunk and limbs
• Provides autonomic innervation of most viscera
• Has extensive communications with the brain through ascending and descending tracts
• Through these tracts conveys information to higher centres and mediates controlling influences over spinal mechanisms

• Is cylindrical with two enlargements:
  – Cervical (segments C3-T1) to upper limb
  – Lumbar (segments L1-S3) to lower limb

• Tapers to a cone (conus medullaris), ending in a strand of connective tissue (filum terminale)
• At 3 months of fetal life it runs the whole length of the vertebral canal
• By birth it ends at L3
• In adulthood it ends between L1 and L2

• Cervical segments lie about 1 spine higher than their corresponding vertebra
• Thoracic segments 2 spines higher
• Lumbar segments 3-4 spines higher

There are 31 pairs of spinal nerves:
8C, 12T, 5L, 5S & 1C

Two rows of fascicles lie at each segment -
Dorsal roots Ventral roots
Primary afferents Efferents
Cell bodies in dorsal Cell bodies in grey matter
spinal root ganglia (DRG)

• These roots fuse (near intervertebral foramen) to form the mixed spinal nerve
Each nerve divides to form a small dorsal or posterior ramus and a larger ventral or anterior ramus.
Motor neurons of cord and brain stem are called lower motor neurones.

Note:
• Dorsal median sulcus
• Ventral median fissure
• Dorsal and ventral horns
• White matter (ascending & descending fibres)
• Grey matter (nerve cell bodies, dendrites & synapses)
• Central canal (csf)
• Cord is surrounded by three mater (csf in subarachnoid space)

Proportions of grey and white matter vary along the cord
• Higher levels have more WHITE matter
• GREY matter is 'H' shaped with four protrusions:
  – Two dorsal horns
  – Two ventral horns

T and upper L also contain lateral horns containing preganglionic sympathetic neurones

Rexed's laminae are 10 laminae in grey matter
• Laminae I-III substantia gelatinosa
• Laminae VII - Clarke's Column (C8-L3)
• Lamina IX - motor supply

Completely surrounds grey matter
• Ascending and descending tracts of fibres that connect brain and spinal cord
• Dorsal, lateral and ventral funiculi
• Intersegmental or propriospinal fibres immediately around (peripheral) to grey matter (fasciculus proprius)

Ascending tracts
• Medial Lemniscal/ dorsal columns:
  – Proprioception, vibration, discriminative touch
  – To fasciculus gracilis (medial – lower body) and cuneatus (lateral – upper body)
  – Ascend to medulla CROSS to become Media Lemniscus then ascend to thalamus then cortex
• Spinothalamic:
  – Lateral; pain and temperature
  – Medial; crude touch
  – Ascend on same side (1 or 2 segments) then CROSS before ascending to thalamus
• Spinocerebellar:
  – Proprioception
Dorsal ipsilateral cerebellum

Ventral contra and ipsilateral cerebellum

• Spino-reticular:
  • Deep/ chronic pain

Both spinothalamic tract and medial lemniscus end in the ventral posterolateral division (VPL) of the nucleus of thalamus

Thalamic nuclei project to primary somesthetic cortex of postcentral gyrus

Here the contralateral half of the body is represented as an upside-down homunculus

Descending projections can influence transmission in the ascending somatosensory pathways, for eg raphespinal tract inhibits perception of stimuli that would be painful

Cerebral cortex is needed to localise the source of a painful stimulus and recognition of objects by touch

Descending tracts
• Descending tracts originate from the cerebral cortex and brain stem (upper motor neurones)
  • Their role concerns control of movement, muscle tone, spinal reflexes, spinal autonomic functions and transmission of sensory information to higher centres.
  • Eg cortico-spinal tracts, rubrospinal, tectospinal, vestibulospinal and reticulospinal tracts

• Corticospinal: control of voluntary muscles
• Tectospinal: head-turning in response to visual stimuli
• Rubrospinal: assists in motor functions
• Vestibulospinal: muscle tone and posture
• Reticulospinal: spinal reflexes

• The spinoreticulothalamic pathway is closely related to the spinothalamic tract, and together can be called the Ventrolateral system (or anterolateral)
• Similarly the medial lemniscus system can be called the Dorsomedial system

• The trigeminothalamic pathway acts in the same way as the spinothalamic and medial lemniscus pathways do in the trunk and limbs, but for the head

Complete spinal cord lesion:
  • Weakness in all muscle groups below the site of lesion
  • Spasticity and hyper-reflexia (loss of descending inhibition to motor neurones)
  • Complete sensory loss below lesion

Hemi-section of spinal cord (Brown-Séquard syndrome)
– Ipsilateral weakness below the lesion (damage of ipsilateral descending motor cortico-spinal tract).
– Ipsilateral loss of dorsal column proprioception below lesion (ascending tracts damaged before they decussate in brainstem)
– Contralateral loss of spino-thalamic pain and temperature below lesion (fibres crossed just after entering cord)

Inflamed DRG or herniated discs:
– Stimulate pain and temperature fibres causing pain and burning sensations in area supplied by that nerve root (e.g., C4 – shoulder, C10 – umbilicus, L5 – big toe)

Medial lemniscus system:
• Defective proprioception and discriminative touch follows from interruption anywhere along its course
Tests
– Standing with eyes closed tests proprioception in lower limbs (Romberg’s test)
– Identify an object in hand with eyes closed (stereognosis)
– Two-point discrimination test
– ‘Draw’ on skin