Ascending & Descending tracts notes

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Ascending tracts

Dorsal columns

- Carry proprioception & discriminative (fine) touch.
- 1st order neuron → dorsal root ganglion → ascend ipsilateral as Fasciculus Gracilis (medial) & Fasciculus Coneatus (Lateral) → terminate in:
- 2nd order neuron → end in the medulla in Gracilis & cuneatus nuclui → the axons of 2nd order neurons decussate in mid medulla as internal arcuate fibers → Ascend as Medial lemniscus → terminate in:
- 3rd order neuron → end in ventral posterior nucleus of the thalamus → ascend to cerebral cortex as thalamocortical fibers → to somatosensory area.

Lesions in Dorsal columns:

- Tabes dorsalis → syphilitic infection, Affects: **lumbosacral dorsal spinal roots** and **dorsal columns of the spinal cord**. → high step page and unsteady gait (sensory ataxia)
- Subacute Combined Degeneration of the spinal cord → B12 deficiency → Affects: Dorsal columns = Sensory ataxia. And Lateral columns (Lateral corticospinal tracts) = Weak & spastic limbs.
- Multiple sclerosis → affects specifically fasciculus Cuneatus of the cervical region → loss of proprioception in hands and fingers (**Asteriognosis**)

Spinothalamic tracts

- In brain stem, the two tracts constitute the Spinal Lemniscus.

Lateral STT → Pain & thermal sensation:

- 1st order neuron → small cells in dorsal root ganglion → end in:
- 2nd order neuron → substantia gelatinosa of Rolandi → decussate in Anterior White Commissar → spinal lemniscus in brainstem → end in:
- 3rd order neuron → Ventral posterior nucleus of thalamus.

Anterior STT → 1/2 Non- Discriminative touch (crude touch) and pressure:

- 1st order neuron → Medium cells in dorsal root ganglion → end in:
- 2nd order neuron → Cells of main sensory nucleus or (nucleus proprius) in the spinal cord → decussate in Anterior White Commissar → spinal lemniscus in brainstem → end in:
- 3rd order neuron → ventral posterior nucleus of thalamus.

Lesions in STT:

- Syringomyelia → Central canal enlarged → cavity compress the adjacent nerve fibers (which are 2nd order neurons decussate in this place) → selective loss of pain and temp. sensation in upper limb → Joints of the limbs become disorganized without discomfort (Charcot's joint) → Dorsal columns function is normal.

Spinocerebellar tracts

- Axons of 2nd order neurons.
- Carry information from **muscle spindles**, **Golgi tendon** and **tactile receptors** to the cerebellum for the control of **posture** and **coordination of movements**
- 1st order neuron → Large cells of dorsal root ganglion.
- 2nd order neuron → Cells of the nucleus dorsalis (Clark's nucleus or nucleus thoracis) → cerebellum

Posterior (dorsal) SCT:

- 2nd order neuron cell bodies → Only above level L3.
- The axons terminate (ipsilateral) = uncrossed → enter the cerebellar cortex by inferior cerebellar peduncle.

Anterior (ventral) SCT:

- 2nd order neuron cell bodies → lumbosacral segments.
- Axons of 2nd order neuron cross to opposite side → ascend to midbrain → cross to the original side → ipsilateral function → enter the cerebellar cortex via superior cerebellar peduncle.

Lesions in SCT:

- Friedrichs ataxia → inherited degenerated disease, affect SCT, affect childhood → incoordination of arms, intense **tremor**, **wide base reeling gait ataxia** → wheelchair in 20yrs.

Spinotectal tract

- Ascend in **anterolateral** part, close to spinothalamic tract.
- 1st order neuron → in dorsal root → ends in:
- 2nd order neuron → cell bodies lie in the base of dorsal horn → cross to the opposite side → to periaqueductal grey matter and superior colliculi in midbrain.
- → Involved in reflexive **turning of the head and eyes** toward a point of cutaneous stimulation.

Spino-olivary tract

- Indirect spinocerebellar pathway (spino-olivo- cerebellar)
- Impulses from the spinal cord are relayed to the cerebellum via inferior olivary nucleus.
- Found at all levels of SC.
- Contribute to movement coordination associated primarily with **balance**.

Spinoreticular tract

- Origin → dorsal horn → ascend in **ventrolateral**.
- Medullary reticular formation → Contain **uncrossed** fibers
- Pontine reticular formation → contain crossed & uncrossed fibers → thalamus (spino-reticular-thalamic system) → involved in perception of dull aching (slow pain)
- Forms part of the ascending reticular activating system.

Descending tracts

Corticospinal tracts

- Origin:
  - 30% → motor area4 = 1ry motor area = precentral gyrus. → Essential for voluntary initiation of finely controlled movements, especially the distal limb.
  - 30% →
    - Premotor area → Coordination movement, setting the body in the a certain posture to perform a specific task.
    - Supplementary area → project mainly to area4 → Planning & programming motor sequence.
  - 40% → Parietal lobe (somatosensory area 1,2,3)
  - when use complex finger movement → all areas are activated, except premotor area.
  - When imagines the complex finger movement → supplementary motor area.
  - 3% of pyramidal fibers → derived from highly excitable pyramidal **Betz cells** in area4.
    - The axons from the Betz cells → send collaterals to cortex → **inhibit** adjacent region → sharpening the signal.
- Pathway: cerebral cortex → corona radiate → internal capsule gennu → brainstem →
  - **Corticobulbar tract**. Terminates on LMN = cranial nerve nuclei of opposite side. → decussate just before reaching the nuclei. → directly innervate V, VII, XI, XII. But not III, IV, VI → by medial longitudinal fasciculus.
  - **Corticospinal tract**.
    a. 80& = **Lateral** corticospinal tract → their fibers ends in:
      - DIRECTLY on AHCs = Monosynaptic.
      - Interneurons of grey matter.
      - Sensory neurons of dorsal horn.

      Lateral = responsible for fine discrete movement of distal limb.

b. 20% = Ventral corticospinal tracts. → Synapse w\ interneurons = polysynaptic, synapse w\ AHCs of mainly neck & upper limb → bc it passes **medially = control the axial & proximal limb muscle**.
    - These fibers may be concerned w\ control of bilateral postural movement by supplementary area

- Function of corticospinal tracts:
    - Initiation of fine, discrete, skilled voluntary movement (by lateral).
    - Lateral → control distal muscles.
    - Medial → control posture of axial & proximal muscle for balance, climbing, walking.
    - Effect on stretch reflex → Faccilitate muscle tone by Gamma motor neurons. يعني تحافظ على مستوى العضلات، لا مشدودة مرة ولا مرتخية مرة.
    - Sensory motor coordination (by parietal lobe)
    - Corticobulbar → control face & neck muscles, facilitate their tone, involved in face expression (VII) , mastication (IX) , swallowing (VII, IX)
- Each column has 6 layers, pyramidal cells lie in 5th layer. → function of column: make the signal sharp, amplify by stimulating large no. of pyramidal fibers to the same muscle or synergistic muscle.
- Dynamic & static signals are transmitted by the pyramidal neurons, if a strong signal is sent to muscle to cause initial rapid contraction then much weaker continuing signals → maintain contraction for long periods.
    - Dynamic neurons → initial, rapid development of force. (Red nucleus has a lot of Dynamic) why? → bc Red nucleus is close to cerebellum, plays imp role in rapid initiation of muscle contraction.
    - Static neurons → Maintain the force of contraction. (area4 has a lot of Static)
- Lesions:
    - Removal of 1ry motor cortex (area pyramidalis → contain Betz cells) → causing variable degree paralysis, we have paresis not paralysis in this case.
        - If caudate nucleus & premotor & supplementary areas are intact → Gross postural & limb fixation can still occur, the problem is that we have loss of voluntary control of discrete movement of distal limbs.
    - Stroke:
        - Muscle spasticity → if the lesion affect the motor cortex or corticospinal pathway & adjacent areas (e.g. basal ganglia) → there is no inhibitory signals for vestibule&pontine reticulspinal tracts → = highly activated gamma fibers → **Spasm**. هذا اللي يصير عادة مع الأشخاص اللي يصير لهم حادث، يصير شكلهم مخشبين ومشصبين لأنه النزيف أثر على الbasal ganglia.
        - Hypotonia → because the 1ry motor cortex responsible of static neurons (continual tonic stimulatory effect) → now it is lost → low muscle tone (hypotonia) , this happen if the basal ganglia is intact!!

Extrapyramidal tracts

- Origin:
    - Rubrospinal tract, Vestibulispoinal tract, Reticulospinal tract, Tectospinal tract, Olivospinal tract.
- Functions:
    - Sets the postural background needed for performance of skilled movement.
    - Controls Subconscious gross movement. مثل الحركات اللي يعملها بدون تفكير للمسلز الكبيرة، مثل المشي والتسلق. هي عكس البيراميدال اللي تحتاج حركات دقيقة وصغيرة.

Rubrospinal tracts → Lateral

- Lateral = supply the distal muscles needed for skilled movement.
- Origin: Lower portion of **Red nucleus** → Magnocellular portion.
- Receive **direct** fibers from the primary motor cortex through CorticoRubral tract & some from corticospinal tracts.
- **Cross** in the opposite side in at the same level in red nucleus. Terminate mostly in interneurons (**Indirectly**) along w\ corticospinal fibers. & some terminate directly on AHCs.
- Functions:
  - Stimulation of magnocellular portion → result in contraction of single or more than 1 muscle.
  - The corticoRubroSoinal serves as accessory rout for transmission of **discrete signals from the motor cortex**.
  - facilitatory to the gamma and alpha MNs of the distal **flexor** muscles, but they are **inhibitory** to extensor muscles.
- Lateral motor system of the cord = corticospinal & Rubrospinal.
- Medial motor system of the cord = Vestibulo-reticulospinal system.
- Contralateral.

Vestibulospinal tracts

- Origin: Vestibular nuclei in pons.
- Ipsilateral.
- Function:
  - Control posture & righting reflexes. → Excitation to spinal motor that supply axial & postural muscles.
  - Control eye movement (by medial longitudinal fasciculus)
- Types:
  - Lateral vestibule-spinal → Posture.
    - from lateral vestibular nuclei.
    - Descend ventrally.
    - Excite the **extensor** motor neurons to maintain Posture.
  - Medial vestibule-spinal → Head & eye movement coordination. ماله علاقة بالposture & proximal limb muscles.
    - from medial vestibular nucleus.
    - Descend ventrally.
    - Ends in Cervical segment.
    - Some fibers form the medial longitudinal fasciculus → eye movement.
- Role of the vestibular nuclei to excite the antigravity muscles:
  - It transmits excitatory signals to the anti-gravity muscles by way of medial & **lateral** vestibulospinal tract.
  - Without the support of vestibular nuclei → pontine reticular system = loss of much of its excitation of the axial antigravity muscles. Bc they receive **strong excitatory signals** from vestibular nuclei.

Tectospinal tract

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- Origin → Superior & inferior colliculi.
- Ends in the contralateral cervical motor neurons.
- Function → Mediate & facilitate turning of the head in response to visual or auditory stimuli.

Olivospinal tract

- Origin → Inferior olivary nucleus.
- Found only in cervical region. = supply neck muscles. * it also sends fibers to cerebellum.

Reticulospinal tract

- Function →
    1. Influence motor functions as voluntary & reflex movement.
    2. **Excitatory or inhibitory to muscle tone**.
- Types:
    1. Pontine (medial) reticular tract → from pontine reticular formation.
        - Highly excitable
        - Descend in anterior white columns of spinal cord.
        - Increase Gamma motor neurons. → Excitatory to axial, antigravity & Extensor m.
    2. Medullary (lateral) reticular formation → from medullary reticular formation.
        - Inhibitory system.
        - Descend in lateral white columns on both sides.
        - Receive strong excitatory inputs from: تنشطها عشان ترسل انهبشن سقنالز.
            - Corticospinal tract.
            - Rubrospinal tract.
            - Other motor areas (e.g. basal ganglia).
        - Inhibit Gamma motor neurons = inhibit antigravity muscles = Decrease muscle tone.