Brown-Séquard Syndrome and Tabes Dorsalis — Anatomy and Lesions of the Spinal Cord

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The spinal cord is the continuation of the brain stem medulla below the foramen magnum. This article discusses lesions and diseases of the spinal cord, highlighting the Brown-Sequard syndrome and Tabes Dorsalis.

Anatomy of the Spinal Cord
The spinal cord consists of “H” shaped grey matter surrounded by white matter. The central canal contains cerebrospinal fluid (CSF) and runs in the centre of the “H” of grey matter.

The grey matter “H” is organised into anterior horn subserving motor function and thinner posterior horn subserving sensory function. The white matter tracts are organised as shown in the diagram. The lateral corticospinal tract, spinothalamic tract and the dorsal tracts are the most important. The functions of various tracts can be summarised as follows:

<table>
<thead>
<tr>
<th>Tract</th>
<th>Description</th>
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<tbody>
<tr>
<td>Dorsal column: Gracilis (medial) and cuneatus (lateral). The organisation from medial to lateral is sacral to cervical fibres.</td>
<td>Ascending tract: Position sense, vibration sense and fine touch from ipsilateral side to the gracilis and cuneate nucleus in the medulla. They cross in medulla as internal arcuate fibres and proceed to the contralateral somatosensory cortex via the thalamus.</td>
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<td>Pyramidal tract: The organisation from medial to lateral is cervical to sacral fibres.</td>
<td>Descending tract: Lateral corticospinal tract: crosses in the pyramid in the medulla. Anterior corticospinal tract: crosses in the spinal cord. Provides supraspinal contralateral inhibitory control on the anterior horn cells modulating fine motor activity.</td>
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<tr>
<td>Spinothalamic tract: The organisation from medial to lateral is cervical to sacral fibres.</td>
<td>Ascending tract: Anterior spinothalamic axons cross in the anterior white commissure to form the contralateral lateral spinothalamic tract after ascending ipsilaterally for about 2 levels. They carry pain and temperature sensations.</td>
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<tr>
<td>Dorsal and ventral spinocerebellar tracts</td>
<td>Ascending tracts: Provide unconscious proprioception information to the cerebellum.</td>
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<td>Vestibulospinal, rubrospinal and tectospinal tracts</td>
<td>These form the extrapyramidal system mainly for control of antigravity muscles.</td>
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**Blood supply of the spinal cord**

The spinal cord is supplied in a segmental fashion. The major blood supply is from one *anterior spinal artery (ASA)* and two *posterior spinal arteries (PSA)* from the extradural part of the vertebral artery.

The branches of the same anastomose extensively forming the *vasa corona*. It is reinforced by medullary branches of the lateral branch of *intercostal arteries* at the corresponding levels.
The largest medullary branch is the **artery of Adamkiewicz**. Also known as **arteria radicularis magna**, it typically arises from a left posterior intercostal artery at the level of the 9th to 12th intercostal artery, which branches from the aorta. It supplies the lower two thirds of the spinal cord via the anterior spinal artery.

The anterior spinal artery supplies the anterior 2/3rd of the spinal cord. Traumatic injury, occlusive thrombosis of the ASA secondary to infection or embolus lead to **anterior cord syndrome**. It mainly involves the **corticospinal tracts** and the **spinothalamic tracts** bilaterally.

Occlusion of the posterior spinal artery leads to **posterior cord syndrome**. The dorsal column is predominantly involved.

Injury to the artery of Adamkiewicz especially in operative procedures like **abdominal aortic aneurysm repair** and neurosurgical procedures can lead to **post-operative paralysis** and **neurological deficits**.

**Brown-Séquard Syndrome**

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The physiologist **Charles-Édouard Brown-Séquard** first described this condition in 1850. It involves **damage to one side of the spinal cord** resulting in **ipsilateral loss of motor function** and **posterior column sensations** and **contralateral spinothalamic involvement** one to two levels below the level of cord damage.

Cord involvement can be summarised as follows:

- The **corticospinal lesion** produces **ipsilateral spastic paralysis** below the level of the lesion (due to loss of moderation by the UMN). At the level of the lesion, there is flaccid paralysis of the muscles supplied by the nerve of that level (since lower motor neurons are affected at the level of the lesion).
- The lesion to the **posterior column tracts**, **fasciculus gracilis** or **fasciculus**
cuneatus, results in ipsilateral loss of vibration and proprioception (position sense) as well as loss of all sensation of fine touch.

- The damage to the spinothalamic tract leads to contralateral pain and temperature sensation being lost beginning one or two segments below the lesion due to Lissauer's tract.
- Involvement of descending sympathetic fibres in lesions above T1 can lead to ipsilateral Horner's syndrome.

It is classically seen in cases of traumatic spinal cord injury and in intradural extramedullary (IDEM) tumors like neurofibromas and schwannomas which cause cord compression from one side. Less likely causes include infections like tuberculosis and ischemic occlusive diseases of the spinal cord.

Any presentation of spinal injury that is an incomplete lesion (hemisection) is called a partial Brown-Séquard or incomplete Brown-Séquard syndrome.

Brown-Séquard plus syndrome is Brown-Séquard syndrome with bladder involvement.

Magnetic resonance imaging (MRI) is the imaging of choice in spinal cord lesions.

Treatment depends on the inciting factor. Use of steroids to decrease cord edema and inflammation is controversial in spinal cord injury.

Tabes Dorsalis

Also known as syphilitic myelopathy, Tabes Dorsalis is a culmination of slow degeneration and demyelination of dorsal column nerves. Quite a rare entity nowadays, it was rampant in times when neurosyphilis was commonly left untreated for long time. It was seen in males more than females, typically in mid-life.

Co-infection with HIV can potentially lead to a resurgence of this sequel of syphilis. A sexually transmitted disease in nature, it is caused by the spirochete bacterium Treponema pallidum.

Cord involvement can be summarised as:
Involvement of the **dorsal column white matter tracts** leads to loss of position sense, vibration sense and discriminative anaesthesia with preservation of pain and temperature sense. Loss of proprioception leads to positive **Romberg's sign**. Severe ataxia is present.

- Involvement of **large diameter dorsal nerve root fibres** leads to intense pain, paraesthesias and weakness
- Involvement of **dorsal root ganglion cells** leads to diminished reflexes.

It is classically associated with **Argyll-Robertson pupils (ARP)**. This is seen in young females with accomodation reflex present, absent light reflex and absent bilateral deep tendon reflexes.

**To remember:**

Accomodation Reflex Present: in ARP.

Few other classically described rather rare entities with Tabes Dorsalis are:

- **Tabes dorsalgia**: related back pain.
- **Tabetic gait**: high-steppage gait due to loss of proprioception.
- **Tabetic ocular crisis**: also known as **Pel's crisis**, it comprises of an attack characterized by sudden intense eye pain, tearing of the eyes and sensitivity to light.

*Treponema pallidium* is very sensitive to **Penicillins**. However, the neurological deficit once set in is rarely completely reversible. **Physiotherapy** for paralysis and pain management with help of **opiates** form important treatment adjuncts.

**Prophylactic treatment** for those who come inadvertently into sexual contact with syphilitic patients is indicated.

Tabes Dorsalis can progress to blindness, paralysis and dementia if not controlled at the right time.

**Summary**

- Brown-Séquard syndrome involves hemisection of cord with ipsilateral motor and posterior column function involvement and contralateral spinothalamic functions – pain and temperature involvement.

- Tabes Dorsalis mainly involves the posterior column, sensory fibres and dorsal root ganglion cells. There is pain, paraesthesias, weakness, ataxia and loss of reflexes.

**Review Questions**

The correct answers can be found below the references.

1. **A 25-year-old male met with RTA about 4 months back. He has burning sensation in both upper limbs and a vague sensation of pain in both hands. He has urinary urgency. The rest of the neurological exam is normal. What is the likely diagnosis?**
   - A. Post-traumatic syringomyelia
   - B. Post-traumatic anterior cord syndrome
   - C. Post-traumatic Brown-Séquard syndrome
2. A 33-year-old female met with RTA about 4 months ago. She has neck pain, right sided hemiparesis, loss of vibration sense in right sided limbs and loss of pain and temperature sense in left sided leg and abdomen. What is the likely diagnosis?
   A. Post-traumatic syringomyelia
   B. Post-traumatic anterior cord syndrome
   C. Post-traumatic Brown-Séquard syndrome
   D. Post-traumatic depression

3. In Argyll Robertson pupils seen in patients with Tabes Dorsalis, which of the following statements is true?
   A. Accomodation reflex absent, light reflex present
   B. Accomodation reflex absent, light reflex absent
   C. Accomodation reflex present, light reflex present
   D. Accomodation reflex present, light reflex absent

References

DeJong's Textbook of Neurology

Correct answers: 1, 2, 3D

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