

# 1. SPINAL CORD: TRACT PATHOLOGIES

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Case 1 .....	2
Presentation .....	2
Relevant Anatomical Background .....	3
Case 2 .....	5
Presentation .....	5
Relevant Anatomical Background .....	5
References .....	6

Movement is crucial to human beings and animals in general and damage to motor systems lead to disabilities. Sensory systems are equally important which provide information to the brain about sensations. This chapter gives an overview of these motor and sensory pathways<sup>1</sup>.

The spinal cord can be divided into a part that contains white matter and a part that contains gray matter<sup>2</sup>. The spinal cord lies within the vertebral canal and is surrounded by three protective layers known as the meninges. It is cushioned against trauma by the CerebroSpinal Fluid (CSF).

A point to note here is if the spinal cord is floating in the CSF, why doesn't it move around in the vertebral column. The answer are the denticulate ligaments (which are extensions of pia mater; the innermost layer of the meninges) and the filum terminale which is the inferior extension of the pia mater<sup>3</sup>.

As stated in the previous chapter, the spinal nerves consist of motor or sensory roots from each segment of the spinal cord which leave through the intervertebral foramina.

## Case 1

### *Presentation*

A rugby athlete while talking to his friend casually tells him that he could not throw well today because he is feeling a burning sensation over his left shoulder and arm and that he will immediately take a cold shower after his rugby training; see Figure 1.

The friend, who is a medical student, inquires about the pain and asks how long he had the pain and if it was getting worse. The person replies that he had been experiencing this pain for the past two weeks and it was made worse by coughing or sneezing. The student touched his friend's right shoulder and the person frowned with pain. His friend immediately took him to the neurology clinic. The student told the neurologist about the weakness of his friend's right deltoid and biceps brachii muscles and the hyperesthesia in the same area. The neurologist asks the medical student about a differential diagnosis. The student replies that in his opinion the patient has spondylosis of the vertebral levels C5, C6 and C7. This could be because the

<sup>1</sup> Knowledge of general spinal cord anatomy is a prior requirement to study this chapter.

<sup>2</sup> Gray matter contains the cell bodies of the neurons while white matter is the collection of myelinated axons. Also, note that the arrangement of gray and white matter is different in the brain and the spinal cord. The details will be discussed in the chapter on Brain Pathologies.

<sup>3</sup> The lower portion of the filum terminale is also covered by dura mater as well.



Figure 1. The person with shoulder pain and burning sensation [1].

patient is an athlete. The neurologist is impressed by the student's answer and praises his observational and medical skills. The neurologist turns to you and inquires how this medical student reached a diagnosis. What do you say?

### *Relevant Anatomical Background*

The patient was suffering from spondylosis, which is a general term used for degenerative changes in the vertebral column. Due to the patient's extensive exercise and using his body to its limits in athletics, the vertebral column has degenerated. Bone spurs<sup>4</sup> (or Osteophytes) have formed over the intervertebral foramina with pressure on the nerve roots. See Figure 2.

The burning pain and hyperesthesia was due to the pressure on the posterior nerve roots. The muscle weakness was due to the compression of the anterior (motor) nerve roots. Coughing or sneezing also increase the pressure within the vertebral column and result in further pressure on the nerve roots.

The Deltoid muscle is innervated by spinal nerves C5 and C6 and the biceps brachii muscle is innervated by C5, C6 and C7. This knowledge is the reason why the medical student could pinpoint the spinal cord levels where the degeneration had occurred.

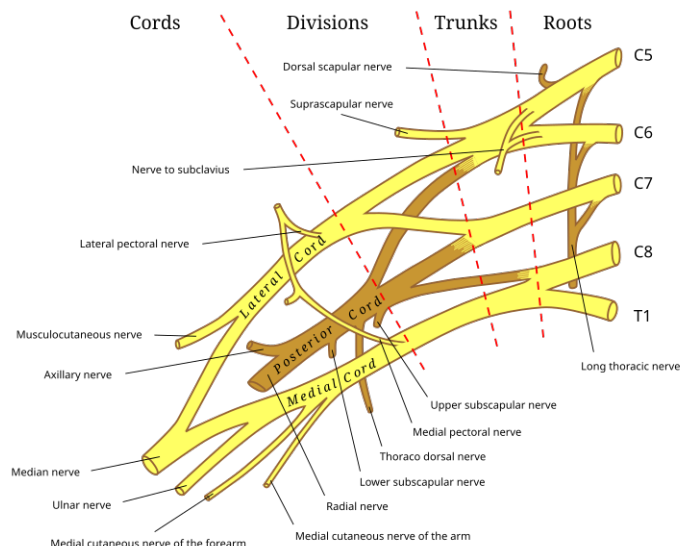


Figure 3. The spinal nerves C5 to T1 are the nerves that innervate the muscles of the arm and the hands<sup>5</sup> [3].

<sup>4</sup> These are bone outgrowths that usually tend to form over joints due to extensive use of the joint. The cause is not known but they generally only form over joints. The formation is not concerning on its own but this growth can immobilized joints or press on nerves as is the case with our patient.

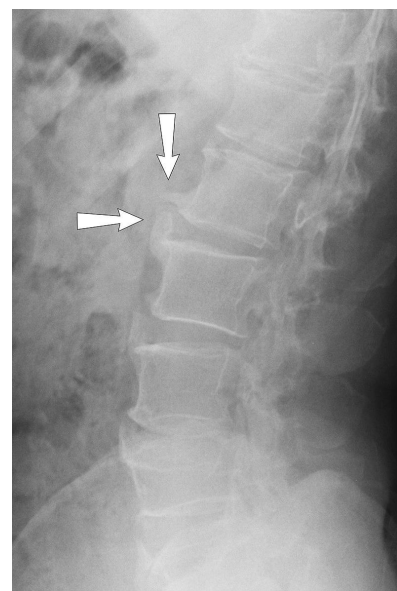


Figure 2. X-ray showing bone outgrowths at the Lumbar spine level [2].

<sup>5</sup> This image shows the .

This knowledge of which spinal nerve innervates which muscle (or muscles) is known as that nerve's myotome. The myotome of all the nerves that innervate the upper limb (the arm and the hands) is shown in Figure 4. Knowing all of the nerves and their spinal cord levels is not of extreme importance right now but a general understanding is invaluable. As an example, knowing that the shoulder area is innervated by C3 and C4 spinal nerves is enough.

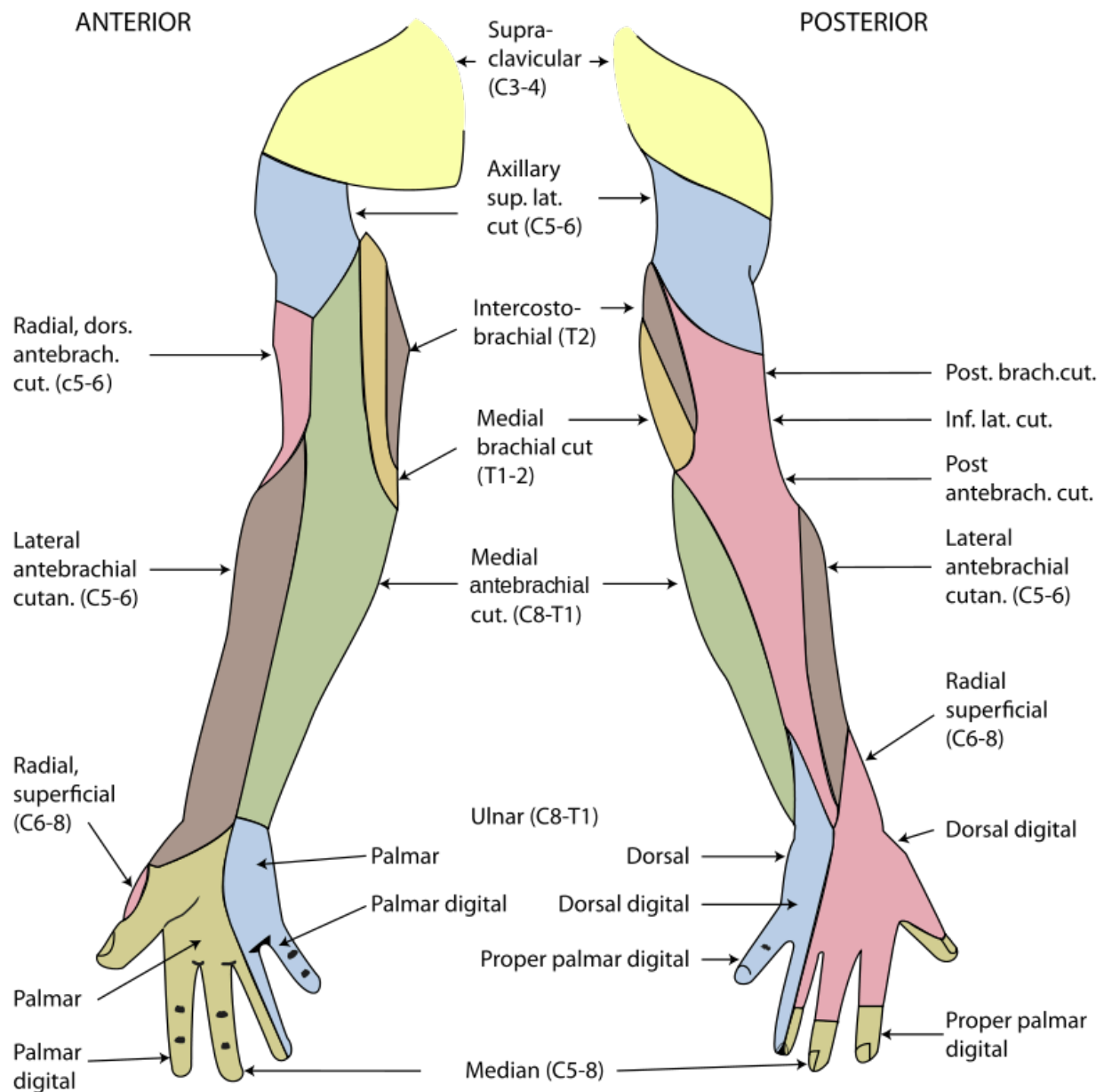


Figure 4. The myotome of all the nerves innervating the arm and hands. These nerves collectively come from the brachial plexus. [4]

## Case 2

### *Presentation*

A 76-year-old woman presented to the hospital with progressive difficulty walking. Initially, she had been able to ambulate with the assistance of a cane, but over the last day, she became unable to walk altogether. Upon examination, both lower extremities exhibited muscular weakness, increased muscle tone, and hyperreflexia, particularly in the knees where the knee jerk reflex was exaggerated.

Sensory examination revealed a loss of pain sensation bilaterally below the level of the fifth thoracic dermatome. Additionally, proprioception in both great toes was impaired, and vibratory sense was absent below the level of the fifth thoracic segment.

Suggest a possible diagnosis and what the treatment plan will be. How is pain conducted in the spinal cord and how is vibrational sense conducted. Comment also on the fact as to why the patient had difficulty walking.

### *Relevant Anatomical Background*

Radiological Examination showed a small swelling at the level of the first lumbar vertebra. Histological Examination revealed that it was a meningioma. The tumor was removed by performing a laminectomy of the first, second and third lumbar vertebrae and the patient started to recover. Initially walking with a stick and later without one.

The lateral spinothalamic tracts are responsible for pain conduction. Postural and vibrational sense is transmitted in the posterior white column in the fasciculus cuneatus (for the upper limb) and the fasciculus gracilis (for the lower limb). The difficulty in walking was due to the pressure on the corticospinal tracts in the lateral white column. This ultimately resulted in the paralysis of the muscles of the lower limbs.

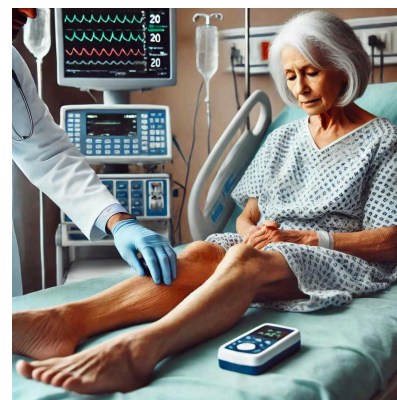


Figure 5. A woman being examined by a doctor for her legs. [5]

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