Development of innovative training solutions in the field of functional evaluation aimed at updating of the curricula of health sciences schools

MODULE BIOMECHANICS OF SPINE

Didactic Unit C: HOW DO I ASSESS SPINE?

C.1. What methods may I apply to assess the function of the spine appropriately?

Part I: Assessing impairment: anamnesis and physical examination of the spine

Index

1. Objectives

- To learn the importance of carrying out an anamnesis correctly and a physical examination to establish a diagnostic suspicion and a degree of impairment in the subject being assessed.
- To learn the American Medical Association's impairment classification system according to the diagnosis ("Injury Model").
- To learn the fundamental requirements for a complete physical examination of the spine, including learning a series of specific tests often used for spinal pathology.

2. Assessing impairment: anamnesis and physical examination of the spine

2.1. Introduction

Back pain, including cervical and lower back (lumbar) pain, is one of the most frequent causes for patients to see both general practitioners and specialists who deal with disorders related to the musculoskeletal system such as Traumatology, Physical Medicine and Rehabilitation and Rheumatology.

Fortunately, the vast majority of pain conditions are of a non-specific origin, without a known cause, and they are predominantly mechanical, while specific spinal conditions like those resulting from tumour processes (primary or metastatic) and traumatic or inflammatory ones are much less common, though often more serious.

Also, it must be noted that although the spine is not usually the preferred or usual location for referred pain of visceral origin, there are some very characteristic cases such as pain radiating to the back in a myocardial infarction or acute lower back pain in cases of nephritic colic. Thus, it is very relevant to perform an appropriate, exhaustive anamnesis, detecting signs of possible serious conditions, and ruling out non-musculoskeletal origins for the pain under evaluation. Therefore, among other relevant information, the clinician should obtain insights into the onset of the pain, whether it started acutely, following an exertion or change of posture, after trauma, or whether its onset was insidious. Mechanical pain worsens with movements but improves at rest, while inflammatory pain is usually nocturnal, and tumoural pain is very intense and persists night and day. In cases of pain with a traumatic origin, it might occur due to minimal trauma when there is osteoporosis, which is common among the elderly. As for chronic vertebral pain disorders, they usually appear in the context of degenerative pathology. In other kinds of diffuse pain that is not clearly located or chronic pain disorders, associating hypersensitivity with pressure at certain specific points, non-restorative sleep and unjustified fatigue, fibromyalgia should be confirmed or ruled out[1].

In general, a good clinical history should always include a past medical history, information about the patient's socio-cultural environment, and it must look into the characteristics of the patient's disorder, starting with the three basic Hippocratic questions: "What's the matter with you?", "When did it start?" and "Why do you think it's happening?". Based on the initial data, a targeted physical examination should be carried out to confirm or rule out the diagnostic suspicion arising from the initial information. Only if necessary, the corresponding diagnostic tests may be requested, once again with the intention of confirming or discarding the diagnostic suspicion established in the same medical activity.

2.2. Cervical spine

Anamnesis and diagnosis-based impairment

As mentioned before, symptoms related to the spine are among the most common in the adult population.

One of the most common conditions in the spinal column is cervicalgias (pain in the cervical region). Sometimes this kind of pain even extends towards the head or one or both of the upper limbs, with a possible restriction to movement or neurological dysfunction associated with it. Cervicalgias are a common condition with an estimated prevalence of 10-13%, appearing at some time in life in 70% of the population[2].

Table 1 – Most common causes of cervical pain Taken from https://www.fisterra.com/guias-clinicas/cervicalgia-dorsalgia/

Mechanical cervicalgia	• Radiating cervicalgia	• Non-segmental • Segmental: radiculopathy
Inflammatory cervical pain	• Rheumatic diseases	• Rheumatoid Arthritis • Ankylosing spondylitis and other spondyloarthropathies • Fibromyalgia • Juvenile chronic arthritis • Polymyalgia rheumatica • Polymyositis • Forestier-Rotes-Querol disease • Ankylosing vertebral hyperostosis
	• Tumours (primary or metastatic): prostate, breast, kidney, lung and thyroid cancers	
	• Infections	• Discitis: Staphylococcus aureus, Mycobacterium tuberculosis, Brucella • Osteomyelitis • Meningitis • Herpes zoster • Lyme disease
Referred cervical pain	• Abdominal and diaphragmatic diseases: gallbladder, subphrenic abscess, pancreas, hiatal hernia, peptic ulcer • Ischemic heart disease • Aortic aneurysm • Tumours of the pulmonary vertex • Vertebrobasilar insufficiency • Acromioclavicular pathology • Temporomandibular pathology • Thoracic outlet syndrome	

In order to make a good differential diagnosis of the condition and clinical picture, or to study the patient's evolution and/or establish the originating impairment, it is always important to gather a set of fundamental data, which will be shown in the subject's clinical history. This data refers to the characteristics of the clinical picture itself, as well as to the patient's own

characteristics, which in some way could also have influenced the appearance of the clinical condition (study of the aetiological or injury mechanism(s)) or affected its progression. It is important to gather the following data:

- Personal data: including age, profession and employment status, and health habits (above all, physical exercise).
- Personal pathological antecedents: prior pathology, including the one related to the current condition or pre-existing diagnoses.
- Current illness:
    - When and where the pain appeared; time of evolution.
    - Nature of the pain: whether it is associated with movements or postures (mechanical), or if it is continual, at rest and/or interferes with nocturnal rest (inflammatory), or if there are neuropathic characteristics associated (cramp, allodynia, paraesthesia, burning).
    - Factors attenuating or exacerbating the condition.
    - Location and frequency with which the pain appears (if we are working with a sheet or template, we can mark the location with an X):

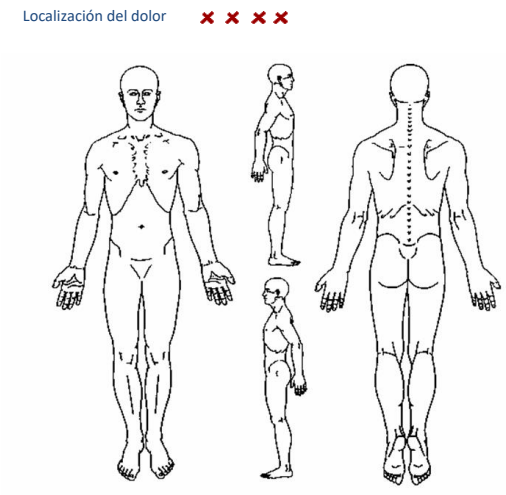

Figure 1. Possible locations of the pain. Source: Instituto de Biomecánica de Valencia (IBV)

    - Existence or not of pain radiating towards other zones and which ones, most notably the possibility of radiating to the upper limbs (possible radicular pain). If so, it is important to identify the radiating territory, and whether it corresponds to a specific dermatome.

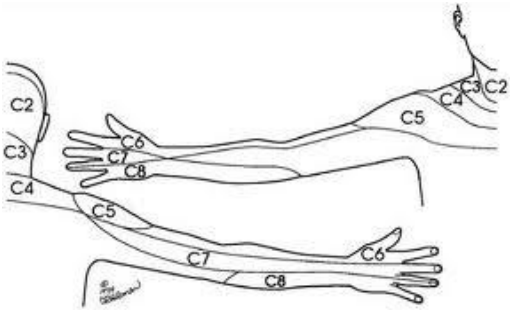

Figure 2. Identification of dermatomes in an upper limb. Source: Instituto de Biomecánica de Valencia (IBV)

    - Whether there is a restriction to cervical movement in this context.
    - Whether there is a weakness or loss of sensitivity in the upper limbs or other places.
    - Whether the patient has undergone or is undergoing any kind of treatment and if it provides any relief.
    - Existence of other concomitant symptoms: vertigo, cephalea, tinnitus, vasovagal symptoms, etc.
- Related complementary tests, if any (X-rays, magnetic resonances, computerised axial tomographs, electrophysiological tests, etc.)
- The following section corresponds to a physical examination of the subject, which will be explained in detail later.

It should be noted that a good anamnesis and physical examination, as well as a series of well-indicated complementary tests that confirm a specific diagnostic suspicion (provided that they are necessary), are fundamental to come to an accurate diagnosis of the condition, and therefore to choose the best possible way to handle deal with patient.

On evaluating this type of condition, and especially **in assessing the impairment or disability (if any) caused by it**, it is important for the evaluation criteria to be standardised so that two different professionals can establish an equivalent degree of disability for the same subject. With this rationale, the guidelines of the American Medical Association put forward a set of standards for physical examination and to assign a degree of disability or impairment, if this is the purpose for evaluating the case[3].

In this vein, the AMA gives a two-fold vision:

- An evaluation of the case and of the impairment based on the established diagnosis, “injury model”, in which the patient is assigned to different groups depending on the diagnosis. Clearly, for this type of evaluation it is necessary to carry out a previous evaluation procedure for the case in which the pertinent anamnesis, physical examination and complementary tests (if necessary) confirming the diagnosis have already been carried out. Hence, this model attempts to document the physiological and/or structural impairments related to the different injuries that could be located in the segment.
- An evaluation of impairments based on findings from the physical examination, fundamentally related to movement of the segment, following the so-called “range of motion model” or “functional model”.

Following the first “injury model”, also known as the “diagnosis-based estimates model”, the following categories are established for the cervical/cervicodorsal segment, each one with an associated degree of disability or impairment:

Table 2 – Levels of cervicodorsal impairment according to the AMA's model of injury[3].

Degree of impairment in the cervicodorsal region	Characteristics
I: Discomfort or symptoms	There are no significant findings for the patient, no muscular defence, neurological impairment, loss of structural integrity in X-rays or signs of impairment related to injury or illness. Overall body impairment is 0%.
II: Minor impairment	The data is compatible with a specific injury or illness, with muscular defence observed by the doctor, loss of mobility or radicular discomfort. There are no signs of radiculopathy (no motor or sensorial impairment) or loss of structural integrity. A vertebral compression of under 25% may be associated with it, fracture of the posterior element without dislocation or progressive spondylolysis, consolidated without loss of structural integrity or radiculopathy. There are no interruptions in the spinal canal. Overall body impairment of 5%.
III: Radiculopathy	The patient shows signs compatible with radiculopathy like loss of reflexes and muscular atrophy greater than a 2 cm reduction in the circumference of the upper limb (compared to the healthy side). The impairment is objectively confirmed in the physical examination or via an electrophysiological test. Structurally, it may imply compression of the vertebral body by 25-35%, fracture of the posterior element, and slight displacement interrupting the spinal canal. Overall body impairment of 15%.
IV: Loss of integrity of a segment of motion or different places of neurological damage.	The patient shows a loss of a motion segment, loss of structural integrity and bilateral radiculopathy in different places. The loss of structural integrity implies a translation greater than 3.5 mm of one vertebra over another, or an angular motion in a motion segment of more than 11º greater than the motion of an adjacent segment. There must be a documented record of muscular defence and pain. Structurally, this would involve compression of more than 50% with no residual neurological damage, structural damage of a

	motion segment in several places without residual motor neurological damage; for example, a dislocation or fracture at several places. Overall body impairment of 25%.
V: Serious neurological damage in the upper limb.	Major upper limb impairment, objectively demonstrated and requiring the use of a functional or adaptive external device. Total neurological loss at a single place or severe neurological loss at several places. There is structural damage with severe motor impairment of the upper limb, but with no serious damage to the lower limb. Overall body impairment of 35%.
VI: Cauda equina syndrome with no intestinal or bladder signs.	Cauda equina syndrome with objectively demonstrated partial serious permanent loss of function in one or both lower limbs, requiring the use of an external walking device (if not required, this would be a grade IV). There is no intestinal or bladder impairment. Overall body impairment of 40%
VII: Cauda equina syndrome with intestinal or bladder signs.	Severe lower limb impairment similar to grade VI, accompanied by intestinal/bladder damage that requires an adaptive device. The structural implications are similar to those of category VI or previous categories, but the functional implications are greater. Overall body impairment of 60%.
VIII: Paraplegia, total loss of lower limb function.	The patient has total or practically total lower limb paralysis, with or without loss of intestinal and bladder function. Structurally, the implications may be similar to those of categories II, III, IV and V. Overall body impairment of 75%

Physical examination[1]

The cervical spine comprises the first seven vertebrae. Thanks to this bone structure and the powerful musculature within it, it is responsible for holding up and providing stability for the head, as well as providing mobility in all spatial directions. Due to its structure and in the context of functionality where it is to be found, cervical pathology manifests itself in most cases with muscle defence responses, which are often to avoid pain, as well as poor attitudes or postures, restricted mobility and often rectification of the physiological lordosis (concave curvature in the sagittal plane traced by this segment of the spine).

A complete physical examination includes an inspection of the area, palpation of painful points or alterations in tone; essentially, an assessment of mobility and finally a series of specific tests. In addition, in some cases and depending on the diagnostic suspicion, it will be necessary to complement an isolated exploration of the cervical segment with a neurological examination of the upper limbs (strength, sensitivity, osteotendinous reflexes, irritative pyramidal signs) or even by performing a more detailed neurological examination including the lower limbs or sphincters (mainly when there is suspicion of spinal pathology).

The main parts of the physical examination of the cervical spine are summarised below:

- **Inspection**

During this first inspection phase, we visually review the possible alterations or deviations from normality that may guide us towards a specific pathology. Amongst other information, we must look at the patient's attitude as regards the positioning of their head (centred, to the side, a tendency to remain in anterior cervical flexion or lateral rotation/flexion, whether the patient raises their shoulders and tends to block motion of the neck segment during the assessment, etc.). It is essential to assess the existence of asymmetries of any kind, as well as the presence of anomalous masses in any region.
It is also important to consider whether deviations from normal posture are mobile/reducible, or are fixed, which could indicate the existence of severe muscle contractures, torticollis, dystonia or structural alterations such as Klippel Feil syndrome. One sign of serious pathology that should make us sound the alarms is the so-called Rust's sign, whereby the patient needs to hold their own head in their hands, indicating alto-axoid subluxation in a probable context of trauma.

- **Palpation**

To carry out suitable palpation of the cervical region, the patient is usually placed on a chair or the examination table with the assessor standing behind.
It begins at the occipital level, on both sides of the external occipital protuberance, at the insertion of the trapezium, the posterior recti of the neck and with palpation of the suboccipital nerves of Arnold (see figure 3); points that can be painful in degenerative or traumatic processes, and which are also painful trigger points in clinical pictures with fibromyalgia.

Figure 3. Palpation of the Arnold points (left), spinous process at C7 (centre) and transverse processes in the lower cervical spine (right). Images taken from Granero-Xiberta J. 2010[1].

Next, the insertions of the sternocleidomastoid muscle are palpated at the mastoid processes, which is done by lateralising the patient's head towards the opposite side. Sometimes, a contraction of this muscle may be palpated, often unilaterally, which causes a contraction that leads to a posture in contralateral rotation with ipsilateral lateral flexion and a more or less severe increase in tone of the fibres. This type of contracture can be spontaneous or post-traumatic.

Next, the cervical spinous processes from C2 to C7 (*vertebra prominens*) are palpated. In most cases, T1 protrudes more, so that to locate C7 we must ask the patient to flex and extend their neck: C7 corresponds to the mobile vertebra, while T1 remains in a more or less stationary position. It is important to check whether there is pain in these places and if the alignment is normal. The articular facets on both sides of the spinous and articular processes, which can be painful, especially in degenerative cases, are also palpated (see Figure 3).

Palpation of the trapezius muscles' fibres is very significant in the context of any type of cervicalgia, especially in ones of a mechanical kind, since it is a very common place for these types of algias to settle (see figure 4). The trapezius muscle forms the posterior "wings" of the neck, inserting into the clavicle and the spine of the scapula. It is advisable to palpate the two trapezius simultaneously to assess asymmetries in muscle tone, as well as to assess if there are contractures or painful points.

Palpation of the anterior side is also carried out from behind the subject. Emphasis is placed on palpation of the sternocleidomastoid muscles and the possibility of palpating lymphatic chains, the thyroid gland and carotid pulse.

Figure 4. Palpation of trapezius fibres (left) and supraclavicular fossa (right). Images from Granero-Xiberta J. 2010[1].

At the supraclavicular fossa, the existence of a cervical rib or tumours in the pleural dome, such as a Pancoast tumour, should be confirmed or ruled out. On both sides of the cricoid and deep down, the Chassaignac tubercles or anterior carotid tubercles on the transverse process of C6 can be palpated.

- **Mobility examination**

As mentioned above, injuries in the cervical region often also involve a restriction of movement, whether anatomical or pain-avoiding.
It is important to note which arcs are actively decreased (range of active motion) and which decrease passively (it is the assessor who gently moves the head). In the former case, the decrease is probably due to pain. When the restriction is also passive, there is probably a structural injury hindering movement in the direction being assessed.

An evaluation of mobility can be carried out visually, though it is very inaccurate. For this reason, it is advisable to use some type of instrument, whether it is the classic goniometer or other more advanced systems (this matter will be reviewed later). In some cases, a measuring tape can also be used to measure the chin-sternum distance or the ear-shoulder distance. The head can lean forward (*flexion* of the neck) between 35º and 45º, backwards

(*extension* of the neck) another 35º-45º, to the side (*lateral tilt* right and left) about 45º, and rotate to both sides.

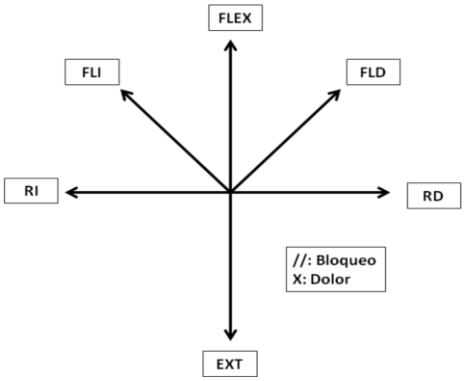

Figure 5. Motion ranges to be examined in the cervical region. We can indicate which arcs are restricted and which are painful. Source: IBV.

- **Neurological examination**

If there is suspicion of possible root or spinal damage of some sort, it is imperative to carry out a targeted neurological examination. If there is a cervical pathology, and especially a suspected radiculopathy, it is essential to examine the upper limb's strength, sensitivity and reflexes. In this context, it is important to know the correspondence between the myotoma, dermatome or osteotendinous reflex examined and the corresponding root:

Table 3. Expected damage in the event of radiculopathy according to the root. Source: Preston DC, Shapiro BE. (2005)[4].

Root	Painful territory	Sensory damage	Muscular weakness	Reflexes affected
C3-C4	Paraspinal muscles, Superior shoulder	Neck	Diaphragm, nuchal muscles, strap muscles	None
C5	Neck, shoulder, anterior arm	Shoulder	Deltoid, supraspinatus, infraspinatus, rhomboid, biceps, brachioradialis	Biceps, brachioradialis
C6	Neck, shoulder, anterior upper arm extending to antecubital fossa	Thumb, index finger, radial forearm	Deltoid, supraspinatus, infraspinatus, rhomboid, biceps, brachioradialis Triceps, latissimus dorsi, pronator teres, flexor carpi radialis, extensor carpi radialis	Biceps, brachioradialis
C7	Neck, shoulder, dorsum of forearm	Middle finger	Triceps, latissimus dorsi, pronator teres, flexor carpi radialis, extensor carpi radialis	Triceps
C8	Neck, shoulder, ulnar forearm	Ring, little fingers, hypothenar eminence	Intrinsic hand muscles, finger extensors, finger flexors	None
T1	Neck, shoulder, ulnar arm	Ulnar forearm	Intrinsic hand muscles (Homer's syndrome)	None

- **Specific manoeuvres or tests**[1]

Root Stretch Test: Spurling test

Extend the neck and turn it towards the side in pain. The pain usually increases locally if it is a mechanical type. If there is radicular pain, it may appear radiating to the upper limb through the territory corresponding to the affected root(s). Further exacerbation of pain can be caused by passively stretching the upper limb of the affected side during the manoeuvre.

Figure 6. Spurling test Source: IBV

Axial compression test (Jackson manoeuvre)

Put pressure on the patient's head with their neck in a neutral position. The pain usually increases and radiates via the dermatome corresponding to the root(s) affected in the case of radicular pain.

Figure 7. JACKSON TEST Source: IBV

Manual cervical traction

Pull the patient's spine from the chin and occipital zone. This manoeuvre often relieves pain.

Figure 8. Cervical traction Source: IBV

Lasègue test for the brachial plexus

From the initial position, (90º shoulder abduction, 90º elbow and fingers outstretched), the examiner extends the elbow. Radiating pain may appear congruent with the affected metameric areas.

Figure 9. Jackson test. Source: IBV

Valsalva Manoeuvre

The patient must try to blow against the back of their hand or with their thumb in their mouth. This is a manoeuvre that increases intra-abdominal pressure, at the same time increasing intra-rectal pressure. This increase in pressure will cause radicular pain in cases where there is a conflict of space due to a discal or tumoural pathology.

There are other ways to perform the manoeuvre, for example by asking the patient to try to blow as hard as possible with their mouth shut and pinching their nose. In this context, it is also common for radicular pain to increase with coughing, sneezing or defecation, gestures that act similarly to the Valsalva manoeuvre.

Adson Manoeuvre

This test assesses the possible presence of thoracic operculum or thoracic outlet syndrome. It is based on observing if the radial pulse disappears when carrying out abduction, extension and external rotation of the arm, starting from the position of arms crossed. In addition, the patient is asked to rotate their head towards the affected side. At that moment, the pressure from the scalene muscles can compress the subclavian vein and make the radial pulse disappear.

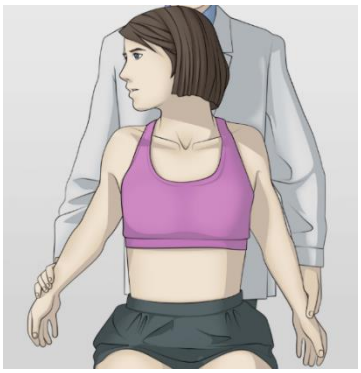

Figure 10. Starting position for the Adson manouevre.[5] Website: https://medisavvy.com/adsons-test/

Soto-Hall Manoeuvre

With the patient in decubitus supine, they are asked to flex their neck by bringing their chin close to the sternum, while the examiner presses the sternum down slightly. If there is a traumatic or degenerative disorder, especially if it occurs with a muscular contracture, a pain in the neck appears.

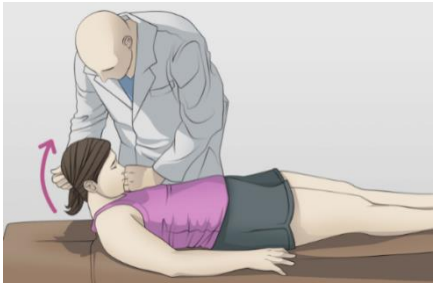

Figure 11. Soto-Hall Manoeuvre Image from https://medisavvy.com/soto-hall-test/[6]

As part of your theoretical training, we recommend watching a video about physical examination of the cervical spine. You can see some example videos via the following links:
https://www.youtube.com/watch?v=X4yjcxlBpuo
https://www.youtube.com/watch?v=_oZp-FKeDe0
https://www.youtube.com/watch?v=nz84ESfxMwM
The material that the hyperlinks lead to is public and available for viewing online. It has been selected for its suitability to the subject covered in this unit (physical examination of the spine: cervical spine), after performing a search using the terms "cervical spine physical examination"

in the website indicated above. You can find and peruse other interesting public educational videos like this using the same search terms.

2.3. Dorsal spine

Anamnesis and diagnosis-based impairment

As for dorsal spine pathology, in addition to the existence of deformities (this topic will be dealt with in the following sections), there are clinical pictures of pain located in this region, also called dorsalgias. Dorsal pain is in itself a less common location than lumbar or cervical pain, but on the other hand it may appear associated with the other two. However, in the case of dorsalgias, especially when they appear in isolation (and not as an extension of pain mainly located in the lumbar or cervical area), it is very important to confirm or rule out pathologies of non-musculoskeletal origin, since they can lead to referred pain, i.e. manifestations of pathologies of internal thoracoabdominal organs. We must also confirm or rule out pathological fractures, especially in the female population of a mature age and with low-intensity trauma or overexertion as a trigger. In this sense, any osteoporotic fracture above T6 can lead us to think about the existence of neoplasia.

The deformities (scoliosis and kyphosis) mentioned above can also be the source of dorsal pain symptoms, especially in young or children's population. Within this group, dorsal pain in the context of Sheuermann's disease, which occurs with progressive wedging of the vertebrae with hyperchondosis and predominant pain in the T5 to T12 segment[1,2], is particularly notable.

Table 4 – Most common causes of dorsal pain. Taken from https://www.fisterra.com/guias-clinicas/cervicalgia-dorsalgia/[2]

Mechanical dorsalgia	Sharp	• Vertebral fracture (pathological or not). • Herniated disc
	Chronic	• Scheuermann's disease (juvenile kyphosis or growth dysplasia). • Kyphosis and scoliosis. • Spondyloarthrosis • Functional dorsalgias: benign functional dorsalgia.
Inflammatory dorsalgia	Rheumatic diseases	• Fibromyalgia • Spondyloarthrosis and disc degeneration. • Ankylosing spondylitis and other spondyloarthropathies • Osteoporosis (vertebral crushing / fractures). • Myofascial pain syndrome.
	Primary or metastatic tumours or myeloma.	
	Infections.	
Referred dorsalgia	• Abdominal diseases: gallbladder, pancreas, peptic ulcer • Ischemic heart disease • Pericarditis • Aortic aneurysm	

- Herpes zoster

As with cervical and lumbar pain, in this case it is also essential to gather the clinical data in an orderly, systematic way. The data is necessary to make a good diagnosis so as to differentiate, study the evolution or evaluate the impairment caused. This data must again include:

- Personal data: including age, profession and employment status, and health habits (above all, physical exercise).
- Personal pathological antecedents: prior pathology, including the one related to the current condition or pre-existing diagnoses.
- Current illness:
    - When and where the pain appeared; time of evolution.
    - Nature of the pain: whether it is associated with movements or postures (mechanical), or if it is continual, at rest and/or interferes with nocturnal rest (inflammatory), or whether neuropathic characteristics are associated with it (cramp, allodynia, paraesthesia, burning). Factors attenuating or exacerbating the condition.
    - Location and frequency with which the pain appears (if we are working with a sheet or template, we can mark the location with an X):
    - Pain radiating or not to other areas, and which ones.
    - Whether there is weakness or loss of sensitivity somewhere.
    - Whether the patient has undergone or is undergoing any kind of treatment and if it provides any relief.
    - The existence of other concomitant symptoms: weight loss, stiffness, significant pain or not in other joint locations, vasovagal symptoms, etc.
- Related complementary tests, if any (X-rays, magnetic resonances, computerised axial tomographs, gammagraphs, electrophysiological tests, etc.).
- The following section is about a physical examination of the subject, which will be explained in detail later.

Furthermore, as mentioned in the section on the cervical spine, it is also relevant for both the dorsal and lumbar spine to have standardised criteria to evaluate **the impairment or disability (if any) caused by them**. Along these lines, the American Medical Association's guidelines for evaluating impairment also propose assigning a degree of disability or impairment, if that is the purpose of evaluating the case.

Below, there are the categories contemplated by the AMA for the dorsolumbar spine, which are similar or equivalent to those for the cervicodorsal region previously explained in some cases, and correspond to the classification according to the "injury model" already described in the previous section:

Table 5 – Levels of dorsolumbar impairment according to the AMA's injury model[3].

Degree of dorsolumbar region impairment	Characteristics
I: Discomfort or symptoms	There are no significant findings for the patient, no muscular defence, neurological impairment, loss of structural integrity in X-rays or signs of impairment related to injury or illness. The overall body impairment is 0%.
II: Minor impairment	The data is compatible with a specific injury or illness, with muscular defence observed by the doctor, uneven loss of mobility (including dissymmetry) or radicular discomfort. There are no signs of radiculopathy (no motor or sensorial impairment) or loss of structural integrity. A vertebral compression of under 25% may be associated, fracture of the posterior element without dislocation or progressive spondylolysis, consolidated without loss of structural integrity or radiculopathy. There are no interruptions in the spinal canal. Overall body impairment of 5%.
III: Radiculopathy	The patient has a minor neurological impairment of the lower limb related to a dorsolumbar injury. The impairment is demonstrable via physical examination: there is abolition of reflexes and/or unilateral muscular atrophy in the lower limb unrelated to another disorder. Structurally, this may imply compression of the vertebral body of 25-50%, fracture of the posterior element, and a slight displacement interrupting the spinal canal. Overall body impairment of 15%.
IV: Loss of integrity of a segment of motion or different places of neurological damage.	The patient shows a loss of a motion segment, loss of structural integrity, bilateral radiculopathy in different places. The loss of structural integrity implies a translation of greater than 5 mm of one vertebra over another, or an angular motion as regards a motion segment of more than 11º greater than the motion of an adjacent segment. There must be a documented record of muscular defence and pain.

	Structurally, this would involve compression of more than 50% with no residual neurological damage, structural damage of a motion segment in several places without residual motor neurological damage; for example, a dislocation or fracture at different places. Overall body impairment of 20%.
V: Radiculopathy and loss of integrity of the motion segment	Major lower limb impairment with loss of reflexes and muscular atrophy. The impairment is demonstrable via physical examination or an electrophysiological test. In this case, there is structural damage causing motor neurological impairment, but no cauda equina syndrome. Overall body impairment of 25%.
VI: *Cauda equina* syndrome with no intestinal or bladder impairment.	Serious *cauda equina* syndrome objectively demonstrated with partial loss of use in one or both lower limbs, requiring the use of an external walking device (if not required, this would be a grade V). There is no intestinal or bladder impairment. Overall body impairment of 35%
VII: *Cauda equina* syndrome with intestinal or bladder impairment.	*Cauda equina* syndrome with loss of function in one or both lower limbs, requiring the use of an external walking device. There is also permanent intestinal or bladder impairment requiring external adaptive devices. Overall body impairment of 55%.
VIII: Paraplegia	The patient has total or practically total lower limb paralysis, with or without loss of intestinal and bladder function. Structurally, the implications may be similar to those of categories II, III and IV. Overall body impairment of 70%

The physical examination of the dorsal spine will be reviewed jointly as an examination of the dorsolumbar region in the section on the lumbar spine.

2.4. LUMBAR SPINE

Anamnesis and diagnosis-based impairment

Back pain, and in particular lower back pain (or *lumbalgia*) is, as we have previously mentioned, one of the most frequent clinical cases among the adult population. As such, it is one of the most common causes for visits from patients in primary care. Not surprisingly, it is estimated that the prevalence of lumbalgia throughout people's life is 80%, i.e. 8 out of 10 people will suffer from it at least once in their life[1].

Although the cause of the symptoms is often not visibly identified, there is a smaller percentage of subjects whose pain can be explained within the context of a structural injury (disc pathology, mainly herniated nucleus pulposus, canal stenosis, foraminal stenosis in degenerative contexts, etc.). Furthermore, there are also less common cases (which is why it is important to detect alarm signals and carry out a proper diagnostic procedure) in which the origin of the pain is a serious pathology, for example neoplastic or infectious processes, or else a visceral pathology with referred lumbar pain[7].

In this context, it is essential to carry out a suitable and comprehensive anamnesis and physical examination, targeted and always based on knowledge of the pathological forms and their symptoms. In this vein, it is fundamental to know if complementary tests are advisable or not (they are not necessary in all cases), which must always be requested based on a previous diagnostic suspicion.

A suitable anamnesis must be aimed at gathering sufficient data to guide the physical examination and establish the initial diagnostic suspicion. To do so, efficient communication with the patient is important, making comprehensible, direct and simple questions with no specific medical terminology that many people do not understand.
The most relevant data to be gathered in cases of lumbar pain are as follows:

- Personal data: Including age, profession and employment status, and health habits (above all, physical exercise). In this section, it is important to know how to detect possible signs of interference in the progression of the illness, increasing the probability of therapeutic failure, known as "**yellow flags**". These may include[7]:
    - Concurrence of processes related to the job environment, such as incapacitation or economic compensation.
    - Factors related to the pain itself: the patient has undergone unsuitable, ineffective treatment previously, is afraid of the pain or generalised pain, or believes that any activity that entails some pain is damaging for them.
    - Psychosocial factors: the patient's acceptance of their role as an ill person, disorders or alterations in mood, lack of social or family support, or over-protective behaviours.
- Personal pathological antecedents: prior pathology, including the one related to the current condition or pre-existing diagnoses. If they have any kind of allergy or previous surgical operations, it is also important to know the usual medication they take and if they have any toxic habits.
- Current illness:

- When and where the pain appeared; time of evolution.
- Nature of the pain: whether it is associated with movements or postures (mechanical), or if it is continual, at rest and/or interferes with nocturnal rest (inflammatory), or whether there are associated neuropathic characteristics (cramp, allodynia, paraesthesia, burning).
- Attenuating factors (such as rest, change of posture, heat) or factors that exacerbate the condition (such as lifting weights, turning, walking, sustained postures, coughing, etc.).
- Location and frequency with which the pain appears (if we are working with a sheet or template, we can mark the location with an X):

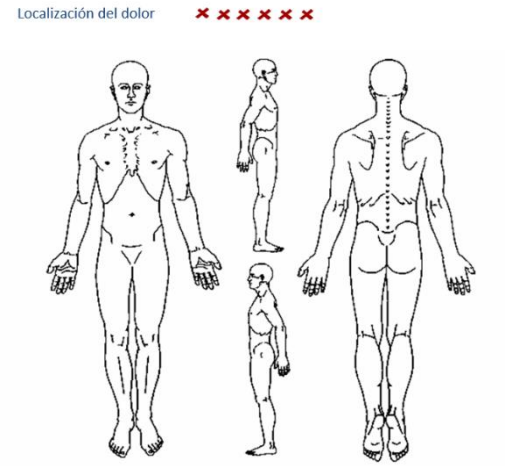

Figure 12. Possible locations of the pain. Source: IBV

- Pain radiating or not to other areas, and which ones. Locate the specific territory if the distribution corresponds to a dermatome.

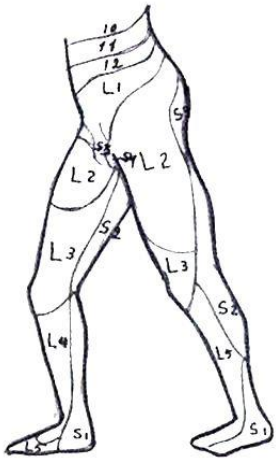

Figure 13. Dermatomes in the lower limb. Source: IBV

- Whether there is weakness or loss of sensitivity at some point, in this case especially at the perineum (related to a possible *cauda equina* syndrome, which occurs with “saddle” anaesthesia) and the lower limbs. Whether there is some

kind of sphincter disorder (incontinence or urinary retention) or changes in bowel habits.
- Whether the patient has undergone or is undergoing any kind of treatment and if it provides any relief.
- Existence of other concomitant symptoms: fever, constitutional syndrome or gastrointestinal, genitourinary, gynaecological or rheumatic symptoms.

When collecting data it is essential to detect alarm symptoms, also known as **"Red Flags"**, which can lead us to suspect that the lumbar pain is due to a specific, potentially serious cause[7]:

- Neurological clinical picture: acute paresis with muscle balance of 3/5 or less.
- Horsetail or *cauda equina* syndrome (urinary retention, saddle anaesthesia).
- Ankylosing spondylitis pain.
- Prior trauma.
- Constitutional syndrome.
- Personal oncological antecedents.
- Associated fever syndrome.
- Drug addiction via parents.
- Steroid use.
- 1st episode of lumbar pain at <20 or >50 years of age.

In the case of the lumbar spine, there are also standardised criteria designed to systematise evaluation of the impairment or disability (if any) caused by its disorders, for loss of mobility and for the established diagnosis. Listed below are the categories contemplated by the AMA for the lumbosacral spine, which are similar or equivalent to those of the cervicodorsal or dorsolumbar regions previously explained, and correspond to the classification according to the "injury model":

Table 6 – Levels of lumbosacral impairment according to the AMA's injury model[3].

Degree of impairment in the lumbosacral region	Characteristics
I: Discomfort or symptoms	There are no significant findings for the patient, no muscular defence, neurological impairment, loss of structural integrity in X-rays or signs of impairment related to injury or illness. The overall body impairment is 0%.
II: Minor impairment	The data is compatible with a specific injury or illness, with possible muscular defence observed by the doctor, uneven loss of mobility (including dissymmetry) or radicular discomfort. There are no signs of radiculopathy (no motor or sensorial impairment) or loss of structural integrity.

	There may be a vertebral compression of under 25% associated, fracture of the posterior element without dislocation or progressive spondylolysis, consolidated without loss of structural integrity or radiculopathy. There are no interruptions in the spinal canal. Overall body impairment of 5%.
III: Radiculopathy	The patient shows signs of radiculopathy such as a loss of reflexes or unilateral atrophy of more than 2 cm in circumference. The impairment is demonstrable via physical examination or an electrophysiological test. Structurally, it may imply compression of the vertebral body of 25-50%, fracture of the posterior element, and a slight displacement interrupting the spinal canal. Overall body impairment of 15%.
IV: Loss of integrity of a motion segment	The patient shows loss of a motion segment. The loss of a motion segment or structural integrity implies a translation greater than 5 mm of one vertebra over another, or an angular motion in a motion segment of more than 11º greater than the motion of an adjacent segment. At the lumbosacral joint, this loss of structural integrity is defined with an angular movement 15º greater than that of the L4-L5 segment. There must be a documented record of muscular defence and pain with or without neurological anomalies. Structurally, this would involve compression of more than 50% with no residual neurological damage, or else structural damage of a spine segment in several places, but without residual neurological damage. Overall body impairment of 20%.
V: Radiculopathy and loss of integrity of the motion segment	Radiculopathy with loss of integrity of a motion segment. There is atrophy and/or a loss of reflexes, numbness or concordant electromyographic data. Overall body impairment of 25%.
VI: *Cauda equina* syndrome with no intestinal or bladder impairment.	Serious and objectively demonstrated damage with bilateral, objective permanent impairment to the two lower extremities. There is no intestinal or bladder impairment. Overall body impairment of 40%.

VII: *Cauda equina* syndrome with intestinal or bladder impairment.	*Cauda equina* syndrome with loss of function in one or both lower limbs, requiring the use of an external walking device. There is also permanent intestinal or bladder impairment requiring external adaptive devices. Overall body impairment of 60%.
VIII: Paraplegia, total loss of function in the lumbosacral region of the spinal cord.	The patient shows total paraplegia due to neural compression in the lumbar region of the spine. Overall body impairment of 75%

Physical examination[1,7]

A proper physical examination of the dorsolumbar section and of any type of condition that affects it should include:

- **Inspection**

In general, an inspection of the dorsolumbar spine is carried out with a load, i.e. with the patient standing. We can thus examine two planes: the lateral plane, placing the subject in profile, and the frontal plane, placing ourselves behind them.
In the lateral plane, we shall observe whether or not the physiological curves are preserved (dorsal kyphosis, lumbar lordosis) or not; and if not, to what extent and how they are altered.

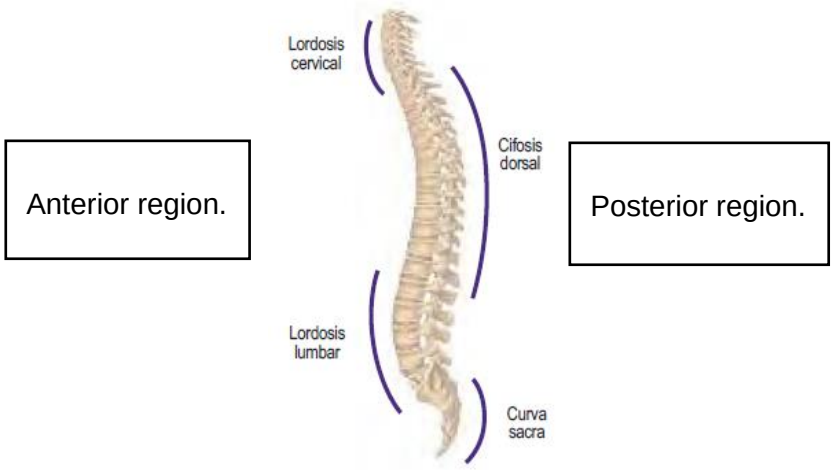

Figure 14. Physiological curves of the spine in the lateral plane. Image taken from Granero-Xiberta J. 2010[1]

In the frontal plane, we must observe above all whether there are asymmetries between one half and the other (shoulder and scapula height, pelvic scale, lower limb dyssmmetry, etc.).

- **Palpation**

In the thoracic region, it is preferable to perform the palpation with the patient in decubitus supine. We can thus palpate the sternum (with its three parts: manubrium, body and xiphoid), sternocostal and chondrocostal joints and the ribs, which can be followed along their entire length up to the costovertebral joint. Both clavicles can also be palpated along their entire length, including the sternoclavicular and acromioclavicular joints (the latter is a common place for musculoskeletal pathology to settle, especially of the degenerative or post-traumatic kind). It is necessary to pay attention to painful points, deformities, excessive segment mobility or abnormal tumours in all of the structures palpated.

To palpate the structures of the spine, both dorsal and lumbosacral, the standard posture is standing (patient with their back facing the assessor) or, and often preferably, in the decubitus prone position or Maigne's position, in which the subject is in the decubitus prone posture across the examining table, so that their legs and arms are hanging off the table. In these postures we can palpate both scapulae, especially their medial border, the tip and the super-internal angle, where the angular muscle of the scapula (or *levator scapulae*) sits inside, which is often painful in different post-traumatic processes or patients with fibromyalgia. The tip of the scapula corresponds approximately to T7.

Figure 15. Palpation of the spinous process (left) and the lumbar paravertebral region (right) in the Maigne posture. Images taken from Granero-Xiberta J. 2010[1].

We must palpate all of the dorsal and lumbar spinous processes in search of painful points, deformities or hypermobility. It is sometimes possible to determine the existence of lumbar spondylolisthesis if there is a palpable gap between one spinous process and the next.
We can also palpate the iliac crests, which usually correspond to L4, the articular pillars and the paravertebral musculature of each of the dorsolumbar points, often painful regions in degenerative or traumatic musculoskeletal processes, or in the context of disc pathology.

It is important to confirm or rule out pathology at the sacroiliac joints, which can be associated with pain in the lumbosacral region. In this case they can be painful on palpation, and usually some of the specific manoeuvres to be seen later will be positive. Furthermore, both the sacrum and coccyx can be painful on palpation, whether in traumatic or spontaneously initiated cases, with a notable frequency of coccydynia symptoms (mechanical pain profile in the coccyx).

Lastly, in addition to paying attention to painful points, deformities, hypermobility and changes in muscle tone in the palpated regions of the spine, it is also possible to observe other types of signs or symptoms such as hyperalgesia, allodynia (sensitivity to palpation or minimal rubbing of the skin) or vegetative disorders.

- **Mobility examination**

Pathology in the dorsal region of the spine, and especially in the lumbar or lumbosacral region, can often occur with restrictions to mobility, whether of a structural origin or associated with pain caused by said movement and thus a pain avoidance inhibition to the mobility of a segment.

The evaluation of mobility can be carried out visually, though this strategy is very inaccurate, so it is advisable to use other types of instruments that provide objective, more or less sensitive and precise measurements, such as classic goniometers, inclinometers and other more advanced systems that will be discussed later.

The mobility of the dorso-lumbar spine is examined with the patient standing. The dorsal column has motion in the three planes of space: flexion, which ranges between 20º and 45º, extension, also from 25º to 45º, lateral tilt, from 20º to 40º to each side, and rotation of about 35-50º also on each side.

The lumbar spine's maximum motion is in L4-L5 and L5-S1, and it can also perform active movements of flexion (40º-60º), extension (20º-35º), lateralisations (20º-30º to right and left) and some rotation of 3º-18º to each side.

Figure 16. Lateral inclinations of the trunk. Website: https://medisavvy.com/forestiers-bowstring-sign/ [8]

In any case, in addition to a simple visual evaluation, there are a number of specific strategies to assess the mobility of the dorsolumbar segment that are very useful if there are no other more precise measuring instruments, often resorting simply to the use of a common measuring tape. Here are some such strategies:

Finger-ground distance measurement

To assess flexion of the trunk, the patient is asked to lean forward until they touch their toes or the floor immediately in front of them with their fingertips, without bending their knees. The distance from their fingertips to the floor is measured in centimetres.

An increase in this distance may mean a limitation to vertebral mobility or else a shortening of the posterior chain (mainly hamstring musculature).
Although standardised classification values are not usually used for this test in clinical practice, some authors have made proposals in this regard. For example, Ferrer V. 1998[9] proposes the following categorisation:

Normal: values under 4 cm
Grade I shortening: between 5-10 cm
Grade II shortening: 12 cm or more.

Ott's test

This is used to measure the degree of flexibility in the dorsal area of the spine. It is carried out with the patient standing, measuring the distance between a point marking vertebra (spinous process) C7 and a point 30 cm below it. The subject is asked to perform an anterior flexion, attempting to curve the dorsal region as much as possible, and vice-versa; with normal subjects performing anterior flexion, the distance between the two points marked increases from 2 to 4 cm, and in extension it decreases by 1-2 cm.

Schöber's test

The method for this test is very similar to the previous one, but in this case it is used to assess the mobility of the lumbar region of the spine.

In this case, the two points marked correspond to vertebra (spinous process) S1 and a point 10 cm below it. This distance should increase in flexion by about 5 cm for normal subjects, and decrease in extension by 2 to 3 cm. The test is positive in flexion when there is an increase of less than 5 cm in the distance calculated between the two points[1]. This suggests lumbar spine stiffness, and can lead us to suspect the existence of ankylosing spondylitis.

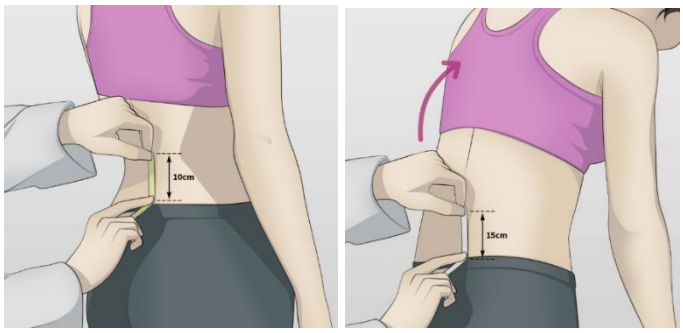

Figure 17. Schober's test. Image taken from https://medisavvy.com/schobers-test/[10]

- **Neurological examination**

If there is suspicion of possible radicular or spinal damage of some sort, it is imperative to carry out a targeted neurological examination. If there is a lumbar pathology, and especially suspected radiculopathy, it is essential to examine the strength, sensitivity and reflexes of the lower limb. In this context, it is important to know the correspondence between the myotoma, dermatome or osteotendinous reflex examined and the corresponding root:

Table 7. Expected damage in the event of radiculopathy depending on the root.
Source: Preston DC, Shapiro BE. (2005)[4]

Root	Painful territory	Sensory damage	Muscular weakness	Reflexes affected
L3	Anterior thigh, groin	Anterior thigh	Iliopsoas, adductors, quadriceps	Knee
L4	Anterior thigh	Medial calf, medial foot	Quadriceps, adductors, (iliopsoas)	Knee
L5	Posterolateral thigh and calf, extending into toe and dorsum of foot	Dorsum of foot, great toe, lateral calf	Tibialis anterior, tibialis posterior, extensor hallucis longus, peronei, gluteus medius, tensor fascia latae	None
S1	Posterolateral thigh and calf, extending into toe and dorsum of foot	Lateral foot, posterior calf, sole of foot	Gastroc-soleus, hamstrings, gluteus maximus	Ankle

Specific tests

Within the physical examination of the dorsal and lumbar spine, there are a series of specific manoeuvres or tests that should be performed only if indicated and depending on the diagnostic suspicion established based on the previous anamnesis. Although there are more manoeuvres, some of the most important and widely used ones for examining the lumbar spine are listed below.

Lasègue test

This involves raising the patient's leg with their knee extended, until they notice a pain radiated along the lower limb, passing throughout the territory of the root affected. It is usually considered significant when the elevation angle is between 10º and 60º with respect to the horizontal. In fact, a herniated nucleus pulposus is usually suspected as the cause of pain when it radiates beyond the knee, with root irritation in the Lasègue test between 30 and 60º.

This test examines roots L4, L5, S1 and S2 (more specific for L5-S1). If pain appears, it is positive.

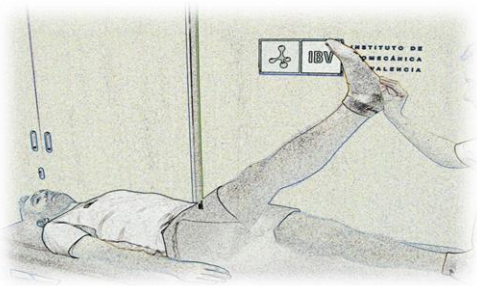

Figure 18. Classic Lasègue test. Source: IBV

Variations on the Lasègue test

Lasègue in lateral decubitus: the manoeuvre is exactly the same as the classic Lasègue one, but it is performed in lateral decubitus. It helps corroborate the suspicion of a root pathology.

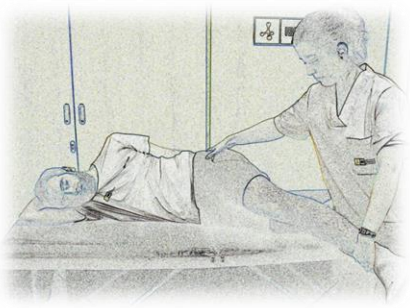

Figure 19: Lasègue in decubitus lateral. Source: IBV

Lasègue in the decubitus prone position (Barraquer-Ferré): the manoeuvre is the same as the classic Lasègue one, but it is carried out in the decubitus prone position. It helps corroborate the suspicion of a root pathology.

Bilateral Lasègue in a sitting position: with the patient sitting and their neck in flexion, the assessor simultaneously raises their two lower limbs. In this case, a medial compression due to central disc herniation should be suspected.

Reverse Lasègue: this examines radicular pain caused by an upper lumbar pathology (L3- L4). The examination is carried out by raising the leg on the affected side with the patient in the decubitus prone position.

Figure 20. Reverse Lasègue test. Image from Granero-Xiberta J. 2010[1].

Bragard test: Beginning with the classic Lasègue manoeuvre, the leg is lowered from the point where the pain began (if any) to the point where there is no more pain, and a dorsal flexion of the passive ankle is carried out. This manoeuvre stretches the sciatic nerve again and reproduces the pain.

Neri test: With the patient sitting with their legs dangling off the examination table, the cervical spine is flexed. The entire thecal sac is stretched, especially in the lumbosacral roots, which can cause irradiated pain if they are involved.

Phalen's test: Pain radiating to the posterior side of both lower limbs on performing a trunk extension while standing. Compatible with lumbar canal stenosis.

As part of your theoretical training, we recommend watching a video about physical examination of the lumbar spine. You can see some example videos via the following links:
https://www.youtube.com/watch?v=q1gX9hORtLY
https://www.youtube.com/watch?v=IijlOJPHk1s&t=23s
The material that the hyperlinks lead to is public and available for viewing online. It has been selected for its suitability to the subject covered in this unit (physical examination of the spine: lumbar spine), after performing a search using the terms "lumbar spine physical examination" in the website indicated above. You can find and view other interesting public educational videos like these using the same search terms.

3. Key ideas

- In order to properly evaluate the lumbar, dorsal and cervical spine, it is essential to carry out a proper anamnesis, gathering important information to guide in carrying out a suitable diagnosis or to provide data related to the expected progression and the impairment caused by the condition.
- A proper anamnesis will provide data related to the subject's antecedents, including personal and pathological information, the location and characteristics of the pain, other associated symptoms, possible injury mechanisms, mitigating or exacerbating factors, and alarm signs and symptoms.
- In physical examination of the spine, it is particularly necessary to carry out an initial inspection, palpating the structures involved, examining the mobility of the segment being studied, and to perform a series of specific tests only when indicated and in a targeted way (i.e. in the context of a specific diagnostic suspicion based on the previous anamnesis). In addition, it is essential to perform an examination of any impairment associated with the condition (in addition to mobility, loss of strength, sensitivity, coordination, interference in ADL, etc.) if there is any.
- Once the diagnosis or aetiology of the condition is known, the American Medical Association offers a guide to the level of global body impairment caused.

4. References

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