Examination of the adult spine

This article summarizes the approach to examination of the adult spine in a non-emergency setting. Spinal examination is crucial for detection of pathological conditions of the spine and can be used by GPs, emergency doctors, rheumatologists and surgeons in related specialties such as orthopaedics or neurosurgery.

This article does not cover the protocol-driven assessment of the patient with potential traumatic spinal injuries. The authors recommend consulting the Advanced Trauma Life Support protocol and the American Spinal Injury Association (2015) spinal injury assessment tool for further information in this setting.

Anatomy

Thirty-three vertebrae make up the vertebral column. Apart from the inferior nine vertebrae of the sacrum and coccyx which are fused (Ellis, 2002) the vertebrae articulate with one another via the vertebral bodies, separated by intervertebral discs, and via the articular facets. The intervertebral foraminae between each pedicle of adjacent vertebrae allow passage of the paired nerve roots, dorsal root ganglia, spinal arteries and veins. Spinal nerves C1–7 pass above their corresponding vertebra while the C8 nerve root travels between C7 and T1, thereafter all nerve roots pass below their corresponding vertebrae (Ellis, 2002).

Intervertebral discs are seated between each vertebral body, allowing dynamic movement of the column and contributing to the normal spinal alignment. The outer part of the intervertebral disc is a solid annulus fibrosis while the inner nucleus pulposus is gelatinous until older age when it usually solidifies and atrophies (Ellis, 2002). These discs may cause symptoms in the context of trauma or degeneration because the posterior aspect of the surrounding annulus fibrosis is comparatively thin, allowing herniation of the nucleus pulposus and possible compression of the nerve roots.

The surface anatomy of the spine extends down the midline from the occiput to the coccyx. The C7 vertebra is known as the vertebra prominens and is an easily palpable landmark. The sacral dimples may be seen in slimmer patients and typically correspond to the L4 level.

Stepwise approach to the examination

Whenever a patient is examined the clinician should introduce him-/herself, explain to the patient the purpose of the assessment and what will be involved. The patient should be asked to give verbal consent and offered a chaperone. It is good practice to wash your hands before examining the patient.

In the scenario of the spinal examination, the clinician should ask the patient whether he/she has any back pain or whether particular movements will exacerbate the pain. This is not strictly part of the examination but demonstrates a patient centred-approach and helps focus the clinician's mind on possible pathology.

Observe the setting and the patient

The presence of any walking aids such as a foot drop splint, walking stick or mobility frame should be noted in order to gauge the patient's current mobility, which may or may not be an indicator of pathology of the spine.

For examination of the spine, the patient should be wearing underwear that allows the spine to be inspected. Aim to observe the patient from the front, side and from behind. This can be done either by moving systematically around the patient or remaining still and asking the patient to turn at 90° and 180° respectively. While examining the patient, the clinician should keep describing to the examiner the presence of positive findings as well as the absence of important and relevant negative findings.

Table 1 shows a collection of signs which the clinician should look for during this observation phase, along with the corresponding pathology that each sign may represent.

Examine the patient while standing

Gait

Observe the patient's gait over a suitable distance (3–5 metres), allowing the patient to walk away from and towards the clinician.

Antalgic gait: The patient will characteristically spend less time weight bearing on the affected side than the normal side. An antalgic gait signifies that the patient is guarding against pain but pathology may be in the spine or lower limb, so this is non-specific.

Trendelenburg gait: This signifies weakness of the hip abductors (e.g. gluteus medius and minimus). There is a distinctive

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Table 1. Signs on observation of the patient in spinal examination

Category	Sign	Possible pathology
Skin	Scars	Surgical approaches, trauma
	Cafe au lait spots	Neurofibromatosis
	Sinus, hair tuft or dimpling	Spina bifida
Soft tissues or muscle	Paravertebral masses	Postural, tumour
	Muscle symmetry or wasting	Postural or neuromuscular
Bone	Sagittal curvature	Scoliosis
	Coronal curvature	Kyphosis, lordosis

pattern of 'sagging' of the unaffected side of the pelvis during the stride phase on the affected side. This axial imbalance causes the patient to compensate by swinging the torso to the weakened side. If a Trendelenburg gait is suspected, the clinician could then perform Trendelenburg's test (*Figure 1*) by standing face to face with the patient and asking him/her to stand on one leg while both palms are held in the hands of the clinician. A positive finding is sagging of the pelvis to the contralateral side or, if the patient tries to compensate for this imbalance, an increased pressure felt in the examiner's hand on the contralateral side to the abductor weakness.

A high stepping gait: A high stepping gait may be observed with or without an audible foot slapping in the plantar phase of the gait. This should alert the clinician to a possible foot drop secondary to weakness of ankle dorsiflexion. This sign may occur in multiple underlying pathologies including neuromuscular weakness, mononeuropathy of the deep peroneal nerve or sciatic nerve, nerve root compression or even central causes such as stroke or motor neurone disease.

Abnormal symmetrical gait: In the context of central neurological conditions or in peripheral neuropathy the patient may demonstrate symmetrical but abnormal gait and the clinician should look for signs such as a wide-based gait, foot shuffling and tightrope walking.

Heel and toe walking: Finally, as a useful quick screening test for myotomal weakness of L4–S1 the clinician can ask the patient to attempt to walk on the heel alone (L4/L5) or toes alone (S1) and note any weakness in the corresponding myotome.

Figure 1. Trendelenburg's test.

Palpation

Palpation of the spine should be performed from behind the patient with a single hand, using the free hand to steady the patient. Palpation of the vertebrae should start just below the occiput and continue down to end at the coccyx, palpating over each vertebra in turn. The clinician should be alert for tenderness or any mass or 'step' deformity which can occur in fragility fractures or spondylolisthesis. Additional palpation of the paravertebral muscles is recommended to differentiate between soft tissue and bony tenderness because a common cause of back pain is lumbrosacral sprain. Alternatively this part of the examination can be performed while the patient is lying on his/her front.

Movements

Assess the active movements of the cervical, thoracic and lumbar spine separately. Unlike other physical examinations of the musculoskeletal system passive movements are not used.

Cervical spine: The patient should be asked to perform the movements listed in *Table 2* to assess cervical spine movement. The patient should be standing with his/her back to the clinician.

Thoracic spine: The thoracic spine contributes little to flexion and extension of the spine but is the main section of the spine involved in rotation. The authors recommend asking the patient to sit down in order to restrict rotation from the pelvis and lower limbs. Assessment of isolated rotation of the thoracic spine requires the examiner to ask the patient to twist towards each side to face the opposite wall. Normal rotation of the thoracic spine is around 60° each direction (*Figure 2*).

At this point, the clinician's hands may be placed on the patient's chest as he/she is asked to take a deep breath in. Asymmetrical chest expansion or a restricted chest expansion may be seen in severe kyphosis, scoliosis and ankylosing spondylitis.

Lumbar spine: The patient should be asked to perform the movements listed in *Table 3* to assess lumbar spine movement. It is important to take into account that the thoracic spine contributes to a small amount of flexion and extension but isolation of thoracic and lumbar movements is not possible. There is negligible rotation at the lumbar spine. *Figures 3* and *4* demonstrate these movements.

Figure 2. Thoracic rotation.

Table 2. Movements of the cervical spine

Patient command	Movement	Area tested	Normal range of movement
Nodding	Flexion/extension	Atlanto-occipital	Around 50% of the cervical spine mobility
Chin on chest and tilt head back	Flexion/extension	Cervical spine (whole)	'Chin to chest' or 50° flexion – 30° extension
Turn head side to side	Rotation	Cervical spine (whole)	70–90°
Tilt head to get ear to shoulder	Lateral flexion	Cervical spine (whole)	40°

Table 3. Movements of the lumbar spine

Patient command	Movement	Area tested	Normal range of movement
Touch your toes keeping knees straight	Forward flexion	Lumbar (and thoracic)	40–60°
Arch backwards	Extension	Lumbar	10–15°
Run a hand down the side of your leg	Lateral flexion	Lumbar (and thoracic)	20°

Figure 3. Forward flexion of the lumbar spine.

Figure 4. Lateral flexion of the lumbar spine.

Special tests

Spurling's compression test: An additional special test may be used for cervical radiculopathy. The clinician stands behind the patient and applies gentle downward pressure with his/her hand on the patient's head. The cervical spine should be flexed toward one side and then the other. A positive test occurs if dermatomal arm pain is felt with the neck flexed towards the affected side.

Modified Schober's test: With the patient standing the clinician marks a point around 5 cm below the L4 vertebra (best identified by the sacral dimpling) and another point 10 cm above the L4 vertebra (*Figure 5*). The patient is then asked to attempt to touch his/her toes without bending the knees. As the lumbar spine flexes the clinician should measure the widening between these two points (*Figure 6*). If the gap fails to widen more than 5 cm there is limitation of flexion of the lumbar spine. A modification of this test involves the clinician using a finger to mark each point and observing the separation between the fingers as the patient bends forward.

Examine the patient while lying on the back

Sciatic nerve stretch tests

In Lasegue's test or straight leg raise the patient lies supine on the couch. The clinician holds the foot or ankle and keeping the knee in extension the leg being tested is elevated passively (*Figure 7*). A positive finding is the onset of shooting pain down the back of the leg to a level below the knee.

The test may then be further confirmed using techniques to exacerbate the sciatic nerve stretch. Bragard's test involves the clinician finding the angle at which the straight leg raise is symptomatic, lowering the leg by 5°, then dorsiflexing the foot (*Figure 8*). Again a positive finding is the onset of shooting pain down the back of the leg. An alternative to dorsiflexing the foot would be asking the patient to lift his/her head off the bed.

Figure 5. Modified Schober's test – points marked.

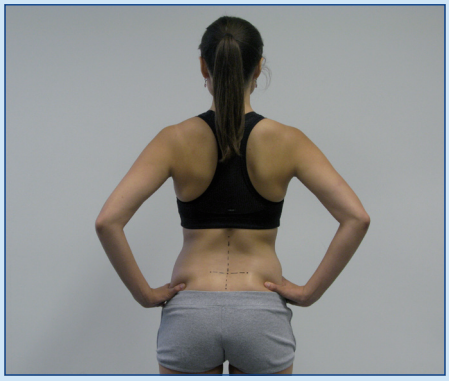

Figure 6. Modified Schober's test – in flexion.

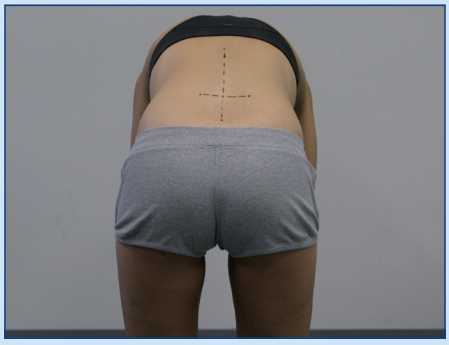

Figure 7. Straight leg raise test.

Tests for sacroiliitis

The Figure 4 or FABER test involves a supine patient with one leg flexed, abducted and externally rotated at the hip. The knee is flexed to allow the ankle to rest on the thigh of the other leg. The clinician applies gentle downward pressure to the flexed knee and looks for the positive finding of pain in the sacroiliac joints. This test is often referred to as the FABER test and provides a memorandum for the sequence of hip movements involved (Flexion, ABduction and External Rotation).

Examine the patient while lying on the front

Femoral nerve stretch test

The femoral nerve may be stretched by lying the patient prone and the clinician lifting a leg off the bed causing hyperextension at the hip joint. Pain radiating down the anterior thigh is considered a positive finding (*Figure 9*).

Neurological examination

The neurological status of the patient should be examined. The minimum

Figure 8. Bragard's test.

Figure 9. Femoral nerve stretch test.

requirement would be to assess light touch sensation in each dermatome. Similarly motor examination should be completed for each myotome. Clinicians should be confident in assessing the reflexes of the lower limb at the knee (L3/L4) and the ankle (S1). A comprehensive review of the neurological examination of the upper and lower limb is beyond the scope of this article although the American Spinal Injuries Association (2015) *International Standards for Neurological Classification of Spinal Cord Injury* is recommended as a useful reference tool. The most commonly accepted tests for motor and sensory function are summarized in *Table 4*.

Table 4. Nerve roots and corresponding tests for myotomes and dermatomes

Root level	Motor	Sensory
C5	Elbow flexion	Lateral and proximal to cubital fossa
C6	Wrist extension	Dorsal side of thumb base
C7	Elbow extension	Dorsal tip middle finger
C8	Finger extension	Dorsal tip little finger
T1	Finger abduction (little finger)	Medial and proximal to cubital fossa
L2	Hip flexion	Anterior-medial thigh
L3	Knee extension	Medial distal femur
L4	Ankle dorsiflexion	Medial malleolus
L5	Great toe dorsiflexion	Dorsum of the foot
S1	Ankle plantarflexion	Posterolateral side of the foot

KEY POINTS

- Spinal examination is commonly used in emergency and elective practice.
- Systematic assessment of the patient is needed to detect pathology.
- Special tests can be used to isolate specific pathology.
- Concluding the examination of the spine should involve an assessment of the neurovascular systems of the lower limbs, a summary of findings and a differential diagnosis.

Concluding the examination of the spine

Following the examination the clinician should thank the patient before giving a focussed summary of the positive examination findings along with a differential diagnosis. In an exam scenario the authors recommend that the candidate states the most likely diagnosis first. *Table 5* shows a guide to the breakdown of common diagnoses in spinal examination. Further investigation may be warranted such as blood tests and imaging. **BJHM**

Conflict of interest: none.

American Spinal Injuries Association (2015) International Standards For Neurological Classification Of Spinal Cord Injury. www.asia-spinalinjury.org/elearning/ISNCSCI.php (accessed 15 November 2015)

Ellis H (2002) *Clinical Anatomy: a revision and applied anatomy for clinical students.* 10th edn. Blackwell Publishing, Oxford

Table 5. Differential diagnoses to be considered during spinal examination

Group	Pathology	Key features
Mechanical	Lumbosacral strain	Pain typically worse with activity. Muscular tenderness and/or muscular spasms
	Fragility fracture	Pain, loss of height. Bony point tenderness
	Facet joint disease	Typically chronic pain, no neurology, improves lying down
	Spinal stenosis	Pain intermittent and worse walking down hill, relief with spine flexion
	Spondylolisthesis	Pain with hyperextension of lumbar spine. Palpable step deformity and/or neurology
Radiculopathy	L4/L5 disc prolapse	Radiating pain in dermatomal distribution, great toe dorsiflexion weakness, reduced sensation dorsum of foot
	L5/S1 disc prolapse	Radiating pain in dermatomal distribution, ankle plantarflexion weakness, reduced sensation sole of foot and calf, reduced ankle reflex
	Cauda equina syndrome	Bilateral motor and sensory deficit with perianal numbness and/or urinary retention
Developmental	Scoliosis	Spinal curvature deviating from midline by >10° in the coronal plane
	Kyphosis	Excessive thoracic curvature defined as >45° in the sagittal plane
Inflammatory	Ankylosing spondylitis	Morning lumbar spine stiffness improves with activity Reduced lumbar flexion Pain on FABER test as a result of sacroiliitis Rheumatoid factor (RhF) negative, HLA B27 positive
Endocrine	Paget's	Mild pain, generalized skeletal pain, headaches, reduced hearing, heart failure. Raised alkaline phosphatase level
Infection	Osteomyelitis	Systemic symptoms, typically >3 months, consider in immunocompromised
	Discitis	
	Epidural abcess	
Malignancy	Multiple myeloma	Renal failure, anaemia, bone lesions
	Metastatic disease or lymphoma	Systemic symptoms, e.g. night pain, weight loss, fevers and malaise, neurology only if compression
	Primary cord tumour	Pain and/or neurology. Systemic symptoms, e.g. night pain, weight loss, fevers and malaise
Other referred pain	Pelvic pain Abdominal aortic aneurysm Renal colic Peptic ulcer Pancreatitis	(Always consider visceral causes of back pain)