Clinical examination of the spine

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Abstract

A thorough and competent clinical examination of the spine is a fundamental skill for all surgical doctors. This should be built upon the foundations of an in-depth knowledge of the associated anatomy and physiology. Clinical examination of the spine should be performed in the setting of spinal trauma, degenerative disease of the spine and spinal deformity. A methodical approach to the examination is essential and should include clinical history, inspection, palpation, movement and special tests. Examination findings will guide further investigations, narrow differential diagnoses and determine subsequent management of patients.

Keywords Anatomy; deformity; examination; spine

A competent examination of the spine is a fundamental skill to possess throughout the duration of any surgical career. Knowledge of spinal anatomy and physiology in combination with an effective examination will aid the clinician in narrowing differential diagnoses and tailor specific investigations. In this article, we have broadly divided clinical examination of the spine in to three areas. These are clinical examination skills required in the setting of spinal trauma, degenerative disease and spinal deformity.

Introduction

It is vital to approach the examination of the spine in a methodical and competent manner. This is particularly important given that pathology of the spine can occur in patients of all ages and in a vast array of medical and surgical presentations. As with all clinical encounters, a through history should initially be obtained from the patient. The Apley approach to examination[1] should form the structure to the examination of the spine and should include inspection, palpation, movement and special tests. Clinical examination of the spine should include examination of the axial skeleton and a comprehensive neurological assessment of both upper and lower limbs.

Anatomy of the spine

To appreciate a clinical history and examination findings, it is first important to consider the components of the spine and expected examination findings. The spine consists of seven cervical vertebrae, 12 thoracic vertebrae, five lumbar vertebrae, five sacral vertebrae and four coccygeal vertebrae. The fused segments of the sacrum and coccyx provide little contribution to movement.

Intervertebral discs between each of the cervical, thoracic and lumbar vertebral bodies permit movement and act as shock absorbers. The vertebral canal is located posterior to the vertebral body, within which the spinal cord is located. Pairs of nerves exit the spinal cord and cauda equina as nerve roots at each vertebral level. The spinal cord terminates at the level of L1, at which point the cauda equina continues caudally.

Clinical history

A focused history should be performed prior to examining any patient. This should identify complaints of pain, including back and radicular limb pain, loss of function and neurological deficit, including bladder and bowel dysfunction. A typical pain history should be obtained, including site, onset, radiation and alleviating or exacerbating factors. Current analgesic requirements and previous treatments, including conservative and surgical measures, should also be identified.

A patient's age should guide potential diagnoses. Degenerative back pain is uncommon in younger age groups and this should prompt further investigation, particularly in the presence of atypical or red flag signs and symptoms.

Lower back pain with associated radicular pain or sensory disturbance into the leg or foot is suggestive of a nerve root compression. The most common cause for this is prolapsed intervertebral disc; however, other causes are possible and should be considered. Any associated bladder or bowel dysfunction, or perineal paraesthesia necessitates emergency clinical assessment and investigation to rule out cauda equina syndrome (CES).

A myelopathic patient will typically describe an unsteady gait, limb weakness, sensory distrubance of the upper and/or lower limbs and urinary dysfunction.

A detailed clinical history should be taken from any patient presenting with a spinal deformity. Areas to explore include prenatal and antenatal history, childhood milestones, onset of puberty and family history. Other medical comorbidities should also be discussed, as these can impact upon the appropriate of treatment measures available to the patient.

General examination

Inspection

Inspection of the entire spine should be performed with the patient adequately exposed. When inspecting the spine, the clinician should identify any obvious swellings, scars to suggest previous surgery, skin changes such as café au lait spots or neurofibromas in neurofibromatosis, hairy patches at the caudal aspect of the spine in spina bifida, and asymmetry of muscle bulk in scoliosis or wasting of muscle as may be seen in neuromuscular conditions. Café au lait spots and neurofibromas are present not only on the back and therefore careful skin inspection should be performed of the anterior trunk and limbs.

The spine should be inspected in the coronal and sagittal planes to elicit any evidence of a deformity of the spine and to

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assess whether the spine is balanced. A spine is said to be balanced clinically when the head is centred over the pubic symphysis in the coronal plane and centred over the femoral head in the sagittal plane (Figure 1). In the coronal plane a weighted string or plumb line can be used to further assess balance. The string should be pressed against the C7 spinous process and allowed to hang. In a spine balanced in the coronal plane, the plumb line should overly the natal cleft. This can be further assessed by performing whole spine radiographs. In the sagittal plane, the cervical spine has an expected lordosis of 30°, the thoracic spine a kyphosis of 20°–40° and a lumbar spine lordosis of 40°–60°.

In degenerative disease of the spine, a kyphotic deformity is typically seen in patients of advancing age, due to a reduction in disc hydration and thus disc height. This may also present with a lumbar hyperlordosis in an attempt to compensate for a more cranially sited kyphosis. Kyphosis at the cervicothoracic junction is typically seen in ankylosing spondylitis, a chronic inflammatory condition which typically affects the axial skeleton and results in ankylosis of the spine. A loss of lumbar lordosis is observed in patients with underlying degenerative disease of the lumbar spine and is the result of paravertebral muscle spasm.

Inspection is key in identifying and assessing a deformity of the spine, such as scoliosis. Scoliosis is a three-dimensional deformity of the spine. In the standing position, shoulder asymmetry may suggest a scoliosis and this is assessed by comparing acromial or scapular height. Asymmetry of the pelvis may also be suggestive of a spine deformity or a leg length discrepancy. It is imperative to measure true leg length in patients presenting with a scoliosis, as it may be a compensatory deformity driven by a leg length discrepancy. Formal measurement of leg length is performed by measuring from anterior superior iliac spine (ASIS) to medial malleolus and comparing to the contralateral side, or by placing blocks of known height under the shorter limb until pelvic obliquity is resolved.[2]

As well as examining the spine in a standing position, the patient should perform the 'Adams forward bend test', to further examine for a deformity and appreciate the curvature of the spine. While examining the patient from behind, the patient is asked to bend forwards by flexing at the hips. In a thoracic spine curvature, a rib prominence will be present (Figure 2).

Palpation

Palpation should be performed from the occiput caudally along each spinous process. The facet joints on each side of the spinous process should also be palpated throughout the spine. Surface anatomy can aid in identifying the level of the spine being palpated. For example, the most prominent spinous process, vertebra prominens, at C7, the inferior angle of scapula at T7 and iliac crests at the level of L4.

When the patient presents with a history of trauma, any steps in the spinous processes or areas of tenderness on palpation are suggestive of an acute injury. In the absence of trauma, these findings may be suggestive of a degenerative pathology, such as a spondylolisthesis where one vertebra slips forward in relation to another, or facet joint spondylosis when palpating in the paraspinal region.

Pain or tenderness on palpation of the spinous processes and paraspinal area may also suggest a destructive or infective process, as well as other rheumatological disorders, such as fibromyalgia.

Movement

This is best assessed with the patient performing active movements. Starting with the cervical spine, flexion, extension, lateral flexion and rotation are assessed. This can be achieved by asking the patient to place their chin on their chest, look to the ceiling, put their ear onto their shoulder and look over each shoulder. One might expect reduced flexion and extension in cervical spine spondylosis and a patient may complain of radicular arm pain on lateral flexion to the contralateral side if a cervical disc prolapse is present.

Thoracic spine rotation is assessed with the patient seated and a value of 30° is considered normal. It is difficult to isolate flexion and extension movements of the thoracic spine given the splinting effect of the thoracic rib cage and the orientation of the thoracic facet joints.

Lumbar spine movements for assessment include flexion, extension and lateral rotation. Schober's test[3] provides an objective assessment of lumbar flexion. While the patient is standing upright, a horizontal line is drawn at the level of the posterior superior iliac spines (PSISs). A second parallel line is drawn 10 cm cranial to the PSIS. On lumbar flexion, the distance between the two lines should increase by at least 5 cm. A patient should be expected to achieve 60° flexion of the lumbar spine. Reduced flexion is suggestive of spondylosis, which may include ankylosing spondylitis.

Extension of the lumbar spine should be assessed with the clinician standing behind or to the side of the patient while supporting them during the movement. 25° of lumbar spine extension is expected. Reduced extension is suggestive of facet joint degeneration.

Lateral flexion of the lumbar spine is assessed by asking the patient the patient to reach down the side of the leg as far as possible and can be recorded as either the location of the lower limb reach, for example the knee or ankle, or the distance from fingertip to the floor.

The next essential step in assessing a patient's movement is to examine their gait. An abnormal gait pattern can be the result of a spinal pathology as well as other causes. Gait should be assessed with the patient walking away from and towards the clinician and from the side. An antalgic gait is suggestive of pain, such as in a lumbar disc prolapse with radicular leg pain. A Trendelenburg gait is suggestive of weak hip abductors or hip pathology, and further history and clinical assessment should focus on the hips should this be present. A high stepping gait may be evident in a patient with a foot drop secondary to a lumbar disc prolapse or other cause. A broad-based, unsteady gait is seen in cervical myelopathy, the result of spinal cord mechanical compression with resultant inflammation and

Coronal and sagittal balance

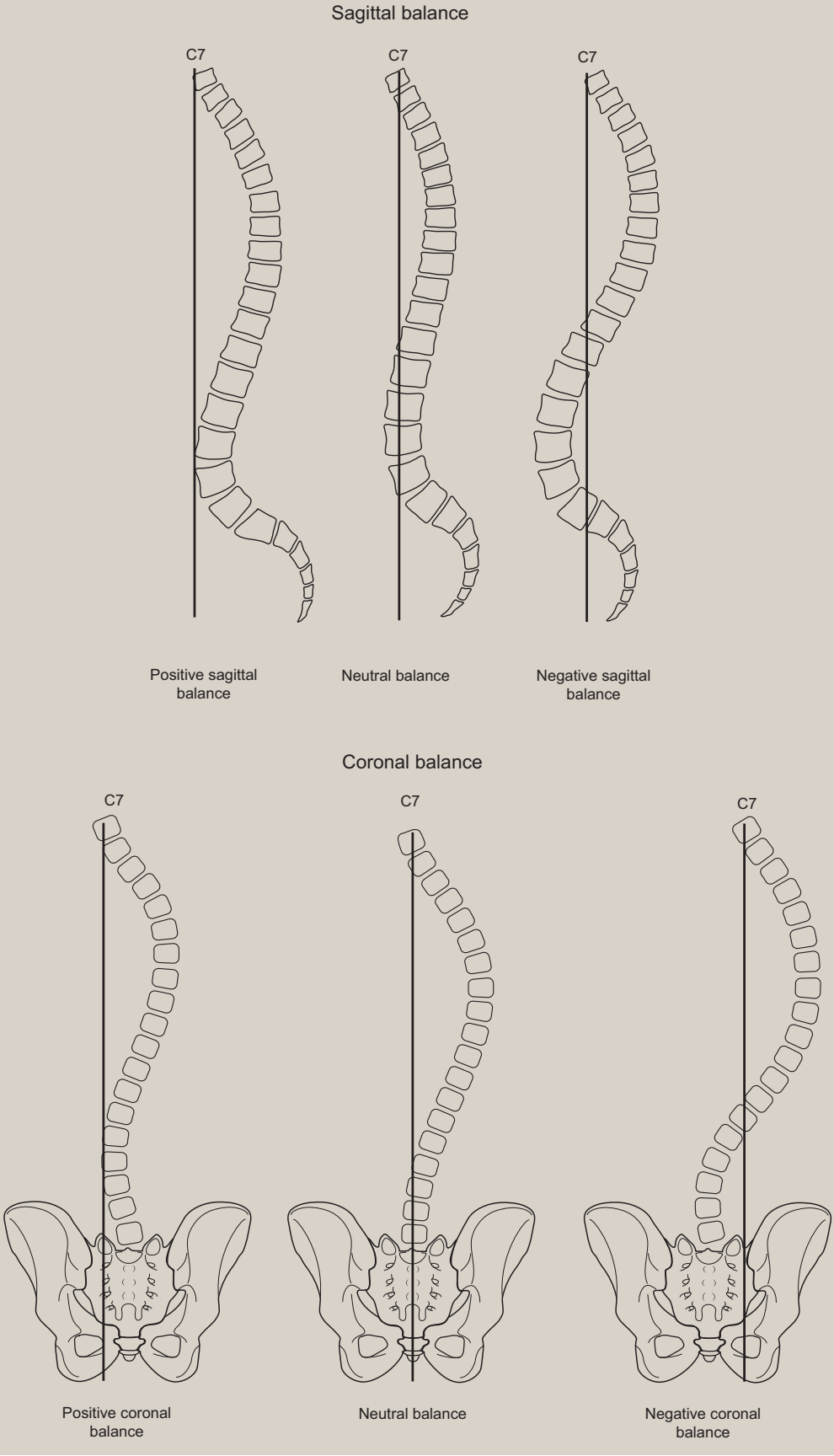

Figure 1

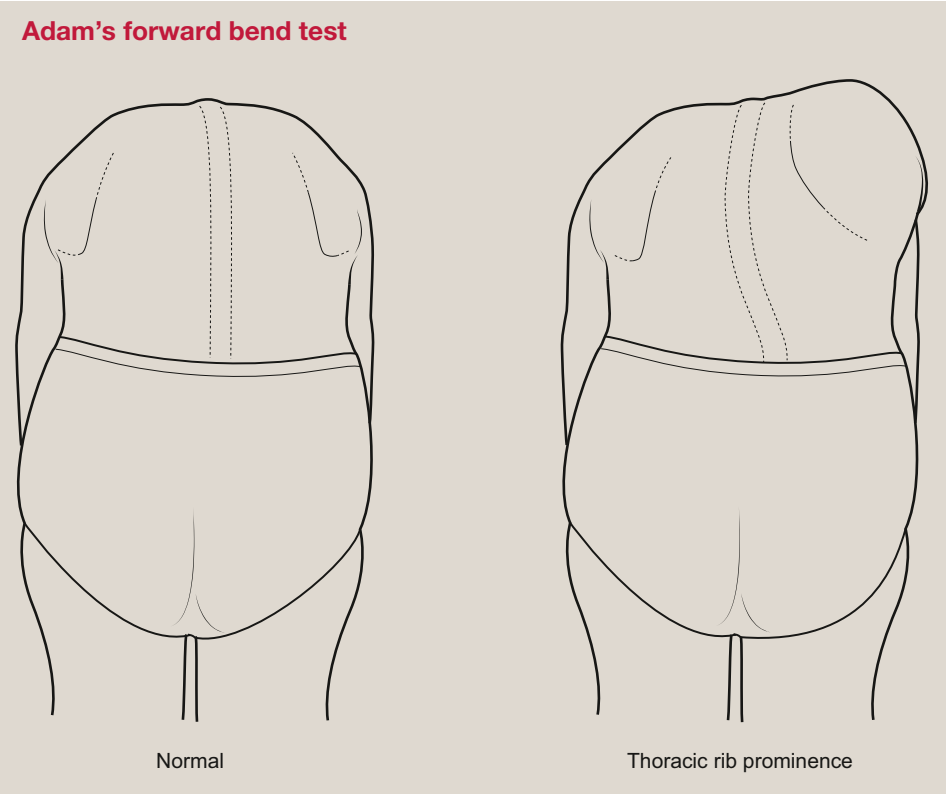

Figure 2

oedema. This results in compression of the long tracts of the spinal cord.[4]

Neurological examination

A thorough neurological examination is an essential component of a clinical examination of the spine, and should include tone, sensation, power and reflexes for upper and lower limbs. Tone of the upper limb is best assessed by passively flexing and extending the elbow, wrist and fingers. In the lower limbs, passively internally and externally rotate the hips by 'rolling' the leg. Increased tone or spasticity is suggestive of an upper motor neurone pathology, compared to reduced tone or a flaccid paralysis in lower motor neurone lesions.

Sensation should be assessed in each of the dermatomal distributions on the dorsal and ventral aspects of each of the limbs and trunk. A score of 0 indicates absent sensation, 1 for altered sensation and 2 for reported normal sensation.

Muscle power is graded according to the Medical Research Council (MRC) grading system.[5] This grading system is demonstrated in Table 1. The myotomes for each muscle should be tested individually and scored accordingly. The upper and lower limb myotomes are found in Table 2.

The American Spinal Injury Association (ASIA) chart is a scoring system based on the neurological assessment of a patient with a potential spinal cord injury and grades a patient's functional impairment as a result of their spinal cord injury.[6] The ASIA chart also serves as a useful reference chart for the neurological examination of a patient (Figure 3).

Reflexes are an important feature of the neurological assessment of a patient and should be performed in the upper and lower limbs, as well as the abdomen. The abdominal reflex is performed while the patient is lying supine. The abdomen is stroked radially outwards from the umbilicus in the four quadrants. A normal response is for the umbilicus to move towards the quadrant being stroked. An abnormal response is if this reflex is absent or diminished and may suggest a thoracic cord compression, syrinx or tethered cord. Brisk reflexes of the upper or lower limbs suggest an upper motor neurone pathology, such as spinal cord compression. Diminished reflexes are evident in

Medical Research Council (MRC) muscle power grading

0	Complete paralysis
1	Flicker of movement
2	Movement with gravity eliminated
3	Movement against gravity, but not against resistance
4	Movement against resistance, but reduced power
5	Normal power against resistance

Table 1

Upper and lower limb myotomes and principal muscles

Nerve root	Action	Principal muscles
C5	Shoulder abduction	Supraspinatus/deltoid
C6	Wrist extension	Extensor carpi radialis/ulnaris
C7	Elbow extension	Triceps
C8	Finger flexion	Flexor pollicis/digitorum communis
T1	Finger abduction	Dorsal interossei
L2	Hip Flexion	Iliopsoas
L3	Knee extension	Quadriceps femoris
L4	Ankle dorsiflexion	Tibialis anterior
L5	Great toe extension	Extensor hallucis longus
S1	Ankle plantarflexion	Gastrocnemius and soleus

Table 2

lower motor neurone lesions, such as nerve root compression caused by an intervertebral disc protrusion.

Special tests

The findings of the clinical history and examination to this point should direct the clinician towards a selection of specific special tests.

Table 3 details the specific special tests for particular pathologies of the spine.

A clinical examination of the spine is completed by performing an abdominal examination to assess for any masses, including neurogenic bladder distension, assessment of the sensation of the perianal region and a digital rectal examination, to assess anal tone and voluntary anal contraction. Peripheral pulses and vascular status of the limbs should also be examined to rule out vascular claudication as the cause of the patient's symptoms and signs.

ASIA standard neurological classification of spinal cord injury

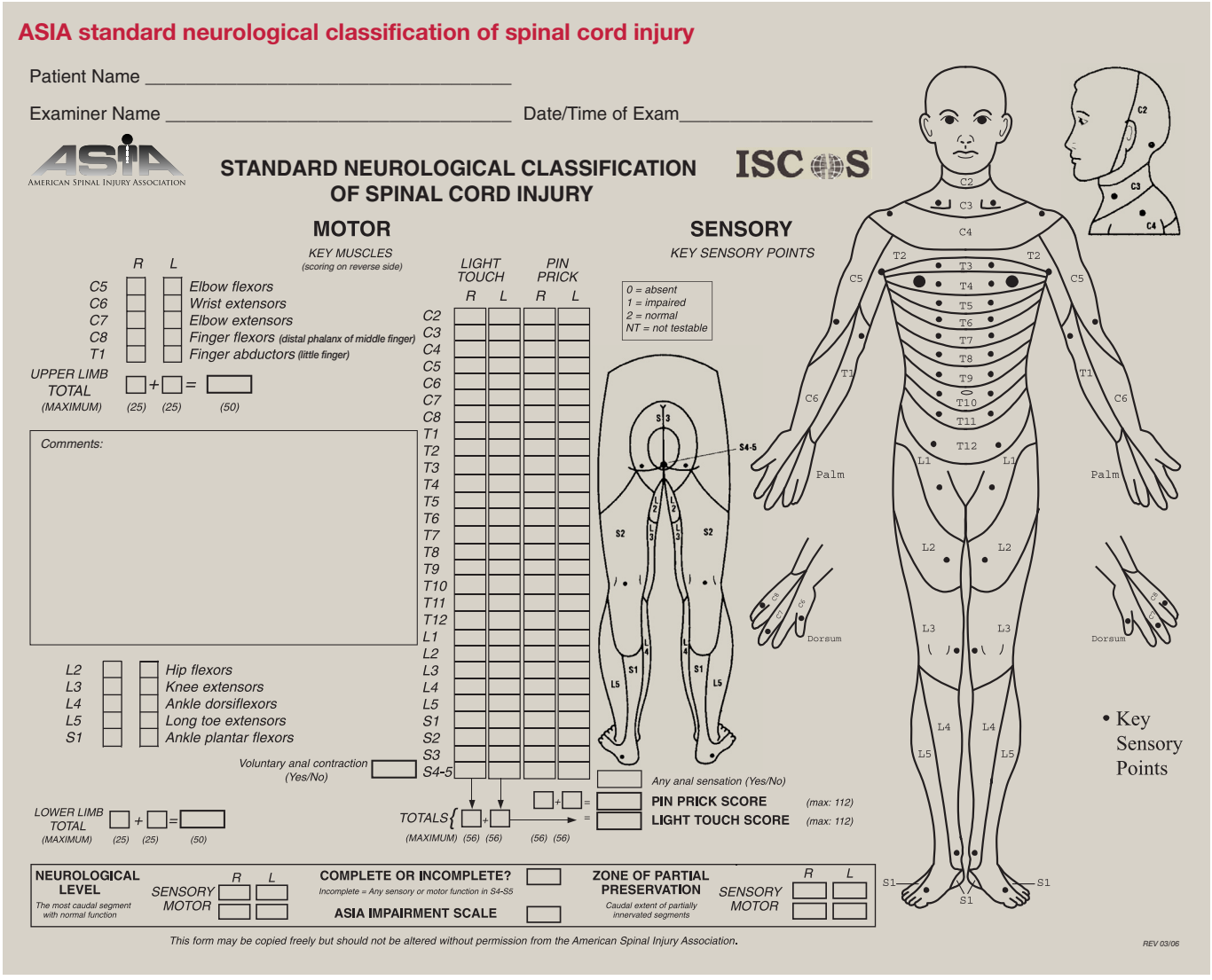

Figure 3

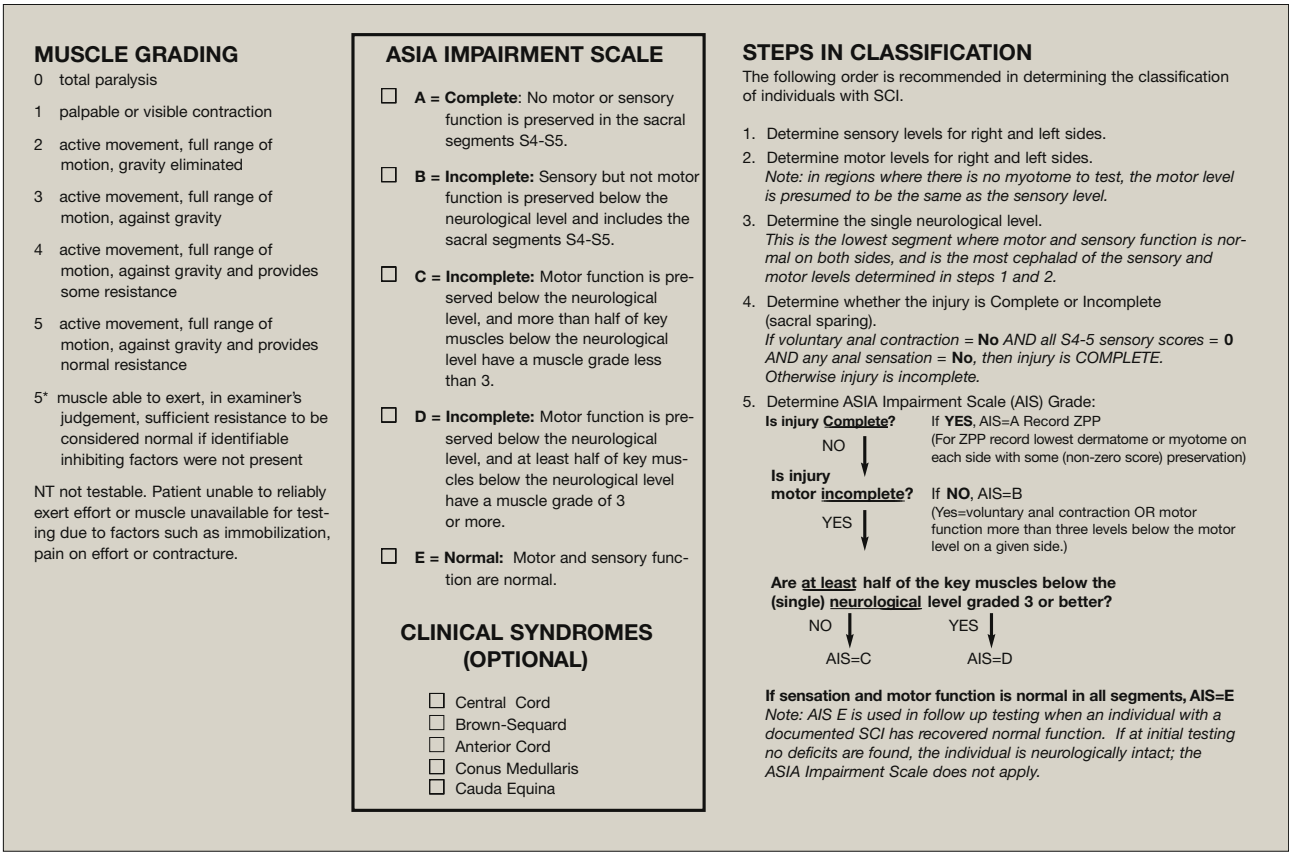

Figure 3 (*Continued*).

Special tests

Cervical radiculopathy	
Spurling's test	Ask the patient to extend and laterally flex the cervical spine towards the side of the suspected pathology. This will exacerbate the patient's symptoms
Spurling's manoeuvre	Cervical spine is loaded with axial pressure, hyperextended and laterally flexed towards the side of the suspected pathology. This will exacerbate the patients symptoms
Shoulder abduction relief	Following the *Spurling's manoeuvre,* full abduction of the ipsilateral shoulder results in relief of symptoms
Cervical myelopathy	
Heel-toe walk	Ask the patient to walk placing the heel directly ahead of the contralateral foot. The patient will be unable to do so due to poor balance
Rhomberg's test	Ask the patient to remain balanced with their feet together, shoulders flexed to 90° and elbows extended fully. If the patient is able to maintain balance with their eyes open, ask the patient to repeat the test with their eyes closed. A positive test is if the patient is unable to maintain balance with their eyes closed
Hoffman's sign	Flick the distal phalanx of the middle finger causing flexion at the distal interphalangeal joint. A positive result is obtained if the interphalangeal joint of the thumb flexes at the same time
Inverted radial reflex	Finger flexion is demonstrated when testing the brachioradialis tendon reflex
L'hermitte's sign	Cervical spine flexion results in electric shock sensations caudally in the spine and lower limbs
Clonus	Performed at the ankle. More than 3 beats is pathological
Babinski reflex	Up-going plantars are present in cervical myelopathy
Lumbar radiculopathy	
Straight leg raise (SLR)	While lying supine and maintaining full knee extension, the patient is asked to elevate the leg. The radicular pain will be reproduced and the degree of hip flexion this occurs at should be noted (normally between 30° and 60°)
Lasegue's sign	Having performed the SLR test, the leg is gently lowered and the ankle passively dorsiflexed. The radicular pain is again reproduced
Crossover sign	Performing a SLR on the unaffected leg initiates pain in the affected leg that remains stationary
Bowstring sign	Having performed a SLR, flex the hip and knee each to 45°. This should relieve any radicular pain. While in this position, apply pressure to the popliteal fossa. Pain will again be exacerbated
Femoral stretch test	With the patient lying prone, passively flex the knee to 90° and lift the foot upward. Anterior thigh pain is suggestive of tension in the lumbar nerve roots

Table 3

Conclusion

A competent and thorough clinical examination of the spine is essential for all clinicians. The clinical history obtained from a patient should guide the elements of the clinical examination. Clear communication and documentation of the results of the clinical history and examination will aid in determining further investigations and a diagnosis. ◆

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Practice points

- Thorough and competent examination of the spine is essential in the settings of spinal trauma, degenerative disease of the spine and spinal deformity
- The examination should follow a methodical approach and include clinical history, inspection, palpation, movement and special tests
- The examination findings will narrow potential differential diagnoses and determine subsequent investigation and management