

Clinical examination of the lumbar spine

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History

Introduction

Assessment of backache and/or sciatica is never easy. Despite the increasing accessibility of highly sophisticated technical aids, diagnosis of lumbar problems still relies on the principles of history and clinical examination.

Taking the history is by far the most significant tool in the diagnostic procedure. Whereas examination techniques – both clinical and paraclinical – give current information only, the history also puts the evolution of the disease in the picture. History not only is the record of past and present suffering but also constitutes the basis of future treatment, prevention and prognosis. Furthermore, it also gives information about the degree of disablement the problem has produced and will produce.

For these reasons, a careful history, detailed and in chronological sequence, cannot be taken in a hurry. The examiner must make time to listen and have the patience to unravel complicated stories. Most patients have difficulty organizing their story or remembering every detail. Sometimes they are even unable to give precise responses to simple questions, and mix up past and present symptoms, pain and disablement, and physical, emotional and social disturbances. For a satisfactory diagnosis, however, it is essential to obtain a description of the past and present pain in meticulous detail. Therefore the examiner should develop a specific technique of questioning which is chronological and precise. The answers (both positive and negative) form a pattern that is related to knowledge of applied anatomy, biomechanics and pathogenesis. Taking a history thus translates the patients' subjective complaints into an anatomical and biomechanical context which correlates with one of the well-known syndromes.

The importance of the chronological order in which the symptoms present is illustrated by the following (simple) case

report: a patient states that he developed a sudden backache, which was followed a few days later by severe pain in the left calf. Two days later he noticed numbness of the outer two toes and difficulty standing on tiptoe. By that time the backache had ceased. This is the story of an S1 root compression with neurological deficit, almost certainly caused by a large disc protrusion at the level of L5–S1. This chronological description pinpoints not only a diagnosis but also the therapy: manipulative treatment will be of no help and the patient should either be treated by epidural local anaesthesia or surgery, or await spontaneous recovery.

In practice, the patient's symptoms are not always as obvious as in this idealized case but it does give an idea of the value of a good history. After the history has been taken, the examiner should have a fair idea of the diagnosis or at least be able to distinguish activity-related backache from non-activity-related, referred or functional pain.

Localization of the symptoms

Symptoms are grouped under the headings lumbago, backache and sciatica. These terms are used as follows:

- *Lumbago*: a sudden attack of severe low back pain, causing some degree of fixation and twinges on attempted movement.
- *Backache*: discomfort in the lower back.
- *Sciatica*: pain that radiates strictly from the buttock to the posterior thigh and calf. It is restricted to a specific dermatome (L4, L5, S1 or S2) and may be accompanied by paraesthesia and motor and/or sensory deficit. In practice, however, the term is used inaccurately if pain and paraesthesia are felt in the anterior part of the thigh and/or lower leg (L2–L3).

Pathogenesis

In lumbar spine problems, the mechanism of causation is usually reflected in the behaviour of the pain. Localization of the symptoms, their evolution and the relation to activity and posture differ according to the tissue involved. Pain in the lumbar and pelvic–gluteal area is usually of local origin but may also be *referred* from intra-abdominal or pelvic lesions. Sometimes lumbar pain is devoid of any organic basis and is then labelled as *non-organic* or *'functional'*. Local organic disorders may or may not be related to activity. The former are called *activity-related spinal disorders*, the latter *non-activity-related spinal disorders* (Box 36.1).

Activity-related spinal disorders (Ch. 38)

These are caused by a mechanical dysfunction: discodural and discoradicular lesions, capsular or ligamentous lesions, and spinal stenosis.

Discodural interactions may cause all three major syndromes: lumbago, backache and sciatica. Both articular and dural symptoms are present and have a strong tendency to evolve over time: because the discal displacement seldom

Box 36.1

Origin of low back pain

Organic disorders

Activity-related spinal disorders

- Discodural and discoradicular disorders
- Capsuloligamentous disorders
- Stenotic disorders

Non-activity-related spinal disorders

- Inflammation (septic and rheumatic)
- Osseous disorders
- Acquired defects
- Tumours
- Metabolic disorders

Pain referred to the back

- Visceral disorders

Non-organic disorders

remains stable, localization and intensity of the symptoms vary with localization and intensity of the dural impingement.

Lesions of the facet joints are characterized by localized pain. There is absolutely no change in localization. Dural and root symptoms are also absent.

Ligamentous pain typically occurs in relatively young people. It is created by prolonged or increased postural stress and abolished by correction of posture. In long-standing cases, movements also become painful at full range. In disorders of the lumbar ligaments, pain is always intermittent and vague and never referred below the upper buttocks. Lesions of the iliolumbar or sacroiliac ligaments, however, may give rise to slight reference of pain in the groin and the back of the upper thigh, respectively. Again, neither dural nor root symptoms are present.

In central spinal stenosis, chronic and vague lumbo-sciatica is brought on by walking or standing and relieved by stooping or sitting. Pain is often associated with feelings of numbness and weakness in both legs. These patients are never under 30 years old and more often are over 60.

In stenosis of the lateral spinal recess, a middle-aged or elderly patient complains of unilateral sciatica coming on during standing and walking. Sitting or bending forwards alleviates the pain immediately. As in central spinal stenosis, dural symptoms and signs are absent, as are root signs.

Non-activity-related spinal disorders (Ch. 39)

These include:

- *Inflammatory diseases*, both septic and rheumatological.
- *Osseous disorders*, such as osteoporosis, fractures or tumours.
- *Acquired defects* of the vertebral arch.
- *Intraspinal lesions*, such as neuroma, metastases and cysts.

In ankylosing spondylitis, pain may vary in an unexpected way. One day the patient awakes without any discomfort and is able to do any kind of heavy work. The next week, the patient may

wake up early with a painful back and disablement persists for the rest of the day. This differs markedly from the patient with discodural backaches, in whom pain starts on getting up or when an attempt is made to put on socks or tights. The back thus aches during certain movements or positions, whereas others ease the pain.

In rheumatoid conditions, the pain is typically experienced most severely in the morning and improves throughout the day.

In malignant disease, pain is unremitting and worse at night. Lumbar pain increases steadily even after root pain has set in; its distribution is not confined to a single dermatome.

Pain referred to the back

Pain in the back that is completely unrelated to movement or posture and displays hardly any temporal pattern suggests a referred source from intra-abdominal or pelvic lesions, such as those of the aorta, and the genitourinary and gastrointestinal tracts. In the initial stages of these diseases, the history may signal the disease via warning signs. Some of these are briefly discussed here.



Warning

- Pain in the upper lumbar region suggests the possibility of aortic aneurysm, neoplasm, caries or ankylosing spondylitis, or may result from visceral disease.
- Steadily increasing lumbar pain, especially in elderly patients, also occurs in malignant disease.
- Gradually expanding and increasing pain is associated with a lesion that is increasing in size: for example, neoplasm or neuroma. A good example of this is a patient with backache, followed by sciatica in which the pain in the back worsens instead of diminishes.
- Continuous pain, not altered by movement and posture, is ominous; it is important to remember, however, that 'endless' pain may also be present in psychogenic disorders.

Problem solving

While taking the history, the examiner endeavours to find an answer to the following questions:

- Is this an organic or non-organic lesion?
- Do the symptoms point to activity-related disorders?
- If so, is it a disc lesion?
- What sort of disc lesion is present?
- What other type of lesion is more in accordance with the symptoms?
- What type of person is the patient? Is it obvious that the degree of pain and effect on daily activities tally with appearance and behaviour?

Because low back pain is most often caused by a soft tissue lesion and so is frequently attributed to disc disorders, the history serves in the first place to verify whether this is the case. 'All discs are alike, all other lesions are different' is Cyriax's statement, which has been proved true in orthopaedic

practice. Therefore, in disc displacements of all types, confirmation of the facts detailed in Chapter 33 is expected.

The history also provides an opportunity to interpret the credibility of the patient's story, again by looking for 'unlikelihoods' – facts that do not correlate with one of the well-known syndromes. If, during the history, the slightest doubt arises, the clinician should be on the alert. More 'unlikelihoods' should then be sought in the patient's story or during the following clinical examination. In contrast, when patients state exactly what is expected and normal for a comparable case, there is certainly no reason to doubt their reliability; nor will a search for possible psychoneurotic components be necessary. Patients devoid of a physical cause will rarely escape detection if the history is properly taken. In these patients, none of the well-known physical patterns emerges – the rules and facts of referred pain do not fit. They do not so much describe their symptoms as the degree of suffering. They fail to supply relevant answers and, if the examiner insists, questions are often resented.

During the history the interviewer should obtain specific data on the following:

- Age and daily activities
- Symptoms:
 - Pain
 - Paraesthesia
 - Influence of posture, movements or coughing/sneezing
 - Bowel or bladder problems/S4 root
- Patient's reaction to these symptoms.

Age and activities of daily living

Disc lesions causing backache and sciatica are most common between the ages of 20 and 50 years. Over 60, the frequency decreases. Under the age of 20, discodural interactions are rare, although not impossible.

Sciatica caused by a posterolateral disc protrusion can be expected from adolescence to old age.

In elderly patients, lateral recess stenosis is to be more frequently expected as the cause of root pain (Table 36.1). Also, degenerative spinal stenosis is a disease that occurs predominantly in the elderly.

Spondylolisthesis can provoke posterior ligamentous pain in the young. Postural ligamentous pain is also more frequent in young patients with a standing job.

Ankylosing spondylitis typically provokes alternating sciatica between 15 and 35 years of age. It is 4–9 times more frequent in men.¹

Table 36.1 Age-dependent disorders

Age (years)	Disorder
15	Spondylolisthesis
15–35	Ankylosing spondylitis
20–50	Disc lesions
Elderly	Spinal and lateral recess stenosis

The activities undertaken as part of the patient's profession, hobbies and sports will give additional information that is extremely important in judging the actual functional incapacity and in designing a treatment strategy. Most patients do not suffer from pain, rather from the disability the pain provokes. It is obvious that discodural backache will produce more disability in a truck driver who has to sit for the whole day than in a patient who does light and varying work. For some, normal activities are unrestricted but their favourite sport is impossible, and this is a major concern.

Profession and activities are also important in relation to treatment, recurrences and prophylaxis. If a bricklayer gets lumbago every second year, his back can be judged to be reasonably stable and manipulation will help him sufficiently each time there is a new attack. If, by contrast, an office worker has attacks of lumbago five times or more a year, these repeated events indicate that the back is very unstable. Although manipulation may solve the problem for a short time, it is obvious that stronger prophylactic measures will be necessary; successful manipulation should be followed by sclerosing injections, back school and/or a good lumbar support.

Routine of history taking

In disorders of the lower back, symptoms can diversify. The clinician must try to obtain a clear impression not only of present discomfort but also of former events (see Box 36.4). Pain is the most common and important symptom and is usually what forces the patient to seek medical help. Other symptoms are not always mentioned spontaneously but should be asked about: the presence of paraesthesia, numbness, a cold foot or incontinence.

Symptoms are usually presented by the patient in a very disorganized way. The interviewer then tries to create 'order in the dis-order'. The best approach is chronological, the patient being asked about events leading up to the onset of the symptoms and then recounting chronologically what has happened since.

Pain

All the different aspects of pain should be investigated: localization, onset, evolution and duration of the perceived 'current' pain; influence of movement and posture; and the presence of dural symptoms. It is also very useful to obtain information on the same factors in previous attacks (Box 36.2).

In disorders of the lower back, pain may be experienced as backache, as gluteal pain with or without reference to one or both legs, or as typical root pain.

Current pain

Side and level

Patients are first asked if they feel any pain at the present time and to point to its location. The method chosen may give information on emotional status. A stable patient generally places the palm of the hand at the site of maximal pain and

Box 36.2

Pain: important reminders

Current pain

Localization

- Side: unilateral, bilateral or central?
- Level: upper lumbar, lower lumbar, gluteal, leg?

Onset

- When did the pain start? Days, weeks, months or years ago?
- How did the pain start? Suddenly, gradually?

Evolution

- Relationship between back pain and leg pain?

Relationship between pain and activity

- What posture or movement makes the pain worse?
- Is coughing painful?
- What eases the pain?
- Is there any nocturnal pain?

Previous pain episodes

- Earliest manifestation?
- Localization?
- Frequency of attacks?
- Pain-free intervals?
- Previous treatment?

moves it across the body to demonstrate the route of radiation. A psychologically unstable patient never touches the painful area but only points it out vaguely with the thumb.²

Back pain may be felt *centrally, unilaterally or bilaterally*. Central pain can never be referred from a unilateral structure – for example, a facet joint or a sacroiliac joint. Bilateral pain also hardly ever has a central origin. Unilateral pain in one buttock is typical of a discodural problem. Sometimes the sacroiliac joint is responsible but a strained muscle is a rarity.

Bilateral, vague leg pain is usually dural pain. Segmental pain in both legs can sometimes be caused by two protrusions. However, bilateral root pain is more often the result of spondylolisthesis, spinal stenosis, lateral recess stenosis or metastases. Bilateral osteoarthritis of the hip joints and intermittent claudication due to thrombosis in the iliac arteries may also create pain in both legs.

The level of the pain is also important. In backache with dural reference, pain is usually situated in the lower lumbosacral region, and may radiate downwards to one or both buttocks.

If the patient points to the upper lumbar area, the investigator should immediately be on the alert. Malignant diseases in the lower back have a great preference for this area (see p. 536).

In sacral, coccygeal or perineal pain and numbness, compression of the S4 root is a real risk and constitutes an absolute contraindication to manipulation.

In sciatica, unilateral pain in the relevant dermatome results from pressure on the dural sleeve of one of the lower lumbar nerve roots. It is important, though not always easy, to distinguish radicular pain from dural pain. The latter is extrasegmentally referred and therefore experienced over a larger area, not restricted to one dermatome. It may even spread upwards to the chest or down both thighs, sometimes reaching the ankles. By contrast, the segmental pain of root compression is easily recognized when a patient presents with a severe ache in the leg clearly situated within the borders of the respective dermatome. The difference between radicular and dural pain is extremely important in both diagnosis and treatment. Every effort should therefore be made to obtain a precise description of the localization and characteristics of the pain. To a patient, a leg is a leg, and most are not precise about whether the pain is in the front or back of the thigh, whether it spreads beyond the knee and whether it is localized or generalized.

Pain in one lower buttock only is rarely dural; more commonly, it is a segmental reference from S2.

Onset of pain

Low back disorders may be acute, chronic or recurrent. The patient should identify the first time that the symptoms occurred. 'When did your back problem start?' is thus an important question.

A long history of, say, 20 years of 'suffering' from backache requires further questioning on whether the problem is continuous or intermittent. It may be that there was just one attack of acute lumbago 20 years ago with a second attack 2 days ago; or a constant and daily ache may have been present over the whole period of 20 years; or the problem may be recurrent, incapacitating backache six times a year. Although in all three instances the history extends over a period of 20 years, it is obvious that the diagnostic and therapeutic approach will differ, as will the prophylactic measures to be taken.

Information about the duration of symptoms is also extremely important in cases of sciatica. There is no limit to the duration of radicular pain resulting from lateral recess stenosis but in discoradicular interactions a course terminating in spontaneous recovery is the rule. Once the protrusion has shifted to one side, symptoms tend to abate; the protrusion has settled itself outside the intervertebral joint and there it lacks nutrition and shrivels away. As a rule, the patient recovers within 12 months of the onset of radicular pain. However, this only applies in patients under 60 years of age.

The next question concerns the speed of onset: 'How did it start: was the onset sudden or gradual?'

Backache coming on over some hours, or even the morning after doing heavy work involving much stooping and lifting, suggests a soft disc lesion slowly increasing in size, i.e. a soft nuclear displacement. Cyriax used to say: 'Pulp oozes, cartilage subluxates in an instant.' In this type of discal displacement, traction is usually the treatment of choice, except in very acute cases where it is strongly contraindicated. An epidural injection is then the alternative.

Acute lumbago starting suddenly, at the moment the patient bent forwards or lifted a weight, is typical of a hard, annular disc displacement. In a case that is not too acute, manipulation is almost always successful in one or two sessions.

Course of pain

In most discoradicular interactions, pain typically starts in the back and sooner or later shifts into one leg. 'Shifting pain' of this nature strongly indicates a disc lesion. If backache gradually increases and after some time extends into one leg and finally involves the back and both legs, a progressive lesion such as a tumour is very likely and the examiner should be on the alert.

Pain starting in the leg, slowly getting worse over a period of months and finally spreading upwards to the posterior aspect of the thigh, is very suggestive of a primary posterolateral protrusion compressing the S1 root. The lesion occurs in young adults and is always nuclear.

Chronic sciatic pain in the elderly, extending over months to years, is typical of radicular pain from a narrowed lateral recess.

'Alternating pain' in the legs suggests bilateral sacroiliac arthritis, which is usually a manifestation of early ankylosing spondylitis. Less often, it indicates a disc lesion in a very unstable lumbar intervertebral joint.

Sequence of backache and root pain: which came first, backache or root pain?

Usually, backache is followed by root pain and ceases when the root pain begins. From that point, the mechanism of gradual spontaneous recovery starts. However, there are exceptions and there is no point in awaiting spontaneous recovery in patients over 60.

Root pain without previous backache, which is caused by a primary posterolateral protrusion, has been shown to be irreducible by manipulation. All displacements of this nature appear to be nuclear, moving posterolaterally from the onset.

What factors influence the symptoms?

In activity-related spinal disorders, it is obvious that there is a relationship between the symptoms and posture or exertion.

Posture and exertion

In a discodural interaction, the ache is increased by stooping, lifting, sitting or coming upright after sitting and is relieved during walking and in recumbency. However, there are some characteristic histories that are slightly different from the usual findings for disc lesions. For example, a patient between 20 and 40 years of age may awake without any pain and remain asymptomatic over the next few hours, even on exertion. During the day backache comes on, slowly getting worse. On going to bed, the pain ceases after an hour or so. This is the typical history of a 'self-reducing' disc lesion.

A patient may complain of pain in the lower back which comes on with prolonged standing. The ache gets worse and is finally followed by bilateral root pain, eventually with paraesthesia in both feet. Sitting or lying down results in cessation within a minute. In young patients this pattern suggests a spondylolisthesis. If the patient is elderly, stenosis of the spinal canal should be suspected.

In 'ligamentous postural' syndromes, pain is particularly increased by maintenance of a particular posture, whereas altering the position relieves the pain. Moreover, the longer the position is maintained, the more intense the pain becomes.

Barbor³ described the discomfort of ligamentous pain as ‘the theatre, cocktail party syndrome’: it is impossible to sit at the theatre or stand at the cocktail party without low backache occurring. In contrast, the symptoms are relieved by activity. This syndrome is typically found in the young.

Coughing and sneezing

Another factor that may influence symptoms is raised intra-abdominal pressure during coughing and sneezing (Box 36.3). Pain in these circumstances may be a dural sign produced by sudden increased intradural pressure, which in turn causes sudden expansion of the dura pressed against the protrusion. Although it is very often related to a disc protrusion, it is clear that any *space-occupying lesion* in the lumbar spinal canal compressing the dura mater (e.g. a neuroma or malignant tumour) may evoke the same response. Often the patient will not mention it spontaneously, so the investigator must enquire about coughing and sneezing.

In disc lesions, coughing and sneezing normally increase the lumbar or gluteal pain. However, when they also increase the pain in the leg, manipulative reduction will almost certainly fail. Epidural injections should then be tried. A neuroma may evoke the same sign but the pain is usually felt more in the leg than in the back.

In active sacroiliitis, pain on coughing is felt in the buttock and sometimes radiates into the thigh. It results from the painful distraction of the joint caused by the momentarily increased intra-abdominal pressure.

‘Early morning’ pain

This wakes the patient and eases on getting up, after which it is possible to do fairly heavy work; the pattern is suggestive of ankylosing spondylitis. The pain is felt centrally in the whole lumbar region and varies from day to day.

Sometimes early morning pain is caused by a discodural interaction. The increased hydration of the disc during recumbency possibly exacerbates an existing small posterior bulge,

which then slowly compresses the dura mater, so waking the patient before dawn. This type of disc lesion is best treated by epidural local anaesthesia.

It should be emphasized that these histories are quite different from the usual story for a patient with a small disc lesion who has a painful stiff back on getting up in the morning. Turning in bed is also mentioned as causing a twinge and is quite different from increasing pain in a recumbent position.

Root pain worsening during the night

This results from a large protrusion with a high degree of inflammation. For this reason, manipulation and traction will be of no help and the patient is best treated by an epidural injection.

Continuous pain

If lumbar movements or posture do not influence the pain, there is certainly no mechanical lesion and the condition may be the result of some other pathological disorder such as intra-abdominal or spinal malignancy or infection, a bruised dura or bruised nerve root sleeve.

Duration of pain

Lumbago usually recovers spontaneously within a week because of the strong counterpressure exerted by the posterior longitudinal ligament, which gradually reduces the large posterocentral displacement.

In backache, there is no predictable time limit: the protrusion is small and remains more or less in contact with the rest of the intervertebral content of disc, end-plates and ligaments, thus receiving sufficient nutrient supply to maintain it. Because of a decrease in intervertebral height, the counterpressure exerted by the posterior longitudinal ligament becomes less effective. As a result, the discal tissue may remain displaced for years, with or without remission. Spontaneous recovery probably never occurs, whereas reposition by manipulation or traction is simple and is indicated, regardless of how long the patient has had the problem.

In sciatica, the protrusion has slipped posterolaterally and becomes extra-articular. Consequently, the bulge is cut off from its nutrient supply. Slow but continuous shrinking sets in from the moment the backache ceases, and results in spontaneous remission of the sciatic pain within 8–12 months. Therefore treatments such as manipulation and traction are worth trying but only during the first 6 months. Once this time limit has passed, they are not relevant because the process of spontaneous recovery becomes more and more likely to succeed. Later recurrences at the same level are no longer likely. In major or long-standing sciatica, epidural local anaesthesia may relieve the pain during the period of spontaneous recovery. If this fails and pain remains unbearable, surgery is indicated.

Root pain that does not get better within a year or even gets worse after, say, 8 months is suggestive of conditions other than disc lesions, such as neuroma or lateral recess stenosis.

Previous attacks

Previous attacks should be related to age, localization, origin, evolution, influence of movement and posture. Also important are the frequency of attacks, as well as the type of treatment and its result.

Box 36.3

Low back pain disorders in which coughing produces symptoms

Intraspinal lesions

Intradural

- Neuroma

Extradural

- Disc protrusion
- Disc infections
- Metastasis
- Epidural abscess
- Haematoma

Extraspinal lesions

Sacroiliac joint

- Arthritis
- Strain

Age

If a patient states that episodes of backache or lumbago have occurred since childhood, spondylolisthesis with a secondary disc lesion should be suspected.

Localization of symptoms

In disc lesions, the localization of symptoms is determined by the site of the pressure on the dura mater or nerve root. In a new episode, the pain may have similar localization. However, as a disc may easily shift and compress sensitive structures at other places, repeated attacks of backache caused by the same disc may provoke pain on different sides. Reports of former attacks, not located on the same side, point to a disc protrusion as the cause of the problem. A shifting pain means a shifting lesion, and only the disc is free to move from one side to another.

Pain changing from one buttock to the other is also seen in early ankylosing spondylitis with involvement of the sacroiliac joints.

In capsular and ligamentous disorders or in spinal stenosis, localization is fixed, and remains unchanged over a long period.

Cause

A disc is damaged by prolonged wear and tear but symptoms only become manifest at the moment of internal derangement. An annular crack can also be caused by a single injury, but if there is a time gap between the injury and the onset of pain it will usually be very difficult to prove the aetiological significance of the latter.

Evolution

Episodic backache for years does not suggest progressive, serious disease. Greater suspicion arises if elderly patients, for the first time in their life, get a backache that is progressive. When pain is continuous, it is therefore vital to know if it is getting better or worse, is unchanging or is variable.

Frequency of attacks

The frequency of previous attacks provides information about the stability of the disc; it should always be considered in relation to the patient's profession. If the frequency is less than once a year in a person doing heavy work every day, the implication is that the disc is relatively stable. Treatment other than reduction and back school instruction is not required. In contrast, in a patient who does a fairly light job, attacks of lumbago three or four times a year indicate an unstable disc. Reduction is then just one part of the solution. The back requires stabilization with a corset, sclerosing injections into the surrounding inert structures or even operative intervention.

Pain-free intervals

The degree of pain and disability in between attacks must be assessed. Do the symptoms disappear completely and can the patient do everything that is wished between the bouts of pain, or does the pain never completely recede? In the former, reduction has been complete and a manipulative attempt will probably succeed again; in the latter, either the disc has not been reduced completely or a second (ligamentous) lesion

remains. In either event, continuing pain is a bad prognostic sign for manipulation or traction alone.

Previous treatment

It is also necessary to determine whether the symptoms disappeared spontaneously or as the result of some specific treatment.

Discodural interactions

The history may also serve to obtain an idea of the degree of discodural interactions.

Marked articular symptoms (twinges) and postural deviation

These are characteristic of intense discodural contact. The deformity is noticed by the patient or by others. The typical case is acute lumbago in which the patient is painfully locked in flexion by a large central protrusion at the posterior aspect of a lumbar intervertebral joint. Any attempt to extend the lumbar spine squeezes the protrusion further backwards and increases the already painful pressure on the dura mater. Adoption of the flexed position decreases the pressure exerted by the subluxated part of cartilage on the dura mater.

A large posterolateral protrusion is accompanied by some deviation of the lumbar spine in lateral flexion, so projecting one hip sideways. The patient is not able to move in the opposite direction. Such lateral deviation suggests a lesion at the fourth or perhaps the third lumbar level.

When the lumbar spine is fixed in flexion or in lateral flexion because of root pain, all conservative treatment is likely to fail and surgical management is indicated.

If a patient with acute lumbago states that twinges are felt on even the slightest movements, therapists should be on their guard. Although manipulation can be tried safely, it will not always be tolerated. Traction, however, should definitely be abandoned, because it makes matters worse, usually at the moment it is released. The safest and most effective treatment is epidural local anaesthesia. It almost always affords immediate relief, although the large displacement remains present, continuing the marked deviation and limiting joint movements. Manipulation, carried out from the next day on, is much better tolerated and usually gives good results.

Numbness and/or weakness

The patient states that the foot flops during walking or that standing on tiptoe is impossible: this suggests a large posterolateral protrusion not reducible by manipulation or traction.

Box 36.4 summarizes the routine of taking a pain history. Table 36.2 outlines some typical histories.

Paraesthesia

When the patient states that there are 'pins and needles', this is pathognomonic of pressure on or inflammation of the peripheral nervous system. In practice, the cause is pressure. These symptoms are extremely important but are often not mentioned by the patient, so the examiner must enquire about them.

Box 36.4

Summary of pain history**Location**

- Central, unilateral, bilateral
- Level ('forbidden area', S4 dermatome)

Onset

- Low back/leg
- Sudden/gradual

Evolution

- Shifting pain
- Expanding pain
- Alternating pain
- Sequence of backache–root pain
- Usual evolution – primary posterolateral protrusion

Factors influencing pain

- Relation between symptoms and posture/activities
- Typical histories:
 - Self-reducing disc lesion, spondylolisthesis
 - Spinal stenosis
 - Ligamentous postural syndrome
- Pain on coughing, in back/leg
- Twinges
- Early morning pain/nocturnal pain
- No influence on movement or posture

Duration of pain

- No time limit for backache
- Spontaneous recovery in unilateral sciatica

Previous attacks

- Frequency
- Pain-free periods

Two different syndromes causing paraesthesia must be considered: nerve root compression and pressure on the spinal cord.

Pressure on a nerve root results in a typical set of symptoms: pain and paraesthesia, strictly related to the segment involved. Pressure on the dural sleeve of a nerve root causes severe segmental pain. Pins and needles indicate that the nerve fibres are irritated and they are always felt in the distal extremity of the dermatome. For this reason, it is vital to determine their exact areas; an accurate dermatomal distribution of paraesthesia is always a better pointer to the affected nerve root than is the pain itself.

In external compression of the nerve root, the sheath is compressed before the fibres and pain will therefore appear before paraesthesia. In discoradicular interactions, the sequence of segmental pain first, followed later by pins and needles and numbness, is therefore an 'inherent likelihood'. If the paraesthesia appears before the pain begins, other lesions such as a neuroma or tumour should be suspected. In lateral recess

stenosis, pain and paraesthesia usually appear simultaneously. Also, the symptoms do not tend to change over months or years.

If the paraesthesia is painless, a lumbar disc protrusion is an unlikely cause. Multiple sclerosis, diabetes, pernicious anaemia or cord compression is more likely. In these circumstances, pins and needles are also more diffuse in both feet or in all four limbs. The symptoms extend beyond the borders of innervation of any root or peripheral nerve. In cord compression, neck flexion may also bring on pins and needles.

Danger to S4 nerve roots

These roots are situated in the midline of the spinal canal, well protected by the posterior longitudinal ligament. In a large posterocentral protrusion, this ligament is placed under increased pressure. Finally, the ligament may rupture and damage the S4 roots (cauda equina syndrome).

Because mobility tests for the fourth sacral roots do not exist, it is almost impossible to evaluate their function. The diagnosis of cauda equina syndrome should therefore be made entirely on the history. Patients typically present with a classic triad of (1) saddle anaesthesia, (2) bowel and/or bladder dysfunction, and (3) lower extremity weakness.⁴ Some patients are timid and do not mention these symptoms, so it is important to ask about them in the three types of case in which a large posterocentral protrusion is to be suspected: acute lumbago, acute perineal pain and bilateral sciatica. It should be re-emphasized that manipulation is absolutely contraindicated; even traction is not at all safe if the slightest suspicion of compression of the fourth sacral roots arises. Prompt surgery is required and any delay results in substantial morbidity.⁵

The patient's reaction to the symptoms

History taking should also determine how far the patient is disabled by the symptoms. Some patients are stoical, while others react in a hypersensitive way. Before active therapy such as manipulation is instituted, the presence of pronounced psychological factors must be established. For this reason, patients should be encouraged to relate how far their daily activities are disturbed. Later on, during the clinical examination, it will be established objectively how bad the handicap really is. If disablement is severe for a minimal lesion, it is likely that psychological problems are responsible for the symptoms and should be treated first. Furthermore, it is unwise to manipulate or inject a patient who seems to demonstrate psychoneurotic behaviour or is involved in a compensation claim.

Inspection

One important feature of this part of the examination is gaining an idea of the degree of disability. The clinician should observe the patient from the moment he or she enters the consulting room. In particular the following are noted:

Table 36.2 Some typical histories

Diagnosis	Age	Pain localization	Dural symptoms	Posture	Exertion
Discodural backache	15–70	Lumbar gluteal	+	Sitting provokes Walking eases	Bending provokes
Postural syndrome	30 or younger	Lumbar	–	Provokes	Eases
Lateral recess stenosis	Elderly	Leg, unilateral segmental	–	Standing and walking provoke Sitting, lying or bending forwards eases	No influence
Sciatica	Usually 20–50	Leg, unilateral segmental	+	Sitting often provokes Supine lying often eases	Provokes
Ankylosing spondylitis, 'active stage'	15–35	Lumbar; less often unilateral gluteal	–	Often worst on waking	May aggravate pain already present
Spondylolisthesis	15–35	Lumbar, bilateral sciatica	–	Prolonged standing provokes	Largely unconnected with exertion
Spinal malignant disease	No particular age Increasing central backache in an elderly patient	(Upper) lumbar, legs; multisegmental distribution	+	No particular postures, worse at night	Muscle spasm markedly limits movements

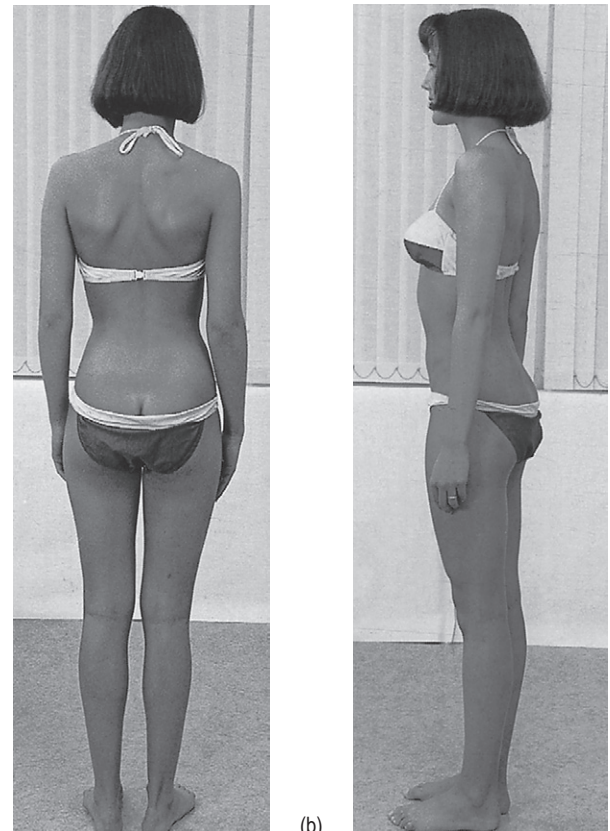
- *How does the patient enter the room?* A posture deformity in flexion or a deformity with a lateral pelvic tilt, possibly a slight limp, may be seen.
- *How does the patient sit down and how comfortably/uncomfortably does he or she sit?*
- *How does the patient get up from the chair?* A patient with low back pain may splint the spine in order to avoid painful movements.
- *What is the facial expression?* Is it in accordance with the pain the patient seems to suffer?

Next, the patient undresses so that posture can be observed, especially the lower back, pelvis and lower extremities. This is best done in good and uniform light; light falling from a unilateral source will give unilateral shadows, which may give a false idea of shape and posture.

The shape of the normal trunk

The patient should be observed posteriorly and laterally. From the posterior aspect, the shoulders and pelvis should be level and equal, and the soft tissue structures on both sides should be symmetrical (Fig. 36.1a). The thoracic and lumbar vertebrae should be vertically aligned. The angles of the scapulae should be level with the seventh thoracic spinous process; the iliac crests should line up with the fourth lumbar vertebra. The lower extremities should share the body load and be in good alignment: the hip joints not adducted or abducted, knees not bowed or knock-kneed, feet parallel or toeing out slightly, and the calcaneal bones neither pronated nor supinated.

From the side (Fig. 36.1b), the thoracic kyphosis and lumbar lordosis are observed and should have a normal curve.

**Fig 36.1** • The shape of the normal trunk.

The pelvis should be in the neutral position, i.e. the anterior superior iliac spines lie in the same vertical plane as the symphysis pubis. Hip, knee and ankle joints should be neither flexed nor hyperextended.

The pathological trunk

Posterior view

Many lumbar spinal disorders present with *asymmetrical posture*. This asymmetry may be in the vertical plane – the spinous processes do not align, or in a horizontal plane – the iliac crests, the anterior and posterior superior spines and the greater trochanters are not level in relation to each other. A pelvic tilt may be caused by anatomical changes above or below the greater trochanter, such as changes of the femoral head and neck or anatomical leg length discrepancy from growth disturbance. A lateral shift or list may have several causes.

Static scoliosis (Fig. 36.2a)

The origin of the list is a pelvic tilt due to a leg length difference; placing boards of various thicknesses under the foot of the shorter limb levels the pelvis, making the list disappear.

There is no clear evidence as to the significance of differences in leg length in the generation of spinal symptoms. If a platform under the shorter limb eases or even abolishes the pain while standing or on lumbar flexion or extension, a raised heel is advised. Some physicians recommend correction of any kind of leg length inequality. However, most investigators agree that mild leg length inequality of up to 15 mm is not a factor that contributes to low back pain.^{6,7} Correction is therefore only of importance in recurrent attacks of lumbago and in the presence of a difference of more than 15 mm.

Sciatic scoliosis (Fig. 36.2b)

The lateral shift caused by mechanical dysfunction and muscle spasm in the lower lumbar spine is called sciatic scoliosis. It usually results from painful impingement of dura mater or

nerve root. Most often, a shifted disc is responsible but it is good to remember that any space-occupying lesion in the vertebral canal can cause such an impingement.

In disc lesions, gross lateral deviation usually results from displacements at the L4 or L3 levels. Disc lesions at L5–S1 seldom result in marked lateral deviation because of the stabilizing action of the iliolumbar ligaments on the joint, although some pelvic tilt remains possible.

In lumbar disc displacements, six possible types of deviation (sciatic scoliosis) exist:

- *Towards the painful side.* This shows that the displacement is situated medially, i.e. at the axilla of the nerve root.
- *Away from the painful side.* In this case, the protrusion lies lateral to the nerve root, which is drawn away by the deviation of the trunk.
- *Alternating deviation.* This demonstrates that the dura mater slips from one side to the other of a small midline protrusion. It is also diagnostic of a protrusion at the fourth lumbar level.
- *Deviation on standing, which disappears during flexion.*
- *No deviation when standing erect but marked deviation on attempted trunk flexion.* This is often seen in root pain.
- *A momentary deviation when the trunk is flexed halfway.* The patient is seen to deviate suddenly at a particular moment during flexion, returning to a symmetrical posture as this point is passed. Usually pain is felt at the moment of deviation but occasionally it is not. This sign indicates that a fragment of disc alters its position at the back of the intervertebral joint and temporarily touches the dura mater.

Idiopathic scoliosis (Fig. 36.2c)

The curve of an idiopathic scoliosis, present since childhood, differs from a lateral shift associated with recent disc problems in that it is accompanied by a lower thoracic or lumbar rotation deformity. If this is not evident in the erect posture, it will become obvious during flexion.

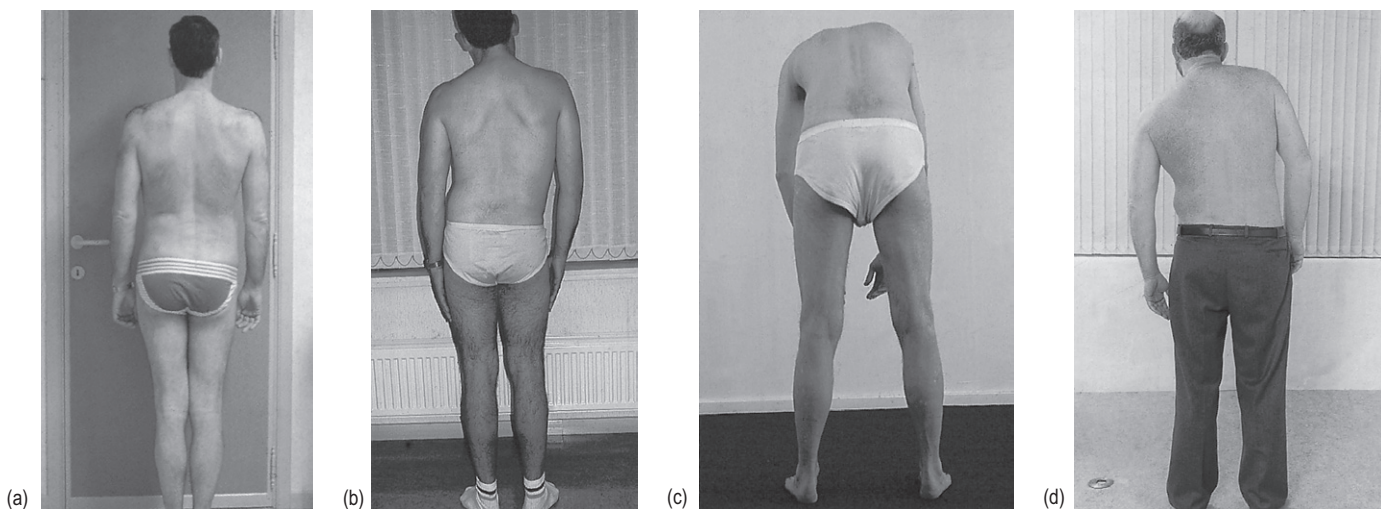


Fig 36.2 • Types of scoliosis: (a) static; (b) sciatic; (c) idiopathic; (d) psychogenic.

Psychogenic scoliosis (Fig. 36.2d)

In a psychogenic scoliosis, the wrong level is held fixed: although the pain is alleged to be lumbar, the patient holds neck, shoulders and thoracic spine in deviation whereas the lumbar spine remains vertical.

Lateral view*Increased lumbar lordosis*

This often results from weak abdominal muscles and is then compensated by an increase in thoracic kyphosis. Lumbar lordosis may also compensate for a flexion deformity of the hip joint.

Excessive lordosis

If this is not compensated by an equally excessive thoracic kyphosis, it is suggestive of spondylolisthesis. The whole

spine lies in a plane anterior to the sacrum. This is characterized by a mid- or low-lumbar shelf at the spinous processes which, if not visible, can be palpated: when the hand slides gently downwards along the spinous processes, it engages the step at the fourth or fifth level (Fig. 36.3b). In concealed spondylolisthesis the shelf disappears during recumbency, and radiography in this position may not reveal the displacement.

Kyphotic posture

This is typical in acute lumbago. A large posterior projection accounts for a block at the back of the intervertebral joint; any attempt to straighten the back results in painful squeezing of the dura mater by the subluxated fragment. The patient stands in flexion deformity, with or without a lateral pelvic tilt. A discoradicular interaction at L3 may also force the spine into an antalgic kyphosis.

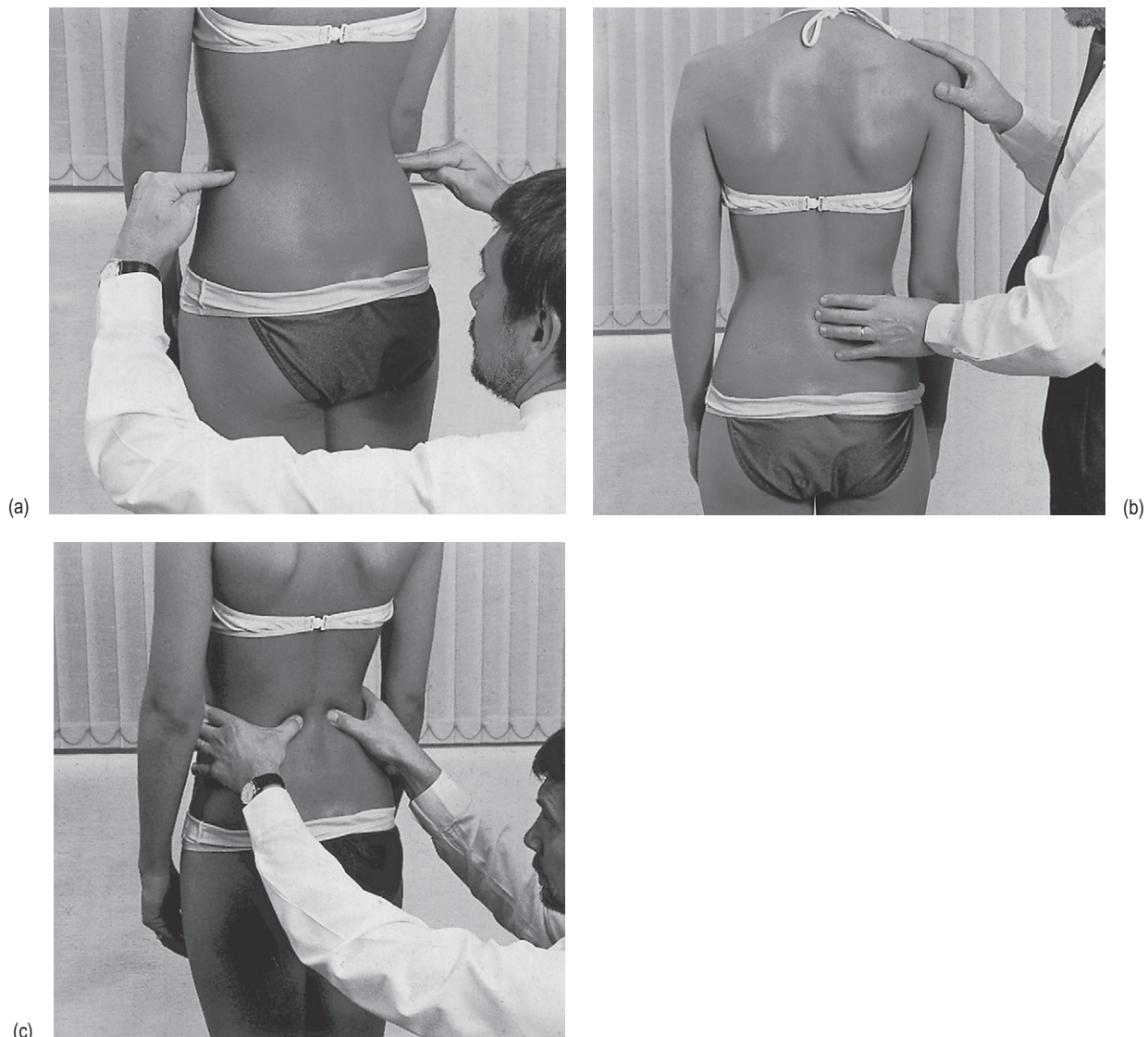


Fig 36.3 • Palpation of the iliac crests (a), shelf (b) and muscle spasm (c).

Exaggerated thoracic kyphosis

In young patients, this is characteristic of ankylosing spondylitis or adolescent osteochondrosis. In the elderly, it may indicate senile osteoporosis.

Angular kyphosis

This is caused either by gross thinning of two adjacent discs or by a wedge-shaped fracture of a vertebral body. The sign thus calls for a radiograph.

Flattened back

Patients with lumbar spinal stenosis or lateral recess stenosis usually present with a flattened back. They stay in a slightly stooped position, eliminating the normal lumbar lordosis.

Reduction of the space between the iliac crest and the thoracic cage

This indicates shortening of the thoracolumbar spine by disc-space narrowing at consecutive levels or marked osteoporosis.

Muscles

Wasting

Wasting of the paraspinal muscles is rare but may indicate chronic inflammatory disease, such as ankylosing spondylitis or tuberculosis, or point to poliomyelitis or a myopathy. It may also be seen after a previous spinal operation because of denervation.

Marked wasting of the calves, hamstrings or buttock occurs in fifth lumbar and first sacral root palsy.

In severe arthritis of the hip, the buttock, hamstrings and quadriceps will show visible wasting.

Spasm

Asymmetric spasm of the paraspinal or gluteal muscles, making them stand out compared to the normal side, is an ordinary finding in discodural or discoradicular problems, and is then accompanied by an adaptive posture in flexion or in side flexion. In mild cases, the difference in tension can be palpated (Fig. 36.3c). Muscle spasm, accompanied by visible flexion and/or lateral deformity, is also an unfavourable sign in sciatica. The protrusion nearly always proves irreducible.

Spasm of both sacrospinalis muscles, holding the lumbar spine in lordosis, may be suggestive of serious disease such as metastasis.

Skin and hair

A midline dimple or tufts of hair may suggest a variety of congenital, osseous or neurological disorders. In over 80% of all cases of occult spinal dysraphism, excess hair is present in the midline.

The colour of the skin may be an indication of vascular disorders. If the foot turns a dusky red on standing but blanches on elevation, advanced arterial obstruction is present. If this is associated with a painful limb, intermittent claudication is a real possibility.

Functional examination



Before the examination of lumbar movements is begun, the patient should be asked if there is any pain at this moment and to point out its site. If he or she indicates the upper lumbar/lower thoracic area, the examiner should be on the alert. Disc lesions at this spot are extremely rare but serious non-activity-related disorders are often situated here. Therefore the area is called the 'forbidden' area (Fig. 36.4).

In order to avoid missing important information, the examination must be performed in a practical and orderly routine. Tests are conducted in a standing position first, followed by lying supine and prone.

Examination standing

Procedure

Four active movements are examined while the examiner watches the patient from behind: backward bending, side bending to each side and forward bending completed at full range by neck flexion (Fig. 36.5).

Movements should be performed smoothly and gradually. Any deviation and/or restriction are noted and painfulness ascertained. As a movement is performed, the patient should tell the examiner when pain is felt and where. Momentary pain during the movement (painful arc) should not be missed and is pathognomonic for a disc lesion.

- *Extension* is recorded by noting the accentuation of the lumbar curve, as well as how far the patient can lean back before the pelvis tilts.
- *Lateral flexion* is measured by determining how far the patient can run the hand down the side of the leg. At full

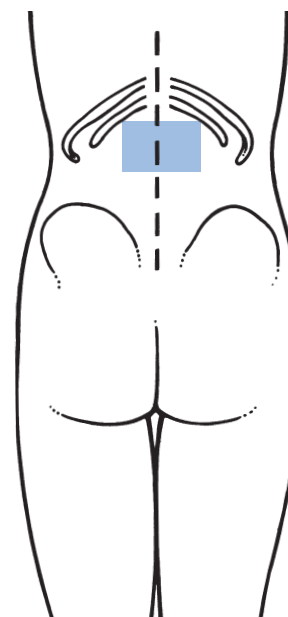


Fig 36.4 • The 'forbidden' area.

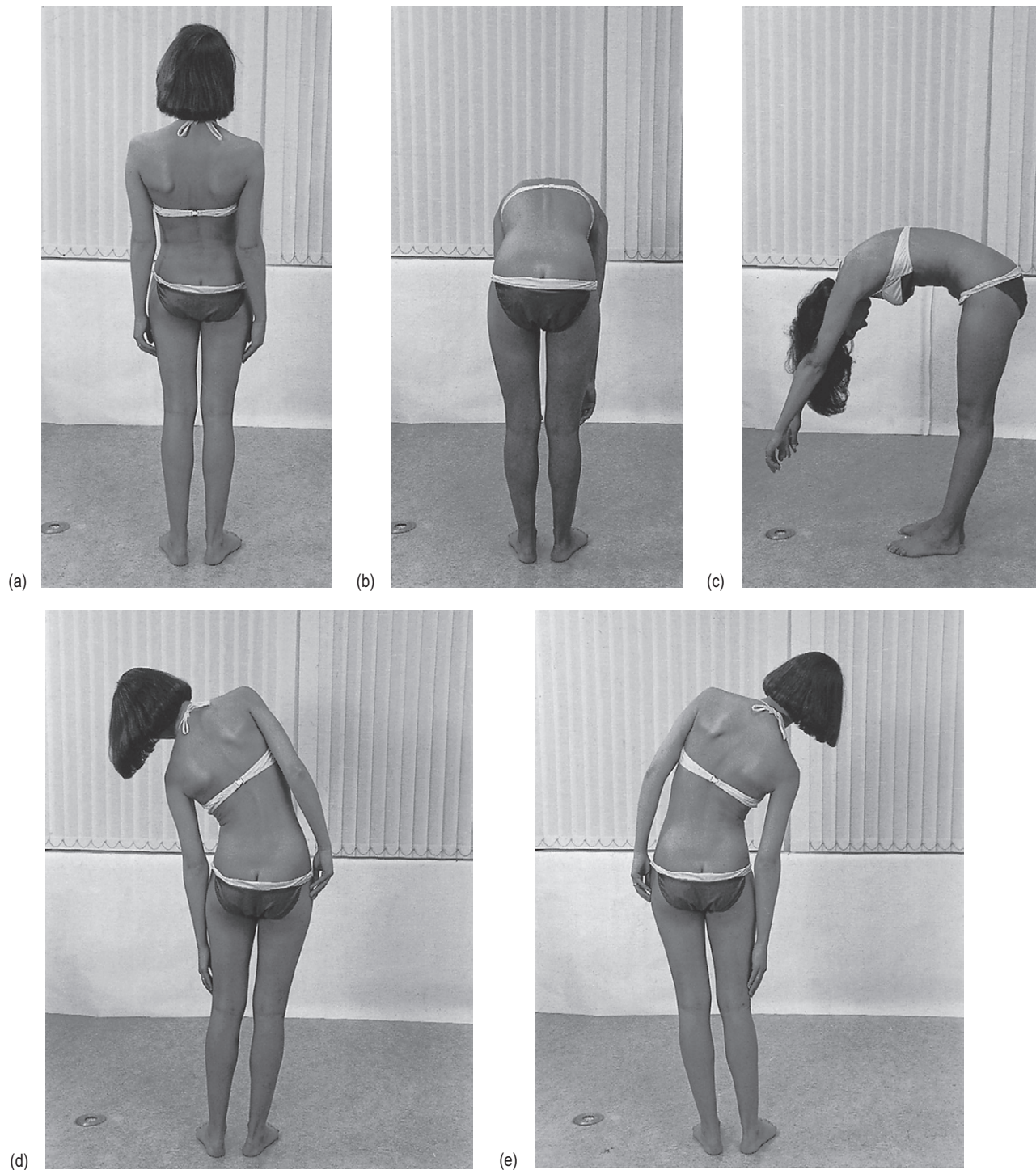


Fig 36.5 • Examination standing: (a) backward bending; (b, c) forward bending; (d, e) side bending.

range the lumbar spine should be curved uniformly in both directions. The patient is not allowed to bend forwards or backwards while performing the movement.

- *The range of forward flexion* is assessed by noting the distance of the fingertips from the floor. When complete body flexion has been attained, the lumbar spine is flattened or in young people even slightly convex. Forward

bending is usually the most restricted and painful movement and may leave a persistent ache obscuring the responses to other movements. It is therefore preferable to examine this movement last. However, in ligamentous disorders and in stenosis of the spinal canal, bending forwards may be pain-free or may cause only minor discomfort.

The patient is also asked to flex the neck whenever forward bending becomes painful or at the full range of flexion. This movement stretches the dura by traction exerted from above. Pain provoked on neck flexion is a typical finding in backache and lumbago.

Findings

After the four lumbar movements have been tested, one of the following patterns may emerge:

- A partial articular pattern, with or without deviation.
- A painful arc of movement.
- End of range painful.
- Full articular pattern.
- Full range, no pain.

Partial articular pattern

This is very suggestive of internal derangement and strongly suggests a disc protrusion. One or more of the lumbar movements are painful, whereas the others are not, or are less painful (Fig. 36.6). If there is limitation of range, its degree is unequal and corresponds with the degree of pain.

The severity of the signs depends on the size of the displacement. The most striking example of the partial articular pattern is an attack of acute lumbago from a gross discodural interaction. Although all movements commonly hurt, pain and limitation on one movement will be more serious than in the opposite direction. A distinctive asymmetry is present.

Pain may be felt centrally or unilaterally, depending on the position of the protrusion. If the attack of lumbago is caused by a posterocentral displacement, flexion and extension are very painful and grossly restricted, whereas side flexion is only painful at the end of the range. In a gross unilateral protrusion, one side flexion may be completely blocked and painful, together with flexion and extension, whereas side flexion to the opposite side is not limited and causes only slight discomfort.

In backache caused by internal derangement, some movements are slightly limited or only painful at their extremes, and others are normal. Restriction of movement is not as striking as in acute lumbago.

Rarely, lesions of the posterior arch, i.e. posterior ligaments and capsules of the facet joints, cause a partial articular pattern but neither restriction nor a painful arc is to be expected here. Spinal deviation is also absent.

Painful arc

A painful arc may occur during or on the way back from forward bending or side bending. It always means that a fragment of disc shifts, jarring the dura mater momentarily via the posterior longitudinal ligament. Sometimes a painful arc exists when the trunk passes the vertical on swinging from one side to the other. The sign is usually associated with a partial articular pattern but it can also be an isolated finding.

Sometimes there is only a painless momentary deviation, which implies an arc unnoticed by the patient; a fragment of disc alters its position at the back of the intervertebral joint, without touching the dura mater.

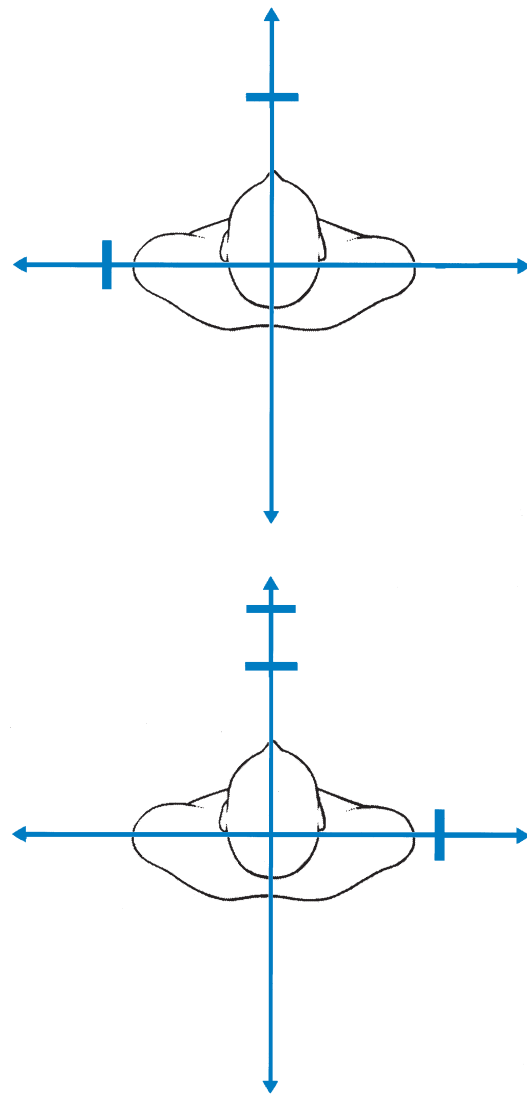


Fig 36.6 • Examples of partial articular patterns.

A painless click is a sign of abnormal articular displacement that is insufficient to irritate sensitive structures. It is not defined as an arc and its clinical significance is unclear.

The finding of a partial articular pattern together with a painful arc leads to three important conclusions:

- It is never psychogenic.
- It is pathognomonic of a disc protrusion – the dura comes into contact with the protrusion and slips over it.
- It indicates that the protrusion is small and reducible.

Pain at the end of movement

This is a common symptom in a small disc protrusion. However, it can also be the result of stretching an injured muscle or a sprained ligament or capsule. The discovery that resisted movement in the opposite direction is painless excludes the muscles. In a sprained ligament there is never a painful arc, and dural signs or root signs are absent. The movement that is supposed to stretch a ligament is also predictable: in sprain of the supraspinous and interspinous ligaments, full flexion is

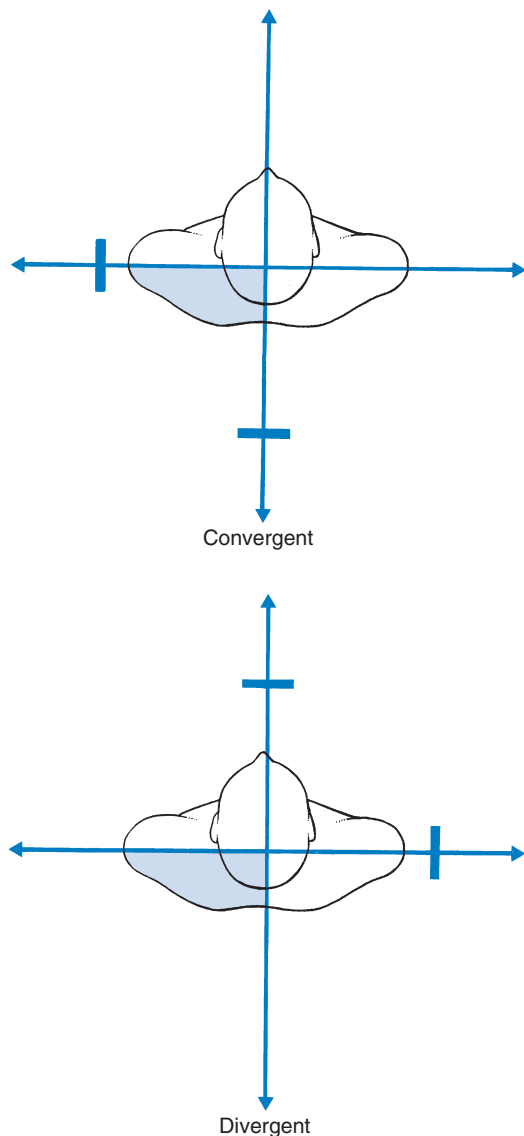


Fig 36.7 • Pain (coloured side) at the end of movement.

painful. If the iliolumbar ligaments are sprained on one side only, side flexion away from that side is painful, although there may also be pain on full flexion or on full extension.

In a capsular lesion of one of the apophyseal joints, movements also cause pain at the end of the range but now a convergent or divergent pattern is to be expected. This means that in a left-side joint, extension and side flexion to the left or flexion and side flexion to the right are painful (Fig. 36.7).

Full articular pattern (Fig. 36.8)

If all movements are painful and/or restricted in a uniform pattern, arthritis, arthrosis, fracture or malignant disease is suspected. In this respect, age and habitus are very important. Therefore gross limitation in every direction is quite normal in an elderly person but in adolescence it is usually a sign of a non-activity-related spinal disorder.

The typical example is a patient with ankylosing spondylitis who has a flat lumbar spine combined with bilateral limitation

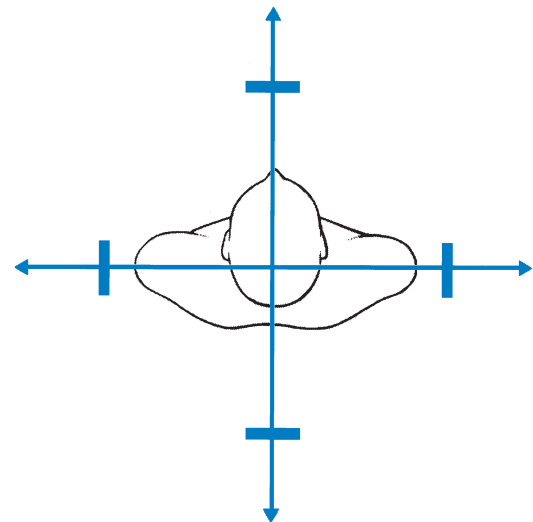


Fig 36.8 • Full articular pattern.

of side flexion and gross rigidity on forward flexion. The same limitations are present in tuberculosis of the disc or vertebra, malignant or benign tumour, Paget's disease and chronic osteomyelitis.

The finding of a full articular pattern is therefore often a warning sign and an indication for technical investigations.

Full range, without pain

Sometimes none of the four lumbar movements causes any discomfort. This may occur in the following circumstances.

- *History of a lumbar disc lesion but without displacement at the time of examination.* This is a well-known event in patients presenting with a self-reducing type of disc lesion. Every morning the patient awakes comfortable and is able to bend the back in every direction without any pain. After some hours the back begins to ache. If such a patient is seen early in the morning, all clinical tests are negative. Another example is the patient who is seen some days after an attack of acute lumbago. Because of spontaneous recovery, all symptoms may have been lost and no disc protrusion is present at the time of examination.
- *Pain referred to the back in the case of visceral disease.* If the history reveals that pain is not aggravated by activity or relieved by rest, a non-activity-related disorder should be suspected.
- *Ligamentous postural syndrome.* The pain is only provoked after standing or walking for a long time. Spinal movements are painless for the simple reason that the stress applied during the tests is not sufficient to induce pain.
- *Spondylolisthesis without a disc lesion.* This disorder resembles the ligamentous postural syndrome but patients may complain of bilateral sciatica as well. Inspection often shows a mid- or low-lumbar shelf.
- *'Bruised' dura mater or dural sleeve.* These patients have started with an ordinary attack of lumbago and/or sciatica.

There is a constant ache in the back or the limb, unaltered by movement or posture and most often worse at night. Epidural local anaesthesia abolishes the symptoms, which proves the dural origin.

- *Spinal stenosis.* The typical history is that of pain coming on during standing and walking. Lumbar movements, except perhaps extension, do not provoke the pain. If the patient is asked to stand for a while, pain arises in the back and limbs, disappearing again on flexion.

Interpretation

Each of the four movements may show some particularities that can have diagnostic importance. However, it should be emphasized again that a clinical diagnosis is only made on the patterns that emerge after all the tests have been performed.

Extension

The movement is initiated by contraction of the paravertebral muscles, whereas the iliopsoas and abdominal muscles relax smoothly to allow the movement to reach its extreme. The backward bending is usually limited to 20–30°. In order to stabilize the back, the patient can place both hands on the iliac crests while performing the test.

Painful limitation as part of a partial articular pattern

In acute lumbago, extension is usually completely blocked because of a large posterocentral protrusion. This limitation is part of a gross partial articular pattern. In sciatica, if trunk extension is considerably limited by severe pain shooting down the back of the limb, the prognosis is very poor and surgery is almost always indicated.

Painless limitation

In middle-aged or elderly people, painless limitation of extension results from osteophyte formation and/or diminished intervertebral joint space.

In long-standing ankylosing spondylitis, pain ceases when bony ankylosis is complete. Then not only extension is limited but also both side flexions.

Vertebral hyperostosis (Forestier disease) also leads to increasing painless stiffening of the spine.

Painful limitation and full articular pattern

Elderly patients with a spondylotic back show painless limitation of all four movements. However, if a disc lesion is superimposed, extension may also become painful. A similar picture may be seen in spinal stenosis: although there is a full articular pattern, pain and paraesthesia are only provoked by extension. Painful limitation of extension may also indicate ankylosing spondylitis. There is an obvious full articular pattern but only extension is painful.

In lateral recess stenosis, extension may provoke pain and/or paraesthesia in one leg only.

Pain on full range

In unilateral discodural backache, one common pattern is for extension to be of full range and painful centrally, whereas flexion causes unilateral lumbar or gluteal pain.

The L3 root is stretched on extension and relaxed on flexion. Therefore, in L3 root compression, extension is often painful whereas flexion produces relief.

In sciatica, extension sometimes causes pain in the lower limb instead of the back. If the patient is under the age of 60, manipulation will almost certainly fail.

Localized central pain on full extension may result from local periostitis at a spinal process.

Unilateral pain at the upper sacroiliac region or in the groin on full extension may result from a lesion of the iliolumbar ligaments.

In backache caused by a lesion of the capsule of a facet joint, a convergent pattern is often present: both extension and side flexion towards the pain produce pain at the end of range.

It is sometimes difficult to find the source of the problem if trunk extension creates pain in the buttock or the lower limb. When the pain is felt in one buttock only, its origin may be in the lumbar spine, the sacroiliac joint or the hip joint. When it is combined with segmental pain over the front of the thigh, the lesion must originate in the third lumbar segment: a third lumbar disc lesion or arthritis at the hip joint. They can be differentiated by performing an extension movement of the lumbar spine after flexing the hip to 90° – a position that avoids extension strain falling on the hip joint. If the pain is felt at the back of the thigh, the fifth lumbar and the sacroiliac joints are likely to be strained. Further investigation will then differentiate between these two locations.

Deviation

Sometimes the lumbar spine is seen to deviate slightly during extension so as to avoid pain. This involuntary manoeuvre strongly suggests a disc lesion.

Side flexion

This movement is initiated by the paravertebral muscles, the psoas major and the external and internal oblique abdominal muscles on the same side. Contralateral muscles relax smoothly, controlling the movement. At the end of the range, the thorax and iliac crest approximate laterally. Side flexion accounts for approximately 15–20° on both sides.

Painful limitation of both side flexion movements

Cyriax stated that: 'All serious diseases of the lumbar spine result in limitation of the range of both side flexion movements.' The finding of this sign should be considered as a warning in young and middle-aged patients. Malignant and benign neoplasms, tuberculosis, chronic osteomyelitis, ankylosing spondylitis and fractures must be excluded.

Painless limitation of both side flexion movements

This is a normal finding in the elderly and is usually associated with spondylosis, or advanced osteoporosis, in which case extension and flexion are also seriously restricted.

Painful limitation of one side flexion movement

This usually results from a large unilateral protrusion. The joint is blocked at one side only. At the fourth or third lumbar level, these protrusions are usually associated with lateral deviation of the lumbar spine on standing.

If side flexion away from the symptomatic side is painful and limited, manipulative reduction is likely to have good results, although it may take special techniques and several sessions to produce a lasting cure.

In contrast, if side flexion towards the painful side hurts in a patient under the age of 60, manipulation often fails and traction is more likely to succeed. If this movement also causes pain in the lower limb instead of in the lumbar region or the upper buttock, manual reduction is almost impossible.

If gross limitation of side flexion away from the painful side is the only positive finding, a serious extra-articular lesion must again be suspected. Abdominal neoplasm or a neuroma at the lumbar or lower thoracic level commonly demonstrates this warning sign.

Pain at full range

Together with a partial articular pattern, this points towards internal derangement at an intervertebral joint. The absence of any limitation means that the protrusion is small and indicates that manipulation should succeed quickly.

Pain at the end of one side flexion is exceptionally caused by a muscular lesion, fracture or sprained ligament.

- *In a muscular lesion or fracture of a transverse process*, pain arises from stretching (bending to the contralateral side). Resisted side flexion in the opposite direction is also painful.
- *In unilateral posterior ligamentous dysfunction syndrome*, painful side bending towards the contralateral side suggests a lesion of either the iliolumbar ligament or the capsule of a facet joint. In the former, anteflexion and extension may also be painful. A facet joint lesion shows a divergent pattern: as well as side flexion, forward flexion is also painful at the end of range.

Painful arc

A painful arc during side flexion indicates a disc lesion, usually at the fourth lumbar level. An arc may be very subtle and present as a slight momentary pain when the patient moves the trunk from one side to the other. Sometimes the arc is quite extensive and can be missed if the patient is not encouraged to continue the movement when the pain appears.

Flexion

This is a complex movement that influences not only the lumbar spine and its neural contents but also the sacroiliac and hip joints. The movement is initiated by contraction of the iliopsoas and abdominal muscles. It then proceeds due to the force of gravity, the paravertebral muscles, gluteal muscles and hamstrings relaxing smoothly to allow the movement to be carried out to its extreme. At the end of the range, the vertebral column is stabilized only by the passive action of vertebral ligaments fixed to the bony pelvis.

Bending forwards causes pelvic rotation together with flexion of the lumbar spine. Normally, a smoothly graded ratio exists between the degree of pelvic rotation and that of lumbar flattening. This constitutes the 'lumbar–pelvic rhythm', which is difficult to quantify. However, at any phase of body flexion, the extent of lumbar curve flattening must be accompanied by a proportional degree of pelvic rotation around the transverse axis of the two hip joints. During these movements, a posterior shift of the hips in a horizontal plane takes place simultaneously, in order to maintain balance, an integral part of the pelvic portion of the lumbar–pelvic rhythm. The rhythm is disturbed if any of the component parts lacks function.⁸

Painful limitation

In an acute and severe discodural interaction, pain grossly limits trunk flexion because the weight of the body on forward bending further increases the size of the protrusion. In addition, this movement stretches the dura and draws it strongly forwards against the protrusion. Flexion of the neck performed at the moment of maximum lumbar flexion further stretches the dura from above and therefore increases the pain.

Flexion may also be limited by root pain. If this is the only sign, it usually indicates a primary posterolateral protrusion as found in young adults. The sign is then regarded as a root sign rather than an articular sign. Also, in secondary posterolateral protrusions, trunk flexion is limited by posterior leg pain. Here, however, this sign is associated with back or buttock pain on one or two other lumbar movements. Again, neck flexion may provoke or increase the pain in the limb, as it draws the nerve root structures more against a projection into the spinal canal.

Fixation in lordosis

During flexion, the lumbar spine may stay fixed in lordosis because of spasm of the sacrospinalis muscles. If both side-bending movements are also markedly limited, a serious non-activity-related disorder must be excluded.

Pain at the end of range

Central or unilateral pain in the low back on full flexion is a common articular sign found in most cases of backache and results from a small midline protrusion contacting the dura mater. It is usually accompanied by pain on some of the other spinal movements as part of a partial articular pattern. Rarely, localized central pain is caused by a sprained supra- or interspinous ligament. The only clinical finding then is pain at the end of flexion and extension.

If pain on full flexion is felt unilaterally at the level of the sacroiliac joint or the buttock, a small unilateral discodural conflict is likely. However, this must be differentiated from a lesion of the sacroiliac joint, hip joint or gluteal structures, all of which are also stretched at the end of flexion. A strained iliolumbar ligament is possible too. Side flexion away from the painful side is then also painful. An inflamed capsule of the facet joints may give rise to local unilateral pain, perhaps with slight reference to the upper buttock. Side bending away from the painful side is painful – the divergent pattern. It is important to note that, if the accessory movement of neck flexion, performed at the moment of full flexion, provokes or increases the pain in the back or buttock, all ligamentous, facet joint, sacroiliac or hip lesions can be excluded. This sign points to irritation of the dura mater.

Painless limitation

In elderly people, limitation of flexion, in combination with limitation of extension and both side movements, is normal and results from spondylosis. However, if a small lesion (disc or ligament) is superimposed on this condition, flexion is also painful. In L3 root compression, flexion is usually full and painless, because this movement relaxes the nerve.

Painful arc

A painful arc on flexion always means that a fragment of disc shifts, jarring the dura mater halfway through the movement.⁹

The pain disappears when the patient continues forward bending.

Lateral deviations

Lateral deviation of the spine during forward flexion also points to a disc lesion. It is caused by the way the spine accommodates a protrusion, preventing it from pressing on the dura mater or the dural investment of the nerve root. Usually the spine that stands upright symmetrically deviates on flexion. Sometimes the deviation that was present while standing disappears on bending forwards. In other patients, the deviation alternates, one way on bending forward and the other way on straightening up, the implication being that the dura mater has to be held to one or other side of a small projection.

Standing on tiptoe

The last test in the standing position is standing on tiptoe, which examines the strength of the calf muscles and thus the integrity of the S1/S2 segment. The patient is invited to perform the test, first on the good leg and then on the bad. The examiner steadies the patient with both hands, without taking any of the weight (Fig. 36.9). Inclining the body forwards and flexing the knee is evidence of weakness.

This test is best repeated several times in order to discover those cases with only slight weakness.

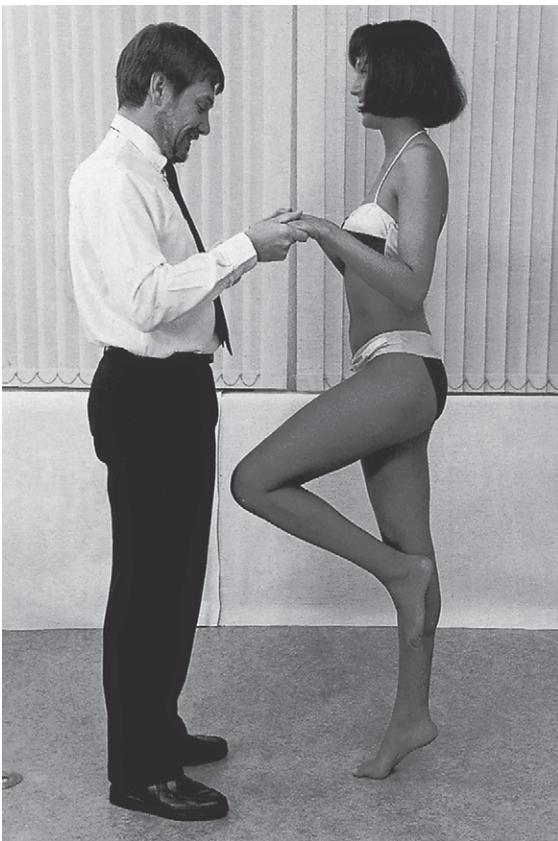


Fig 36.9 • Standing on tiptoe.

Warning

Standing

- Impossible to stand for a moment because of severe pain.
- Full articular pattern.
- Limitation of the range of both side flexion movements in young and middle-aged patients.
- Gross limitation of side flexion away from the painful side as the only positive finding.
- Fixation in lordosis during flexion together with marked limitation of both side flexion movements.

Examination supine

The patient is asked to lie supine. The way patients move to get on the couch should correspond to their previous performance and to the information gained from the history. In suspected exaggeration or 'malingering', careful observation of the patient's attitude can be informative. For example, turning from a sitting to a supine position places particular strain on the low back, and, especially in acute lumbago, patients can be expected to support themselves with their arms. Moving onto and off the couch easily means that the psoas muscles must have normal strength. If, before lying down, the patient is able to sit on the couch with the legs stretched out, straight leg raising must be of full range. Other discrepancies are discussed in Section 8.

Sacroiliac joints

Pain in the buttock most often results from disorders of the lumbar spine. However, pain from hip and sacroiliac disorders is referred to the same area. To exclude sacroiliac disorders, a specific test should be done to exert tension on the capsule and ligaments of the sacroiliac joint without affecting the lumbar spine or the hip joint. Distraction of the iliacs seems to be the best scanning test that fulfils this condition.¹⁰ It is performed as described below.¹¹

The examiner places the hands on the anterior superior spines of the ilium with the arms crossed (Fig. 36.10). Pressure is exerted in a downward and outward direction and should be evenly distributed to prevent moving the lumbar region.

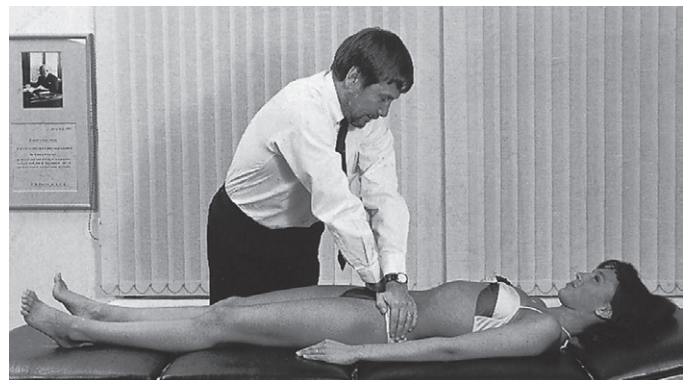


Fig 36.10 • Testing the sacroiliac joints.

In a positive test, a deep-seated unilateral ache is evoked at the gluteal and/or posterior crural area. In acute lumbar pain syndromes, it may be necessary to perform this test with the patient's forearm supporting the low lumbar area. In this way, the lumbar segments are better prevented from moving into flexion. This measure also prevents a tender part of the sacrum or of one of the posterior superior iliac spines from being pressed painfully against the couch. Confirmation of unilateral pain strongly indicates sacroiliitis or strain of the anterior sacroiliac ligaments. In contrast, if the patient states that the pain is felt centrally, it is clear that this is irrelevant, because it is impossible for a unilateral structure to refer pain centrally. Probably it has more to do with the appearance of referred tenderness at the dorsal part of the sacrum, which is pressed against the couch. Discomfort at the anterior superior iliac spines can also be ignored.

The distraction test at the sacroiliac joint has very high specificity and 100% sensitivity.¹² The test is extremely important in the clinical diagnosis of back pain and should never be omitted; there is almost nothing in the nature and extent of sacroiliac pain that distinguishes it from a disc protrusion compressing either the dura mater or the dural extent of the S1 and S2 nerve roots. The fact that the pain probably comes and goes irrespective of posture and exertion, or often changes sides, draws attention to the possibility of sacroiliac arthritis. To make matters more confusing, coughing also hurts because the increase in abdominal pressure painfully distracts the ilium from the sacrum. Also, routine clinical examination does not usually differentiate sacroiliac arthritis from a disc lesion: the lumbar movements may increase the pain a little at full range; flexion can be very painful and even limited; and straight leg raising may also prove to be painful. It should therefore not be surprising that the diagnosis is easily missed and that patients are often treated on the assumption that a disc lesion is present, which may even lead to unnecessary surgery. Moreover, a normal radiographic appearance of the sacroiliac joints does not always exclude arthritis, as symptoms may precede the radiological evidence by months or even years. It is therefore vital never to forget the sacroiliac distraction test during routine lumbar examination.

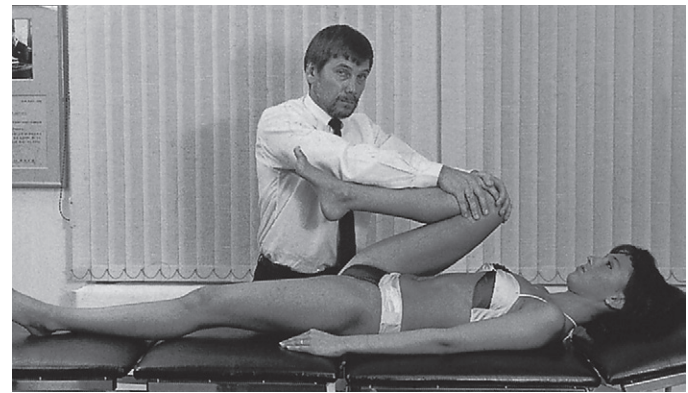
Hip joints

After the sacroiliac joints are tested, three basic tests for the hip joints are performed. It may be important to differentiate between the lumbar spine and the hip joints, especially in the case of pain in one buttock and/or the anterior thigh.

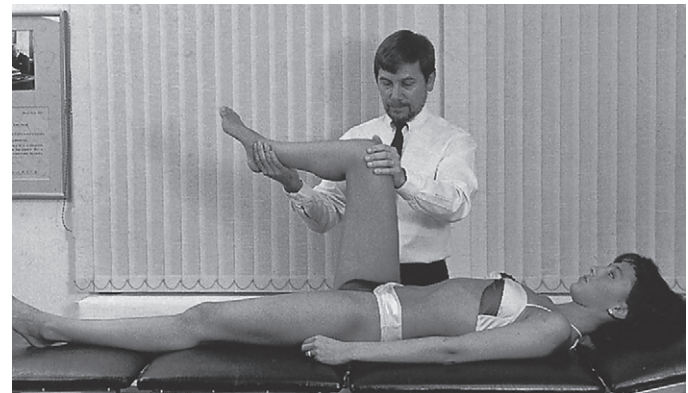
Both sides, the uninvolved one first, are tested for range, end-feel and pain on flexion, lateral rotation and medial rotation.

The thigh is moved into flexion until it touches the abdomen (Fig. 36.11a). The movements of rotation are tested while the hip joint is held in 90° of flexion. One hand stabilizes the femur at the knee, while the other is placed at the distal end of the lower leg and performs the rotation movement (Fig. 36.11b, c).

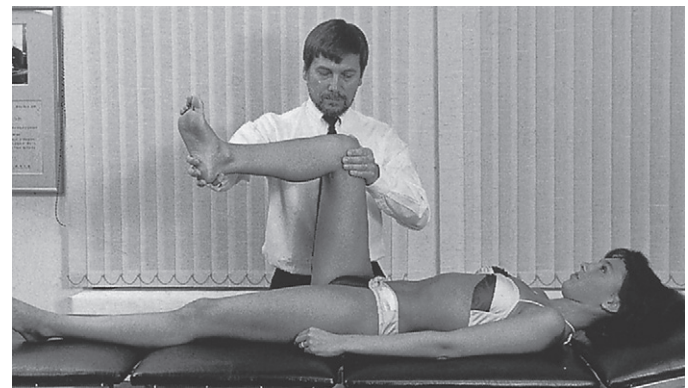
In minor lumbar lesions, none of these movements usually hurts at the back. In a patient with severe lumbar pain, however, some of these tests can be slightly painful. Full hip flexion,



(a)



(b)



(c)

Fig 36.11 • Testing the hip joints: (a) flexion; (b) medial rotation; (c) lateral rotation.

for instance, may exert slight traction on the sciatic nerve roots. Also, full medial rotation stretches the sciatic nerve trunk and may cause an ache in the buttock.¹³ The same applies to the sacroiliac joints. Moving the hip joint beyond full range involves the next link of the moving chain – the sacroiliac joint – and may evoke sacroiliac pain. Full lateral rotation at the hip stretches the anterior sacroiliac ligaments and full medial rotation has the same effect on the posterior ligaments (see Ch. 43).

Straight leg raising test

The straight leg raising (SLR) test is performed to estimate the mobility of the dura mater, as well as the dural investments of the nerve roots at the *fourth lumbar to second sacral segments*.

Historical note

This test was first presented by JJ Frost in 1881 with reference to his teacher, Ernest Charles Lasègue. Frost proposed the test as an aid in distinguishing hip from sciatic pain.¹⁴ Later, a number of workers^{13,15-17} demonstrated that this movement exerts tension on nerve roots and dural tube. The mobility of the nerve roots at the intervertebral foramen has also been investigated and shows a range of 2–8 mm on SLR.¹⁸⁻²⁰ Careful study²¹ of subjects between 35 and 55 years of age showed a downward movement of 1.5 mm for the fourth lumbar root, 3 mm for the fifth lumbar root and 4 mm for the first sacral root. A more recent study on fresh cadavers showed the intrathecal movement of the lumbosacral roots induced by SLR of 70° to be 0.96 mm, 1.54 mm and 2.31 mm for roots L4, L5 and S1, respectively.²²

Significance of the test

In a study of 50 consecutive surgical patients with clinical and radiographic evidence of lumbar disc herniation, it was shown that SLR was the most sensitive preoperative physical diagnostic sign (96%) for correlating intraoperative pathology of lumbar disc herniation.²³ The sign has also been helpful in diagnosing discodural backache.^{24,25} However, the significance of neither the presence nor the absence of the signs should not be overestimated.^{26,27} SLR as an isolated phenomenon has *no* diagnostic significance and must always be interpreted in association with other clinical findings. As can be seen in **Box 36.5**, limitation of the mobility of nerve roots and dural tube is not pathognomonic for a disc lesion.

Box 36.5

Straight leg raising (SLR)

The SLR test may be positive in:

Intraspinal lesions

Discogenic

- Protrusion

Non-discogenic

- Tumour
- Neuroma

Extraspinal lesions

- Sacroiliac joint lesions
- Major lesions at the buttock
- Major lesions at the hip joint
- Lesions of the hamstring muscle belly
- Non-organic disorders

Conversely, a completely painless SLR does not exclude a disc lesion. Circumstances that produce a negative test in discoradicular problems are as follows:

- Cases where the nerve root emerges a little higher up in the foramen and does not come into contact with the protrusion
- Protrusions at the second or third lumbar level and the third or fourth sacral nerve roots, which are not influenced by the manoeuvre
- Minor protrusions that interfere only slightly with the dura mater and therefore do not influence its mobility.

Intraspinal space-occupying lesions

Any space-occupying lesion situated at the anterior wall of the vertebral canal may interfere with the dura mater and/or the nerve root structures and thus painfully limit movement. Most often this is a posterocentral or posterolateral disc displacement but it may also be a tumour, inflammation or haemorrhage.

The sign is absent in radicular disorders where pressure is exerted from behind, such as in a narrowed lateral recess or a hypertrophic apophyseal joint. Because the SLR drags the nerve roots downwards and forwards, they are moved away from the compression during the manoeuvre.

Apparent acute lumbago and negative SLR

Examiners should be on their guard against apparent cases of acute lumbago in combination with a negative SLR. In these cases, it is non-mechanical disorders that should be suspected rather than a lower-level discodural conflict.

Disc lesions at the second or third lumbar level

In these lesions, SLR is usually of full range because the movement does not directly interfere with these roots.¹⁸ However, full SLR may aggravate lumbar pain through traction exerted on the dura via the roots below.

Hamstring tightness

It is also possible for tightness of the hamstrings to limit the manoeuvre, sometimes by up to 50°. By raising the leg on the other side, the same degree of limitation, caused by a similar tightness, will differentiate from the true reactive muscle spasm caused by dural irritation.

Painful disorders of the sacroiliac joint

Straight leg raising may also be painful, though not limited, in sacroiliac disorders. At full range, traction through the tightened hamstrings is exerted on the sacrotuberous and sacrospinous ligaments, and the anterior capsule of the joint.²⁸

Major lesions at the buttock

Serious disorders at the buttock, such as osteomyelitis and metastasis at the ilium or upper femur, a fractured sacrum or chronic septic sacroiliac arthritis, also influence the SLR manoeuvre. The combination with positive hip signs forms the 'sign of the buttock' (see p. 637).

Performing the test

Before testing, it should be assumed that there is at least 90° of flexion at the hip joint; otherwise conclusions cannot be drawn. Then the leg is lifted upwards from the anatomical position by supporting the foot at the calcaneus. To prevent

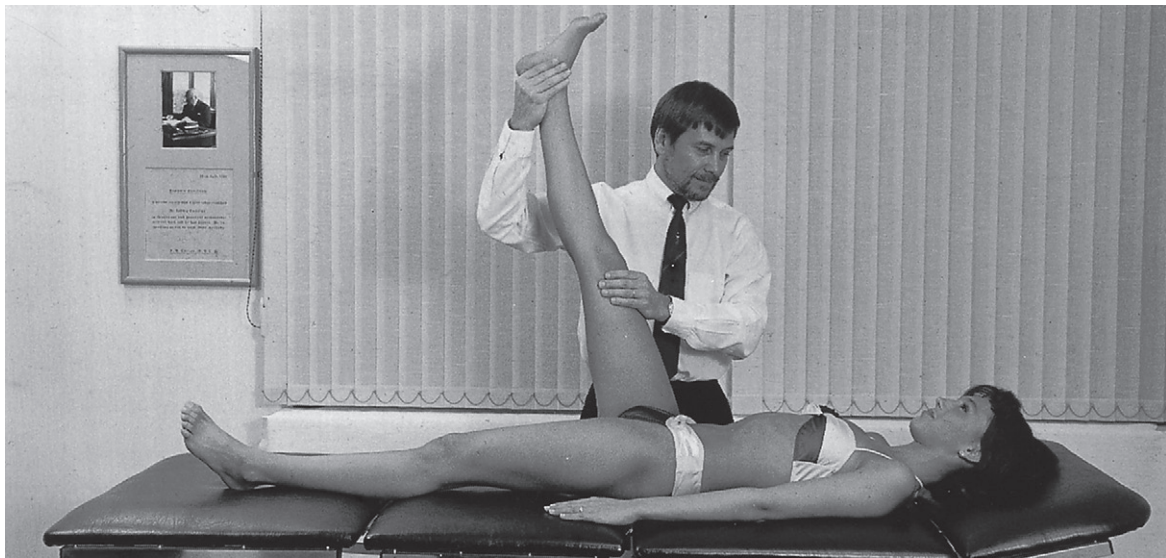


Fig 36.12 • Straight leg raising.

the knee from bending, the other hand is placed on its anterior aspect (Fig. 36.12). The patient should also not be allowed to rotate the pelvis forwards or to abduct and externally rotate the leg at the hip, in order to escape painful stretching.

The examiner should compare both sides for any differences in range, end-feel and degree of discomfort, starting with the painless side. The normal range varies greatly from person to person: due to tension in the hamstrings, stiff patients can only reach 60° whereas hypermobile people may show a range of more than 120°. In impaired mobility of the dura mater and/or one of the two lower lumbar and upper sacral nerve roots, involuntary spasm of the hamstring muscles abruptly prevents further movement to the full physiological range. At this point, the patient may state that pain in the back or leg is reproduced, a sign that the dura or the dural investments of the nerve roots are irritated. The examiner must not fail to force SLR gently, as long as this causes only slight pain and the hamstring muscles do not abruptly terminate the movement. Otherwise a painful arc may be missed or those uncommon cases in which pain begins at, for example 45° but the leg can be moved to 90° without increased discomfort.

The degree of limitation varies with the degree of the discodural or discoradicular interaction. However, this rule only holds as long as there is no parenchymatous involvement. As soon as there are detectable neurological signs, SLR becomes independent of the degree of discoradicular interaction. (See Box 36.6 for an outline of the six stages in the SLR test.)

Painful arc (Fig. 36.13)

The patient feels a momentary pain on the way up and/or on the way down. A painful arc may be an isolated finding during SLR but is usually seen in combination with pain at full range. The finding is very important because it is pathognomonic for a disc lesion: the moving nerve root catches the protrusion momentarily and slips over it. It implies that the symptoms are not caused by a muscular or ligamentous strain, and that a psychogenic disorder can be excluded. Furthermore, such a

Box 36.6

Stages in the straight leg raising test

Six stages can be distinguished and each used as a criterion to ascertain the size of the protrusion.

• Full and painless	This does not exclude disc protrusions. In the supine position these may be too small to make contact with the dura or the dural sleeve and thus these structures can move freely
• Pain on full range	A small protrusion is likely
• Painful arc	Suggestive of a small protrusion. The dura or nerve root slips over the projection
• Painful and limited without neurological deficit	The protrusion is larger, limiting the mobility of the dura or the dural sleeve of one of the lower lumbar or upper sacral nerve roots
• Painful and limited with neurological deficit	A large posterolateral protrusion is compressing a nerve root, impairing mobility and conduction. The severity of the palsy takes over from SLR as the criterion for the degree of interference
• Full and painless with neurological deficit	A large posterolateral protrusion has become maximal, compressing the nerve root so intensively that it has become ischaemic and atrophied

protrusion must be small in size, and therefore manipulation is expected to succeed quickly.

Cross-leg straight leg raising test

This test is positive when moving the uninvolved leg reproduces the back or sciatic pain. This results from movement of the dura and the contralateral nerve, which is dragged downwards and medially.²⁹ It strongly suggests an axial localization of the protrusion and points to the fourth lumbar level³⁰ but

some^{31,32} have failed to correlate the position of the disc protrusion in relation to the root at laminectomy. However, a very high incidence of sequestration or extrusion is seen at operation in patients with cross-leg pain (Fig. 36.14).^{26,33,34}

Straining the contralateral sacroiliac joint

At full range the manoeuvre may also strain the contralateral sacroiliac joint. After taking up all the slack in the ligaments on the uninvolved side, the sacrum and the iliac bone move together and the movement puts a rotational strain on the contralateral joint.

Straight leg raising with neck flexion

At the moment SLR becomes painful, the patient is asked to flex the neck, while keeping the trunk still. This often increases the pain by pulling on the dura mater from above, adding

tension to the impaired dural structures.³⁵ This clear ‘dural sign’ excludes the possibility of a major sacroiliac buttock or hamstring lesion (Fig. 36.15).

Bragard’s test

The presence of nerve irritability can also be confirmed with the manoeuvre known as Bragard’s test. The raised leg should be lowered until pain is relieved. In that position the foot is dorsiflexed, which causes a recurrence of pain as a result of stretching the sciatic nerve via the tibial nerve.^{36,37}

The ‘bowstring’ sign

This is also suggested to be a very reliable test of root tension.¹⁵ In this manoeuvre, SLR is carried out until pain is reproduced. At this level, the knee is slightly flexed until pain abates. The patient’s limb is rested on the examiner’s shoulder and the patient’s thumbs are placed in the popliteal fossa, over the sciatic nerve. If sudden firm pressure on the nerve gives rise to pain in the back or down the leg, the patient is almost certainly suffering from significant root tension.

Lumbago and straight leg raising

The degree of limitation corresponds to the degree of discodural contact.²² In large posterocentral protrusions, SLR is limited bilaterally. Unilateral lumbago often restricts the

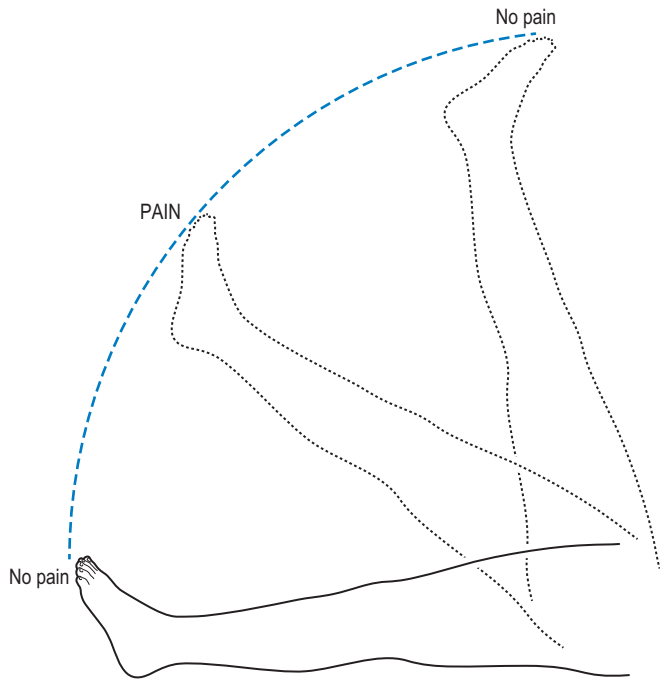


Fig 36.13 • Painful arc on straight leg raising. Redrawn from Cyriax J., *Textbook of Orthopaedic Medicine*, Volume 1, 1982, Harcourt Brace & Co Ltd, Elsevier Health Science Books, with permission.

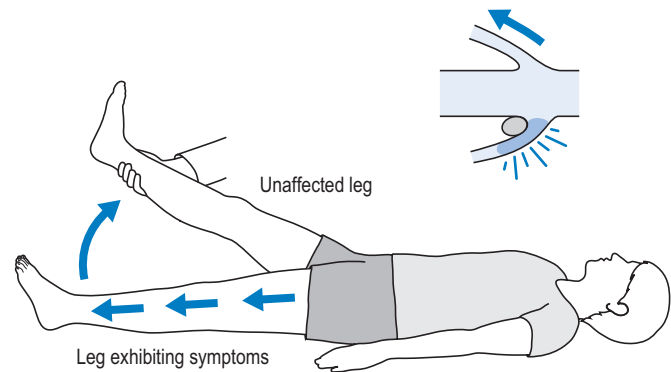


Fig 36.14 • Cross-leg straight leg raising: the localization of the protrusion is axial. Redrawn from Magee DJ. *Orthopaedic Physical Assessment*. 2008, Saunders, with permission.



Fig 36.15 • Modified straight leg raising: with neck flexion.

manoeuvre on the affected side only or to a greater degree on that side than on the other.

Any change in discodural contact alters the range of SLR instantly. Hence, the sign is very useful in assessing the effect of treatment. So, during a manipulation session, before starting traction, or during a period of bed rest, SLR is a good test for estimating progress without stressing the lesion. From the moment SLR becomes negative, active movement of the lumbar spine while standing becomes the new criterion for testing. In this position, intradiscal pressure is raised, which may cause renewed discodural contact.

Sciatica and straight leg raising

The SLR test is very useful to ascertain the degree of discoradicular compression.²³ If the root is not yet atrophic, the degree of restriction of SLR is proportional to the pressure exerted on the nerve root. However, from the point at which conduction becomes impaired, which is coupled with neurological signs, the degree of interference affords the new criterion of the size of the protrusion. Indeed, although the protrusion has become larger, restriction of SLR may not have altered or may even have returned to full range. In the latter case, the patient has developed an ischaemic root palsy. The protrusion has become maximal in size but, as a result of the ischaemia, the nerve root has lost its function, including that of pain conduction. Dural sleeve pain thus ceases and SLR returns to full range. The patient is subjectively better – pain-free – but the lesion is anatomically worse. The large protrusion will undoubtedly be seen on computed tomography (CT), although the SLR test has become negative (see [Box 36.6](#)).

Non-organic disorders and straight leg raising

The range of SLR must always be compared with the range of trunk flexion on standing. Because intradiscal pressure is higher on standing and bending forwards, restriction is expected to be greatest on this test or at least equal to SLR, in which the body weight is off the joint. The converse does not hold: many perfectly genuine disc lesions restrict trunk flexion but not SLR. Unless this difference is appreciated, patients with medico-legal claims may be treated unfairly.

However, the inconsistencies likely in psychogenic disorders should be recognized, in order to avoid treatment of a spinal lesion that does not exist. If there is any doubt, additional tests should be performed to establish these inconsistencies. For example, if the patient sits on the couch with the legs outstretched in front, discrepancy between the degree of alleged limitation of SLR and the degree of hip flexion needed to be able to sit on the couch confirms the suspicion (see online chapter *Psychogenic pain*).

Testing the integrity of spinal segmental innervation

This includes examination of muscle strength, sensation and reflexes of the entire lower extremity. Comparison should always be made with the contralateral side.

When signs of interference with nerve conduction are found, the degree of involvement should also be estimated. In discoradicular interactions, motor conduction may be reduced but there is seldom complete paralysis.

Positive root signs have both diagnostic and therapeutic value. Motor weakness is the most reliable localizing sign of nerve root involvement. Sensory changes, on the contrary, are rather subjective and easily affected by emotional state. Reflex changes may result from a previous episode of nerve root compression. As for treatment, disturbance of spinal segmental innervation indicates that the protrusion is too large and located too far laterally for attempts at manipulative reduction to succeed. For this reason, all tests of conduction should be repeated before each session of manipulation or attempted traction, especially if the patient does not respond in the expected way. It is possible that, during the interval between sessions, a root palsy develops, which makes further attempts at reduction futile.

A disc protrusion usually affects one root only. However, because of the obliquity of the lumbar nerve roots, a large protrusion may lie at the interval between two roots, catching the motor part of the upper root and the sensory part of the lower root. This clinical observation is seen in L4 protrusions affecting the fourth and fifth roots, as well as in L5 protrusions with palsy of the fifth lumbar and first sacral roots.

Impaired conduction of more than two roots is so rare that neoplasm should be suspected first. The same applies to bilateral root palsies.

Diffuse weakness of all muscle groups, particularly the psoas muscle, is highly suggestive of a psychological disorder.^{2,30}

Tests of motor conduction

There are four tests in the supine position.

Resisted flexion of the hip

This tests the L2 and L3 nerve roots. It is performed with the hip joint flexed to 90° so as to eliminate activity of the rectus femoris as much as possible. Both hands are placed at the distal end of the thigh and the patient attempts to resist the strong force applied by the examiner ([Fig. 36.16](#)). At the same time, it is necessary to stabilize the ilium with one knee placed against the patient's ischial tuberosity.

If the attempted movement is weak and painful, neoplasm should be suspected. A second lumbar root palsy is hardly ever caused by a disc protrusion (1 in 1000 lumbar protrusions) and serious disease is more likely: for example, a neuroma or metastasis. The latter may be located vertebally or at the upper femur.

In a third lumbar root palsy, resisted flexion of the hip is only slightly impaired but there is striking loss of power of the quadriceps.

Resisted dorsiflexion of the foot

This tests the L4 nerve root. The patient lies supine with the hips and knees extended. The patient holds the ankle in full dorsiflexion and should resist the full weight of the examiner's body ([Fig. 36.17](#)).

Resisted dorsiflexion of the big toe

This tests the L4 and L5 nerve roots. The examiner places the thumb on the nail bed of the great toe and the fingers on the ball of the foot. The patient is asked to resist the examiner's attempt to plantiflex the great toe ([Fig. 36.18](#)).

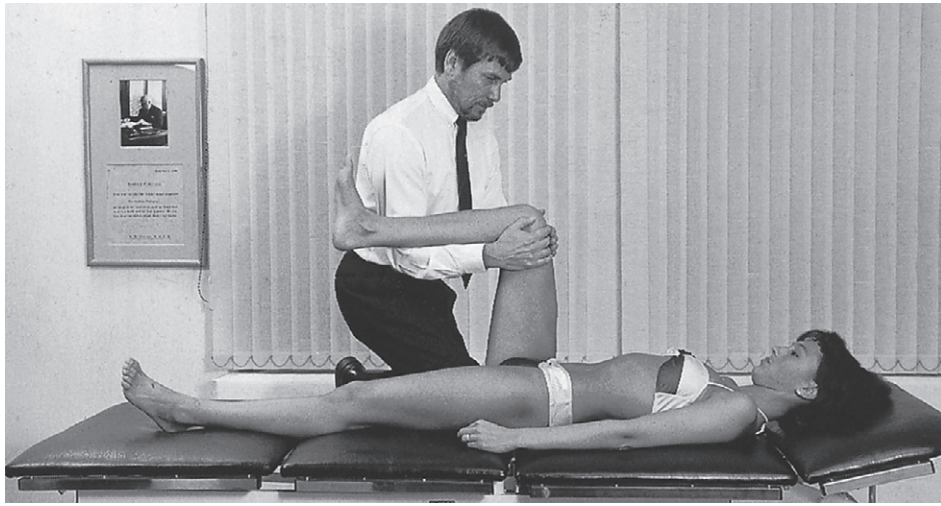


Fig 36.16 • Resisted flexion of the hip.

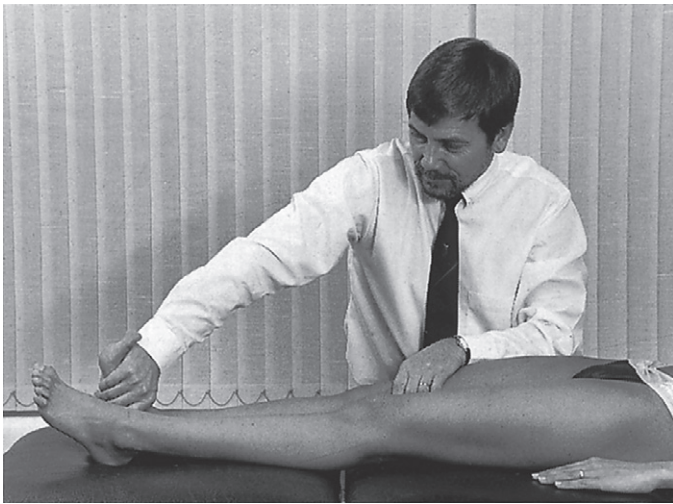


Fig 36.17 • Resisted dorsiflexion of the foot.



Fig 36.18 • Resisted dorsiflexion of the big toe.

Resisted eversion of the foot

This tests the L5 and S1 nerve roots. One hand stabilizes the ankle at the medial side, while the other hand is placed at the outer side of the forefoot. The patient is asked to resist the examiner's attempt to move the foot into dorsiflexion and inversion (Fig. 36.19). When weakness is present, the examiner needs to be aware of efforts to substitute the eversion movement by rotating the leg outwards at the hip.

It should be emphasized that, while these tests are being performed, the patient with normal motor nerve conduction will be able to resist the strongest power exerted by the examiner, except in dorsiflexion of the great toe, where the examiner will be stronger.

Tests of sensory conduction

These are performed next. The various areas are compared bilaterally at the same time (Fig. 36.20):

- Front of the thigh: L2.
- Front and inner side of the lower leg to just above the foot: L3.

- Big toe only: L4.
- Big toe and two adjacent toes: L5.
- Outer border of the foot, together with the two outer toes: S1.
- Sole of the heel: S2.

Disturbed sensory conduction in both legs is atypical in disc lesions but does occur in spondylolisthesis or neoplasm.

Knee reflex text

This may be diminished in lesions of the third lumbar root. Each knee is raised in turn with one hand and the ligamentum patellae struck with the reflex hammer (Fig. 36.21).

Testing the integrity of the spinal cord

The integrity of the spinal cord should be tested in all patients suspected of an upper motor neurone lesion. Clinical syndromes that suggest this are:

- Root palsy affecting more than one root, especially if this is bilateral.



Fig 36.19 • Resisted eversion of the foot.

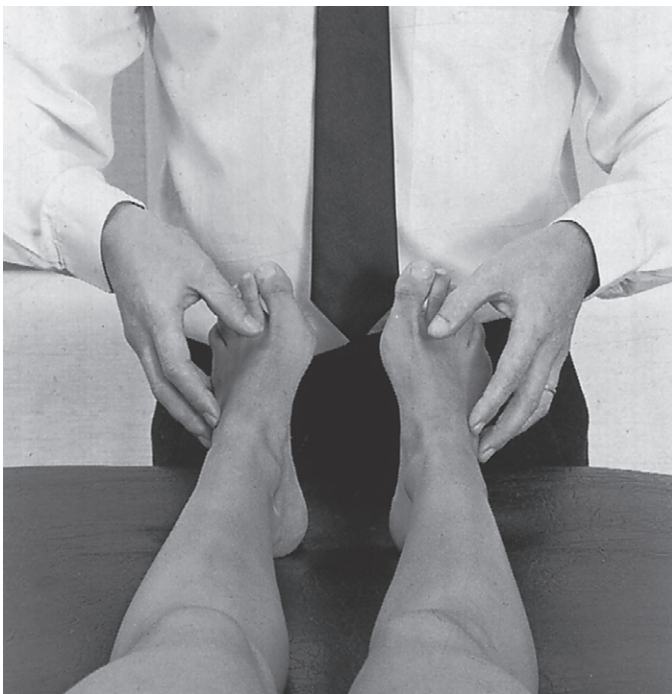


Fig 36.20 • Testing for sensory conduction.

- Backache in the upper lumbar area.
- Complaint of weakness in both legs.
- Paraesthesia in both feet.
- Backache with a spastic gait.

The reverse end of the reflex hammer is run firmly over the plantar surface of the foot from the calcaneus along the lateral

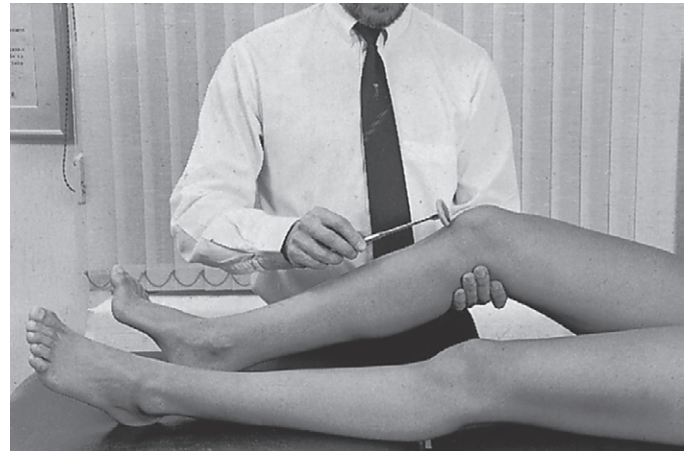


Fig 36.21 • Knee reflex test.

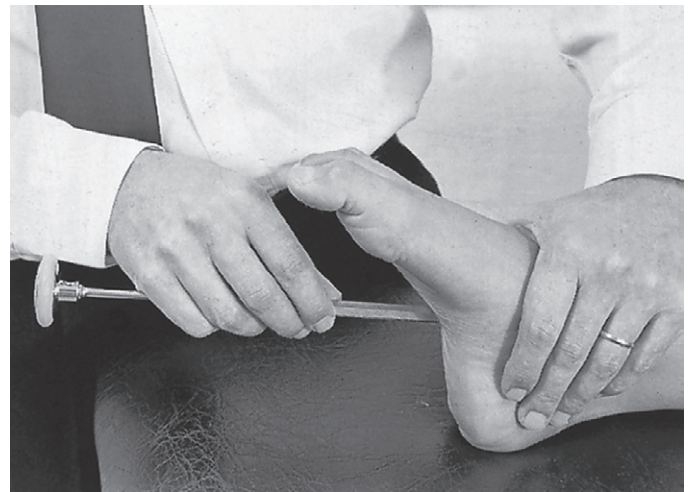


Fig 36.22 • Testing for Babinski's sign.

border to the forefoot, ending at the ball of the great toe (Fig. 36.22). In a positive reaction the great toe extends, while the other toes plantarflex and splay (positive Babinski's sign).

In a negative reaction the toes either do not move at all or flex uniformly (negative Babinski's sign).



Warning

Supine

- A positive sacroiliac distraction test
- Acute lumbago without any dural signs
- Buttock sign
- Discrepancy between trunk flexion and straight leg raise
- Signs of interference with conduction of more than one root
- L2 root palsy
- Bilateral nerve root palsy
- Complete paralysis
- A significantly warmer foot on the affected side

Examination of the circulation

This is optional and depends on the history and findings at inspection.

If intermittent claudication is suspected, the pulses of the femoral, posterior tibial and dorsalis pedis arteries should be felt (Fig. 36.23). If the pulse is diminished or absent at the femoral artery, the diagnosis is almost a certainty. Absence of a pulse at the ankle often exists without any vascular disorder.

In cases of claudication of the buttock, the internal iliac artery may be blocked on its own and the pulse of the femoral artery is normal (see Section 12).

Oedema in one foot is suggestive of venous thrombosis.

Local heat is found in patients with inflamed varices and in osteitis deformans of the tibia dorsalis. Neoplasm at the upper two lumbar levels may interfere with the sympathetic nerves; if so, the foot on the affected side is significantly warmer than the other.

Examination in the prone-lying position

This starts with the ankle reflex test.

Ankle reflex test

The foot is raised with one hand. Then all the slack of the plantiflexors is taken up by the little finger pushing the foot into dorsiflexion, before striking the Achilles tendon (Fig. 36.24).

This reflex is diminished or absent unilaterally in fifth lumbar and first or second sacral root palsy. It is well known that, once lost, this reflex does not return in about half the cases. Hence, in a new attack of lumbago, the absence of the ankle jerk does not confirm recently impaired root conduction.

Absence of the reflex on both sides may have no significance but is one of the findings in tabes dorsalis, malignant disease and spondylolisthesis, when the emerging nerve roots are involved bilaterally.

Passive knee flexion

Next, passive knee flexion is performed to test the mobility of the third lumbar root (Fig. 36.25).³⁸

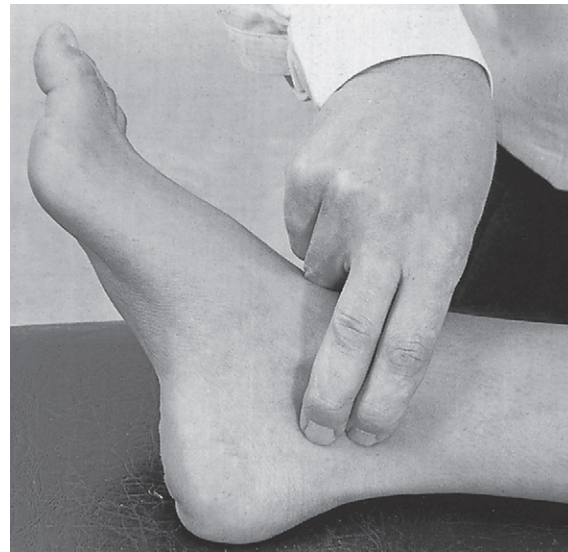
In posterolateral disc protrusions at this level, flexion of the knee is painful at its extreme and occasionally limited in range. Pain is felt in the back and/or the anterior part of the upper leg, depending on whether the test provokes a discodural or a discoradicular interaction. Wasserman described the manoeuvre in 1918. It was performed in soldiers with anterior thigh and leg pain where the SLR test was negative.³⁹

A false-positive femoral stretch test has also been reported in osteoarthritic hip joints, diabetic neuropathy, anticoagulant medication, retroperitoneal haemorrhage and ruptured aortic aneurysm.^{40,41}

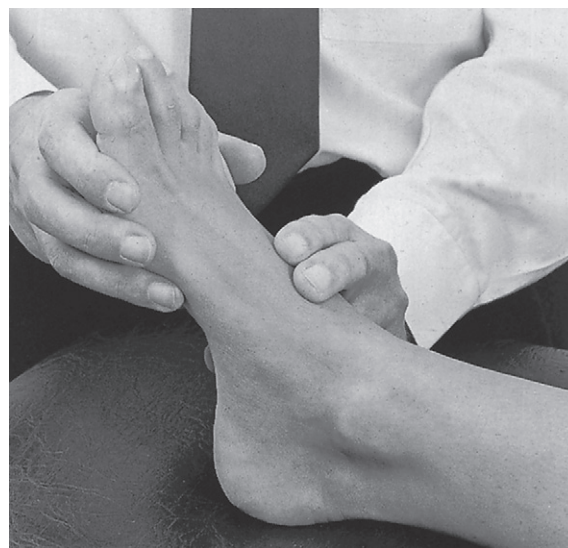
Tightness of the rectus femoris may also influence this movement. The patient experiences anterior thigh pain, which



(a)



(b)



(c)

Fig 36.23 • Feeling the pulses of (a) femoral, (b) posterior tibial and (c) dorsalis pedis arteries.

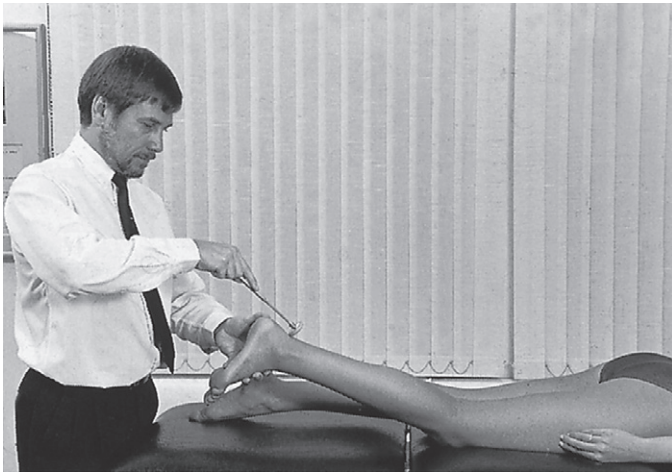


Fig 36.24 • Ankle reflex test.

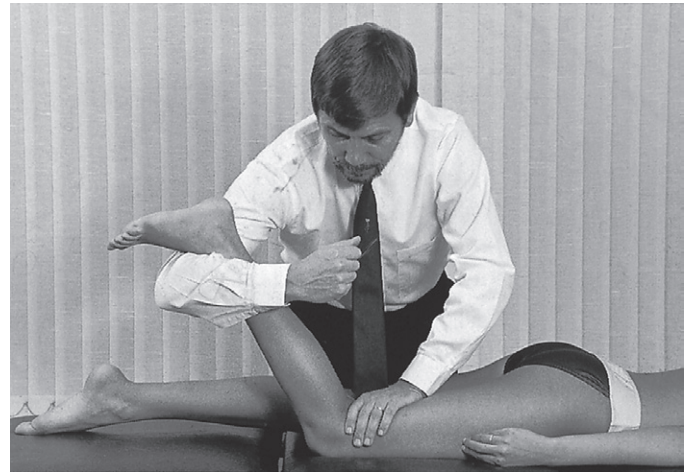


Fig 36.26 • Resisted extension of the knee.

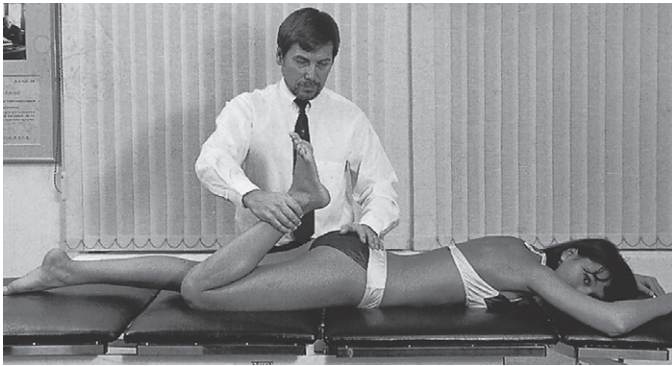


Fig 36.25 • Passive knee flexion.

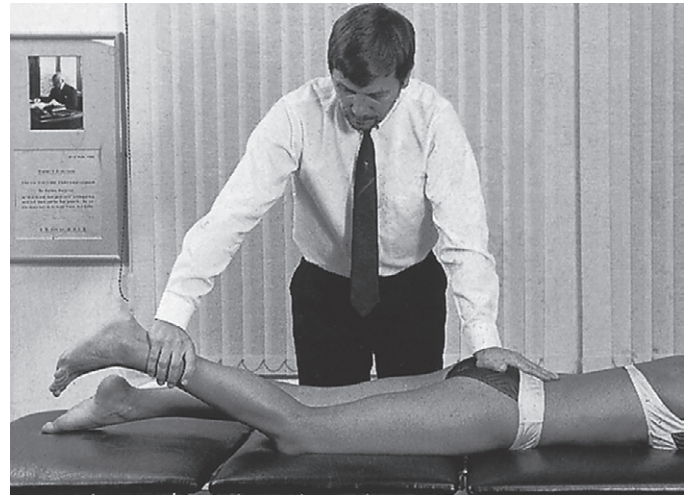


Fig 36.27 • Resisted flexion of the knee.

must be differentiated from the painful reaction in an L3 nerve root entrapment. If the non-painful side is flexed, the degree of pain and limitation can be compared and in this way distinguished from the defensive reflex muscle spasm in an L3 root involvement.

During this test, the pull of the rectus femoris on the anterior inferior spine of the ilium forces the lumbar spine into extension, which may also provoke lower lumbar pain.

Crossed femoral stretching test

This test is considered positive when flexion of the knee on the asymptomatic side reproduces the symptoms on the affected side. It is hypothesized to be a valid manoeuvre to assist in the diagnosis of symptomatic disc herniation.⁴² However, it is a far less constant sign, and in most third lumbar root lesions stretching is painful but not limited.

Testing motor conduction

There are three tests in the prone-lying position.

Resisted extension of the knee

This tests the L3 nerve root. The examiner tries to resist attempted extension with his or her flexed elbow, at the same time fixing the upper leg strongly just above the knee

(Fig. 36.26). The normal patient is stronger than the examiner. Gross weakness goes together with weakness of the psoas, which is partly supplied by the same nerve root. If weakness is bilateral, spinal neoplasm or myopathy should be suspected.

Painful weakness indicates partial rupture of the quadriceps and, in more obvious instances, a fractured patella.

Resisted flexion of the knee

This tests the S1 and S2 nerve roots. The examiner resists attempted flexion at the same time as stabilizing the pelvis (Fig. 36.27). Normally, the examiner is *just* stronger than the patient. Weakness indicates a lesion of the first or second sacral root.

Painful weakness indicates partial rupture of one of the hamstrings.

Testing the buttock muscles

The S1 and S2 nerve roots are tested by asking the patient to contract the buttocks strongly (Fig. 36.28). Weakness is

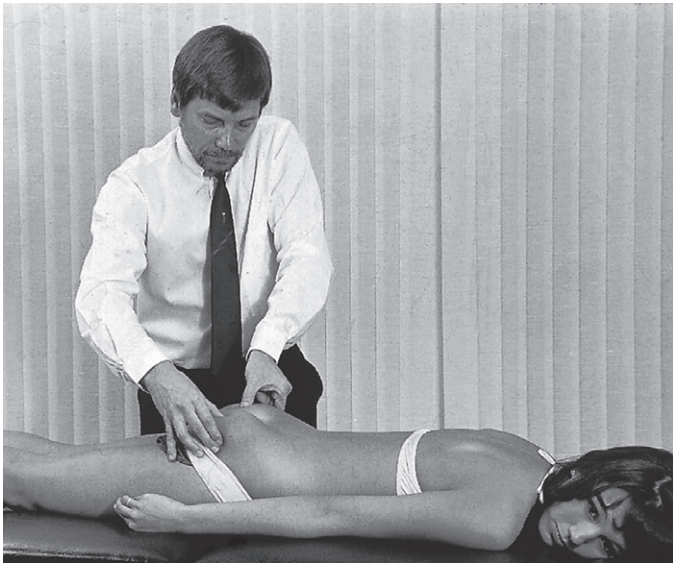


Fig 36.28 • Testing the buttock muscles.

demonstrated by decreased prominence on the affected side and loss of tone on palpation.

Palpation

To detect irregularities of the lumbar spinous processes

The index and middle fingers run quickly down the spine feeling for any *abnormal projections* (Fig. 36.29). If one is found, it may indicate wedging of a vertebral body or complete loss of two adjacent disc spaces. It should also prompt suspicion of bone erosion of a vertebral body (osteoporosis, tuberculous caries, secondary deposit or an old fracture), which requires radiography.

The finding of a *shelf*, most often at the interspace of L4–L5, or loss of a shelf palpable on examination in the standing position, indicates spondylolisthesis.

Pressure towards extension

Next a series of pressures towards extension are exerted to detect the level of the lesion. Starting at the sacrum, each lumbar segment is 'sprung' in turn, and it should be noted at which level pain and muscle guarding are most provoked (Fig. 36.30).

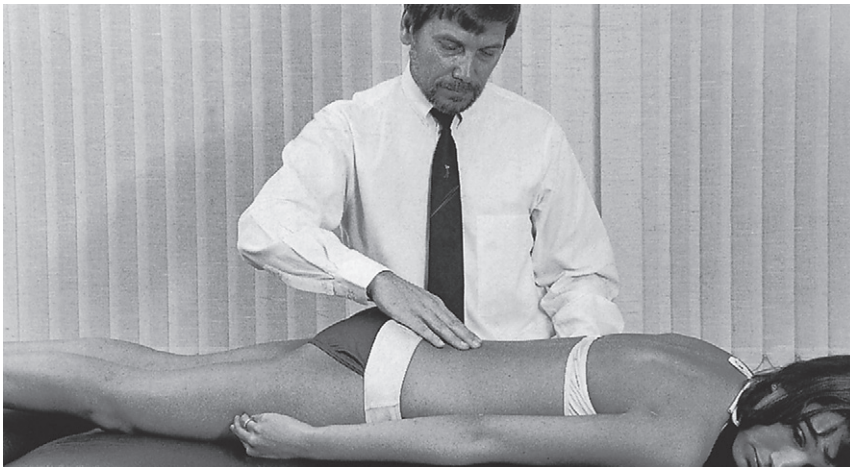


Fig 36.29 • Palpation for irregularities of the spinous processes.

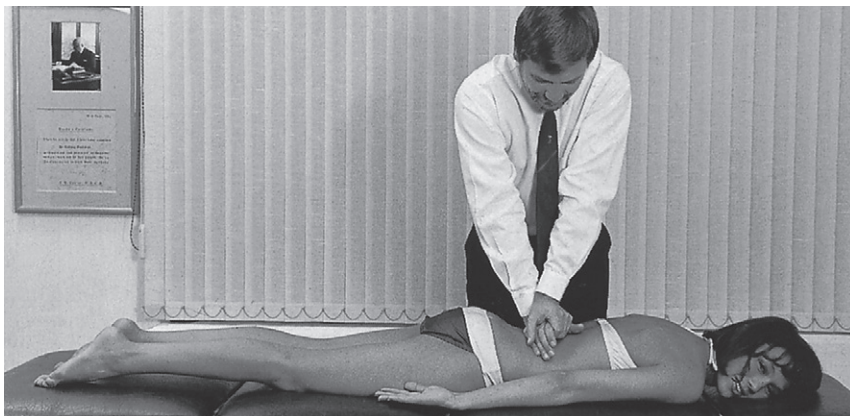


Fig 36.30 • Pressures towards extension.

In mechanical disorders, the expectation is that the painful level is in the *lower* lumbar area. If the *upper* lumbar area is the site of pain, the clinician must be on the alert. Serious disease is to be expected and further examination is indicated.

The test also serves to check the end-feel. In the young, the end-feel should be elastic, whereas in elderly persons it is hard because of spondylosis.

A hard end-feel in patients under 40 years old suggests ankylosing spondylitis.

Functional examination and palpation are summarized in Table 36.3.



Warning

Prone-lying

- An abnormal projection of one of the spinous processes.
- Pain and muscle guarding provoked by pressure towards extension in the upper lumbar area.
- A hard end-feel in patients under 40.

Accessory tests

Finally, the history will sometimes lead to the performance of resisted movements. These are particularly desirable when:

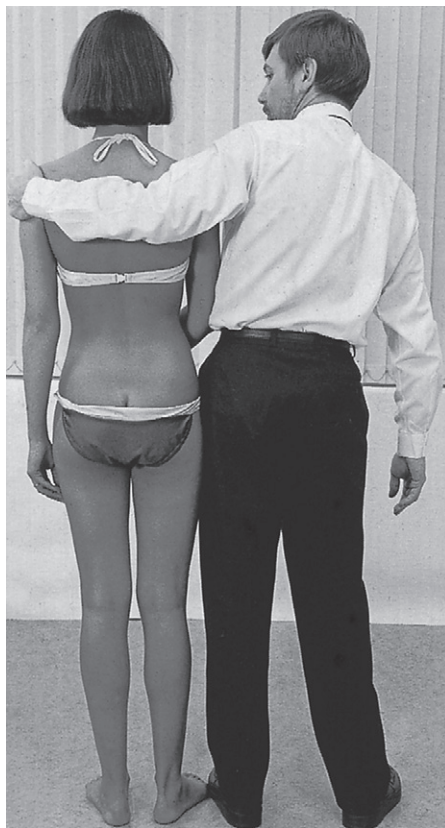
- *A fracture of the last rib or a transverse process is suspected:* local pain following unilateral injury to the lumbar spine. Pain is generated on side flexion away and resisted side flexion towards the painful site. Radiography confirms the diagnosis.
- *A muscle sprain is suspected:* at the lumbar region this scarcely ever occurs. It is only the combination of painful resisted extension with painless passive extension that directs attention to the muscle. However, in some (acute) disc lesions, resisted movements may also provoke pain because of increased compression of the joint.
- *The patient is suspected of psychogenic symptoms:* pain that is provoked by resisted movements is likely to occur here, because these patients tend to equate effort with pain.

Three resisted movements can be performed: (Fig. 36.31).

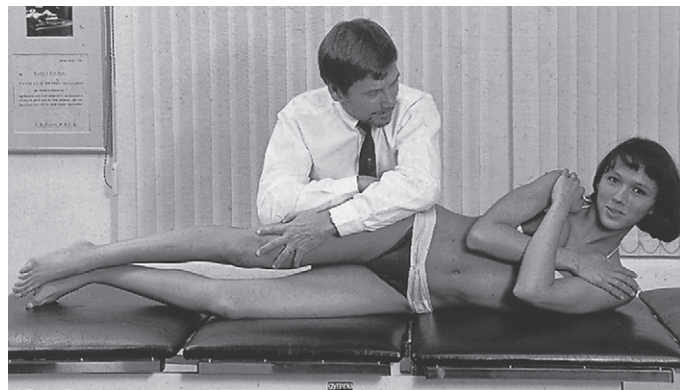
- Prone lying: resisted extension
- Standing: resisted side flexion.
- Side lying: resisted side flexion.

Trunk extension in the prone position is resisted by placing one hand on the upper thorax posteriorly, the other on the back of the knees.

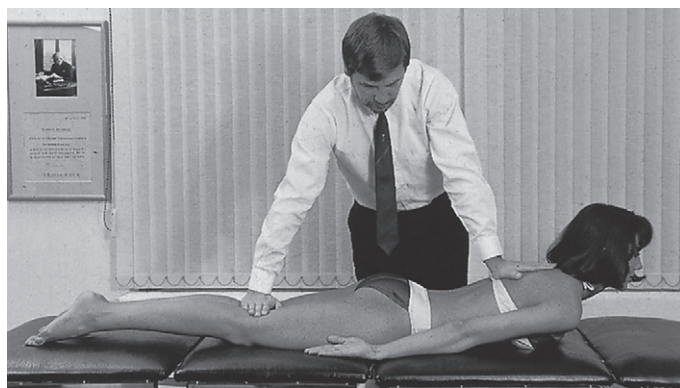
On resisted side flexion with the patient standing, the examiner opposes the movement by applying his hip to the patient's, grasping the latter's far shoulder. Then the patient is asked to bend away from the examiner.



(a)



(b)



(c)

Fig 36.31 • Accessory tests: resisted side flexion (a), (b); resisted trunk extension (c).

Table 36.3 Summary of functional examination and palpation

	Test	Testing
Standing		
Inspection	Deviation	In the sagittal plane In the frontal plane (6 types)
	Pain	Level Side
	Irregularities	Bone Skin Muscle
Lumbar movements	Extension	Range, pain, painful arc, deviation
	Side flexion	Range, pain, painful arc, deviation
	Flexion (+ neck flexion)	Range, pain, painful arc, deviation
Motor conduction	Standing on tiptoe	S1 and S2
Supine		
Sacroiliac joint	Distraction	Inflammation of sacroiliac joint
Hip joint	Flexion	Lesions of the hip joint and buttock
	External rotation	Lesions of the hip joint and buttock
	Internal rotation	Lesions of the hip joint and buttock
Mobility of dura mater and nerve roots L4–S2	Straight leg raising	Range
		Pain
		Painful arc
		Crossed straight leg raising
		Neck flexion
		'Buttock sign'
Motor conduction	Resisted flexion of hip joint	L2 and L3
	Resisted dorsiflexion of foot	L4
	Resisted extension of big toe	L4 and L5
	Resisted eversion of foot	L5 and S1
Sensory conduction	Front of thigh	L2 and L3
	Front of thigh, inner side of lower leg	L3
	Big toe	L4
	Big toe and adjacent toes	L5
	Outer border of foot and two outer toes	S1
	Sole of heel	S2
Knee reflex	Patellar tendon	L3
Plantar reflex	Plantar surface of foot	Spinal cord
Ankle reflex	Achilles tendon	L5, S1 and S2
Prone		
Mobility of L3 nerve root	Passive flexion of knee	Range
		Pain
Motor conduction	Resisted extension of knee	L3
	Resisted flexion of knee	S1 and S2
	Contraction of buttock muscles	S1 and S2
Palpation	Lumbar spinous processes	Irregularities
Extension pressure	Sacrum and lumbar vertebrae	Pain
		End-feel

In the side-lying position, with the body weight now off the joint, the patient crosses the arms in front of the chest; the examiner steadies the patient's thighs during this movement. Then the patient is asked to lift the thorax just off the couch.

Epidural local anaesthesia

Cases are sometimes met in which neither the history nor the physical signs clearly indicate one particular lesion. Although examination will show that the symptoms arise from a mechanical disorder, it may be uncertain whether a disc lesion, a disorder of the posterior structures or a sacroiliac lesion is present. The use of local anaesthesia may then be helpful.

A weak solution of procaine can be introduced epidurally via the sacral route. The solution desensitizes the dura mater and the dural investments of the nerve roots. In a discodural or discoradicular interaction, the pain will cease for the duration of the anaesthesia. In addition, epidural local anaesthesia induced for diagnostic purposes may also yield permanent improvement (see p. 566).

Alternatively, if a disorder of the posterior lumbar elements (facet or ligaments) is probable, local anaesthesia of the suspected structure should be performed. Five minutes after infiltration, the patient is asked to undertake the movements that were previously painful. If these no longer cause distress, the correct area has clearly been chosen and the diagnosis is confirmed. The infiltration must be precise, however, as false inferences may be drawn, a fact that is especially true for infiltration of the facet joints. It has recently been shown that, when relatively large volumes are injected into the facet joint, some extravasation occurs through the thin anterior capsule into the epidural space.⁴³ Facet arthrography confirms that epidural extravasation of dye takes place when more than 2 mL is injected in the facet joint.⁴⁴ More than this amount of local anaesthetic injected into a facet joint may thus result in an unintentional epidural block.

Technical investigations

Plain lumbar radiography

Most observations made on plain radiographs are of little or no value.^{45,46} In particular, congenital anomalies, such as transitional vertebra, occult spina bifida and asymmetric facet orientation, are not clinically significant.⁴⁷

It has also been repeatedly shown that there is no relationship between clinical symptoms and radiological changes associated with degeneration.⁴⁸⁻⁵⁵ The poor diagnostic value of radiographs in patients with low back pain can also be appreciated from the observation that radiographs of the individual with symptoms remain unchanged over time, despite the fact that the symptoms come and go. Because radiographs do not show the position of cartilage, they are of no value in diagnosing current disc lesions either. Radiographs therefore remain a very poor method of indicating causes of past, present or future low back pain.⁵⁶

It is common practice to order routine radiographs to reduce the risk of missing serious disorders. The possibility is in fact slight, and one series of 68 000 spinal radiographs found only 1 in 2500 with serious disorders not suspected clinically.⁵⁷ In contrast, it should be remembered that serious disease does not always show up immediately on a radiograph – about 30% of the osseous mass of a bone must be destroyed before a lesion is radiologically evident⁵⁸ – so that too much reliance on radiographic appearances can give a false feeling of security. In the short term, it is wiser and safer to rely on the history and the clinical examination: if symptoms and signs warrant (i.e. warning signs are found), the patient should be assumed to have a serious disease and, rather than manipulative treatment being undertaken, specific tests should be performed.

A further deterrent in radiographic evaluation of the lumbar spine, and one that it is important to remember, is that it is the single largest source of gonadal irradiation.⁵⁹ The total gonadal dose from a five-view lumbar spine examination is 75 millirads in men and 382 millirads in women⁶⁰ – unnecessary.⁶¹ Oblique views are responsible for 65% of the irradiation dose.⁶² Hall⁶³ estimated that the gonadal dose in women, when only a three-view examination is made, is equal to the dose of plain radiographs of the chest performed daily over a period of 6 years.

Radiographic 'labels' may confuse or bias patients and should never be transmitted to them as statements of disease because there is no evident correlation between radiographic appearances and the actual complaints. To patients, a statement such as 'your back shows a marked degree of arthrosis' means that they are incurable.⁶⁴ It implies a back that is crumbling like mouldy cheese: the situation is definite, incurable and hopeless. The diagnosis of 'osteoarthrosis' condemns the sufferer, and many patients become deeply depressed when they hear that the back is 'worn out'. An anxious or overconcerned patient will then suffer more from the idea that the back is beyond redemption and that no proper treatment for 'osteoarthrosis' exists, than he or she might from the back pain that is experienced. Technical investigation has become a problem rather than an aid. The radiograph does not help the patient; rather it may increase disability.⁶⁵

Conclusion

Plain radiographs of the lumbar spine have a very limited value. They have a low specificity, require a high degree of gonadal irradiation in females, are relatively cost-ineffective⁶⁶ and carry a substantial risk of negative psychological repercussions in suggestible patients. The clinician should always be very careful and restrictive in using radiography. The results should be interpreted in the context of the normal ageing spine. A negative radiographic examination does not always exclude serious disease.

Other imaging studies

Ever since 1921, attempts have been made to increase the contrast in imaging between the various structures in the spine. Initially, gas was introduced into the subarachnoid space.⁶⁷ Next, positive contrast myelography with iodized oil solutions

was begun in 1922.⁶⁸ Gross toxic effects from this, including severe arachnoiditis and late meningeal disorders, led to the development of safer, water-soluble contrast agents.⁶⁹

From the early 1940s, lumbar discs have been injected with contrast material in order to detect disc degenerations and disc ruptures.⁷⁰ However, discography has always been controversial. In the past decade, several authorities have seriously questioned its use: it is painful, expensive and without diagnostic value⁷¹; the sensitivity, specificity and predictive value are not as good as in myelography, CT and magnetic resonance imaging (MRI)⁷²; and the risk of post-discography discitis is high.^{73,74} Discographic studies are therefore considered obsolete.^{75,76}

Recently, high-resolution CT and MRI have in many ways revolutionized the diagnosis of spinal disorders. These techniques not only visualize the bony anatomy and pathological features of the spine but also can confirm disc displacements or bony stenosis. They have therefore become the foundation of diagnostic imaging of the spine. Unfortunately, for a variety of reasons, the ability to visualize spinal disorders has not solved the diagnostic problems or the therapeutic dilemmas.

CT and MRI scans are highly sensitive but relatively unselective. In other words, these techniques have a very high prevalence of abnormal findings in images of asymptomatic individuals: postmortem studies show the existence of large, symptomless disc protrusions in almost 40% of cadavers⁷⁷; myelograms in asymptomatic patients show defects in 37%⁷⁸; and CT scans in subjects over 40 years of age show abnormality in more than 50%.⁷⁹ Numerous MRI studies have also demonstrated the high incidence of disc degeneration in asymptomatic patients.⁸⁰⁻⁸⁶ Although additional imaging techniques are strongly indicated for the evaluation of patients presenting with warning symptoms and signs suggestive of neoplastic or infectious disorders, they have only limited value in the diagnosis of mechanical disorders of the lumbar spine.⁸⁷ It cannot be stressed enough that excessive reliance on diagnostic studies without precise clinical correlation can lead to erroneous (and disastrous) treatment. Diagnosis of spinal disorders depends on a detailed history and physical examination, as does treatment. The increased tendency that has developed over recent years to recommend surgery in the presence of a positive CT scan is a major error. Given the high number of asymptomatic disc protrusions, many patients will go forward to an unnecessary operation. Boden puts it well when he states: 'To get a MRI scan to see *if there is anything wrong with the spine* is usually the beginning of a very dangerous process.'⁸⁸ The presence of a disc protrusion and its size are unimportant; it is the impact of the protrusion on the surrounding pain-sensitive structures that determines management. Imaging cannot usually distinguish symptomatic from asymptomatic disc herniation, since it is usually unable to detect the degree of

inflammation, the degree of pain or the functional impact on a nerve. Clinical examination can do so, provided it is intelligently interpreted.

Electrodiagnosis

The use of electromyography (EMG) was introduced 50 years ago.⁸⁹ Refinement of the technique, together with additional testing procedures (electrodiagnosis), now makes it possible to analyse and document nerve root dysfunction (level, degree and chronicity).⁹⁰ Though it is the only laboratory study that directly assesses the physiological integrity of the roots, the test will not be helpful in patients with so-called non-compressive radiculopathy⁹¹: the protrusion compresses only the dural nerve root sleeve and not the fibres.


Also, EMG examination is very time-dependent. Studies may be falsely negative if they are performed too early or too late in the course of sciatica. When it is done before sufficient fibrillation potentials have developed throughout the muscle, the result will be normal. This will also be the case in chronic radiculopathies, when muscles have been completely reinnervated.

In addition, the cause of the process leading to denervation cannot be determined. Furthermore, in severe compressive neuropathies, (serious) functional loss is easily detected during a proper clinical examination.

These factors mean that electrodiagnosis has very low specificity and sensitivity.⁹² This diagnostic technique is therefore not important in lumbar disorders, except when objective documentation of the physiological integrity of the lumbar roots is required, which is sometimes the case when there are medicolegal implications.

Conclusion

- Additional imaging modalities are highly sensitive and relatively unselective.
- There is a high prevalence of abnormal findings on images of asymptomatic individuals.
- CT and MRI techniques are extremely important in the evaluation of patients with symptoms and signs of non-mechanical (neoplastic or infectious) disorders.
- In mechanical lesions, excessive reliance on diagnostic studies without precise clinical correlation can lead to erroneous (surgical) treatment.

 Access the complete reference list online at www.orthopaedicmedicineonline.com

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