Spine

15

John O'Neill

Degenerative Disease of the Spine

Overview

Degenerative disc disease (DDD), intervertebral osteochondrosis, is one of the commonest causes of low back pain. Low back pain is a leading disability and may be related to multiple factors (Table 15.1). Predisposing factors include age, genetics, and axial loading. DDD may impact upon the adjacent nerves and be a source of symptoms. However, DDD may also cause low back pain from the release of cytokines and stimulate nociceptors. There may also be related facet joint disease. DDD is present in the majority of imaged middle-aged and older patients and may or may not be a source of symptoms, and close clinical correlation is required.

Table 15.1 Common etiologies of low back pain

Mechanical	Degenerative disc
	Degenerative joint disease
	Vertebral fracture
	Spondylosis
	Muscle strain
Neurogenic	Herniated disc
	Spinal stenosis
Rheumatologic	Inflammatory spondylitis
	DISH
	Fibromyalgia
Neoplastic/infiltrative	Benign/Malignant, metastatic
Infection	Spondylodiscitis
	Osteomyelitis
Referred visceral pain	AAA, pancreatitis
Miscellaneous	Depression
	Malingering

Clinical Presentation

Patients with DDD may be asymptomatic, have acute or chronic low back pain, or present with neurologic sequelae. Symptoms and clinical evaluation will help separate those with and without mechanical etiologies. LBP is a leading cause of disability and can be difficult to treat. Chronic LBP is present if symptoms last more than 3 months. Care should be taken to identify red flags, which require urgent investigation (Table 15.2).

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Imaging

Radiographs

Radiographs are limited in the assessment of DDD. Degenerative changes are common and nonspecific. Radiographs can be acquired in

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Table 15.2 Red flags in patients with back pain

Onset <20 or >55 years
Sphincter or gait disturbance
Saddle anesthesia
Severe or progressive motor loss
Widespread neurologic deficit
Previous carcinoma
Systemic unwellness
HIV
Weight loss
IV drug abuse
Steroids
Structural deformity

patients with red flags as the initial line of investigation to help localize pathology for a more detailed cross-sectional imaging study. Vertebral body number, height, and intervertebral disc space height should be assessed (Fig. 15.1). In DDD, there is a loss of intervertebral disc space height, associated reactive vertebral endplate sclerosis, and multidirectional endplate osteophytes. Vacuum phenomena are collections of gas, predominantly nitrogen, and occur in sites of negative pressure within the nucleus pulposus (Fig. 15.2). Vacuum phenomena are a good indicator of

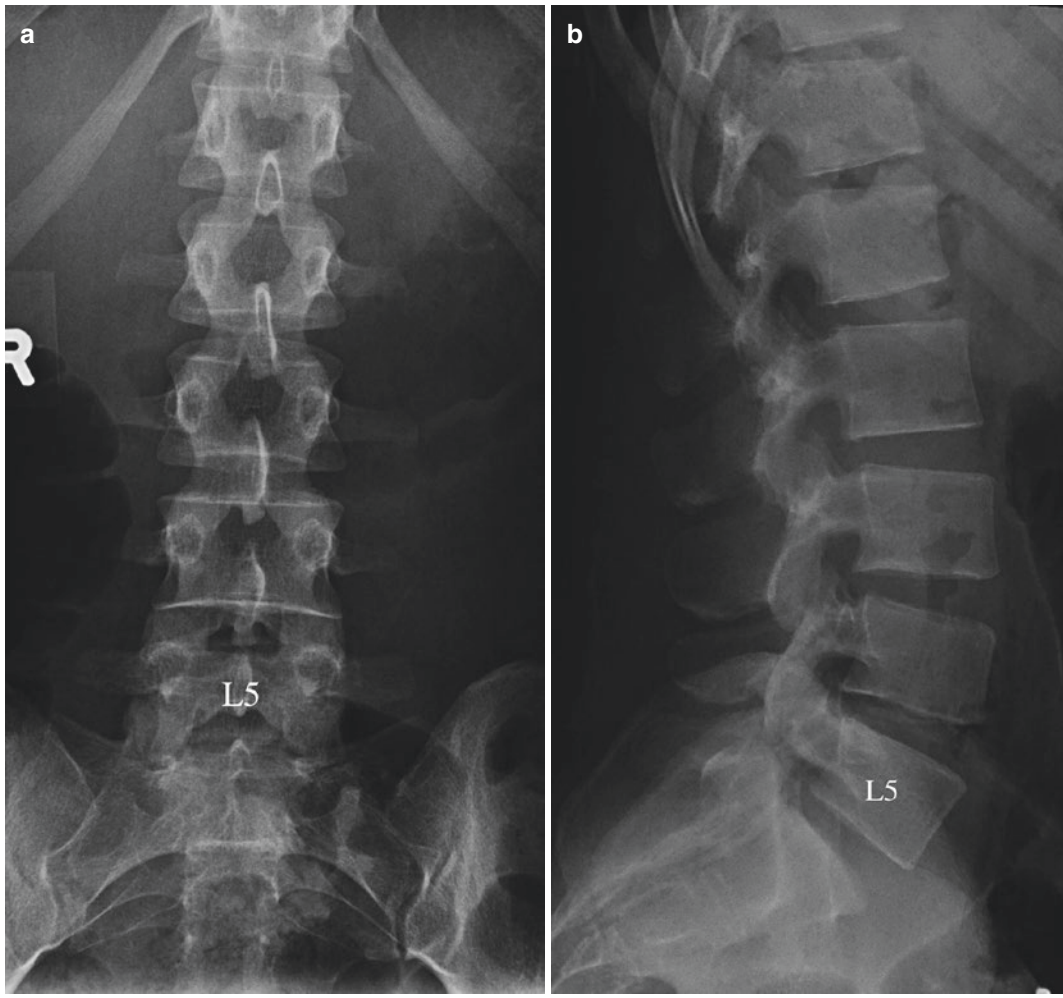


Fig. 15.1 Normal (**a**) AP and (**b**) lateral lumbar spine. *L5* indicates the fifth lumbar vertebra. Note the excellent demonstration of the sacroiliac joints on a well-positioned AP study

DDD and may be circular or linear in appearance. They increase in extension related to the increased distraction of the degenerative disc. Small foci confined to the annulus may occur in spondylosis deformans. In cases of endplate disruption such as Schmorl's nodes, gas may track into the vertebrae with a vertical branching pattern.

Cross-Sectional Imaging

We will adopt the accepted nomenclature from the combined taskforce developed to standardize description of discs (Table 15.3). This is a morphologically based definition and classification model.

MRI

MRI is the noninvasive gold imaging standard in the imaging of DDD with excellent anatomical detail, soft tissue contrast, and lack of radiation. MRI can assess the internal characteristic of the disc. The normal bright nucleus pulposus on T2 losses signal as it desiccates (Fig. 15.3). Vertebral body height, alignment, and disc space height are assessed. CT is more sensitive in the assessment of osteophytes, but MRI can demonstrate Modic endplate changes which, other than sclerosis, may not be visible on CT (Table 15.3). The high signal intensity of CSF on T2-weighted sequences allows for an excellent contrast with the intermediate to low signal intensity disc.

Facet joint degeneration includes joint space loss, and subchondral sclerosis can be readily assessed. Related osteophytosis may extend anteriorly and encroach upon the neuroforamina. With the loss of intervertebral disc height, the ligamentum flavum also decreases in height, is less stretched, and hence can form more mass effect upon the thecal sac (see Fig. 15.20c). In patients with prior disc surgery, intravenous contrast may be required to help differentiate recurrent disc disease from postoperative fibrosis. Postoperative residual disc may enhance up to 6 months postsurgery after which time only epidural fibrosis typically enhances (Fig. 15.8).

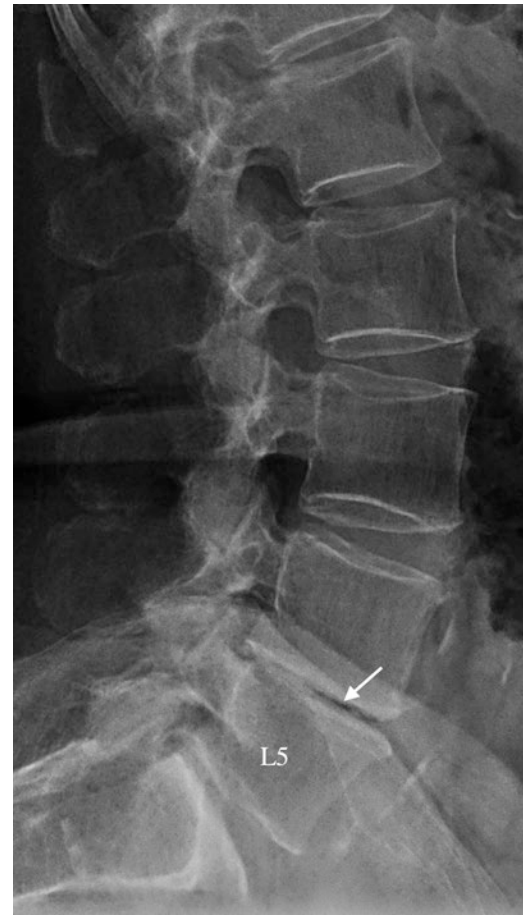


Fig. 15.2 Lateral radiograph lumbar spine in an 80-year-old female with L4–5 and L5–S1 degenerative disc disease demonstrating loss of intervertebral disc space height, vacuum phenomenon (*arrow* L4–5), minor endplate sclerosis, and minimal osteophytic lipping. Note moderate osteopenia

Table 15.3 Nomenclature and classification of lumbar disc pathology

Normal (Fig. 15.3)	Disc is fully and normally developed and free of disease, trauma, or aging
Annular tear/fissure (Fig. 15.4)	Loss integrity annulus, radial/transverse/concentric in shape
Degenerative disc	Aging and pathologic degenerative changes. Changes in a disc characterized by desiccation, fibrosis and cleft formation in the nucleus, fissuring and mucinous degeneration of the annulus, defects and sclerosis of endplates, and/or osteophytes at the vertebral apophyses
Degenerative disc disease	A clinical syndrome characterized by manifestations of disc degeneration and symptoms thought to be related to those changes
Herniated disc (Fig. 15.5)	Localized (less than 50 %/180°) of the circumference of the disc displacement of nucleus, cartilage, fragmented apophyseal bone, or fragmented annular tissue beyond the intervertebral disc space (disc space, interspace). The interspace is defined, cranial and caudal, by the vertebral body endplates and, peripherally, by the edges of the vertebral ring apophyses, exclusive of osteophytic formations
Chronic disc herniation	Disc herniation with the presence of calcification, ossification, or gas accumulation within the displaced disc material, suggesting that the herniation is not of recent origin
Protrusion (Fig. 15.6)	A disc is "protruded," if the greatest distance, in any plane, between the edges of the disc material beyond the disc space is less than the distance between the edges of the base in the same plane. The term "protrusion" is only appropriate in describing herniated disc material. Protrusions with a base less than 25 % (90°) of the circumference of the disc are "focal." If disc material is herniated so that the protrusion encompasses 25–50 % of the circumference of the disc, it is considered "broad-based protrusion"
Extruded disc (Fig. 15.7)	A herniated disc in which, in at least one plane, any one distance between the edges of the disc material beyond the disc space is greater than the distance between the edges of the base in the same plane, or when no continuity exists between the disc material beyond the disc space and that within the disc space. Extruded discs in which all continuity with the disc of origin is lost may be further characterized as *sequestrated*. Disc material displaced away from the site of extrusion may be characterized as *migrated*
Bulging disc	A disc in which the contour of the outer annulus extends, or appears to extend, in the horizontal (axial) plane beyond the edges of the disc space, over greater than 50 % (180°) of the circumference of the disc and usually less than 3 mm beyond the edges of the vertebral body apophyses. This is not a form of herniation
Radial annular tear/ fissure (Fig. 15.4)	Disruption of annular fibers extending from the nucleus outward toward the periphery of the annulus, usually in the vertical (craniocaudal) plane, with occasional horizontal (transverse) components
Spondylosis deformans	Degenerative process of the spine involving essentially the annulus fibrosus and characterized by anterior and lateral marginal osteophytes arising from the vertebral body apophyses, while the intervertebral disc height is normal or only slightly decreased
Modic changes	Reactive vertebral body modifications associated with disc inflammation and degenerative disc disease, as seen on MR images. Type 1 refers to decreased signal intensity on T1-weighted/increased signal intensity on T2-weighted images, indicating bone marrow edema associated with acute or subacute inflammatory changes. Types 2 and 3 indicate chronic changes. Type 2 refers to increased signal intensity on T1-weighted images/ isointense or increased signal intensity on T2-weighted images, indicating replacement of the normal bone marrow by fat. Type 3 refers to decreased signal intensity on both T1- and T2-weighted images, indicating reactive osteosclerosis

Adapted with permission from Lippincott Williams and Wilkins/Wolters Kluwer Health: *Spine* 2001, 26:E93–113, Fardon, DF, et al, Nomenclature and classification of lumbar disc pathology. Recommendations of the Combined task Forces of the North American Spine Society, American Society of Spine Radiology, and American Society of Neuroradiology, copyright 2001

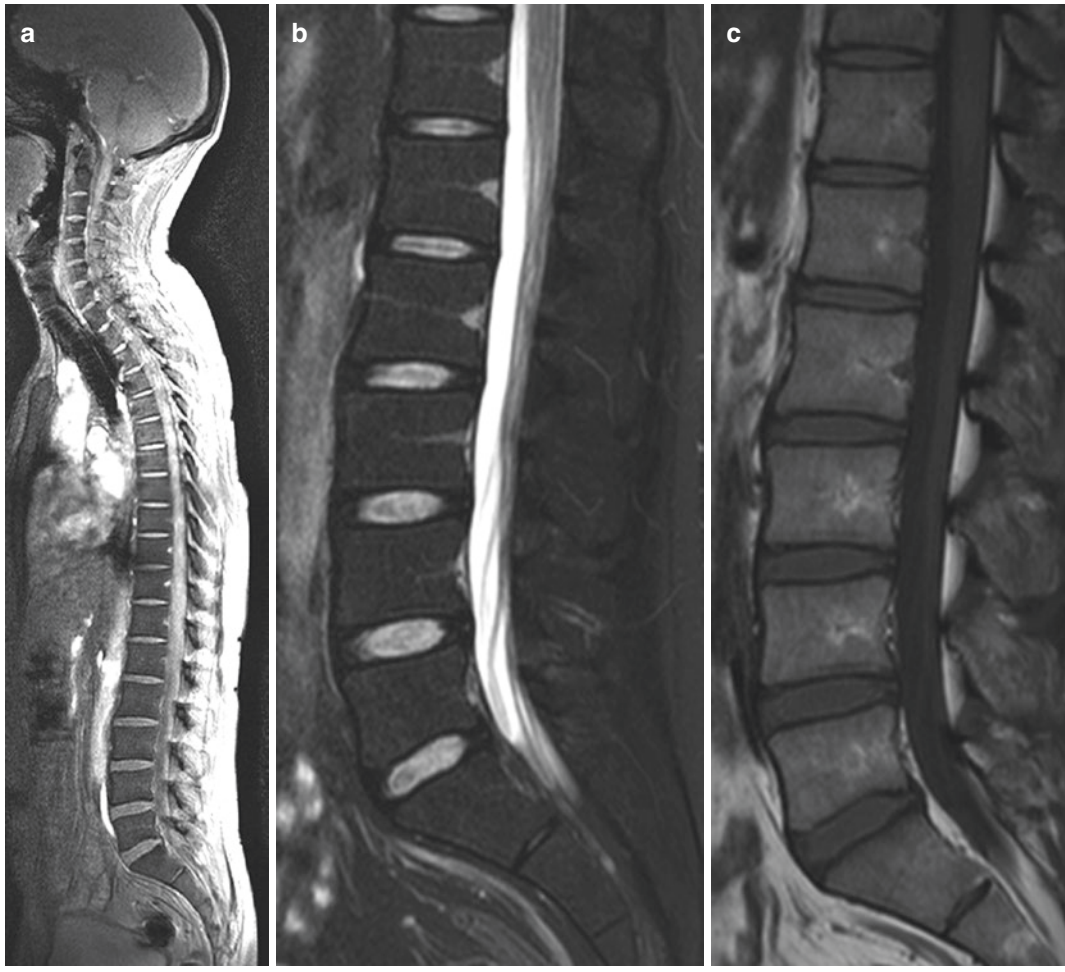


Fig. 15.3 Normal MRI lumbar spine: (**a**) localizer midsagittal image allows for correct counting lumbar vertebrae, (**b**) Sag T2FS demonstrating uniform fat-suppressed marrow SI, central high and peripheral low SI disc and high SI CSF, (**c**) Sag T1 normal morrow SI, low SI CSF, (**d**) Sag T1 through neural foramina demonstrating exciting neural roots and perineural fat, (**e**) axial T2FS at disc level demonstrating the thecal sac with high SI CSF and low SI *dots* representing the cauda equina/nerve roots, and (**f**) inferior to (**e**) at level lateral recesses (*arrows*)

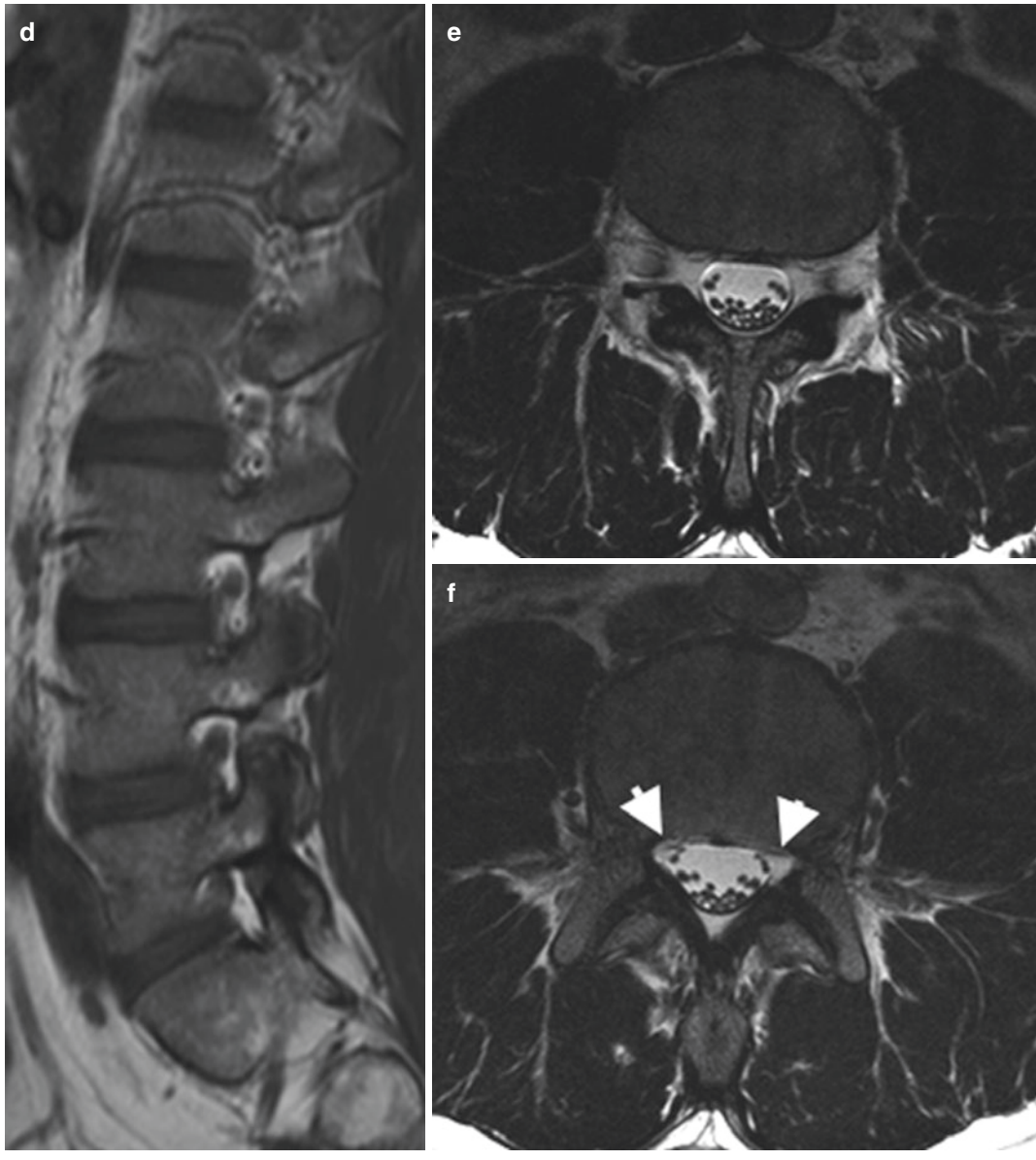


Fig. 15.3 (continued)

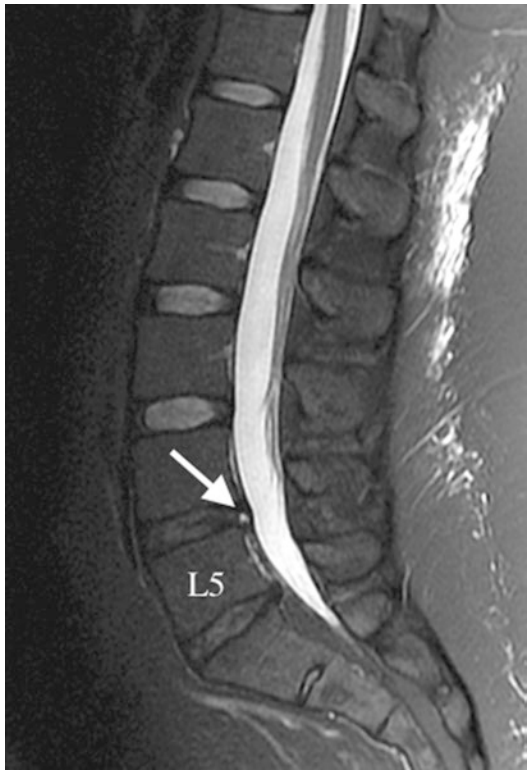


Fig. 15.4 Annular tear shown as a high signal intensity zone (*arrow*) in posterior L4–5 degenerative disc (loss normal signal intensity and height, also present at L5–S1) in a 31 F on midsagittal T2FS

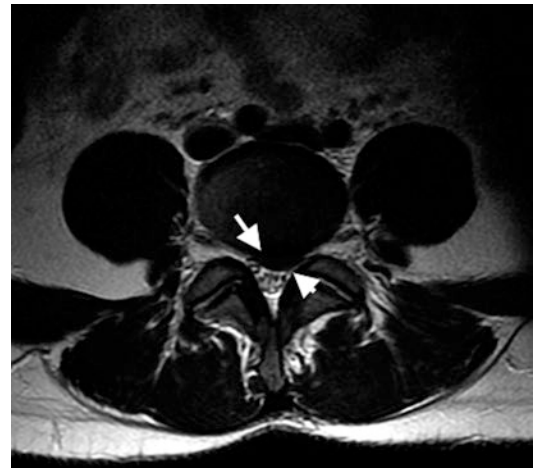


Fig. 15.6 Axial T2FS at L4–5 demonstrating a focal protrusion, base disc herniation wider than AP extension and involving less than 25 % disc circumference, indenting the thecal sac, impinging the left L5 nerve root (*arrowhead*), and abutting without impinging the right L5 nerve root

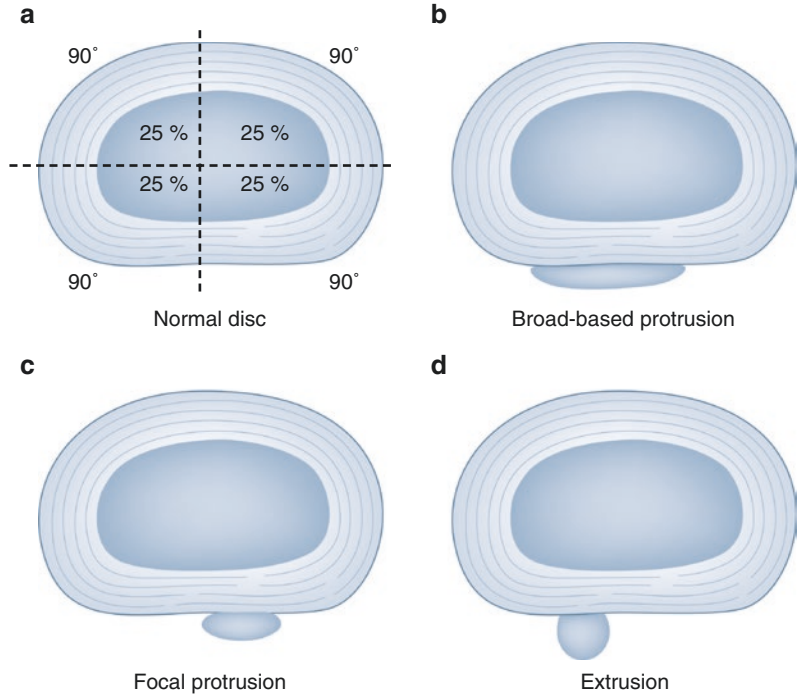


Fig. 15.5 Illustration herniated disc types: (**a**) normal disc divided into four quadrants, (**b**) broad-based protrusion with >25 % disc circumference involved, (**c**) focal protrusion involving less than 25 % disc circumference, and (**d**) extruded disc

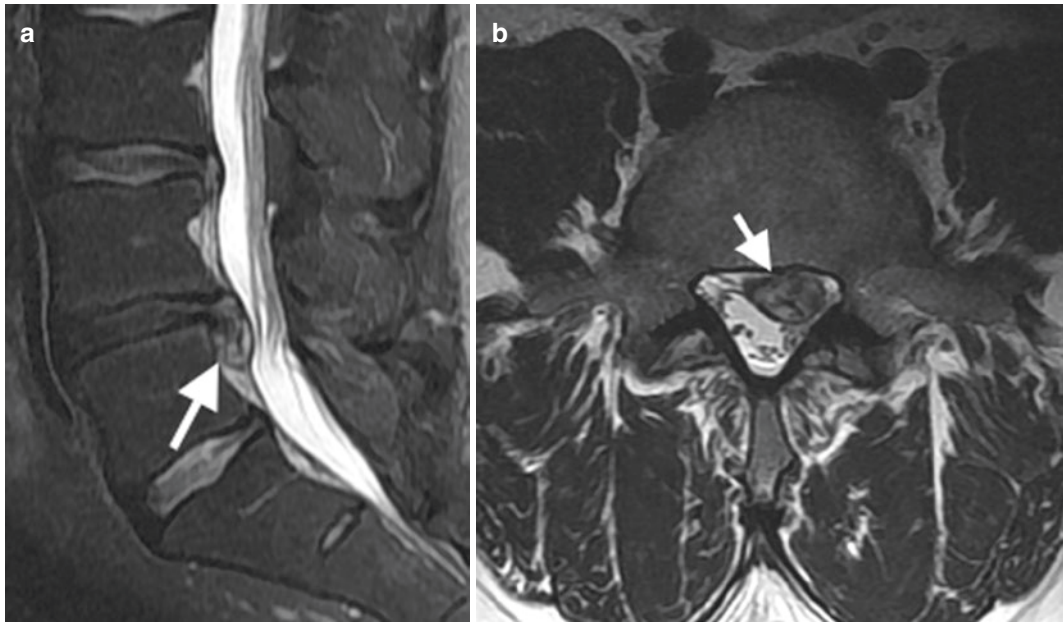


Fig. 15.7 Extruded disc (*arrow*) with inferior migration, without sequestration, at L4–5 extending into the left lateral recess and impinging the left L5 and upper sacral nerve roots (**a**) Sag and (**b**) axial T2FS

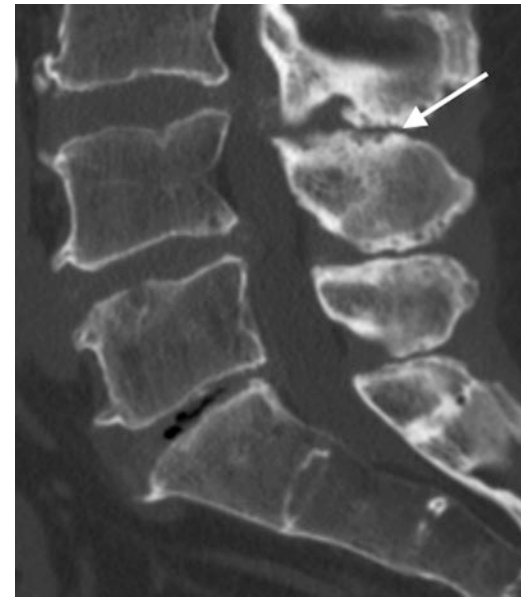


Fig. 15.8 Degenerative disc disease on reformatted Sag CT, bone windows, demonstrating loss of disc height, vacuum phenomenon, minor endplate osteophytosis L5–S1. Less pronounced degeneration at L4–5. Note imaging features of Baastrup disease, contacting adjacent spinous processes demonstrating cortical irregularity and sclerosis (*arrow*)

CT

CT assessment of DDD, particularly of the lumbar spine, is decreasing due to the radiation dose related to CT, increased availability, and higher soft tissue resolution of MRI. CT is not indicated in the assessment of cervical or thoracic DDD due to the limited resolution of the intervertebral disc in these regions unless MRI is unavailable or contraindicated. CT is acquired axially through the intervertebral disc, and alignment can be adjusted for variable lumbar lordosis. Images can then be reformatted in axial and saggital planes and occasionally in the coronal plane.

Intervertebral disc space height, vacuum phenomena, vertebral endplate osteophytes, erosions, and sclerosis are assessed (Fig. 15.9). Disc irregularity, disc bulge, and herniation, as defined in Table 15.3, are assessed in axial and saggital planes. In chronic disc herniation, vacuum phenomena may be presented in the herniated disc. Neuroforaminal/spinal canal narrowing or stenosis can be readily assessed. Saggital images are optimal for assessing the neuroforamina. Neural abutment, disc touches nerve, or impingement, disc adjusts the normal course of the nerve, should be noted. Imaging studies are acquired with the patient in a supine position; however, some changes, such as neural abutment, may only become evident in the erect or flexed positions. DDD is not assessed as a single entity, and associated degenerative changes of the facet joints, ligamentum flavum, and congenital abnormalities such as congenital canal stenosis are reviewed to form a comprehensive assessment of pathology.

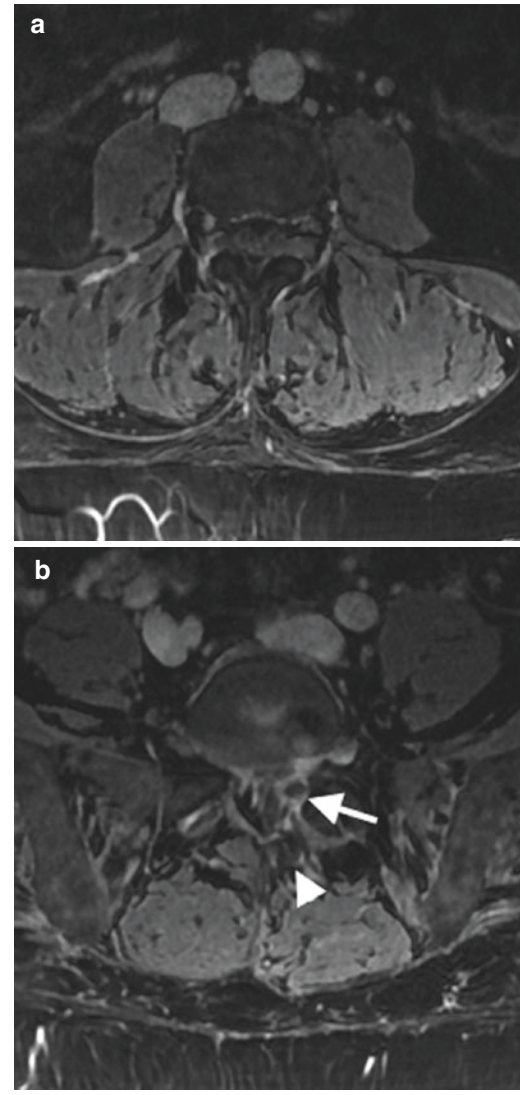


Fig. 15.9 Axial T1FS images (**a**) pre- and (**b**) post contrast demonstrating enhancing soft tissue (*arrow*) surrounding an enlarged left S1 nerve root in keeping with epidural fibrosis in a 58-year-old male patient 1-year post left L5 laminectomy (*arrowhead*)

Ultrasound

Ultrasound currently has no role in the assessment degenerative disc disease.

Nuclear Medicine

Nuclear medicine has a limited role. It may be useful as a skeletal assessment in patients with history of carcinoma in the assessment of metastatic disease.

Cervical and Thoracic Degenerative Disc Disease

The cervical spine has the greatest range of motion and is the second commonest spinal site of DDD after the lumbar spine, usually occuring at the C5–6 and C6–7 levels (Fig. 15.10). In the cervical spine, exiting nerve roots are one level above their disc level, i.e., C6 nerve exits at C5–6. This continues to C8, below which nerves exit below disc level, i.e., L4 exits at L4–5. Uncovertebral joints, joints of Luschka, are present only within the posterolateral aspects of the five lowermost cervical vertebrae. Osteophytes related to degeneration of these joints extend posteriorly into the cervical spinal canal and posterolaterally into the neuroforamina. These joints are best appreciated on the frontal and oblique radiographs of the cervical spine (Fig. 15.11).

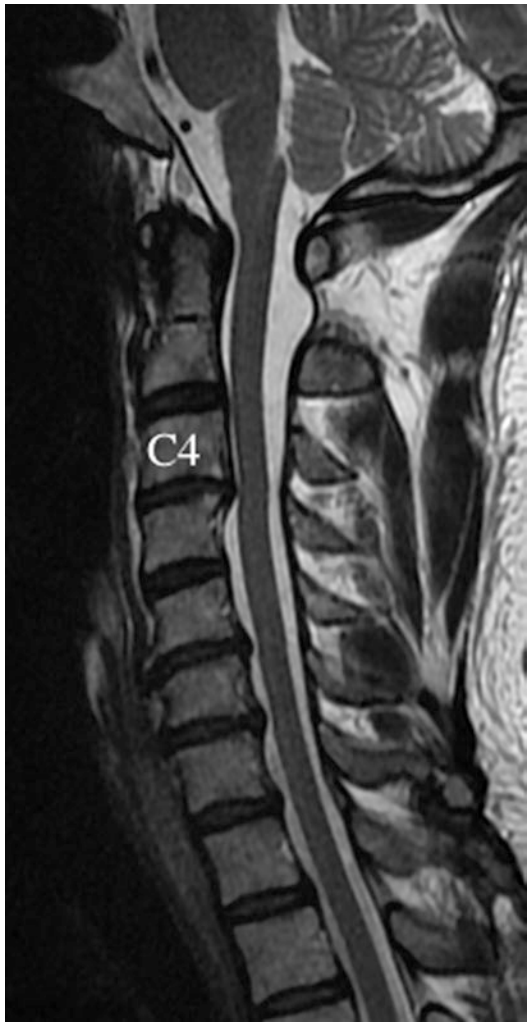


Fig. 15.10 Sag T2FS MRI cervical spine with multilevel mild degenerative disc disease

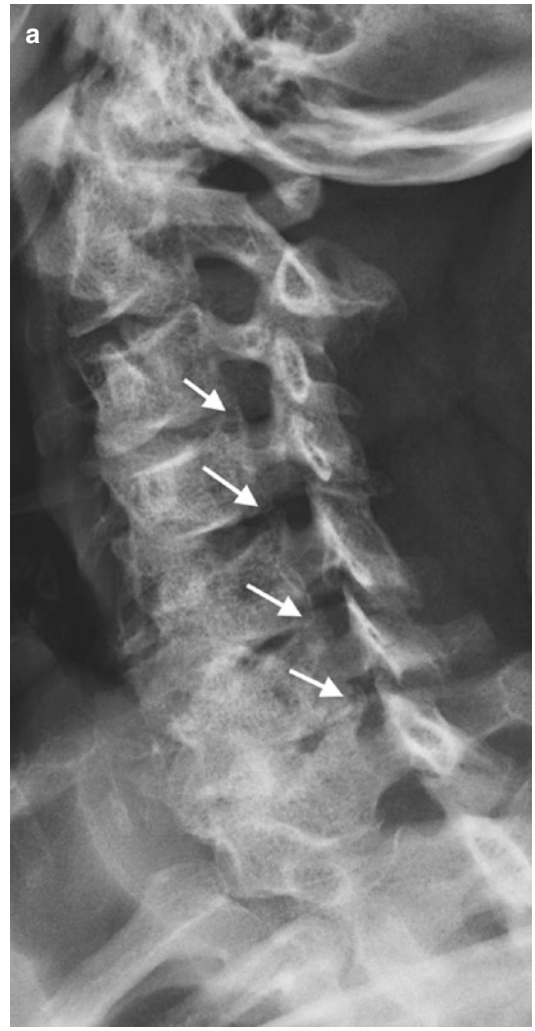


Fig. 15.11 Oblique radiographs cervical spine demonstrating (**a**) left neural foramina with mild to moderate stenosis, gradual worsening as one extending inferiorly, secondary to uncovertebral and degenerative disc disease with loss of height and endplate osteophytes (*arrows*) and (**b**) normal left oblique for comparison

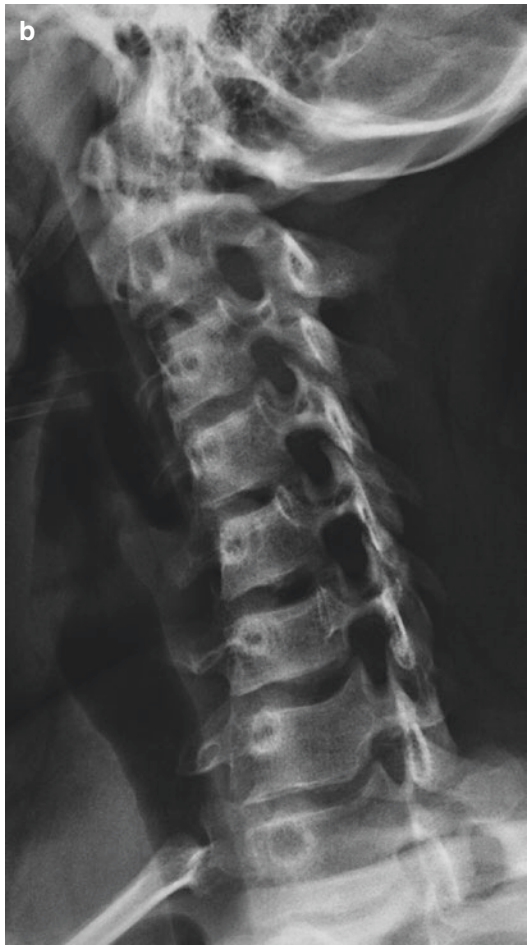


Fig. 15.11 (continued)

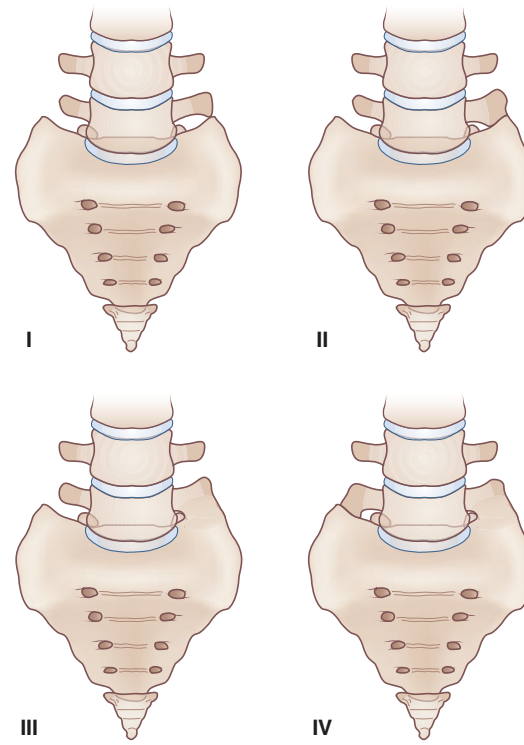


Fig. 15.12 Illustration of Castellvi classification lumbosacral transitional vertebrae (types 1–3 may be unilateral or bilateral)

It is common to find uncovertebral degeneration at the same level as DDD.

The thoracic spine is least involved by DDD due to limited range of motion and ribcage support.

Transitional Vertebra

Transitional vertebrae at the lumbosacral junction are a common congenital anomaly (Figs. 15.12 and 15.13). The upper sacral segment can become lumbarized, and likewise the lowermost lumbar segment can become sacralized. They may be associated with LBP, Bertolotti syndrome (Fig. 15.14). Symptoms are more common in Castellvi types 2 and 4 (Table 15.4).

In sacralization of the lowermost lumbar vertebrae, an elongated unilateral or bilateral transverse process is present which may or may not articulate with the sacrum or occasionally the ilium. This joint may also be fused. There is increased degenerative changes noted in the opposite facet joint and increased risk of DDD at the level above due to decreased range of motion at the level below. In the case of lumbarization of S1, the S1 vertebra is more square in appearance, and there may be a fully formed disc and usually has facet joints instead of the normal fusion at S1–2. Identification of transitional vertebrae is important particularly in surgical patients so correct nomenclature is employed and surgery is performed at the correct level. CT is more sensitive in identifying transitional vertebrae due to wider field of view and ability to differentiate hypoplastic 12th ribs from prominent transverse processes. Identification of the iliolumbar ligament arises from the transverse process of L5 and is a useful landmark.

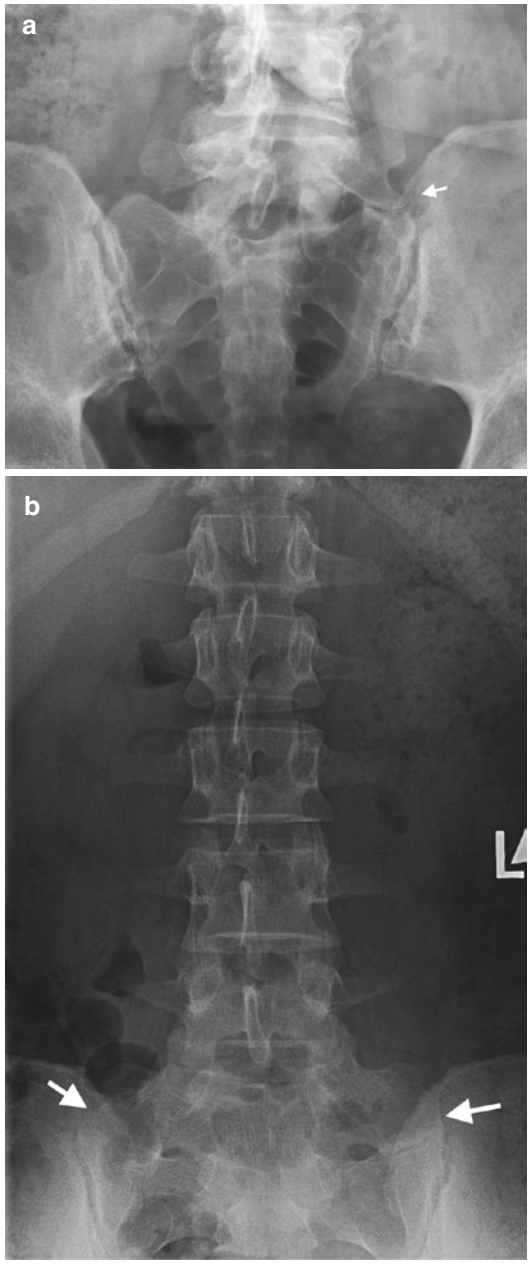


Fig. 15.13 AP radiographs transitional L5 vertebra: (**a**) type 2A, left synchondrosis (*arrow*) and (**b**) type 4, left synchondrosis and right-sided fusion transverse process L5 and sacrum (*arrows*)

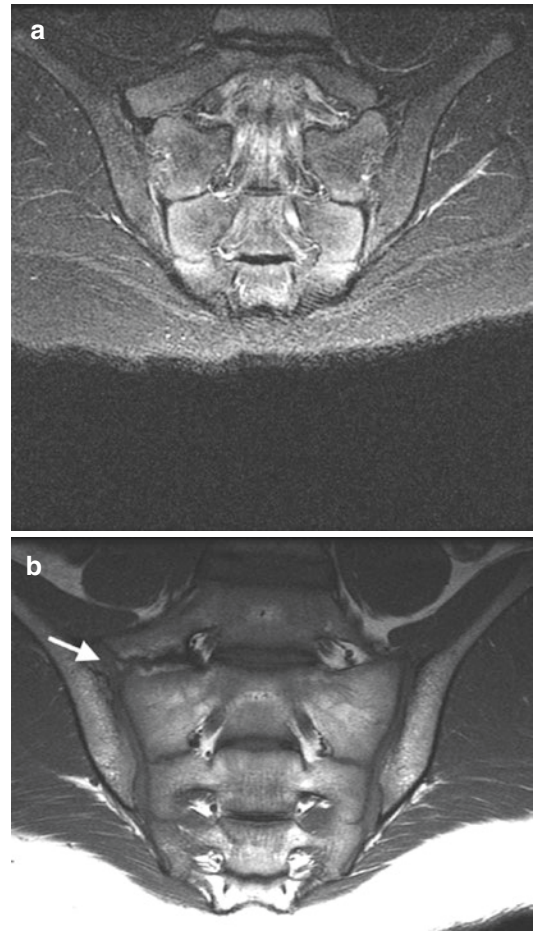


Fig. 15.14 MRI transitional vertebra type 2 b in a symptomatic 15-year-old female elite gymnast with Bertolotti syndrome: (**a**) no osteitis demonstrated on Cor T2FS; (**b**) Cor T1 does demonstrate cortical irregularity and post-inflammatory fat accentuation at right synchondrosis (*arrow*)

Table 15.4 Castellvi classification lumbosacral transitional vertebrae

Type 1 – forme fruste, dysplastic transverse process, >19 mm height
Type 2 – incomplete, enlarged transverse process with pseudoarthrosis with the adjacent sacral ala
Type 3 – complete, enlarged transverse process with complete fusion with the adjacent sacral ala
Type 4 – mixed, type 2 and type 3 on alternate sides

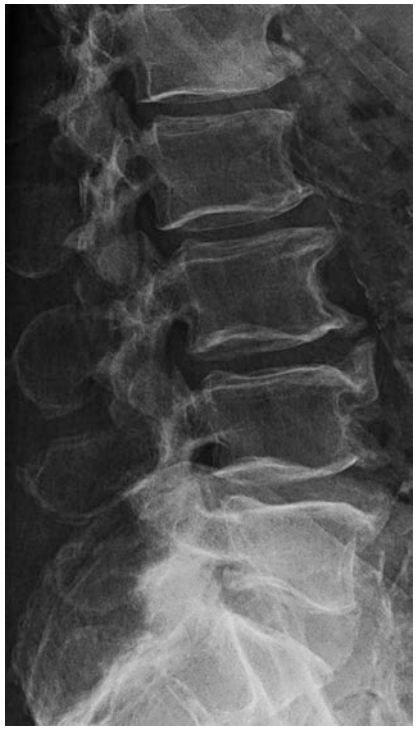


Fig. 15.15 Lateral radiograph lumbar spine demonstrating endplate osteophytosis with maintenance intervertebral disc space height

Spondylosis Deformans

Degenerative process of the spine involves essentially the annulus fibrosus and is characterized by the anterior and lateral marginal osteophytes arising from the vertebral body apophyses, while the intervertebral disc height is normal or only slightly decreased (Fig. 15.15). Occasionally, foci of gas are identified in the peripheral annulus fibrosus of the disc. Osteophytes are usually anterior and lateral with increasing prevalence after 40 years of age.

Spondylolisthesis and Spondylolysis

Spondylolisthesis, from the Greek "a vertebra that slips," indicates anterior or posterior translation, slippage, of a vertebra upon a vertebra above or below it. Spondylolisthesis occurs in up to 4 % of the population, the commonest at the two lowermost lumbar levels. It is divided into open or closed arch. In open arch, there is bilateral spondylolysis, a defect in the pars interarticularis, i.e., that portion of the bone between the superior and inferior articular facets (Fig. 15.16). This is

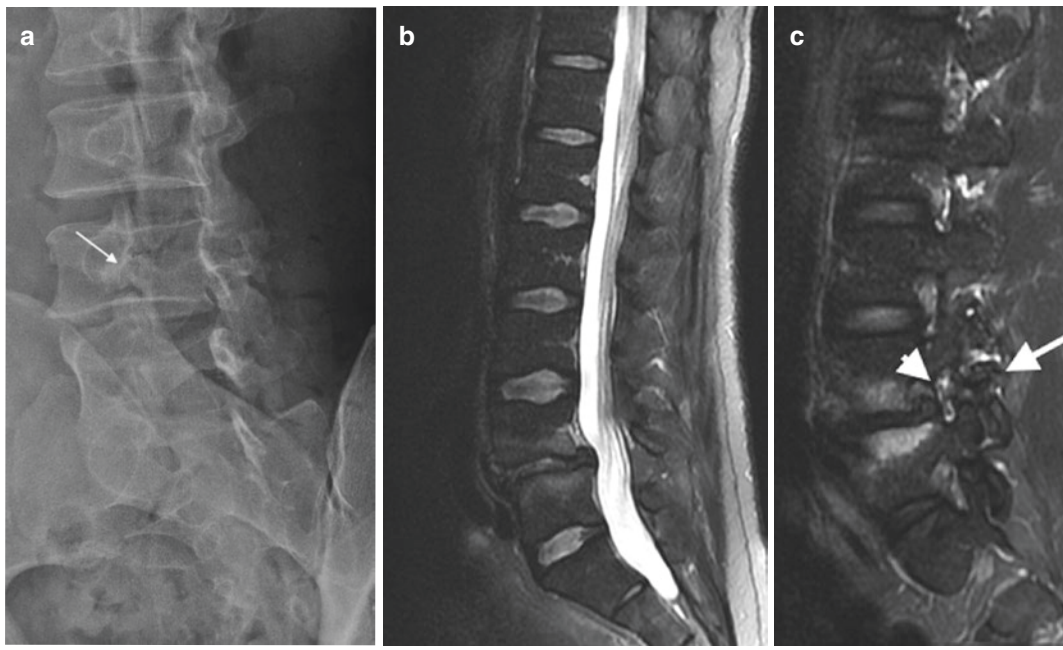
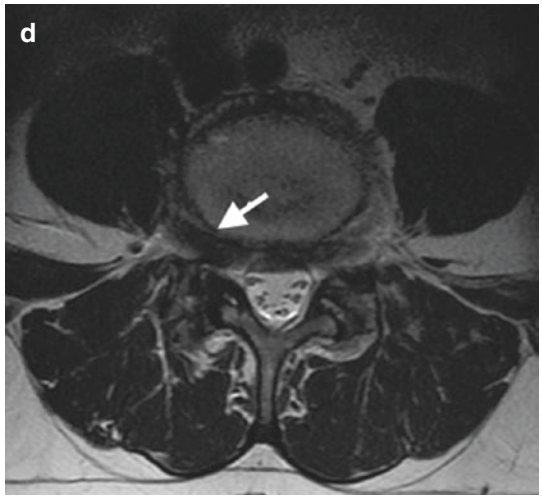


Fig. 15.16 Bilateral spondylolysis and spondylolisthesis of L4 on L5: (**a**) oblique radiograph demonstrating spondylolysis (*arrow*) and (**b**) Sag T2FS same patient presenting 10 years later with right L4 neural impingement having developed grade 1 spondylolisthesis and (**c**) Sag T2FS at the neuroforamina with secondary bilateral foraminal stenosis (*arrowhead*) secondary to uncovered disc, (**d**) Axial T2FS uncovered disc occupying right foramina (*arrow*), (**e**) Sag CT with L4 pars defect (*arrow*) in a different patient



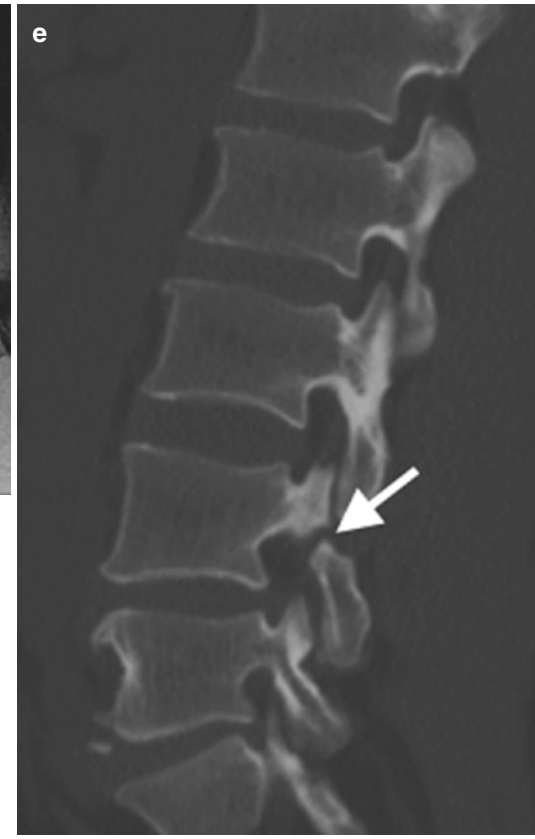


Fig. 15.16 (continued)

usually secondary to a stress fracture related to recurrent microtrauma rather than a single traumatic event. Hypoplasia of the pars may predispose patients to stress fracture. It is more common in adolescent active males and symptomatic in up to 50 % of cases. It will predispose to spondylolisthesis if bilateral. While the vertebra moves forward, the posterior vertebral elements remain in alignment with the adjacent vertebral processes and do not encroach upon the spinal canal. The intervertebral disc may be degenerative with related disc bulge.

In closed arch, degenerative spondylolisthesis, the pars is intact; however, there is instability at the facet joint usually related to degenerative change. The anterior and posterior elements of the vertebra remain connected, and as such the posterior elements move forward and encroach upon the spinal canal and may cause a spinal canal and foraminal stenosis. Retrolisthesis, posterior slippage, may occur, although less common, related to DDD. The cervical and lumbar spines are the most frequently involved.

Radiography

The lateral radiograph best demonstrates the spondylolisthesis. The degree of spondylolisthesis can be measured or graded, grades 1–4 with each grade equivalent to 25 % of the AP diameter of the vertebra, i.e., grade 2 equates to 26–50 % (Fig. 15.17). Anterior slippage of the posterior elements occurs in degenerative spondylolisthesis. In spondylosis, a bony defect in the pars is best visualized on the oblique radiograph. Instability can be assessed with flexion and extension views.

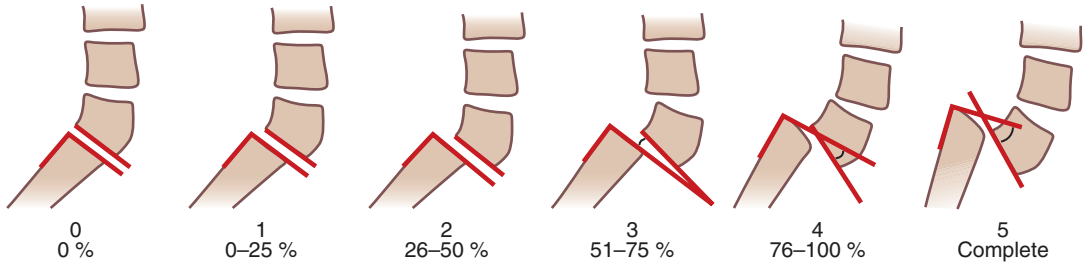


Fig. 15.17 Illustration grades 0–5 spondylolisthesis

CT

CT demonstrates excellent bony detail of the pars (Fig. 15.16e) and the facet joints. It can also assess any associated intervertebral disc disease.

MRI

MRI is less sensitive in assessing pars defect than CT. MRI is excellent and however is assessing associated degenerative disc disease and neuroforaminal/canal stenosis. MRI can also demonstrate Modic endplate type 1 changes, which may relate to instability (Fig. 15.16b–d).

Ultrasound and Nuclear Medicine

Ultrasound has no role to play in diagnosis. Nuclear medicine may localize osteoblastic activity to the involved level but is not routinely indicated given the associated radiation dose and the availability of CT and MRI.

Spondylodiscitis

Overview

Spondylodiscitis is infection of the vertebra and intervertebral disc. Infection can spread via three routes, hematogenous (the commonest), direct external, and contiguous tissue. The lumbar, thoracic, and cervical spine are affected in decreasing order of frequency. There is a bimodal age distribution, <20 and >50 years with males more commonly affected. In children, vascular supply to the disc is present and infection often commences in the disc. In adults, the disc is relatively avascular, and infection begins in the vertebral body and spreads to the disc. Infection can spread into the adjacent soft tissues as a paravertebral collection including psoas and epidural abscesses. Infection may be bacterial, myobacterial, and rarely fungal or parasitic. Common pathogens include *Staph aureus*, *E. Coli*, *Pseudomonas* (drug addicts), and TB.

Clinical Presentation

Presentation is often delayed, as often there is nonspecific back pain. Localized tenderness may be present with limited or no systemic symptoms. With the development of an iliopsoas abscess, there may be secondary hip contracture.

Imaging

Radiographs

Radiographs have low sensitivity early in the course of infection. Infection begins in the vertebral body and spreads to the adjacent disc. Disc space height is decreased, and the vertebral endplates become irregular and ill-defined with increasing osteolysis. Infection spreads into the adjacent vertebra. Endplate irregularity is the most sensitive indicator early in the course of disease. As disease progresses, reactive changes occur in the vertebrae with increasing sclerosis. Paravertebral collections are usually not assessable on radiographs. Occasionally, the psoas soft tissue outline will become enlarged on the affected side. In tuberculous spondylitis (Pott disease), infection spreads not via the disc to adjacent vertebra but via subligamentous spread.

The disc space height is thus preserved. The anterior vertebral margins on the lateral radiograph demonstrate osteolysis with limited or no related sclerosis. The vertebral body may collapse. Paravertebral collections may calcify.

MRI

MRI is the gold imaging standard in the assessment of spondylodiscitis. It provides excellent assessment of the extent of bone and soft tissue involvement. The involved vertebral body is of decreased signal intensity on T1, and this may be secondary to edema with or without sclerosis. T2 high signal intensity confirms the extent of edema, and sclerosis will be low signal intensity on T1 and T2. Focal bone destruction, osteolysis, can be identified but is best appreciated on CT. The intervertebral disc demonstrates loss of height and central fluid signal intensity. The endplates demonstrate multifocal erosions (Fig. 15.18). The adjacent vertebra is usually involved by time of presentation.

Paravertebral collections, abscess and phlegmon, may extend into adjacent soft tissues, and classically the psoas muscle is involved. Posterior extension of phlegmon or abscess may occur into the neuroforamina or spinal canal. Phlegmon will be intermediate to high signal on T2 and low on T1 and demonstrates diffuse increased intensity on T1 post contrast, whereas abscess post contrast will demonstrate peripheral enhancement only. Abscesses may also show restricted diffusion.

CT

CT provides excellent assessment bony architecture, destruction and osteolysis, endplate erosions, loss of intervertebral disc space height, and

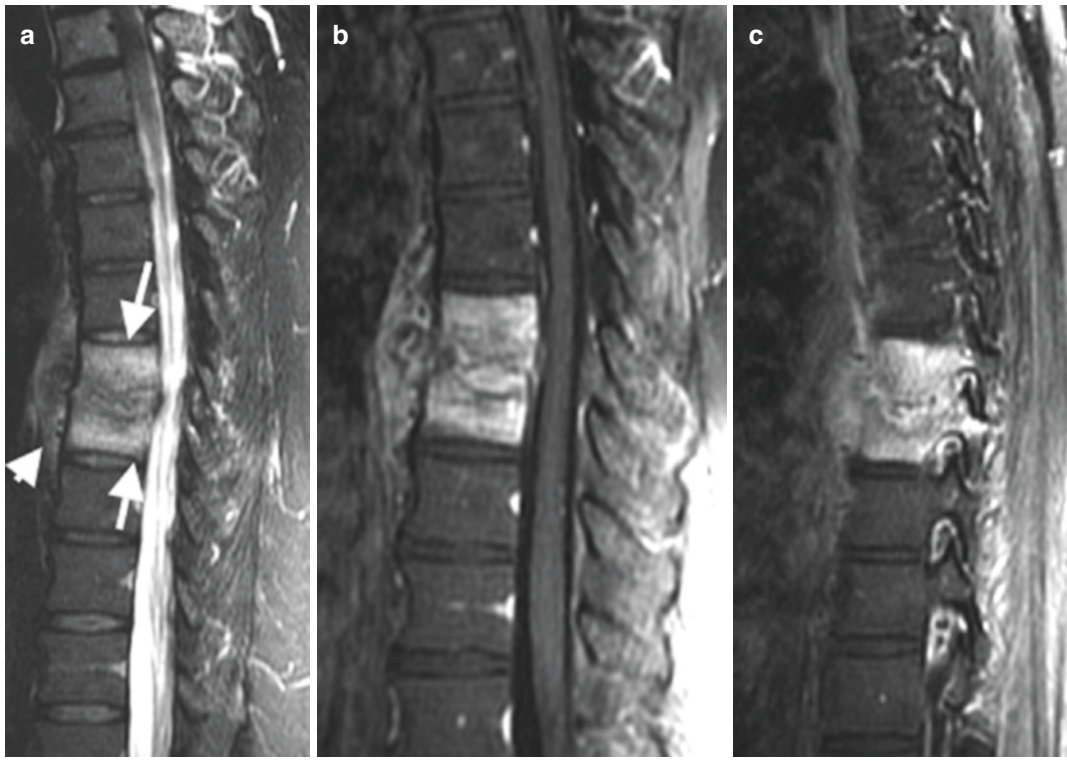


Fig. 15.18 Spondylodiscitis in a 58-year-old male secondary to a *Staph aureus* septicemia: (**a**) Sag T2FS thoracic spine demonstrating osteomyelitis (*arrows*) with high T2 SI in both T8 and T9 vertebral bodies intervening discitis and anterior paravertebral abscess (*arrowheads*). Note the endplate erosions (**b**) Sag T1FS post gadolinium (PG) demonstrating enhancement involved vertebral bodies, disc, and abscess and (**c**) Sag T1FS PG with narrowing neural foramina secondary to extension of paravertebral collection

paravertebral collections. The latter demonstrates enhancement patterns as described above. CT is not as sensitive as MRI in assessing soft tissue or epidural involvement.

Ultrasound

Ultrasound has no role in direct imaging of spondylodiscitis. Occasionally, a posterior paravertebral collection will develop, more common in postsurgical patients, and ultrasound can be used as image guidance for a diagnostic aspiration and therapeutic drainage.

Nuclear Medicine

Scintigraphy, three-phase study will demonstrate areas of increased osteoblastic activity at the site of infection; however, it is nonspecific. It can be helpful to exclude infection, but radiation dose should be considered. Indium- or technetium-labeled leukocytes can be used. Positron emission tomography with F18 FDG (PET) is sensitive in demonstrating increased metabolic activity as hot spots. Malignancy may however have a similar appearance.

Spinal Tumors

Hemangiomas are the commonest benign tumors, and the majority are incidental. They are rounded foci with well-defined margins and of increased signal intensity on both T1 and T2 with areas of signal loss on T2 fat-saturated sequences due to their internal fat component (Fig. 15.19). Atypical hemangiomas have little or no fat and may appear low signal on T1 and can be difficult to separate from more aggressive lesions such as a metastatic lesion. The latter however would be unlikely if only a single lesion was present in the absence of history of malignancy. Occasionally, CT can be performed to confirm atypical hemangioma, which demonstrates a focal lucency with intact thickened internal trabeculae. Large hemangiomas extending to both superior and inferior

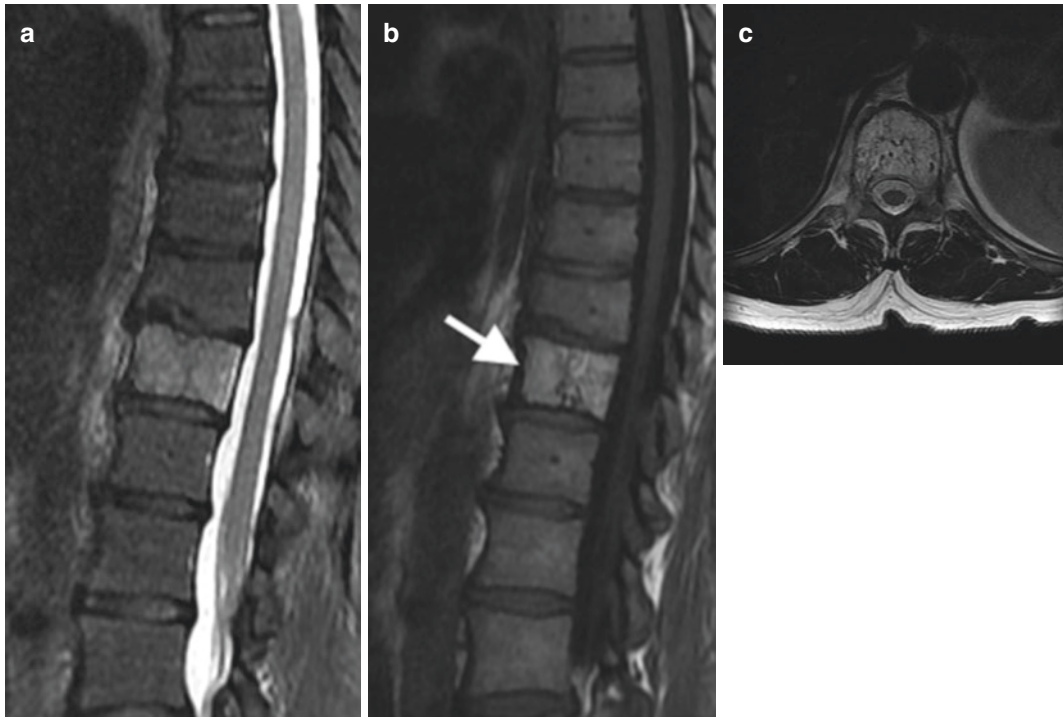


Fig. 15.19 Hemangioma T11, incidental finding: (**a**) Sag T2FS, (**b**) Sag T1, (**c**) axial T1 demonstrating high SI (*arrow in b*) lesion on all sequences occupying all the vertebral body with sparing posterior elements, no associated vertebral collapse. Note the low SI dots on axial T1 due to residual thickened trabeculae

endplates vertebrae predispose to vertebral collapse. Other benign lesions include osteoid osteoma, osteoblastoma, and aneursymal bone cyst. Their description is beyond the scope of this text.

Metastatic lesions are the commonest malignancy of the spine (Fig. 15.20). Multiple focal lesions of low signal intensity on T1, high on T2 if lytic, and low signal on T1 and T2 if sclerotic. Myeloma can have multiple imaging presentations including having a normal marrow appearance. Other varieties include a metastatic like, variegated, and diffuse. Lymphomas, primary or secondary involvement, sarcomas, and chordomas all affect the spine.

Diffuse Idiopathic Skeletal Hyperostosis

Overview

Diffuse idiopathic skeletal hyperostosis (DISH), also commonly known as Forestier disease, is a common idiopathic skeletal disorder producing hyperostosis within the axial and appendicular skeleton. It usually begins in middle age and is almost twice as common in men. Diagnosis requires spinal involvement with anterior flowing ossification of the anterior longitudinal ligament over four contiguous vertebrae and not associated with degenerative disc disease at these levels and absent ankylosis of apophyseal or sacroiliac joints. The latter helps to excludes spondyloarthropathy. There is increased prevalence in type 2 diabetics, and the process is influenced by hyperglycemia, insulin resistance, and growth hormone. There is increased bone proliferation at sites of prior surgery. Atypical imaging features may occur in patients with rheumatoid arthritis such as a lack of associated osteoporosis normally seen in RhA and bone proliferation around erosions. Common areas of involvement are at sites of ligamentous or tendons insertions where excessive new bone formation is present.

Clinical Presentation

DISH is often incidentally diagnosed on radiographs taken for alternate reasons, e.g., lateral chest radiograph. It is slowly progressive, and

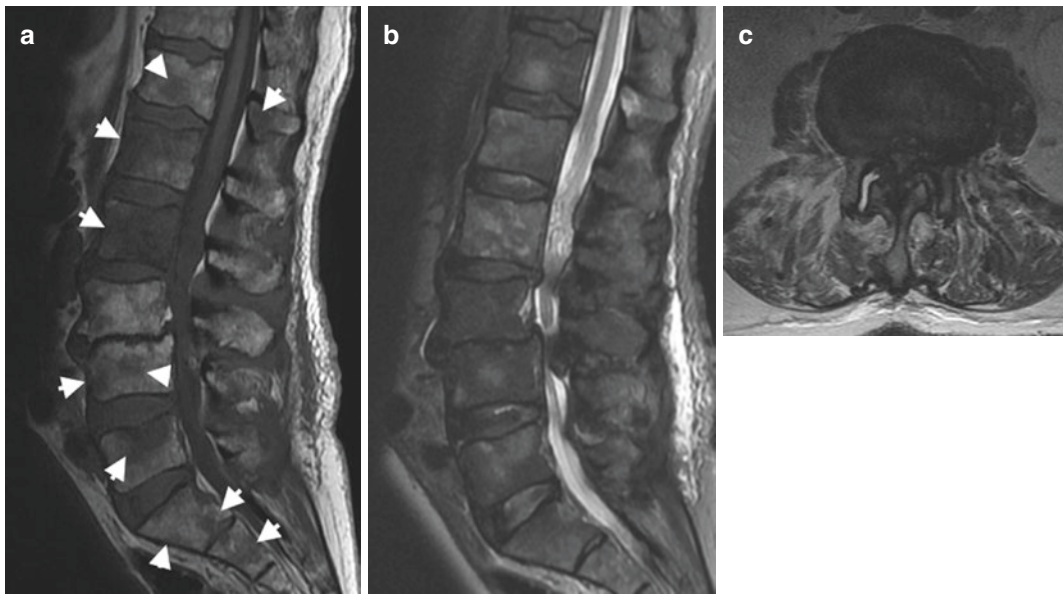


Fig. 15.20 A 74-year-old female with diffuse metastatic breast disease to the lumbar spine superimposed on advanced degenerative disc disease and spinal stenosis: (**a**) Sag T1 with diffuse (*arrowheads*) ill-defined low SI lesions within anterior and posterior elements. (**b**) Sag T2FS lesions are heterogeneous and of intermediate to high SI. (**c**) Axial T2FS L3–4 disc level with severe spinal canal stenosis due to a combination of moderate disc bulge, facet joint degeneration with secondary anterolisthesis, and ligamentum flavum hypertrophy

minor changes may be identified in middle age, which becomes more obvious as the patient ages. The patient is often asymptomatic but may complain of stiffness and spinal restricted range of motion. Peripherally, tendinopathy at tendinous insertion may be present. Rarely, ossification of the posterior longitudinal ligament within the cervical spine and/or ligamentum flavum will produce a secondary spinal canal stenosis with related symptoms.

Imaging

Radiographs

DISH is most commonly diagnosed within the mid- to lower thoracic spine, followed by the lower cervical spine. Ossification or calcification of the anterior longitudinal ligament and paraspinal connective tissue occurs over at least four contiguous vertebrae; this is usually central or right lateral due to the inhibiting effect of pulsations from the thoracic aorta (Fig. 15.21). There may be subtle radioloucency between the band of ossification and the underlying anterior margin vertebral body and intervertebral disc. Anterior osteophytes may be present at the level of the disc, noting that disc space height is maintained. There is no ankylosis of apophyseal joints. There may be related hyperostosis of the adjacent posterior ribs. Ossification of the posterior longitudinal ligament may occur within the cervical spine. This may encroach upon the spinal canal producing spinal canal stenosis. Occasionally, the ligamentum flavum may also calcify/ossify. Similar changes can be seen within the supraspinous and interspinous ligaments. Hyperostosis at the atlantoaxial joint may occur.

Degenerative disc disease may be seen within the lumbar and may be incidental to DISH. The

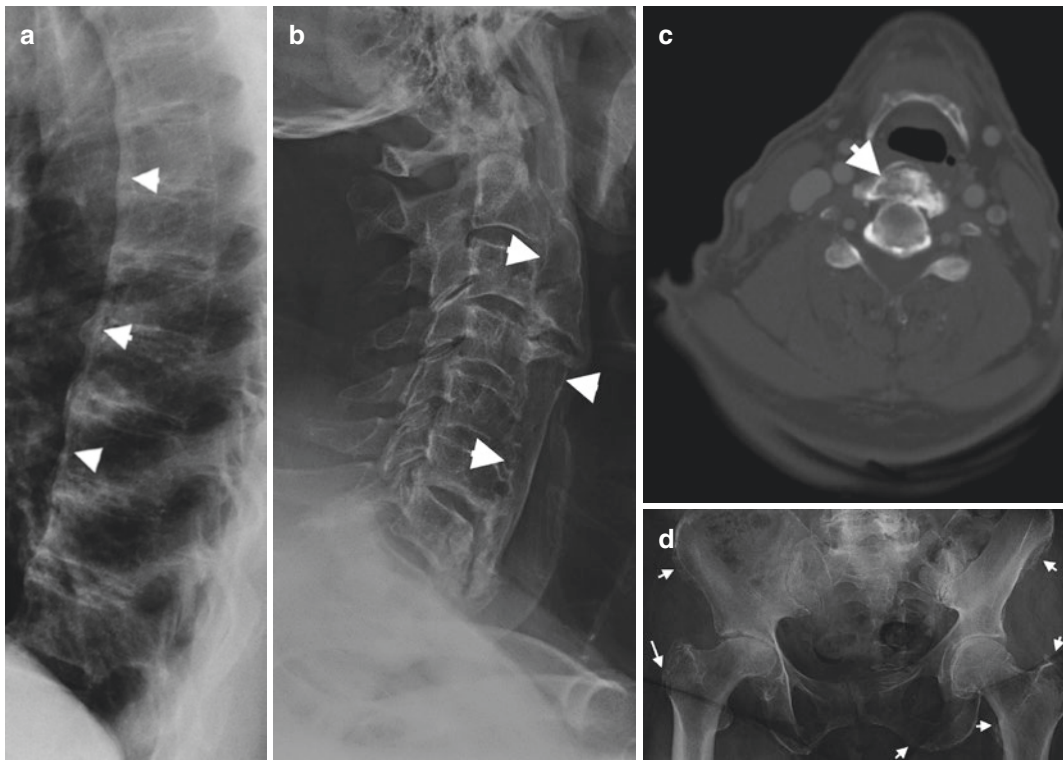


Fig. 15.21 DISH lateral radiograph: (**a**) thoracic and (**b**) cervical spine demonstrating thin ossification thoracic and thick ossification anterior longitudinal ligament (*arrowheads*) in two different patients. (**c**) Axial CT same patient as (**b**) with cervical anterior longitudinal ligament ossification. AP pelvis (**d**) demonstrating prominent enthesophytes (*arrows*) at multiple sites tendon insertion in patient with DISH. Note collapsing femoral head, Postel's coxarthropathy (see Chap. 10)

sacroiliac joints may demonstrate prominent anterior bridging osteophytosis without joint ankylosis or erosions. There is an increased risk of fracture in patients with long-standing DISH related in part to the decreased range of motion secondary to new bone formation. Typical fracture sites are at the junction of a long fused segment and normal spine, and through the mid-vertebral body where the anterior ossification is the thinnest.

Extraspinal disease is common demonstrating new bone formation at ligamentous and tendon attachments. In the pelvis, involvement of the iliac crest and ischial tuberosities is common; femur, greater trochanters; knee, patella/tibial tuberosity; foot, Achilles insertion/base fifth metatarsal; and elbow, olecranon process.

MRI

MRI is usually not performed for the diagnosis of DISH but is occasionally used when complications occur. In acute spinal fractures, as described above, MRI will demonstrate any intraspinal/neural involvement. In patients with associated ossification of the posterior longitudinal ligament or ligamentum flavum, MRI is excellent at assessing related spinal canal stenosis.

CT

CT is required for the same indications for MRI. CT will demonstrate bony detail, calcification, and ossification in better detail; however, MRI is the gold standard for assessing any neural-related symptoms (Fig. 15.21c).

Ultrasound/Nuclear Medicine

Not indicated.

Further Reading

1. Bogduk N. Degenerative joint disease of the spine. Radiol Clin North Am. 2012;50(4):613–28.
2. Burke CJ, Shah D, Saha S, Houghton R. Spondylolisthesis: a pictorial review. Br J Hosp Med (Lond). 2012;73(12):691–5.
3. Del Grande F, Maus TP, Carrino JA. Imaging the intervertebral disk: age-related changes, herniations, and radicular pain. Radiol Clin North Am. 2012;50(4):629–49.
4. Diehn FE. Imaging of spine infection. Radiol Clin North Am. 2012;50(4):777–98.
5. Fardon DF. Nomenclature and classification of lumbar disk pathology. Recommendations of the combined task forces of the North American Spine Society Radiology and the American Society of Neuroradiology. Spine. 2001;26:E93–113.
6. Konin GP, Walz DM. Lumbosacral transitional vertebrae: classification, imaging findings, and clinical relevance. AJNR Am J Neuroradiol. 2010;31(10):1778–86.
7. Olivieri I, D'Angelo S, Palazzi C. Diffuse idiopathic skeletal hyperostosis: differentiation from ankylosing spondylitis. Curr Rheumatol Rep. 2009;11(5):321–8.
8. Taljanovic MS, Hunter TB, Wisneski RJ. Imaging characteristics of diffuse idiopathic skeletal hyperostosis with an emphasis on acute spinal fractures: review. AJR Am J Roentgenol. 2009;193(3 Suppl):S10–9.
9. Wald JT. Imaging of spine neoplasm. Radiol Clin North Am. 2012;50(4):749–76.