

2 Spine

2.1 IMAGING OF SPINAL ABNORMALITIES

1. **Plain Radiography (with tomography)** — still valuable for acute trauma and for long-term sequelae, congenital and other causes of spinal deformity, suspected spondylolisthesis, spinal (as opposed to radicular) pain, and survey views for metastases. Limited role in degenerative diseases (rarely contributes to management), and suspected spinal tumours (may show remodelling in slow-growing tumours such as neurofibroma and ependymoma).
2. **Myelography** — a largely obsolescent method, but widely used in the absence of sufficient availability of MRI. Certain attributes remain of considerable diagnostic value:
 - (a) Suspected disc herniation: sensitive and specific, limited only by inability to show very laterally placed intraforaminal disc fragments.
 - (b) Suspected spinal vascular malformation. More sensitive and more specific than MRI, which is sometimes equivocal due to flow-related artefacts.
 - (c) Intraspinous mass lesions: sensitive, and specific in terms of the compartment involved by the tumour. In most cases it is possible to predict tumour type on the basis of the myelogram.
3. **CT** — of less overall usefulness compared with MRI, but having advantages in its better definition of bone and joint abnormalities.
 - (a) Suspected disc herniation: of little value in the cervical region, but still regarded as sensitive in the detection of prolapsed lumbar disc. Sensitivity further enhanced by postmyelogram CT. Time and dose considerations usually confine the examination to three levels, and this can be a problem in atypical presentations. In the thoracic region, the lack of level-specific clinical information prevents the

effective use of CT, other than as a postmyelographic method, and where further assessment of previously detected calcification is required.

- (b) Suspected fractures and dislocations: CT has great advantages in its potential for detailed study without additional trauma to the patient, and in its excellent definition of bone abnormalities. However, transversely-oriented fractures and mild wedge compression fractures are difficult to visualize.
 - (c) Facet joint disease: technique of choice in most cases, though MRI is not without usefulness in this area.
 - (d) Congenital abnormalities: spondylolisthesis, dysraphism, diastematomyelia, and foramen magnum anomalies require CT for full assessment.
 - (e) Bone tumours of the spine require CT for full assessment, particularly to identify and quantify any calcific components. Intraspinal tumours are not well shown, though calcific components may be shown in meningiomas, and fatty elements in dermoid and teratomatous lesions.
 - (f) Spinal infection: CT is sensitive in the demonstration of epidural and subdural abscess, though a high volume of intravenous contrast may be required. The extraspinal components are also well known.
4. **MRI** — the high soft-tissue contrast, the better tissue characterization, and the freedom from artefact make MRI the optimal technique in many types of spinal pathology. The lack of bone signal is an occasional disadvantage.
- (a) Suspected disc herniation: sensitive and specific in the detection of disc herniation in cervical, thoracic and lumbar regions. Partial volume averaging and soft-tissue contrast problems sometimes limit the demonstration of laterally placed cervical disc fragments. Sagittal scanning allows for multilevel demonstrations, thereby avoiding errors due to over-reliance on clinical findings: this is particularly important in suspected thoracic disc.
 - (b) Spinal stenosis: sagittal sections allow for multilevel displays, which are invaluable in the detection of cervical and lumbar canal stenosis.
 - (c) Spinal tumours: the sensitivity of tumour detection is very high, and the good tissue characterization allows confident histological diagnosis in many cases. Gadolinium enhancement often useful: almost all tumours enhance; other expanding lesions such as infarcts, and acute plaques may

not. The non-invasive nature of MRI avoids disturbance of CSF flow dynamics in the potentially unstable situation of total or near total spinal block. By contrast, myelography may precipitate the need for surgery.

- (d) Vascular malformations: MRI will show the distended veins characteristic of spinal (usually dural) vascular malformations as flow voids, best shown on spin-echo T₂W sections. Sensitivity probably a little inferior to myelography.
- (d) Arachnoiditis: adhesion of the nerves of the cauda equina to the theca and to themselves is best shown by MRI. Given that myelography has a causal role in many cases, it is undesirable to use this for its demonstration.
- (e) Trauma: MRI will show ligamentous injury, particularly oedema and haemorrhage, whereas CT may appear normal or equivocal. Bone marrow oedema secondary to incremental fractures is also shown. Intraspinous complications of trauma (haemorrhage into the epidural or subdural space, or into the cord) are optimally shown by MRI.
- (f) Spinal infection: MRI is rather more sensitive than CT for showing both the intraspinal and extraspinal components, and will demonstrate the rare intramedullary abscess, which CT is unlikely to show.
- (g) Vascular and inflammatory lesions, including MS. MRI will show spinal cord infarction and haemorrhage, and also acute and chronic plaques in demyelinating disease.

Further Reading

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2.2 SCOLIOSIS

IDIOPATHIC

2% prevalence for curves $> 10^\circ$.

1. **Infantile** — diagnosed before the age of 4 years. 90% are thoracic and concave to the right. More common in boys. 90% resolve spontaneously.
2. **Juvenile** — diagnosed between 4 and 9 years. More common in girls. Almost always progressive.
3. **Adolescent** — diagnosed between 10 years and maturity. More common in females. Majority are concave to the left in the thoracic region.

CONGENITAL

Prognosis is dependent on the anatomical abnormality and a classification (see figure opposite) is, therefore, important.

Failure of Formation. **A.** Incarcerated hemivertebra. A straight spine with little tendency to progression. **B.** Free hemivertebra. May be progressive. **C.** Wedge vertebra. Better prognosis than a free hemivertebra. **D.** Multiple hemivertebrae. Failure of formation on the same side results in a severe curve. Hemivertebrae on opposite sides may compensate each other. **E.** Central defect. Butterfly vertebra.

Failure of Segmentation. **A.** Bilateral \rightarrow block vertebra and a short spine, e.g. Klippel–Feil. **B.** Unilateral unsegmented bar. Severely progressive curve with varying degrees of kyphosis or lordosis depending on the position of the bar.

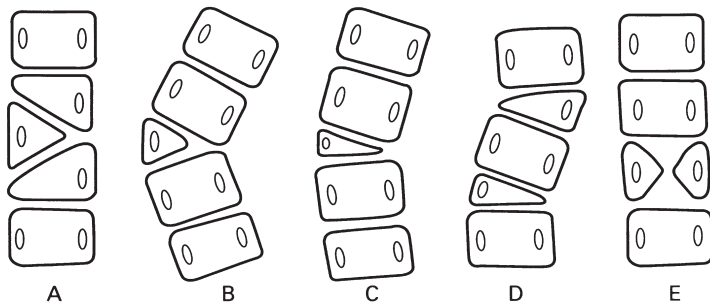
Mixed defects. **A.** Unilateral unsegmented bar and a hemivertebra. Severely progressive. **B.** Partially segmented incarcerated hemivertebra. **C.** Bilateral failure of segmentation incorporating a hemivertebra.

Indicators of serious progression are:

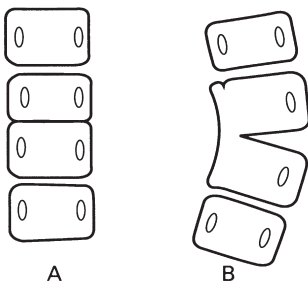
- (a) Deformity present at birth.
- (b) Severe deformity of the chest wall.
- (c) Unilateral unsegmented bars.
- (d) Thoracic abnormality.

Associated abnormalities may occur — urinary tract (18%), congenital heart disease (7%), undescended scapulae (6%) and diastematomyelia (5%).

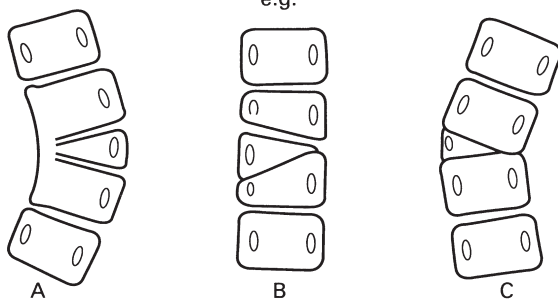
FAILURE OF FORMATION



FAILURE OF SEGMENTATION



MIXED
e.g.



NEUROPATHIC DISORDERS

1. **Tethered cord.**
2. **Syringomyelia.**
3. **Chiari malformations.**
4. **Diastematomyelia.**
5. **Meningocele/myelomeningocele.**

NEUROMUSCULAR DISEASES

1. **Myelomeningocele.**
2. **Spinal muscular atrophy.**
3. **Friedreich's ataxia.**
4. **Poliomyelitis.**
5. **Cerebral palsy.**
6. **Muscular dystrophy.**

MESODERMAL AND NEUROECTODERMAL DISEASES

1. **Neurofibromatosis*** — in up to 40% of patients. Classically a sharply angled short segment scoliosis with a severe kyphosis. The apical vertebrae are irregular and wedged with adjacent dysplastic ribs. 25% have a congenital vertebral anomaly.
2. **Marfan's syndrome*** — scoliosis in 40–60%. Double structural curves are typical.
3. **Homocystinuria*** — similar to Marfan's syndrome.
4. **Other skeletal dysplasias** — spondyloepiphyseal dysplasia congenita, spondyloepimetaphyseal dysplasia, pseudoachondroplasia, metatropic dwarfism, diastrophic dwarfism, Kniest disease, spondylocostal dysostosis.

POST RADIOTHERAPY

Wedged and hypoplastic vertebrae ± unilateral pelvic or rib hypoplasia.

LEG LENGTH DISCREPANCY

A flexible lumbar curve, convex to the side of the shorter leg. Disparity of iliac crest level.

PAINFUL SCOLIOSIS

1. **Osteoid osteoma*** — 10% occur in the spine. A lamina or pedicle at the apex of the curve will be sclerotic or overgrown.

2. **Osteoblastoma***.
3. **Intraspinal tumour** (see 2.21).
4. **Infection**.

Further Reading

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2.3 SOLITARY COLLAPSED VERTEBRA

1. **Neoplastic disease**
 - (a) Metastasis — breast, bronchus, prostate, kidney and thyroid account for the majority of patients with a solitary spinal metastasis. The disc spaces are preserved until late. The bone may be lytic, sclerotic or mixed. ± destruction of a pedicle.
 - (b) Multiple myeloma/plasmacytoma* — a common site, especially for plasmacytoma. May mimic an osteolytic metastasis or be expansile and resemble an aneurysmal bone cyst.
 - (c) Lymphoma*.
2. **Osteoporosis** (q.v.) — generalized osteopenia. Coarsened trabecular pattern in adjacent vertebrae due to resorption of secondary trabeculae.
3. **Trauma**.
4. **Infection** — with destruction of vertebral end-plates and adjacent disc spaces.
5. **Langerhans cell histiocytosis*** — eosinophil granuloma is the most frequent cause of a solitary vertebra plana in childhood. The posterior elements are usually spared.
6. **Benign tumours** — haemangioma, giant cell tumour and aneurysmal bone cyst.
7. **Paget's disease*** — diagnosis is difficult when a solitary vertebra is involved. Neural arch is affected in most cases. Sclerosis and expansion. If other non-collapsed vertebrae are affected then diagnosis becomes much easier.

Further Reading

- Laredo J.-D., el Quessar A., Bossard P. *et al.* (2001) Vertebral tumours and pseudotumours. *Radiol. Clin. North Am.*, 39(1): 137–63.
- Varma R., Lander P. & Assaf A. (2001) Imaging of pyogenic infectious spondylodiskitis. *Radiol. Clin. North Am.*, 39(2): 203–13.

2.4 MULTIPLE COLLAPSED VERTEBRAE

1. **Osteoporosis** (q.v.) — reduced bone density. Vertebral bodies may be wedged or biconcave (fish-shaped).
2. **Neoplastic disease** — wedge fractures are particularly related to osteolytic metastases and osteolytic marrow tumours, e.g. multiple myeloma, leukaemia and lymphoma. Altered or obliterated normal trabeculae. Disc spaces are usually preserved until late. Paravertebral soft-tissue mass is more common in myeloma than metastases.
3. **Trauma** — discontinuity of trabeculae, sclerosis of the fracture line due to compressed and overlapped trabeculae. Disc space usually preserved. The lower cervical, lower dorsal and upper lumbar spine are most commonly affected. Usually no soft-tissue mass. MRI usually shows the end-plates to be spared, c.f. pyogenic infection.
4. **Scheuermann's disease** — irregular end-plates and numerous Schmorl's nodes in the thoracic spine of children and young adults. Disc-space narrowing. Often progresses to a severe kyphosis. Secondary degenerative changes later.
5. **Infection** — destruction of end-plates adjacent to a destroyed disc. Although it is usually not possible to differentiate radiologically between pyogenic and tuberculous spondylitis in white patients the following signs are said to be helpful.

<i>Pyogenic</i>	<i>Tuberculous</i>
Rapidly progressive	Slower progression
Marked osteoblastic response	Less sclerosis
Less collapse	Marked collapse
Small or no paravertebral abscess	Large paravertebral abscess ± calcification
Early bridging of affected vertebrae	

In the acute phase of pyogenic spondylodiscitis, MRI typically shows low signal on T₁W, with loss of definition of the adjacent vertebral end-plates and high signal on T₂W of the disc and adjacent vertebral bodies. The disc shows a variable pattern of enhancement with gadolinium.

6. **Langerhans cell histiocytosis*** — the spine is more frequently involved in eosinophilic granuloma and Hand-Schüller-Christian disease than in Letterer-Siwe disease. Most common in young people. The thoracic and lumbosacral spine are the usual sites of disease. Disc spaces are preserved.

7. **Sickle-cell anaemia*** — characteristic step-like depression in the central part of the end-plate.

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- Laredo J.-D., el Quessar A., Bossard P. *et al.* (2001) Vertebral tumours and pseudotumours. *Radiol. Clin. North Am.*, 39(1): 137–63.
- Mahboubi S. & Morris M.C. (2001) Imaging of spinal infections in children. *Radiol. Clin. North Am.*, 39(2): 215–22.
- Moore S.L. & Rafii M. (2001) Imaging of musculoskeletal and spinal tuberculosis. *Radiol. Clin. North Am.*, 39(2): 329–42.
- Varma R., Lander P. & Assaf A. (2001) Imaging of pyogenic infectious spondylodiskitis. *Radiol. Clin. North Am.*, 39(2): 203–13.

2.5 PLATYSPONDYLY IN CHILDHOOD

This sign describes a decrease in the distance between the upper and lower vertebral end-plates and should be differentiated from wedge-shaped vertebrae. Platyspondyly may be generalized, affecting all the vertebral bodies, multiple, affecting some of the vertebral bodies, or localized, involving one vertebral body (also termed *vertebra plana*).

CONGENITAL PLATYSPONDYLY

1. **Thanatophoric dwarfism** — inverted ‘U’- or H-shaped vertebrae with a markedly increased disc space: body height ratio. Telephone handle-shaped long bones.
2. **Metatropic dwarfism.**
3. **Osteogenesis imperfecta*** — type IIA.

PLATYSPONDYLY IN LATER CHILDHOOD

1. **Morquio’s disease***.
2. **Spondyloepiphyseal dysplasia congenita.**
3. **Spondyloepiphyseal dysplasia tarda.**
4. **Kniest syndrome.**

ACQUIRED PLATYSPONDYLY — see 2.4

Further Reading

- Kozlowski K. (1974) Platyspondyly in childhood. *Paed. Radiol.*, 2: 81–8.

2.6 EROSION, DESTRUCTION OR ABSENCE OF A PEDICLE

- | | | |
|---|---|--|
| <ol style="list-style-type: none"> 1. Metastasis 2. Multiple myeloma* | } | <p>metastatic carcinoma involves the pedicle relatively early and contrasts with the late preservation of the pedicle in multiple myeloma.</p> |
| <ol style="list-style-type: none"> 3. Neurofibroma — often causes erosion of adjacent pedicle or pedicles. Chronic intramedullary tumours, typically ependymoma, cause flattening of both pedicles at affected levels, with a widened interpedicular distance. 4. Tuberculosis — uncommonly. With a large paravertebral abscess. 5. Benign bone tumour — aneurysmal bone cyst or giant cell tumour. 6. Congenital absence — ± sclerosis of the contralateral pedicle. | | |

Further Reading

Bell D. & Cockshott W.P. (1971) Tuberculosis of the vertebral pedicle. *Radiology*, 99: 43–8.

2.7 SOLITARY DENSE PEDICLE

1. **Osteoblastic metastasis** — no change in size.
2. **Osteoid osteoma*** — some enlargement of the pedicle ± radiolucent nidus.
3. **Osteoblastoma*** — larger than osteoid osteoma and more frequently a lucency with a sclerotic margin rather than a purely sclerotic pedicle.
4. **Secondary to spondylolysis** — ipsilateral or contralateral.
5. **Secondary to congenitally absent or hypoplastic contralateral posterior elements.**

Further Reading

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Wilkinson R.H. & Hall J.E. (1974) The sclerotic pedicle: tumour or pseudotumour? *Radiology*, 111: 683–8.

2.8 ENLARGED VERTEBRAL BODY

GENERALIZED

1. **Gigantism.**
2. **Acromegaly*.**

LOCAL (SINGLE OR MULTIPLE)

1. **Paget's disease*.**
2. **Benign bone tumour**
 - (a) **Aneurysmal bone cyst*** — typically purely lytic and expansile. Involves the anterior and posterior elements more commonly than the anterior or posterior elements alone. Rapid growth.
 - (b) **Haemangioma*** — with a prominent vertical trabecular pattern.
 - (c) **Giant cell tumour*** — involvement of the body alone is most common. Expansion is minimal.
3. **Hydatid** — over 40% of cases of hydatid disease in bone occur in vertebrae.

Further Reading

- Bedabout J.W., McLeod R.A. & Dahlin D.C. (1979) Benign tumours. *Semin. Roentgenol.*, 14: 33–43.
- Dahlin D.C. (1977) Giant cell tumour of vertebrae above the sacrum. A review of 31 cases. *Cancer*, 39: 1350–6.
- Laredo J.-D., el Quessar A., Bossard P. *et al.* (2001) Vertebral tumours and pseudotumours. *Radiol. Clin. North Am.*, 39(1): 137–63.
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- Koeller K.K., Rosenblum R.S. & Morrison A.L. (2000) Neoplasms of the spinal cord and filum terminale: radiologic-pathologic correlation. *RadioGraphics*, 20: 1721–49.

2.9 SQUARING OF ONE OR MORE VERTEBRAL BODIES

1. **Ankylosing spondylitis*.**
2. **Paget's disease*.**
3. **Psoriatic arthropathy*.**
4. **Reiter's syndrome*.**
5. **Rheumatoid arthritis*.**

2.10 BLOCK VERTEBRAE

1. **Klippel–Feil syndrome** — segmentation defects in the cervical spine, short neck, low hairline and limited cervical movement, especially rotation. The radiological appearance of the cervical spine resembles (1) above. C2–C3 and C5–C6 are most commonly affected. Other anomalies are frequently associated, the most important being
 - (a) Scoliosis $> 20^\circ$ in more than 50% of patients.
 - (b) Sprengel's shoulder in 30%, \pm an omovertebral body.
 - (c) Cervical ribs.
 - (d) Genito-urinary abnormalities in 66%; renal agenesis in 33%.
 - (e) Deafness in 33%.
2. **Isolated congenital** — a failure of segmentation. Most common in the lumbar spine but also occurs in the cervical and thoracic regions. The ring epiphyses of adjacent vertebrae do not develop and thus the AP diameter of the vertebrae at the site of the segmentation defect is decreased. The articular facets, neural arches or spinous processes may also be involved. A faint lucency representing a vestigial disc may be observed.
3. **Rheumatoid arthritis*** — especially juvenile onset rheumatoid arthritis and juvenile chronic arthritis with polyarticular onset. There may be angulation at the fusion site and this is not a feature of the congenital variety. The spinous processes do not fuse.
4. **Ankylosing spondylitis*** — squaring of anterior vertebral margins and calcification in the intervertebral discs and anterior and posterior longitudinal ligaments.
5. **Tuberculosis** — vertebral body collapse and destruction of the disc space, paraspinal calcification. There may be angulation of the spine.
6. **Operative fusion.**
7. **Post-traumatic.**

2.11 IVORY VERTEBRAL BODY

Single or multiple very dense vertebrae. The list excludes those causes where increased density is due to compaction of bone following collapse. If there is generalized involvement of the spine see 1.11.

1. **Metastases** — sclerotic metastases or an initially lytic metastasis which, after treatment, has become sclerotic. Usually no alteration in vertebral body size. Disc spaces preserved until late.
2. **Paget's disease*** — usually a single vertebral body is affected. Expanded body with a thickened cortex and coarsened trabeculation. Disc space involvement is uncommon.
3. **Lymphoma*** — more frequent in Hodgkin's disease than the other reticuloses. Normal size vertebral body. Disc spaces intact.
4. **Low-grade infection** — with end-plate destruction, disc-space narrowing and a paraspinous soft-tissue mass.
5. **Haemangioma** — sclerosis is accompanied by a coarsened trabecular pattern, predominantly vertical in orientation. ± expansion.

2.12 ATLANTOAXIAL SUBLUXATION

When the distance between the posterior aspect of the anterior arch of the atlas and the anterior aspect of the odontoid process exceeds 3 mm in adults and older children, or 5 mm in younger children, or an interosseous distance that changes considerably between flexion and extension.

TRAUMA

ARTHRITIDES

1. **Rheumatoid arthritis*** — in 20–25% of patients with severe disease. Associated erosion of the odontoid may be severe enough to reduce it to a small spicule of bone.
2. **Psoriatic arthropathy*** — in 45% of patients with spondylitis.
3. **Juvenile idiopathic arthritis*** — most commonly in seropositive juvenile onset adult rheumatoid arthritis.
4. **Systemic lupus erythematosus***.
5. **Ankylosing spondylitis*** — in 2% of cases. Usually a late feature.

CONGENITAL

1. **Down's syndrome*** — in 20% of cases. ± odontoid hypoplasia. May, rarely, have atlanto-occipital instability.
2. **Morquio's syndrome***.
3. **Spondyloepiphyseal dysplasia**.
4. **Congenital absence/hypoplasia of the odontoid process** — many have a history of previous trauma (NB. In children < 9 years it is normal for the tip of the odontoid to fall well below the top of the anterior arch of the atlas.

INFECTION

1. **Retropharyngeal abscess in a child.**

Further Reading

- Elliott S. (1988) The odontoid process in children — is it hypoplastic? *Clin. Radiol.*, 39: 391–3.
- Martel W. (1961) The occipito-atlanto-axial joints in rheumatoid arthritis and ankylosing spondylitis. *Am. J. Roentgenol.*, 86: 223–40.
- Rosenbaum D.M., Blumhagen J.D. & King H.A. (1986) Atlanto-occipital instability in Down syndrome. *Am. J. Roentgenol.*, 146: 1269–72.

2.13 INTERVERTEBRAL DISC CALCIFICATION

1. **Degenerative spondylosis** — in the nucleus pulposus. Usually confined to the dorsal region. With other signs of degenerative spondylosis — disc-space narrowing, osteophytosis and vacuum sign in the disc. A frequent finding in the elderly.
2. **Alkaptonuria*** — symptoms of arthropathy first appear in the 4th decade. Widespread disc calcification, osteoporosis, disc-space narrowing and osteophytosis. The disc calcification is predominantly in the inner fibres of the annulus fibrosus but may be diffuse throughout the disc. Severe changes progress to ankylosis and may mimic ankylosing spondylitis.
3. **Calcium pyrophosphate dihydrate deposition disease*** — predominantly in the outer fibres of the annulus fibrosus.
4. **Ankylosing spondylitis*** — in the nucleus pulposus. Ankylosis, square vertebral bodies and syndesmophytes.
5. **Juvenile idiopathic arthritis*** — may mimic ankylosing spondylitis.
6. **Haemochromatosis*** — in the outer fibres of the annulus fibrosus.
7. **Diffuse idiopathic skeletal hyperostosis (DISH)** — may mimic ankylosing spondylitis.
8. **Gout***.
9. **Idiopathic** — a transient phenomenon in children. The cervical spine is most often affected. Clinically associated with neck pain and fever but may be asymptomatic. Persistent in adults.
10. **Following spinal fusion.**

Further Reading

Weinberger A. & Myers A.R. (1978) Intervertebral disc calcification in adults: a review. *Semin. Arthritis Rheum.*, 18: 69–75.

2.14 BONY OUTGROWTHS OF THE SPINE

SYNDESMOPHYTES

Ossification of the annulus fibrosus. Thin, vertical and symmetrical. When extreme results in the 'bamboo spine'.

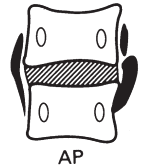
1. **Ankylosing spondylitis***.
2. **Alkaptonuria**.



PARAVERTEBRAL OSSIFICATION

Ossification of paravertebral connective tissue which is separated from the edge of the vertebral body and disc. Large, coarse and asymmetrical.

1. **Reiter's syndrome***.
2. **Psoriatic arthropathy***.



CLAW OSTEOPHYTES

Arising from the vertebral margin with no gap and having an obvious claw appearance.

1. **Stress response** — but in the absence of disc-space narrowing does not indicate disc degeneration.



TRACTION SPURS

Osteophytes with a gap between the end-plate and the base of the osteophyte and with the tip not protruding beyond the horizontal plane of the vertebral end-plate.

1. **Shear stresses across the disc** — more likely to be associated with a degenerative disc.



UNDULATING ANTERIOR OSSIFICATION

Undulating ossification of the anterior longitudinal ligament, intervertebral disc and paravertebral connective tissue.

1. **Diffuse idiopathic skeletal hyperostosis (DISH)**.



Further Reading

Jones M.D., Pais M.J. & Omiya B. (1988) Bony overgrowths and abnormal calcifications about the spine. *Radiol. Clin. North Am.*, 26: 1213–34.

2.15 CORONAL CLEFT VERTEBRAL BODIES

NORMAL VARIANT

Fusion of the anterior and posterior ossification centres of the vertebral body normally occurs before the 16th week of intrauterine life. Persisting notochordal remnants in the lower thoracic and lumbar region may prevent fusion but the condition usually resolves without sequelae in the first few months of life.

AS A FEATURE OF BONE DYSPLASIAS

1. **Chondrodysplasia punctata** — rhizomelic type.
2. **Kniest syndrome.**
3. **Metatropic dwarfism.**

ACQUIRED

As a result of herniation of a normal intervertebral disc into an osteoporotic vertebral body or secondary to trauma.

Further Reading

Fielden P. & Russell J.G. (1970) Coronally cleft vertebrae. *Radiology*, 21: 327–8.
Wilson A.R., Wastie M.L., Preston B.J. *et al.* (1989) Acquired coronal cleft vertebra. *Clin. Radiol.*, 40: 167–73.

2.16 ANTERIOR VERTEBRAL BODY BEAKS



Central



Lower third

Involves 1–3 vertebral bodies at the thoracolumbar junction and usually associated with a kyphosis. Hypotonia is probably the common denominator which leads to an exaggerated thoracolumbar kyphosis, anterior herniation of the nucleus pulposus and subsequently an anterior vertebral body defect.

CENTRAL

1. Morquio's syndrome*.

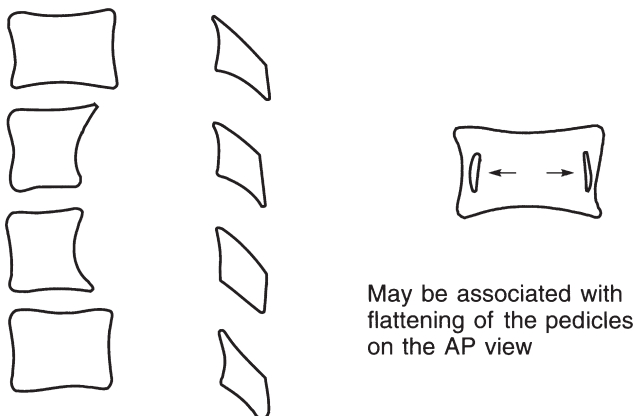
LOWER THIRD

1. Hurler's syndrome*.
2. Achondroplasia*.
3. Pseudoachondroplasia.
4. Cretinism*.
5. Down's syndrome*.
6. Neuromuscular diseases.

Further Reading

Swischuk L.E. (1970) The beaked, notched or hooked vertebra. Its significance in infants and young children. *Radiology*, 95: 661–4.

2.17 POSTERIOR SCALLOPING OF VERTEBRAL BODIES



Scalloping is most prominent: (a) at either end of the spinal canal; (b) with large and slow growing lesions; and (c) with those lesions which originate during the period of active growth and bone modelling.

1. **Tumours in the spinal canal** — ependymoma (especially of the filum terminale and conus), dermoid, lipoma, neurofibroma and, less commonly, meningioma. Chronic raised intraspinal pressure distal to a tumour producing spinal block also causes extensive vertebral scalloping.
2. **Neurofibromatosis*** — scalloping is due to a mesodermal dysplasia and is associated with dural ectasia. Localized scalloping can also result from pressure resorption by a neurofibroma, in which case there may also be enlargement of an intervertebral foramen and flattening of one pedicle ('dumbbell tumour'). However, multiple wide thoracic intervertebral foramina are more likely owing to lateral meningoceles than to local tumours.
3. **Acromegaly*** — other spinal changes include increased AP and transverse diameters of the vertebral bodies giving a spurious impression of decreased vertebral height, osteoporosis, spur formation and calcified discs.
4. **Achondroplasia*** — with spinal stenosis and anterior vertebral body beaks.
5. **Communicating hydrocephalus** — if severe and untreated.

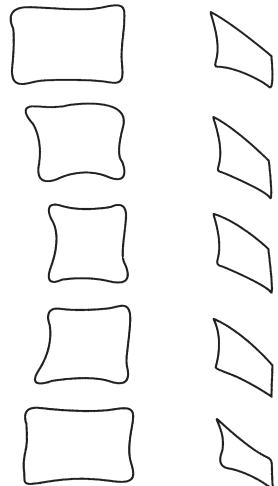
6. **Syringomyelia** — especially if the onset is before 30 years of age.
7. **Other congenital syndromes**
- | | | |
|------------------------------|---|-------------------------------------|
| (a) Ehlers–Danlos | } | both associated with dural ectasia. |
| (b) Marfan's* | | |
| (c) Hurler's* | | |
| (d) Morquio's* | | |
| (e) Osteogenesis imperfecta* | | |

Further Reading

Mitchell G.E., Lourie H. & Berne A.S. (1967) The various causes of scalloped vertebrae and notes on their pathogenesis. *Radiology*, 89: 67–74.

2.18 ANTERIOR SCALLOPING OF VERTEBRAL BODIES

1. **Aortic aneurysm** — intervertebral discs remain intact. Well-defined anterior vertebral margin. \pm Calcification in the wall of the aorta.
2. **Tuberculous spondylitis** — with marginal erosions of the affected vertebral bodies. Disc-space destruction. Widening of the paraspinal soft tissues.
3. **Lymphadenopathy** — pressure resorption of bone results in a well-defined anterior vertebral body margin unless there is malignant infiltration of the bone.
4. **Delayed motor development** — e.g. Down's syndrome.



2.19 SYNDROMES WITH A NARROW SPINAL CANAL

1. **Achondroplasia***.
2. **Hypochondroplasia** — AD. Large calvarium, short stature and long fibula.
3. **Pseudohypoparathyroidism*** and **pseudopseudohypoparathyroidism***.
4. **Diastrophic dwarfism**.
5. **Kniest syndrome**.
6. **Acrodysostosis**.

2.20 WIDENED INTERPEDICULAR DISTANCE

Most easily appreciated by comparison with adjacent vertebrae. ± Flattening of the inner side of the pedicles.

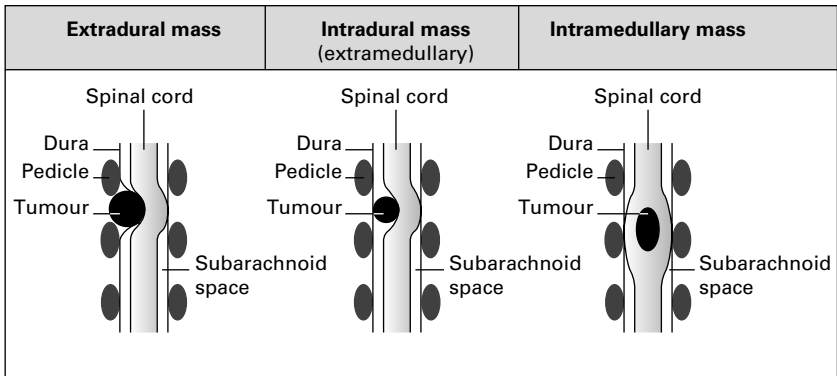


1. **Meningomyelocele** — fusiform distribution of widened interpedicular distances with the greatest separation at the mid-point of the involved segment. Disc spaces are narrowed and bodies appear to be widened. Spinous processes and laminae are not identifiable. Facets may be fused into a continuous mass. Scoliosis (congenital or developmental) in 50–70% of cases ± kyphosis.
2. **Intraspinal mass** (see 2.21) — especially ependymoma.
3. **Diastematomyelia** — 50% occur between L1 and L3; 25% between T7 and T12. Widened interpedicular distances are common but not necessarily at the same level as the spur. The spur is visible in 33% of cases and extends from the neural arch forward. Laminar fusion associated with a neural arch defect at the same or adjacent level are important signs in predicting the presence of diastematomyelia. ± Associated meningocele, neurenteric cyst or dermoid.

2.21 INTRASPINAL MASSES

Mass lesions in the spinal canal are classified as extradural, intradural and intramedullary in situation. Techniques for demonstration include plain radiography (to show secondary bony changes), myelography (obsolescent but much used in areas of inadequate MRI provision), CT (of limited value but may show bone changes, calcification and contrast uptake), and MRI, which is the definitive method at the present time.

The nature of an intraspinal mass may be partly elucidated by myelography, which allows the above subclassification to be made:



EXTRADURAL MASS

1. **Prolapsed or sequestered intervertebral disc** — occurs at all levels. Usually extradural, but occasionally penetrates dura, especially in thoracic region. May calcify, especially thoracic disc prolapse.
2. **Metastases, myeloma and lymphoma deposits** — common; look for associated vertebral infiltration, destruction in body or neural arch, collapse, paravertebral mass, other bone lesions, evidence of primary tumour. Most common sites of primary tumours are prostate, breast and lung. Thoracic spine is the most common site affected, but there may be multiple sites.
3. **Neurofibroma** — solitary, or multiple in neurofibromatosis. Lateral indentation of theca at the level of the intervertebral foramen.
4. **Neuroblastoma and ganglioneuroma** — tumours of childhood arising in adrenal or sympathetic chain, close to spine: direct invasion of spinal canal may occur.

5. **Meningioma** — may be extradural, but most are largely intradural (see below). Commonest site is thoracic, middle-aged females predominate.
6. **Haematoma** — may be due to trauma, dural AVM, anticoagulant therapy, some spontaneous. Long-segment, extradural mass on MRI, which may show signal characteristics of blood.
7. **Abscess** — usually secondary to disc or vertebral sepsis. Long segment extradural mass, with marginal enhancement on CT and MRI.
8. **Arachnoid cyst** — secondary to developmental dural defect. Uncommon, most spinal arachnoid cysts are intradural.

INTRADURAL MASS

1. **Meningioma** — as above commonly thoracic, mainly in middle-aged females. Occasional calcification.
2. **Neurofibroma** — usually extradural, but intradural neurofibromas occur, especially in cauda equina.
3. **Metastases** — from remote primary tumours, or due to CSF seeding in CNS tumours, e.g. pineal tumours, ependymoma, medulloblastoma and primitive neuroectodermal tumour (PNET). Lymphoma may also occur intradurally, particularly in lumbosacral canal.
4. **Subdural empyema.**

INTRAMEDULLARY MASS

1. **Ependymoma** — can occur anywhere in spinal canal, but commonest at conus and in lumbar canal (from filum terminale). Very slow-growing, and bone remodelling is often seen with expansion of the spinal canal. Best shown on MRI: high signal mass on T₂W images, low on T₁W, but with enhancement. Associated cord cavitation may occur.
2. **Astrocytoma** — commonest intramedullary tumour. Appearances similar to ependymoma, but faster growing, and bone changes not a feature.
3. **Dermoid (including lipoma, teratoma)** — most commonly seen in conus medullaris. Different tissue elements include lipomatous tissue: low attenuation on CT, bright on T₁W MRI, cystic spaces (low attenuation on CT, low signal on T₁W, high on T₂W MRI), and soft tissue (intermediate density on CT, and intermediate signal on T₁W MRI, enhancing after gadolinium).

4. **Infarct** — expanding in acute phase.
5. **Haematoma** — cord swelling only on CT, but features of blood on MRI.

Further Reading

- Koeler K.K., Rosenblum R.S. & Morrison A.L. (2000) Neoplasms of the spinal cord and filum terminale: radiologic-pathologic correlation. *RadioGraphics*, 20: 1721–49.
- Loughrey G.J., Collins C.D., Todd S.M. *et al.* (2000) Magnetic resonance imaging in the management of suspected spinal canal disease in patients with known malignancy. *Clin. Radiol.*, 55: 849–55.