Imaging provides answers in childhood back pain

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Back pain is less common in children than in adults, but it may denote serious underlying disease in the pediatric age group and thus requires careful and thorough clinical, imaging, and laboratory-based investigation.

Back pain is less common in children than in adults, but it may denote serious underlying disease in the pediatric age group and thus requires careful and thorough clinical, imaging, and laboratory-based investigation. The causes of back pain in younger patients are various (see table), and knowledge of these may help when correlating symptoms to imaging findings. Children tend to have significant elasticity in their spinal column. This increases the incidence of cord injuries without accompanying bone or joint injury. Most injuries are mild, resulting in bone marrow contusion or strains to the ligament or muscle. Injury commonly results in straight back syndrome caused by muscle spasm. Vertebral body fractures and dislocations are infrequent. Disc herniation in adolescents is more often traumatic than degenerative. Traumatic spondylolysis is usually induced in young, athletic adolescents by repetitive microtrauma, most commonly affecting level L5. Initial x-rays may be normal, reflecting the tendency of spondylolysis to start as a stress phenomenon and progress later into a fracture. SPECT is highly sensitive to the detection of early stress injuries, and normal scans will exclude pars injuries. CT has a higher sensitivity than radiography in detecting pars fractures. Pars edema seen on MRI denotes a stress phenomenon (Figure 1). Ring apophyseal fracture of the posterior vertebral endplate most commonly involves the inferior rim of L4. Disc degeneration may develop during growth either with or without prolapse. Diagnosis is best made by MRI, which will show low signal intensity on T2-weighted images. Spondylolisthesis without spondylolysis may be caused by congenital deficiency of the facet joints. It can also be the result of elongated pars interarticularis, due to either congenital malformation or repetitive microfractures. Diagnosis is made by plain-film x-ray and CT. Scoli...
similar to that seen in tuberculous spondylitis. Juvenile seronegative spondyloarthropathies are the most common inflammatory disorders affecting the pediatric spine. They are a late manifestation that follows sacroiliitis. Juvenile rheumatoid arthritis rarely affects the spine and seldom causes back pain.

NEOPLASTIC DISORDERS

Osteoid osteoma is a common benign bone-forming tumor that consists of a central core of vascular connective tissue and osteoid nidus (usually 1 to 2 cm), with reactive sclerosis of the surrounding bone. The nidus shows calcifications as it matures. Spinal osteoid osteoma, which occurs in 10% to 18% of all cases, involves posterior elements in the main (Figure 3). Dense sclerotic areas obscuring the nidus that can be seen on x-ray are usually at the concave side of painful scoliosis. A CT scan can accurately localize the nidus in most cases. The nidus is frequently calcified and easy to diagnose by CT. When the nidus is not calcified, a CT scan would still be very sensitive in detecting it, but the specificity of the diagnosis will depend on the presence of the surrounding sclerosis that is usually seen in osteoid osteoma. MRI shows bone marrow and overlying soft-tissue edema. The nidus may be visualized on a gadolinium-enhanced study.

Osteoblastoma has a histopathology similar to osteoid osteoma, but it is larger in size and may be aggressive. One-third of all osteoblastomas occur in the spine, and nearly all of them involve posterior elements. Radiography and CT typically show a lytic expansile lesion with varying degrees of mineralization. Surrounding bone sclerosis is rare.

The aneurysmal bone cyst is a benign cystic bone lesion, which may either be a true primary tumor or develop within a preexisting lesion. The spine is involved in 11% of cases, occurring more at the lumbar level. Posterior elements are always involved, with infrequent extension to vertebral bodies. Radiography and CT reveal a well-defined lytic expansile lesion with internal trabeculae and septae. Fluid-fluid levels and enhancing septae are seen frequently on MRI. Angiography is performed if presurgical embolization is planned.

Leukemia is usually encountered in childhood and adolescence, and acute forms represent more than one-third of pediatric malignancies. Radiography shows a generalized decrease in bone density, which may cause compression fractures.

Osteosarcoma is the most common malignant bone tumor in children and young adults. It involves the vertebral column in 4% of cases, mainly the posterior elements (79%). Osteosarcoma is seen as destructive, with variable degrees of mineralization, on radiography and CT. The tumor has no specific features on MRI.

Ewing's sarcoma is the second most common malignant bone tumor in children. The tumor typically involves the vertebral body in the spine (Figure 4). Neurological signs may be seen as well as back pain, due to intraspinal extension. Radiographic and CT findings include a mixture of destructive and sclerotic behavior. Findings are unspecific on MRI.

Langerhans cell histiocytosis is an uncommon disease caused by infiltration of various tissues by a unique type of histiocytes, the Langerhans cell. It may present in three main forms. Vertebral bodies are commonly involved when Langerhans cell histiocytosis affects the spine. This involvement is frequently multifocal but rarely includes posterior elements. Degrees of collapse are variable. Epidural extension is seen in 15% of cases.

Spinal involvement in lymphoma is due to hematogenous spread or direct invasion. It is more commonly encountered in non-Hodgkin's lymphoma than in Hodgkin's disease. Radiography and CT usually demonstrate destructive lesions. Lesions have low signal intensity on T1-weighted MRI and variable signal on T2-weighted images.

Many different types of metastases can occur in the spine. They can be lytic, blastic, or mixed, depending on the primary lesion. MRI is the best modality to detect and assess the extent of metastatic disease in the spine.

COMPLETING THE SPECTRUM

Sickle cell disease can result in either infarction or infection when congested cellular marrow impedes blood flow. Infarctions produce an H-shaped vertebral deformity. These are seen as low signal intensity on T1-weighted MRI and variable signal on T2-weighted imaging.

Primary osteoporosis in childhood is very rare. When it does occur, it is usually caused by osteogenesis imperfecta or idiopathic juvenile osteoporosis. Secondary osteoporosis is more common because it can be caused by a large number of chronic pediatric diseases and also by therapeutic regimens used to treat these diseases, which include some drugs and radiation therapy, as in lymphoma treatment. Childhood osteoporosis is usually asymptomatic but may be discovered after light trauma leading to vertebral fracture (44%). The diagnosis can be confirmed by bone densitometry.
Alkaptonuria is an autosomal recessive genetic disorder caused by deficiency of the homogentisate dioxygenase.\(^1\)\(^2\) This results in the accumulation of homogentisic acid and its metabolites in different structures of the body. Several abnormalities are encountered in the spine, including disc space narrowing and calcification of the intersosseous ligaments.\(^1\)\(^4\) Increased kyphosis is common. Osteopetrosis is a rare skeletal disease caused by aberrant bone resorption that is characterized by increased bone density. Three clinical forms are known: infantile autosomal recessive osteopetrosis, intermediate autosomal recessive osteopetrosis, and adult autosomal dominant osteopetrosis (Albers-Schonberg disease). Back pain may be present either with or without underlying fracture.\(^1\)\(^5\) A variable degree of osteosclerosis is seen on imaging. Accentuation of the vertebral endplates ("sandwich" appearance) and the more typical "bone within bone" appearance will also be seen. In conclusion, a wide range of benign and malignant disorders can cause back pain in children and adolescents. Clinicians and radiologists should be aware of these conditions so that appropriate imaging studies can be ordered and delays in diagnosis and management kept to a minimum.

**CAUSES OF BACK PAIN IN PEDIATRIC PATIENTS**

**Trauma**
- Mechanical or sports injury
- Discogenic herniation
- Traumatic spondylolysis and secondary spondylolisthesis
- Ring apophyseal fracture

**Diseases related to growth disturbance**
- Disc degeneration
- Spondylolisthesis without spondylolysis scoliosis
- Scheuermann's disease

**Infection/inflammation**
- Tuberculous
- Nontuberculous
- Inflammatory spondyloarthropathy

**Neoplastic disorders, benign**
- Osteoid osteoma
- Osteoblastoma
- Aneurysmal bone cyst

**Neoplastic disorders, malignant**
- Leukemia
- Osteosarcoma
- Ewing's sarcoma
- Langerhans cell histiocytosis
- Lymphoma
- Metastases

**Hematological disorders**
- Sickle cell disease

**Metabolic disorders**
- Osteoporosis
- Alkaptonuria

**Miscellaneous**
- Osteoporosis

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**References**

Disclosures:

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