Inflammatory and infectious processes of the spine in children, radiological findings on CT and MRI.

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Learning objectives

Review the radiological anatomy of the spine, embryology and development. Describe inflammatory and infectious processes of the spine in children.
Background

Knowledge of anatomy and embryology of the spine allows early diagnosis of spinal infections.

In children the most common infectious and inflammatory processes are Pyogenic spondilodiscitis and Granulomatous osteomyelitis.

Conventional radiography is usually the initial imaging study of infections of the spine, has gained importance in the diagnosis, treatment and monitoring for its accessibility, although in many cases the sensitivity and specificity are low. The sensitivity of computed tomography is superior, although it lacks specificity. MRI is more sensitive, specific and accurate, and nuclear medicine studies.

Anatomy, Embryology and Development

The functions of the spine include providing rigidity and leverage, give resilience and flexibility of movement and protect the spinal cord.

Their study should be methodical, usually where first alignment and bone density values and specifically the soft tissues, the vertebral bodies, intervertebral discs, vertebral arch (pedicle, lamina and facet) and finally the apophyses are valued (transverse and spinous). Careful evaluation of these structures allows the early detection of diseases.

The spine is divided into three stages: membrane development, chondrification and ossification.

Embryology spine starts when the notochord is separated from the primitive gut neural tube and the 25th day of intrauterine life and filled areas are created mesenchyme. This mesenchyme, which is located laterally to the neural tube form a number of somite that miotonos give rise to precursors of the spine. After the resegmentation, the vertebral bodies are formed. The chondrification of the vertebral bodies occurs between weeks 6th and 8th and ossification begins in the 9th. Between vertebral bodies notochord remnants which give rise to disc nucleus pulposus. The craniocervical joint (occipital, C1 and C2, and ligaments of the atlanto-occipital and atlantoaxial joints) originates in the first five primordial vertebrae.

Two centers in each vertebral hemicuerpo chondrification midline separated by the dorsoventral notochord sheath and a center on each side of the posterior arches. As such centers are formed and joined chondrification, notochord cells are pressed out of the
vertebral body into the disc space are allowed to expand slightly to become the nucleus pulposus. The two centers chondrification merge into a cartilaginous vertebral body and attached to the cartilaginous centers of the arcs that have also been fused behind dorsal neural tube.

On lateral radiographs, the vertebral bodies of the newborn tend to be rectangular and oval in dorsal lumbar region. The anterior and posterior vascular channels are usually prominent in the newborn and young infant. The above channels usually disappear during childhood but can be seen occasionally in adulthood. Subsequent channels can be seen frequently in adulthood. At birth, the synchondroses between the vertebral body and the posterior neural arch quite well displayed (Figure 1,2).

INFLAMMATORY AND INFECTIOUS PROCESSES OF THE SPINE

PYOGENIC SPONDILODYSCITIS

Drainage is infectious and intervertebral disc space, can involve two adjacent vertebral bodies of any segment: Lumbar 48%, 35% thoracic, cervical 6.5%. It can have involucra paraspinal and collections form up to 75% of cases. Clinically, the patient presents with back pain and fever.

Differential diagnoses are degenerative endplate changes, tuberculous vertebral osteomyelitis, spinal neuropathic arthropathy, chronic hemodialysis spondyloarthropathy.

General Features

- Ill defined hypointense vertebral marrow on T1W1 with loss of endplate definition on both sides of the disc.
- Thinning vertebral space.
- Loss of cortical endplate.
- Vertebral collapse.
- Narrowing of the canal.

Radiographic Findings

- At 2-8 weeks of starting clinical radiography is normal.
- Appearance of osteolytic vertebral body platform.
- Increased density of soft tissues.

Computed tomographic Findings

- Vertebral or hypodense with increased volume of the paraspinal soft tissues, with or without involucra of air.
• Following the administration of contrast medium, there is enhancement of the disk, bone and soft tissue.
• Osteolytic vertebral plate appearance.
• Bone sequestration.

**Magnetic resonance findings**

• Thinning of the intervertebral space.
• Ill defined hypointense vertebral marrow won T1W1 with loss of endplate definition on both sides of the disc (figure 3,4).

**GRANULOMATOUS OSTEOMYELITIS**

Is a granulomatous infection of the spine and adjacent soft tissue typically caused by tuberculosis or brucellosis. The patient has chronic back pain, focal tenderness, fever. The differential diagnoses are pyogenic spondylitis, fungal spondylitis, spinal spondylitis.

**Tuberculous spondylitis**

• It is also known as Pott disease.
• Gibbus vertebrae with relatively intact intervertebral discs and large paraspinal abscesses.
• The most common location is mid thoracic or thoracolumbar and anterior vertebral body.
• Isolated posterior element involvement possible.
• Affect multiple vertebrae (non contiguous).
• Radiographic findings may be not be present until weeks after onset of infection, vertebral diffuse sclerosis can occur.
• Computed tomographic findings are important diffuse bone destruction and bone sequestration.
• In magnetic resonance, T1WI hypointense marrow in adjacent vertebrae, hypointense intraosseus, extradural, paraspinal abscesses; T2WI hyperintense marrow, disc, soft tissue infection; STIR hyperintense marrow, disc, abscess; T1 with gadolinium marrow, subligamentous, discal, dural enchancement (figure 5).

**Brucellar spondylitis**

• Anterosuperior epiphysitis at L4 with associated sacroiliitis.
• Posterior elements not affected.
• Anterior endplate at diskovertebral juncture involved in focal presentation.
• Vertebrae morphologically intact despite osteomyelitis.
• Spinal deformity rare.
• Destruction of intervertebral discs.
• Epidural soft tissue mass.
• Paraspinal soft tissues rarely effected.
• In computed tomographic the osseous destruction is focal.
• Magnetic resonance imaging findings are unchanged compared to tuberculous spondylitis (figure 6).
Images for this section:

**Fig. 1:** Radiographs showing the chronological development of the dorsal and lumbar spine.

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Fig. 2: Lateral radiographs showing the chronological development of the cervical spine.

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Fig. 3: Pyogenic spondilodiscitis at early stage. Magnetic resonance images at coronal T1WI (a), sagital T2WI (b) and STIR (c), that shows an abnormal signal intensity in
the intervertebral disc L3-L4 and subcondral marrow edema at the adjacent vertebral endplates.

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Fig. 4: Advanced pyogenic spondilodiscitis. (a) Sagital reformated CT scan shows destruction of T12 and L1 vertebral bodies with posterior protusion and loss of intervertebral disc space. (b and c) Vertebral destruction and large right paravertebral abscess shown in these axial and coronal T1WI MR post gadolinium images.

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Fig. 5: Tuberculous spondylitis (Pott’s disease). Magnetic resonance images on STIR (a) and gadolinium enhanced T1WI (b and c) show marked destruction and wedging of D9 segment with early involvement of adjacent vertebral bodies and relative sparing of the intervertebral discs, and a large epidural soft tissue mass that compress the spinal cord.

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Fig. 6: L5-S1 disc abscess with involvement of adjacent endplates. Serologic markers and aspirate culture were positive for Brucella.

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Findings and procedure details

GE Signa 1.5 T TwinSpeed Excite (GE Medical Systems, Milwaukee, WI, USA) scanner using an 8 element phased array surface coil. For tissue characteritation protocol included systematically a axial, sagital and coronal T1SE, T2FSE, STIR and fat saturation T1SE post gadolinium injection.
Conclusion

Prior knowledge of the anatomy and embryology of the spine in children is important to detect inflammatory or infectious diseases. The use of tomography and magnetic resonance imaging facilitates timely diagnosis and to differentiate them from other diseases.