MR Imaging of spinal epidural lesions.

Poster No.: C-0354
Congress: ECR 2014
Type: Educational Exhibit
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Keywords: Education and training, Diagnostic procedure, MR, Neuroradiology spine
DOI: 10.1594/ecr2014/C-0354

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Learning objectives

The spinal epidural space is a real space extending from foramen magnum to sacral canal and since MRI is the gold standard for spine imaging we present a comprehensive overview of the epidural space anatomy and highlight the key imaging features of major lesions on MRI.

Our objectives are:

1. Classify the spinal epidural lesions depending on the origin.
2. Be able to recognize the MRI signs of epidural pathology.
3. Be able to recognize imaging characteristics of epidural lesions that allow for narrowing differential diagnosis.

Background

The spinal epidural space separates the thecal sac from the surrounding bony spinal canal and communicates freely with the paravertebral space through the intervertebral foramina.

Many diseases can involve the spinal epidural space, either as primary lesions of this space or, more commonly, as an extension from a disease process in the neighbourhood.

Depending on the origin, the spinal lesions located in the epidural space can be classified into:

1. Degenerative
2. Infective-inflammatory
3. Traumatic
4. Vascular
5. Neoplastic (primary or secondary)
6. Miscellaneous

Although we should remember that a single disease process may fall into more than one of the above categories.
Findings and procedure details

Boundaries of the spinal epidural space (fig.1) are:

- **Anterior**: The posterior longitudinal ligament and annular ligaments.
- **Posterior**: Ligamenta flavum and the periosteum of the laminae.
- **Laterally**: Pedicles of the spinal column and the intervertebral foramina containing their neural elements.
- **Superiorly**: the space is anatomically closed at the foramen magnum where the spinal dura attaches with the endosteal dura of the cranium.
- **Caudally**: the epidural space ends at the sacral hiatus, which is closed by the sacrococcygeal ligament.

Contents of the spinal epidural space (fig.2) are:

- Loose areolar connective tissue
- Adipose tissue
- Lymphatics, arteries, and an extensive venous plexus
- Exiting spinal nerve roots as they exit the dural sac and pass through the intervertebral foramina.

MRI SIGNS OF EPIDURAL SPACE PATHOLOGY

- Direct Signs:
  - Expansion of epidural space.
  - Infiltration of epidural fat.
  - Obstructed CSF column.
  - Extension into nerve root canals.

- Indirect Signs:
  - Increased intrapedicular distance.
  - Vertebral expansion or destruction.
  - Paravertebral soft tissue mass.
  - Displacement of spinal cord or thecal sac.
1. DEGENERATIVE LESIONS

Degeneratives changes in the spine are the most frequent cause of impingement on the Epidural Space (ES) and include:

- Herniated disc
- Posterior osteophytes
- Ligament calcification
- Hypertrophy of the ligamentum flavum
- Spondylolisthesis
- Facet joint arthropathy

We must suspected a degenerative origin of epidural lesion when this one has a relationship with marked degenerative facet joints, when there is hypertrophy of the ligamentum flavum or when we check the integrity of intervertebral discs.

1.1 Disc Herniation (fig.3, fig.4, fig.5) : is the commonest cause of epidural lesion and results in compresion of the anterior epidural space, with lateral or medial irritation of nerve root or cauda equina.

- Usually here is a continuity with the parent disc ( not in case of sequestered disc).
- Sequestrated and extruded fragments usually show low signal on T1-weighted images and most of them give high signal on T2-weighted images.
- Most show peripheral contrast enhancement, attributed to an inflammatory response with granulation tissue.

1.2 Facet joint arthrosis : undergoes changes by as a synovial joint.

- SYNOVIAL CYST arises in relation to a degenerated facet joint and present clinically with radiculopathy similar to disc herniation.
- On imaging, synovial cyst is seen as posterolateral epidural lesion compressing the nerve root and/or the thecal sac with signal intensity varying according to the cyst content (fluid, air, calcium, or blood).

1.3 Ligamentous ossification : involving posterior longitudinal ligament or ligamentum flavum is usually associated with decreased signal intensity on all sequences and may be difficult to distinguish from ligamentous hypertrophy .

2. INFECTIVE/INFLAMMATORY LESIONS:
Pyogenic spinal infections most commonly are caused by Staphylococcus aureus (in 60% of patients) and Enterobacter species (in 30% of patients).

Within the infectious-inflammatory lesions the spondylodiscitis highlights and hematogenous way is the most frequent.

Others infectious diseases include pyogenic epidural abscess (think about it after spinal instrumentation) and spinal tuberculosis or fungal infections which are uncommon except in immunocompromised and debilitated patients.

2.1 SPONDYLODISCITIS (fig.6, fig.7, fig.8)

usually affects the discovertebral unit (2 adjacent vertebral bodies and the intervertebral disc) and they may extend into epidural space, posteriors elements ans paravertebral soft tissues. It affects a small proportion (2-7%) of all patients with osteomyelitis.

We should evaluate:

- disk signal intensity (hypointense on T1W and typically hyperintense on T2W).
- disk height (usually decreased).
- vertebral signal intensity alterations (T1W hypointense/T2W hyperintense).
- enplate erosions on T1W images.
- presence of paraespinal and epidural extension (they generally appear isointense to muscle on T1-weighted images and hyperintense on fat-saturated T2-weighted or short-tau inversion recovery (STIR) images).
- behaviour after contrast material administration (avid enhancement).

2.2 EPIDURAL ABSCESS (fig.9, fig.10)

It is an extradural spinal infection with formation of abscess and the result of hematogenous spread of infectious agent (in 55-75% of cases the Staphylococcus aureus is the most common pathogen), direct inoculation of epidural space (penetrating trauma, intervention, diagnostic procedure...)

MRI Signal Characteristics:
- T1WI: Iso or Hypo-intense relative to the spinal cord
- T2WI: High signal intensity
- After contrast administration: slightly heterogeneous enhancement (phlegmonous stadium) / Thick or thin flange surrounding enhancement pus collection of low signal (necrotic abscess) / combination of both (some cases).

Remember! The abscess classically enhances at the periphery when mature, mimicking hematoma and sequestered disc fragment, and enhance homogenously in the immature cellulitis stage, mimicking tumor.

3. TRAUMATIC/IATROGENIC

3.1 EPIDURAL HAEMATOMA (fig.11, fig.12)

is the accumulation of blood in the epidural space and it has a variable aetiology commonly associated with:

- Trauma
- Rupture of epidural venous plexus
- Anticoagulation
- Coagulation....

Remember! 40% are idiopathic.

MRI Findings:

- T1WI: Variable appearance, depending on the age of the haematoma: Acute (within 48 hrs): Iso-intense, > hypo-intense / hyper-intense Sub-acute and chronic: hyper-intense > iso-intense.
- T1 + fat suppression: No signal loss (to distinguish blood from fat)
- T2WI: High signal intensity
- T2 GRE: Blooming
- After contrast administration: no significant enhancement is noted. Some peripheral enhancement from dural hyperemia or linear enhancement in epidural septations or vessels may be seen.

Remember! May associated cord compression.
3.2 EPIDURAL FIBROSIS (fig.13, fig.14)

is a scar formation within epidural space after lumbar surgery and part of failed back surgery syndrome.

MRI findings:

- Postsurgical changes in posterior elements.
- T1WI: Peridural soft tissue intensity (isointense/often surrounds nerve root/ may be mass-like).
- T2WI: variable signal intensity / slightly increased signal relative to disc.
- After contrast administration: immediate homogeneous enhancement.

Remember! In recurrent disc herniation: there is no central enhancement after intravenous contrast (peripheral enhancement common)

4. VASCULAR

4.1 EPIDURAL HEMANGIOMA

Spinal epidural hemangiomas are extremely rare, and most are cavernous.

The most common MR features are solid hypervascular masses with lobular contour.

MR Findings:

- T1WI: Low or intermediate signal intensity (Slow blood flow contribute substantially to the signal).
- T2WI: high signal intensity (explained by high content of stagnant blood).

Remember! Contrast-enhanced CT or MR imaging is generally not performed as part of the routine work-up in a patient with lumbar radiculopathy, but it may be useful for
clarifying the vascular nature of this lesion and for differentiating it from extruded disk herniation, which presents an enhancement that envelopes the extradural lesion,

4.2 ANGIOMATOUS MALFORMATIONS

Dural and intramedullary arteriovenous malformations (AVM) may have large draining veins coursing in the epidural space.

MR Findings:
- **T1WI**: isointense ovoid or round lesions
- **T2WI**: hyperintense
- **After contrast enhancement**: homogeneous enhancement

5. NEOPLASTIC (PRIMARY AND SECUNDARY)

- The primary neoplastic lesions are those that arise from elements of the peidural space like meningiomas, schwannomas, neurofibromas...
- The secondary tumors are metastasis (most frequent), lymphoma, mieloma...(less frequent).

5.1 EPIDURAL MENINGIOMAS

Spinal menigiomas typically occur in adults and usually have an intramedullary site. Conversely epidural location is uncommon.

Meningiomas are usually and intradural extramedullary, but in 15% of the cases presented a localization strictly epidural.

It is uncommon for a spinal menigioma to have an epidural location; in fact, epidural meningiomas account for only 3.5%-7.0% of all spinal meningiomas.

MR Findings:

-Lack of foraminal extension favors a diagnosis of menigioma over schwannoma or neurofibroma.
- T1WI: isointense with spinal cord
- T2WI: not exhibit substantial increased signal intensity
- After contrast enhancement: immediate and homogeneous

5.2 SCHWANNOMAS/NEUROFIBROMAS (fig.15)

Schwannoma and neurofibroma on the other hand are indistinguishable from each other on imaging.

Schwannoma is usually single and occurs in patients with or without neurofibromatosis type 2, while neurofibroma tends to be multiple and is commonly seen in patients with neurofibromatosis type 1.

Both tumors arise in the epidural space with or without intradural component. Typically, schwannoma and neurofibroma extend through and expand the neural foramen, a feature depicted by plain films, CT, and MRI.

MR Findings:

- T1WI: isointense or hypointense relative to cord, roots
- T2WI: hyperintense, heterogeneous (degeneration)
- After contrast enhancement: uniform intense (non-homogeneous) enhancement

5.3 METASTASIS (fig.16, fig.17)

The spine is an extremely common site for development of blastic metastases from:

- prostate
- breast
- carcinoid
- lung
- GI (gastrointestinal tract)
- bladder....
or **lytic metastases** from:

- renal
- breast
- lung
- thyroid
- melanoma
- ovarian...

These lesions may extend into the epidural space by either direct extension of the vertebral body metastasis or by soft tissue invasion into the spinal canal.

This may be associated with impingement of the thecal sac or compression of the spinal cord ("curtain" sign).

**MR Findings:**

- **T1WI**: Low signal intensity/ Paravertebral and epidural soft tissue.
- **T2WI**: Varied appearance/ Often high signal intensity/Sclerotic lesions may be low signal or iso-intense.
- **After contrast administration**: high enhancement (accentuated with application of fat saturation)/ variable enhancement depending of degree of sclerosis (blastic metastases).

**Remember**! Look at of the vertebral bone marrow signal changes. It helps in reaching the diagnosis of metastatic disease.

**5.4 EPIDURAL LYMPHOMA** *(fig.18, fig.19)*

In lymphoma, paravertebral, vertebral, or epidural involvement may exist separately or in any combination. Primary spinal epidural lymphoma is a known separate entity.

Several vertebral involvement, homogenous signal intensity epidural mass that shows extension over several vertebral segments with uniform enhancement, and paravertebral masses extending through neural foramina are the key features of spinal lymphoma on imaging.
Thoracic is the most common location in spine and in the vertebra is in the boy with epidural extension.

MR Findings:

- **T1WI**: isointense homogeneous epidural mass (often multisegmental +/- extend through foramina)

- **T2WI**: various, iso/hypointenso to cord

- **After contrast administration**: avid homogeneous enhancement

### 6. MISCELLANEOUS

#### 6.1 EPIDURAL LIPOMATOSIS (fig.20, fig.21)

The condition is more common in males with Cushings syndrome and presents with signs of spinal cord compression.

MRI is the exam of choice in suspected cases of epidural lipomatosis. In this condition, there is diffuse unencapsulated excessive fat deposition in the epidural (mostly the posterior) space.

MR Findings:

- **T1WI**: high signal intensity on T1WI and suppresses with fat saturation sequences.

#### 6.2 ARACHNOID CYST (fig.22, fig.23)

Spinal arachnoid cysts are relatively uncommon and may be either intra-dural or extra-dural.

It is intraspinal extramedullary loculated cerebral spinal fluid (CSF) collection

As the cysts follow the intensity of CSF and their walls are generally not visible, they may not be identified unless the cord is displaced.

MR Findings:
- **T1WI**: CSF intensity

- **T2WI**: CSF intensity, may even be brighter than CSF on account of no signal loss from pulsation/flow

- After contrast administration: no contrast enhancement

**Images for this section:**

**Fig. 1**: Boundaries of epidural space
Fig. 2: Contents of epidural space
**Fig. 3:** Axial plane T1WI: Focal posterocentral protusion at the L5-S1 level occupies anterior epidural space, compresses thecal sac and left S1 nerve root.
Fig. 4: Sagittal T1WI: same patient
**Fig. 5:** Axial T1WI+C: peripheral enhancement of protrusion

**Fig. 6:** Sagittal T1WI: Disc space infection with hypointense marrow, vertebral collapse, endplate erosion, disc place loss and epidural phlegmon.
Fig. 7: Sagittal T2WI: same patient
Fig. 8: Sagittal T1WI+C: homogeneous enhancement of vertebral bodies and epidural phlegmon causing mass effect on the cord.
Fig. 9: Sagittal T2WI: large dorsal epidural abscess collection as T2 hyperintensity.
**Fig. 10:** Sagittal T1WI+C: same patient after contrast administration with peripheral enhancement of the large dorsal epidural collection.
**Fig. 11:** Sagittal T1WI: epidural fluid collection hyperintense to CSF and cord (subacute hemorrhage).
**Fig. 12:** Axial T1WI: same patient with epidural collection compressing the conus medullaris.

**Fig. 13:** Axial T1WI: hypointense epidural mass (peridural fibrosis) surrounding the right lateral aspect of the thecal sac (with mass effect) and exiting root.
Fig. 14: Axial T1WI+C: Post-contrast image in the same patient shows diffuse homogeneous enhancement of the peridural fibrosis.
**Fig. 15:** Axial T2WI: hyperintense well-circumscribed right transforaminal mass with paraspinal extension and severe mass effect on thecal sac.
**Fig. 16:** Sagittal T2WI: multiple metastatic lesions in vertebral bodies with ventral epidural extension (epidural soft tissue lesion) and cord compression in patient with prostate cancer.
Fig. 17: Axial T2WI: same patient; "curtain sign".
**Fig. 18:** Axial T2WI: large homogeneous epidural mass hypointense to cord with mass effect on thecal sac.
Fig. 19: Sagittal T2WI: same patient
**Fig. 20:** Sagittal T1WI: excessive epidural tissue isointense to fat with mass effect on cauda equina.

**Fig. 21:** Axial T2WI: excessive epidural fat surrounding the compressed thecal sac which shows a Y-shaped configuration.
**Fig. 22:** Axial T1WI: nonenhancing extramedullary loculated CSF intensity collection displacing cord.
Fig. 23: Axial T2WI: same patient intradural arachnoid cyst.
Conclusion

The spinal epidural lesions may arise from the contents of epidural space (intrinsic) or from structures outside the space and encroach on it (extrinsic).

Encroachment on the thecal sac and spinal cord should be carefully assessed to prevent long term neurological sequale. MRI is the modality of choice for the assessment of lesions within the spinal canal as it has exquisite contrast and structural resolution, able to image all compartments.

Personal information

References


