POST-OPERATIVE SPINE IMAGING
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Postoperative spine imaging, either by surgery or by mini-invasive procedures, is a complex tool and depends upon many factors, including the anatomy of the patient, the surgical procedure or the mini-invasive technique that has been chosen, the disease for which it was performed, the age of the patient, the biomechanical condition of the underlying cortical and cancellous bone, the intervertebral disc and musculo-ligamentous tissues, the time elapsed since the surgical procedure, and the duration and nature of the post-surgical syndrome.(1)

Generally, the post-operative imaging is performed in patients in which clinical symptoms (mostly pain with or without neurological deficit) are still present and minor and major complications needs to be excluded.

The post-treatment complications can be distinguished in post-surgical group and post-mini-invasive procedure groups. (2)

However for both types of groups, we can distinguished early or late complications.

For post-surgical group, in the acute stage, it is important to exclude complications such as bleeding, infection, meningoceles/dural lacerations, as cause of neurological deficits; while in late post-surgery recurrent disk herniation, stenosis, instability, textiloma and arachnoiditis frequently cause of persisting or recurrent pain

For mini-invasive group, persisting or recurrent back pain in early or late time from the procedure can be encountered.

In order to understand the post-operative spinal imaging, radiologists must understand the operative and instrumentation options to search the post-surgical or post-treatment patter-complications.

The post-operative spinal imaging technique includes X-ray, CT and MR before and after contrast media inj..

Generally, X-ray is not used in the diagnosis of early or late post-operative complications but only to check the positioning of the metallic implant.

CT is useful to show the post-surgical laminotomy/laminectomy defect and to show marked filament in case of textiloma(foreign body). MDCT is a valuable technique in evaluating (postoperative) spinal stenosis (central spinal canal, lateral recesses and/or foraminal)or in evaluating the result of the post-surgery spinal stabilization.

In the acute post-surgical stage, CT has little role. The main role of CT in the postsurgical spine, however, is after instrumentation or fusion surgery, to check also the correct positioning of metallic implant

CT is far less accurate than MR in:

differentiating recurrent disc from epidural scar and evaluating early complications (hemorrhage, infection, etc.)

MR, thanks to its superiority evaluating soft tissue, is the gold standard imaging for the evaluation of patients with recurrent clinical symptoms after surgery or mini-invasive techniques, in early or late complications. MR is the preferred imaging technique in the postoperative spine. By MR, it’s possible detect the cause of persistent or recurrent back pain in patient affected by herniated disk or vertebral compression fracture treated by surgery or mini-invasive procedure (such as vertebroplasty-Kyphoplasty) on lead to research fibrosis, hematoma or new vertebral fracture.

Tissue enhancement is much better detected with MRI than with CT making the differential diagnosis of recurrent disc herniation versus epidural fibrosis much easier.
Moreover, bone marrow edema, soft tissue inflammation, nerve root enhancement, hemorrhage, and facet joint inflammation are difficult or even impossible to detect on CT. Evaluation of spinal stenosis with MRI is also very accurate. In routine imaging of the postoperative spine, both sagittal and axial MR images are usually obtained. In the sagittal plane, T1W and T2W,STIR and T1W Fat suppressed with contrast agent offer complementary information. Sagittal and axial T2-WI are also excellent for showing the spinal cord and the nerve roots of the cauda equina.

**Early Complications**

**Hematoma**
Hematoma can occur few hours to days following the spinal surgical procedure. MR will show mixed blood breakdown products and is more sensitive than CT especially thanks to T2* sequence. Some hematomas may reach rather large sizes and can extend into the central spinal canal to compress the spinal nerves and/or spinal cord.

**Spondylodiscitis**
Spondylodiscitis, or discitis combined with vertebral osteomyelitis, is a relatively uncommon but serious complication of spinal (and disc) surgery, which may lead to long-lasting and sometimes permanent morbidity. It can be encountered after surgery or some type of disk treatment, but can also occur after diagnostic procedures such as discography and myelography. The infection is mostly due to direct intra-operative contamination. The organisms involved are usually *Staphylococcus epidermidis* or *Staphylococcus aureus*. Early diagnosis and appropriate treatment are mandatory to shorten the disease course and reduce the severe sequelae of spondylodiscitis. The diagnosis of postoperative spondylodiscitis depends on a combination of clinical, laboratory, and imaging findings. MR is probably the only imaging modality able to make a significant contribution to the diagnosis of postoperative spondylodiscitis. Key points include:
- The absence of peridiscal marrow changes (i.e., low signal intensity on T1W and high signal intensity on T2W) makes the diagnosis of septic spondylodiscitis highly unlikely. The same holds true for absence of enhancement of the intervertebral disc space. An enhancing soft tissue mass surrounding the affected spinal level in the perivertebral and epidural spaces is highly suggestive of septic spondylodiscitis.

**Pseudomeningocele**
Pseudomeningoceles typically develop after inadvertent surgical laceration of the dural sac during surgery or following incomplete closure of the dural sac in cases of intradural surgery. Usually, they protrude through a surgical bony defect of the posterior spinal elements to form a cystic lesion with imaging characteristics comparable to CSF both on CT and MRI.

**Late Complications**

**Recurrent Disc Herniation – Epidural Scar Tissue**
Differentiation between scar tissue and recurrent or residual disc herniation is important, since the latter is an indication for surgery. A recurrent disc herniation may actually be made up of disc material, cartilage, bone, or any combination of these. Adequate differentiation may be achieved with relatively high accuracy on contrast-enhanced CT, but is even better made on contrast-enhanced MRI, which is the imaging modality of choice. In the immediate postoperative phase, the epidural space at the site of surgery fills with hemorrhagic and inflammatory tissue and debris. In the first days after surgery this may
resemble a residual disc herniation, especially since the mass effect can be considerable and even more pronounced than in the preoperative phase. In the first few days after surgery it may be impossible to make the differentiation with a residual/recurrent disc herniation on imaging alone. In the following weeks there is reorganization and epidural granulation tissue is formed. This epidural granulomatosis shows strong enhancement with gadolinium. After several months, this epidural granulation tissue organizes into more ordered collagen fibers to epidural scar formation (epidural fibrosis). At this time there is weaker enhancement.

The distinction between epidural fibrosis and recurrent disc herniation can usually be made using existing criteria, including on the one hand obliteration of the epidural fat by uniformly enhancing scar tissue in the anterior, lateral, and/or posterior epidural space in epidural fibrosis, or, on the other hand, early central non-enhancement in recurrent or residual disc herniation. The high signal of normal epidural fat also contrasts well with postoperative epidural fibrosis which is dark. Months after surgery the epidural tissue surrounding a recurrent disc herniation eventually leads to inflammatory changes in the disc material causing more or less enhancement of the recurrent disc material itself. This process may lead to complete spontaneous resorption of a recurrent disc herniation and is reflected in changes of volume and enhancement of the prolapsed disc material.

**Radiculitis**
On MR, enhancement of the intrathecal spinal nerve roots of the cauda equina following i.v. gadolinium administration is observed especially on coronal T1W, as a nerve–root barrier breakdown due to inflammation.

**Arachnoiditis**
They are caused by the surgical procedure itself, the presence of intradural blood following surgery. Three MRI patterns can be found in adhesive arachnoiditis:
-scattered groups of matted or “clumped” nerve roots;
-an “empty” thecal sac caused by adhesion of the nerve roots to its walls;
-an intrathecal soft tissue “mass” with a broad dural base, representing a large group of matted roots, which may obstruct the CSF pathways).

These changes may be focal or diffuse and contrast enhancement of the thickened meningeal scarring and underlying intrathecal roots may or may not be observed.

**Textiloma**
A surgical sponge or “cottonoid”, accidentally left behind in a surgical wound, eventually becomes a textiloma. The foreign body is made of synthetic cotton-like (“cottonoid”) fiber (“rayon”) usually containing a barium sulphate marking filament, visible on radiographic examinations. The pseudotumor consists of the foreign body itself with perilesional reactive changes, forming a foreign-body granuloma.

MR can be confusing and misleading because the most typical radiographic sign of a forgotten “cottonoid”, the filament, is not visible on MRI. Indeed, this filament consists of barium sulphate, which is neither magnetic nor paramagnetic, and therefore causes no visible magnetic trace on MR. These lesions show a moderate degree of peripheral contrast enhancement on T1-WI, believed to be related to an inflammatory foreign-body reaction. On T2-WI, these lesions give low signal, presumably reflecting a dense fibrous tissue reaction peripherally, and central foreign body material lacking mobile protons. This also explains the centrally non-enhancing area on contrast-enhanced T1-WI.

**MR post-vertebroplasty/Kyphoplasty**
MR patterns following Vertebroplasty/Kyphoplasty are mainly characterized by the signal produced by the areas surrounding the cement and by the cement itself. There is little effect on the size of the treated vertebra. Acrylic cement appears as an intraspongy focal area of T1 and T2 hypointensity.
that is mostly oval or rounded; this appearance tends to become stable 6 months after treatment. The area surrounding the cement appears hypointense on T1 and hyperintense on T2, a likely expression of bone marrow oedema; this signal alteration tends to disappear gradually. In pre- and post-vertebroplasty imaging, MRI is regarded as the reference standard for correct evaluation of both container and content. Awareness of cement changes over time and of the reaction of the surrounding bone tissue is crucial for correct assessment of post-vertebroplasty images.

MR is the first choice for patients treated by vertebroplasty/kyphoplasty with new or persistent back pain in order to detect new vertebral compression fractured that can be still the cause of the pain related or not to the treatment or by the normal evolution of the basic diseases (porotic or metastatic diseases).

By the STIR sequent, it’s possible to detect hypersignal of bone spongious (the intraspongious edema) of adjacent or distant metamer that causes persistent back pain.

**Cages, Prostheses, and Instrumentation**

Spinal instrumentation techniques have expanded dramatically during the past several decades, but the search for the perfect operative approach and fixation system continues. Fixation devices are designed for the cervical, thoracic, lumbar, and sacral segments using anterior, posterior, transverse, videoarthroscopic, and combined approaches. In most cases, bone grafting also is performed, because instrument failure occurs if solid bony fusion is not achieved.(3) Radiologists must understand the operative and instrumentation options. Knowledge of expected results, appearance of graft material, and different forms of instrumentation is critical for evaluating position of implants and potential complications associated with operative approaches and spinal fixation devices.

The goal of spinal instrumentation is to maintain the correct anatomic alignment of spinal segments. Post-surgery complications can occur in early or late follow-up.

The MDCT may be acquired at 1-mm beam collimation with multiplanar reconstructions formatted at 3-mm interval reducing the metallic artifacts. It should be performed to evaluate the post-surgery result and the assessment of fused spines

Magnetic resonance imaging has thus far not been useful for direct assessment of implants or hardware, but it assumes a primary role for all other operative complications not directly involving grafts, implants, or hardware

Early post-operative complications are primarily those that occur in the first few postoperative weeks or months: graft extrusion; implant or hardware misplacement; infection; and dural leak (pseudomeningocele)

Examination in multiple planes by CT should be performed because axial images alone can be misleading as the screw takes an oblique course through the pedicle, particularly if there is violation of the superior or inferior cortical margins of the pedicle

**Pseudarthrosis**

Pseudarthrosis is defined as failure of attempted spinal fusion to achieve solid bony arthrodesis by 1 year after surgery. The gold standard for diagnosis of pseudarthrosis continues to be surgical exploration combined with clinical data.

MR has not established a significant role in the diagnosis of non-union or instrumentation failure. When findings are present on MRI, pseudarthrosis is seen as a linear hyperintensity on T2-weighted images and subchondral bands of low intensity on T1-weighted images. Reactive marrow changes and enhancement with gadolinium due to abnormal motion may be seen as well

MDCT with MPR reconstructions and X-ray film show the abnormal lucency with surrounding sclerosis

**Conclusion**
Despite advances in imaging technology, imaging of the postoperative spine remains a challenging and difficult issue. One or a combination of complimentary medical imaging modalities may be recommended.

References

