Degenerative Disk Disease of the Cervical Spine: Spectrum of Imaging Findings

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Purpose

Cervical spondylosis is a chronic degenerative condition of the cervical spine affecting the vertebral bodies, intervertebral disks, facet joints and the contents of the spinal canal. It is commonly seen in people older than 40 years, is believed to be part of the normal aging process of the spine and will affect up to two-thirds of the population during their lifetime.

The goal of our presentation is to illustrate the spectrum of imaging appearances of degenerative disease in the cervical spine on plain radiography, CT, MRI and to review the performance of each method.

Methods and Materials

Cervical spine radiographs, CT and MRI scans were retrieved from consecutive cases stored in our hospital's PACS database in a period of two months. Representative cases were selected and reviewed according to the presence of abnormalities related to the:

- alignment of cervical spine,
- vertebral body height,
- vertebral endplate,
- neural foramen width,
- joint space,
- intervertebral disk and
- uncovertebral and facet joints.

In routine practice, the above entities are initially illustrated by plain radiographs. CT and MRI are used in order to obtain more detailed information.

Standard radiographic views include anteroposterior and lateral projections. Oblique views are obtained for the evaluation of neural foramina and facet joints. Flexion and extension views are only needed in advanced spondylosis and may reveal instability.

Since the introduction of multislice CT technology, CT scan imaging protocol includes volumetric data acquired from the region of interest. Axial reconstructions are the basic imaging data sets and reconstruction in the coronal and sagittal plane are created on a routine basis. Soft-tissue and bone window is essential. Three dimensional
reconstructions are not produced on a routine basis in cases of cervical spine spondylosis but only upon clinician’s request. Overall, CT scanning time is short.

MR Imaging protocol includes images in the coronal, axial and sagittal plane. In our institution, routine cervical spine MR protocol includes conventional sagital T1 and T2 turbo spin echo images and T2 fat-saturated images, axial T1 turbo spin echo and T2 gradient echo imges. At last, coronal T1 turbo spin echo images are acquired for evaluation of cervical spine scoliosis. Supplementary thin axial section (e.g. steady-state) may also be obtained to delineate with detail the margin of disk herniations and for the evaluation of neural foramina. MR scanning times are relatively long.

**Results**

Neck pain is the most frequent cause for imaging request of the cervical spine. Degenerative disease of the cervical spine is a common cause of intermittent neck pain and is also called spondylosis.

Imaging findings in cervical spine degenerative disease include:

- loss of the normal lordotic curvature of the cervical spine which may be presented either as straightening or reverse of the normal cervical spine lordosis,

- joint space narrowing,

- vertebral body degeneration and possible loss of height,

- end-plate sclerosis,

- uncovertebral joint hypertrophy and facet joint arthrosis,

- syndesmophyte or osteophyte formation,

- ligament calcification,

- neural foramen stenosis and

- disk disease which includes disk bulging, disk herniation and disk protrusion/extrusion, disk degeneration and vacuum phenomenon.

Also, degenerative disease of the cervical spine may be associated with changes in the spinal cord.
**Plain radiographs:** They are of limited specificity but are still considered as the first imaging modality for the evaluation the cervical spine (Fig. 1-15).

**CT scans:** Multislice CT provides more detailed information relative to radiographs for the investigation of cervical spine. This information is related to:

- measurements of the spinal canal dimensions,
- the neural foramina and the exiting nerve roots,
- the intervertebral disk. Disk bulging and disk herniation can be directly visualised. Disk degeneration-dehydration and vacuum phenomenon can be readily identified

and

- the spinal canal contents.

CT scan has definite advantages relative to the rest of the imaging modalities in the evaluation of the bony structures and of calcification in the soft tissues. With the use of multislice technology, it has become superior relative to other modalities since image reconstructions can be created in various planes.

(Fig. 16-32).

**MRI:** it is considered to be the imaging modality of choice for the investigation of degenerative disease of the spine in general and of course, of the cervical spine. This is mostly because of the method's excellent soft-tissue contrast capability.

MRI is insensitive to the detection of soft tissue calcification and can lose details related to bone and bone cortex. It is, though, of undisputable superiority and provides additional information relative to plain radiographs and CT scans in the investigation of the:

- intervertebral disk that comprises detection of disk degeneration, annular tears, disk bulge and disk herniation,

- neural foramina and the neural elements within them, in particular neural foramen stenosis and impingement on nerve roots and

- spinal cord. (Fig. 33-45).

A diagnostic algorithm proposed for the investigation of cervical spine degenerative disease starts with plain radiographs in cases of persistent neck pain. In patients with severe pain, radicular pain and neurologic deficits, MRI is thought to be the investigation method of choice. CT should be considered if detailed information about the bony structures is needed.
Fig. 1: Anteroposterior view of the cervical spine. Normal exam.
Fig. 2: Lateral view of the cervical spine. Normal exam. There is normal alignment of the cervical spine vertebrae and preservation of the normal lordotic curve. Normal height of the vertebral bodies. No joint space narrowing is identified.
Fig. 5: Flexion view.
Fig. 6: Extension view.
Fig. 7: Lateral view. Straightening of the cervical spine. Otherwise, normal exam.
**Fig. 8:** Lateral view. Straightening and mild reverse of the normal lordotic curve of the cervical spine. Small anterior osteophyte formation is noted.
Fig. 9: Lateral view. Normal alignment of the cervical spine. Small anterior osteophyte formation is noted at the C3-C4, C4-C5 and C5-C6 levels. There is joint space narrowing at the C4-C5 level and mild end-plate sclerosis. Uncovertebral joint hypertrophy at the C4-C5 and C5-C6 levels is also noted.
**Fig. 10:** Lateral view. Loss of the normal lordotic curve and straightening of the cervical spine. Vertebral body height is normal. There is joint space narrowing, end-pate sclerosis and anterior osteophyte formation at the C4-C5 and C5-C6 levels. Mild uncovertebral joint hypertrophy is noted at the same levels.
Fig. 11: Lateral view. Normal alignment of the cervical spine. Mild loss of height of the C4, C5 and C6 vertebral bodies. There is generous anterior osteophyte formation at the C4-C4 and C5-C6 levels. Very mild loss of height at the C6-C7 levels.
Fig. 16: CT scan of the cervical spine. Coronal reformat. C5-C6 joint space narrowing, right C5-C6 uncovertebral joint hypertrophy and end-plate sclerosis of the C5 vertebra lower end-plate.
Fig. 17: CT scan of the cervical spine. Sagittal reformat. Mild posterior displacement of the C5 relative to the C4 vertebra. C5-C6 joint space narrowing, mild end-plate sclerosis and small anterior osteophyte at the same level.

Fig. 18: Axial CT image through the upper cervical spine at the level of the intervertebral joint space.
Fig. 19: Axial CT image through the upper cervical spine.
Fig. 20: Axial CT image through the upper cervical spine at the level of the intervertebral joint space. Bone window.
Fig. 21: Axial CT image through the upper cervical spine.
Fig. 33: Sag. T2 TSE image through the cervical spine. Midline level. Mild straightening of the cervical spine. Otherwise normal exam.

Fig. 34: Ax. T2 GRE of the upper cervical spine at the C3-C4 intervertebral joint space level. Normal exam.
Fig. 35: Ax. T2 GRE of the upper cervical spine at the C4 upper end-plate level. Normal exam.
Fig. 3: Right lateral oblique view. No stenosis of the neural foramina is identified.
Fig. 4: Left lateral oblique view. No stenosis of the neural foramina is identified.
**Fig. 12:** Anteroposterior view of the cervical spine. Very mild right-ward scoliosis of the cervical spine.

**Fig. 13:** Lateral view. Straightening of the cervical spine. C4-C5, C5-C6 and C6-C7 joint space narrowing, end-plate sclerosis and mild anterior osteophytosis.
**Fig. 14:** Right oblique view. Mild stenosis of the right C3-C4 and C5-C6 foramina and more severe of the right C4-C5 foramen.
Fig. 15: Left oblique view. Stenosis of the left C4-C5 and C5-C8 foramina.
**Fig. 22:** CT scan of the cervical spine. Sagittal reformated images. Normal lordosis of the cervical spine. Normal height of the vertebral bodies. Mild C5-C6 and C6-C7 joint space narrowing, end-plate sclerosis and anterior osteophyte formation.

**Fig. 25:** Axial section through the lower cervical spine. Extensive osteophyte formation and right uncovertebral joint hypertrophy. There is compression of the anterior aspect of the thecal sac and of the cervical cord. Spinal stenosis is identified.
Fig. 23: Axial section through the mid-cervical spine. Extensive left uncovertebral joint hypertrophy. There is stenosis of the left neural foramen and compression of the exiting nerve root.
Fig. 24: Axial section through the mid-cervical spine. Bone window. Same patient and same level as image 23. Extensive left uncovertebral joint hypertrophy. There is stenosis of the left neural foramen and compression of the exiting nerve root.
Fig. 26: Axial section through the lower cervical spine. Bone window. Same patient and same level as image 25. Extensive osteophyte formation and right uncovertebral joint hypertrophy. There is compression of the anterior aspect of the thecal sac and of the cervical cord. Spinal stenosis is identified.
**Fig. 37:** Sag. T1 TSE image. Mid-line section. Straightening of the cervical spine. Multilevel disk disease is identified.
Fig. 38: Sag. T2 TSE image. Mid-line section. Same patient as in image. Straightening of the cervical spine. Multilevel disk disease is identified (C3-C4, C4-C5, C5-C6).

Fig. 39: Axial T2 gradient echo image. Midline posterior disk herniation with compression of the anterior aspect of the thecal sac. Mild left uncovertebral joint hypertrophy.
Fig. 40: Axial T2 gradient echo image. Left lateral posterior disk herniation with compression of the anterior aspect of the thecal sac.
**Fig. 41:** Axial T2 gradient echo image. Large posterior disk herniation with compression of the anterior aspect of the thecal sac and spinal cord. Spinal cord deformation is noted. There is stenosis of the spinal canal. No cervical myelopathy is noted.
Fig. 42: Axial T2 gradient echo image. Midline-left posterior disk herniation with compression of the anterior aspect of the thecal sac and the anterior aspect of the spinal cord.
Fig. 27: CT scan of the cervical spine. Sagittal reconstructions. Midline section. Straightening of the cervical spine. C5-C6 and C6-C7 joint space narrowing, end-pate sclerosis and small anterior and posterior osteophytes. Vacuum phenomenon at the C6-C7 level.
**Fig. 28:** CT scan of the cervical spine. Sagittal reconstructions. Midline section. Multilevel degenerative disease. C3-C4, C4-C5 and C5-C6 mild joint space narrowing. Vacuum phenomenon in the same intervertebral disks. C4-C5 and C5-C6 posterior osteophyte formation.

**Fig. 29:** CT scan of the cervical spine. Degeneration and vacuum phenomenon of the intervertebral disk. Very small midline posterior disk herniation.
**Fig. 30:** CT scan of the cervical spine. Bone window. Same patient and same level as image 29. Degeneration and vacuum phenomenon of the intervertebral disk. Very small midline posterior disk herniation.
Fig. 31: CT scan of the cervical spine. Axial section. Disk herniation. There is compression at the anterior aspect of the thecal sac and -most probably- of the cervical cord within the sac.
**Fig. 32:** CT scan of the cervical spine. Axial section. Bone window. Same patient and same level as image 31. Disk herniation. There is compression at the anterior aspect of the thecal sac and -most probably- of the cervical cord within the sac.
**Fig. 36:** Ax. ss image. Disk delineation is excellent. Neural foramina elements are clearly depicted.
**Fig. 43:** Axial T2 image through the cervical spine. Disk bulging is identified more prominent in left posterolateral position. Left foraminal stenosis is noted.
Fig. 44: Axial T2 section through the lower cervical spine. Prominent disk bulge and compression of the anterior aspect of the thecal sac and of the spinal cord. Mild spinal canal stenosis. Xeural foramina stenosis due to uncovertebral joint hypertrophy.
**Fig. 45:** Sagital T2 section through the left lateral side of the spinal canal.
Conclusion

Standard radiographs are still the first imaging modality used in order to evaluate degenerative disease of the cervical spine. CT scan is used if MRI cannot be performed and if bony abnormalities need to be evaluated. MRI is the imaging modality of choice because not only of its inherent capability for multiplanar imaging but mainly because of its very high tissue contrast resolution.

References


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