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Myelopathy and Radiculopathy Due to Cervical Spondylosis: Myelographic-CT Correlations

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Forty patients with symptoms and signs of radicular disease or spinal cord involvement secondary to cervical spondylosis were studied with myelography (using nonionic water-soluble contrast medium) followed by computed tomographic (CT) myelography. In 17 patients CT was also performed before myelography. CT myelography adds useful information to the myelographic findings. Cord compression is better evaluated and osteophytes can be differentiated from disk herniation. Plain CT can demonstrate a herniated disk but with less accuracy than CT myelography. Cord and root compression are not seen directly on plain CT; for this reason myelography should be the first procedure in patients with myelopathy or myeloradiculopathy, which may be followed by CT myelography.

Computed tomography (CT) has substantially modified the neuroradiologic approach to the diagnosis of herniated disk and spondylosis in the lumbar region [1-5]. But examination of the cervical spine by CT requires a different approach than in the lumbar region. Thinner intervertebral disks, different anatomic landmarks (less or no epidural fat), and a greater frequency of osteophytes and narrowing of the canal than in disk herniations are some of the distinguishing concerns of the cervical spine.

Clinical presentation and differential diagnosis are also different. Pure cervical radiculopathy (neurologic deficit due to nerve root compression) is less common and occurs in younger patients. Myelopathy (neurologic deficit due to spinal cord compression) of different degrees of severity, ranging from simple hyperreflexia to severe progressive paraparesis, is more common and may be associated with signs of radicular involvement. Clinical signs of spinal cord involvement may be mistaken as indicating the presence of chronic degenerative disease of the spinal cord (e.g., amyotrophic lateral sclerosis) or of a tumor in or adjacent to the cord.

With cervical spine CT, there is a need not only to visualize the bony and soft-tissue structures surrounding the spinal canal and to study more levels than in the lumbar region, but also to recognize the effects of spondylosis on the spinal cord and nerve roots. CT slices must be thinner than in the lumbar region in order to visualize the intervertebral disk and neural foramina.

This study compares the myelographic and CT findings in patients with cervical spondylosis in order to assess the values and limitations of CT performed without and with subarachnoid contrast enhancement, and to define the role of CT in the diagnostic evaluation of patients with cervical myelopathy and/or radiculopathy.

Materials and Methods

Forty patients (30 men and 10 women, mean age 56 years, range 30-74 years) with symptoms and signs of radicular or spinal cord disease secondary to cervical spondylosis were examined. The clinical presentation was that of radicular pain in 13 patients. In the other 27 patients signs of myelopathy (usually slowly progressive) were the major complaint. These were associated with radiculopathy in 13 patients.

All patients were investigated by means of myelography, using 15 ml of the nonionic water-soluble contrast medium iopamidol (Iopamiro 300, Bracco, Milan, Italy) in a concentration of 300 mg I/ml introduced via lumbar puncture. CT was performed within 2 hr after myelography in all patients. In 17 patients, plain CT was also performed before myelography. A Siemens Somatom 2N scanner or a GE CT/T 8800 unit was used for the CT studies. An average of three levels were examined, selected on the basis of clinical signs or myelographic findings. Eight to 12 contiguous slices (1.5 or 2 mm thickness) per level were done. The levels were always localized by means of a preliminary digital radiograph in the lateral projection.

Results

Myelographic evidence of nerve root compression and/or of anterior dural sac compression by herniated disk or osteophytes was demonstrated in all patients. A single level was involved in 13 patients (C3-C4, one; C4-C5, three; C5-C6, six; C6-C7, two; C7-T1, one). In the other 27 patients, multiple levels were involved (C3-C4, seven; C4-C5, 14; C5-C6, 22; C6-C7, nine; C7-T1, none).

When CT is performed after myelography with the subarachnoid spaces opacified by contrast medium (CT myelography), anterior compression of the dural sac can be clearly visualized. If there is no space between the posterior margin of the vertebral body and the anterior surface of the sac, the compression is due either to osteophyte (fig. 1) or to ossification of the posterior longitudinal ligament. Otherwise, a herniated disk can be suspected. At CT myelography, anterior compression of the dural sac by osteophytes was found in 27 patients and by disk herniation in 18. The spinal cord outlined by contrast medium can be clearly seen. Compression and deformity of the cord can be demonstrated and may be severe, with reduction of the anteroposterior diameter of the cord even to

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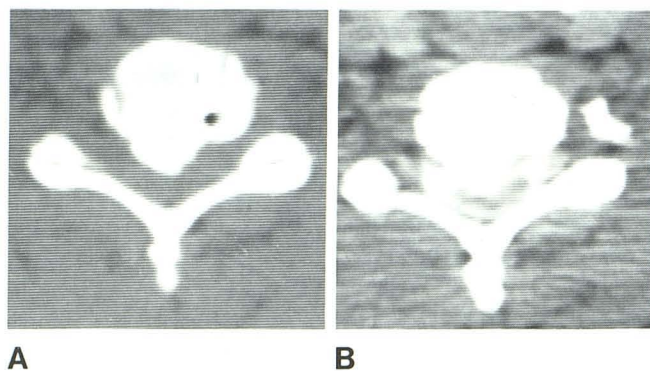


Fig. 1.—Cervical spine of 55-year-old woman with progressive paraparesis in last 2 years. **A**, Plain CT. Large osteophyte protruding into spinal canal. **B**, CT myelogram demonstrates severe degree of cord compression by impinging osteophyte.

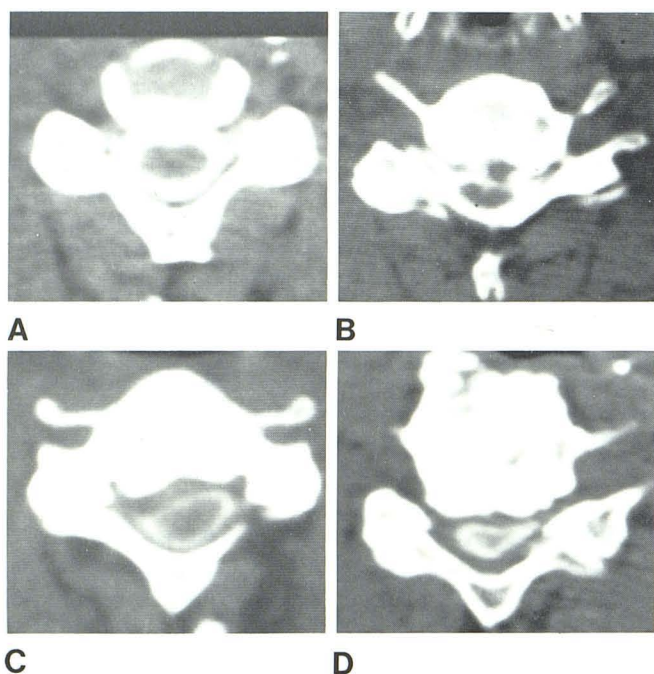


Fig. 2.—CT myelographic images. **A**, Normal spinal cord and nerve roots within neural foramina. **B**, Spinal cord compression by herniated disk. **C**, Osteophyte impinging on right anterior aspect of opacified sac. **D**, Narrow canal and hypertrophy of ligaments.

one-third of normal in some cases (fig. 2). Clear evidence of cord compression was found in 24 cases. Nerve root sheaths opacified by contrast medium can be easily followed to the neural foramina, and compression or amputation was found in 19 cases.

In the 17 patients examined by plain CT before myelography, there was close correspondence between pre- and postcontrast CT in demonstrating narrowing of the spinal canal and neural foramina by osteophytes, seen in 12 cases by both methods. Disk herniation was recognized in eight cases on CT with intrathecal contrast medium, but only in five by plain CT. Cord compression was visualized in 10 patients on CT images with subarachnoid contrast medium, but could not be demonstrated on plain CT. The same was

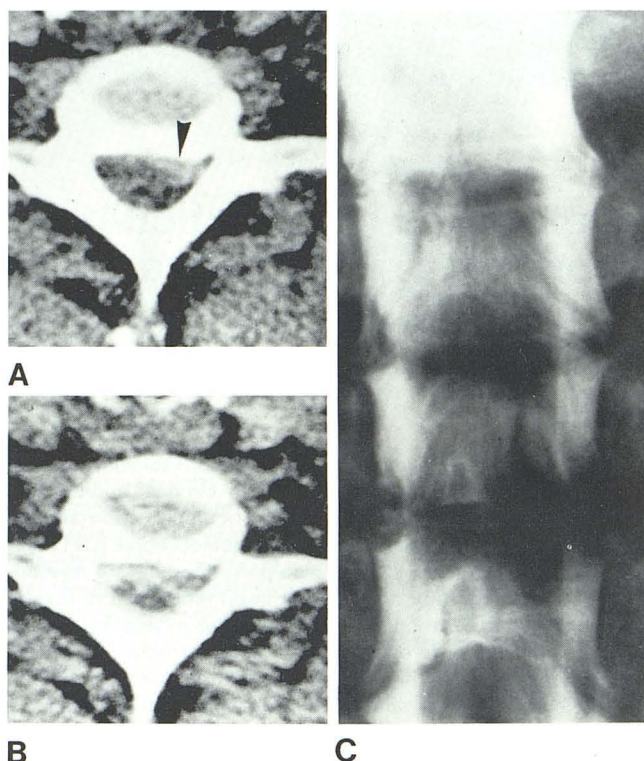


Fig. 3.—Posterolateral disk herniation on left in patient with pure radiculopathy. **A**, Plain CT image shows soft-tissue structure slightly denser than remaining spinal content protruding into spinal canal (arrow). **B**, CT myelogram. Compression and obliteration of opacified subarachnoid space on left side. **C**, Anteroposterior myelogram. Amputation of root sleeve with root swelling.

true for root compression, never directly seen on plain CT, but well demonstrated in 11 patients when the subarachnoid spaces were opacified by contrast medium. Narrowing of the canal or the neural foramina did, however, lead to a suspicion of root compression on plain CT in six of these patients.

When clinical presentation is considered, disk herniation or lateral osteophyte was found in 12 of 13 patients with pure radiculopathy and in six of 27 with myelopathy or myeloradiculopathy (fig. 3). A narrow canal and cord compression were present in 24 patients with myeloradiculopathy and in one with pure radiculopathy.

Discussion

Satisfactory CT examination of the cervical spine requires thin slices (1.5 or 2 mm), precise localization of the scanning plane by preliminary digital radiography, and absence of swallowing or movement artifacts. CT images must include the space between the pedicles of two adjacent vertebrae. An average of eight contiguous slices is necessary at each level to recognize all the pertinent bony and soft-tissue anatomy. These images must be carefully analyzed for reduction of neural foramina, presence of osteophytes arising from vertebral bodies or articular processes, disk degeneration, and herniations.

The density resolution of the spinal canal by current CT units allows reliable recognition of the dural sac when the canal is of normal size in the upper cervical region. But only rarely can the

spinal cord be visualized on plain CT below the level of C2. Disk herniation may be defined as a soft-tissue structure protruding posteriorly from the disk with a density higher than the remaining structures within the spinal canal.

When a prominent osteophyte is demonstrated with resultant narrowing of the spinal canal, the dural sac is seen less well on plain CT, and spinal cord compression can only be suspected, not proven. CT myelography is far superior to plain CT in demonstrating spinal cord and root compression. The spinal cord is sometimes severely narrowed, and the cross-sectional axial plane is best to show the extent of compression and the relation of the dural sac to the walls of the spinal canal.

The presence of subarachnoid contrast medium allows differentiation between compression due to osteophyte or to disk herniation. In a given slice, when the dural sac is displaced posteriorly and no osteophytes are seen at that level or at the levels above and below, one may assume the compression is due to a soft hernia.

Ossification of the posterior longitudinal ligament was identified in three of our patients. In these cases, CT was crucial in demonstrating the thickness and extent of the ossification behind the vertebral body, as it was with a thin line of separation between the ossification and the posterior surface of the vertebral body. This information was essential to the neurosurgeon in planning an operative approach to decompress the affected portion of the spinal cord.

Myelography plays a basic role in patients with cervical myelopathy and/or radiculopathy in showing the spine and spinal cord in its full extent and in demonstrating multiple levels of involvement, dynamic changes with movement, and partial block with the head hyperextended due to posterior compression by infolding of the ligamenta flava. Water-soluble contrast medium is well tolerated and provides excellent visualization of the nerve roots and root sleeves.

We believe the diagnostic protocol should be tailored according to the patient's clinical presentation. In patients with isolated signs of pure radicular compression and with pain and sensory deficit at a well defined level, plain CT should be the first examination. Digital radiography in the lateral projection for localizing purposes could replace plain x-ray films. The CT examination should include the intervertebral space clinically involved and one level above and below. If a disk herniation impinging on the neural foramen and compressing the nerve root or a narrowing of the neural foramen by a lateral osteophyte is seen, myelography can be avoided.

In patients with myelopathy or myeloradiculopathy a myelogram must always be obtained since the pathological levels may be multiple. Identical symptomatology can be due to other causes including tumors and chronic degenerative diseases of the spinal cord. CT myelography provides useful complementary information on the exact location and extent of osteophytes and the degree of cord compression. CT before myelography in these cases does not seem at present to provide sufficient information to avoid myelography.

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