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MR Imaging of the Cervical Spine in Rheumatoid Arthritis

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The cervical spine was examined with MR imaging and conventional radiography in 23 patients with severe rheumatoid arthritis. All patients had neck pain and 17 also had neurologic symptoms. MR provided detailed information about soft-tissue lesions, vertebral dislocation, and narrowing of the spinal canal. Pannus surrounding the odontoid process was revealed in 14 patients, all with horizontal atlantoaxial subluxation. Compression of the medulla and/or spinal cord, caused by dislocated vertebrae and/or the soft-tissue mass around the odontoid process, was seen in 15 patients. When there was more than one dislocation the most important level could be determined. Posterior occipitocervical fusion had been performed in six of the patients, and in only two of these was adequate analysis of the upper cervical spine impossible because of artifacts from metal (stainless steel wires and pins).

Sagittal MR in the neutral position combined with conventional radiography, including lateral views in flexion and extension, provided all the information necessary for further clinical management of rheumatoid arthritis of the cervical spine.

Involvement of the cervical spine is common in rheumatoid arthritis. Such involvement may be severe with neurologic disturbances and may even lead to sudden death, especially after long-standing and aggressive disease. Surgical intervention may be required, and in such patients an extensive neuroradiologic evaluation is necessary; until now, this evaluation has included plain-film radiography, myelography, CT, and CT myelography [1]. MR imaging, with its high contrast discrimination, has been reported to be valuable for assessing the cervical spine and cord. Although MR findings in the neck in several cases of rheumatoid arthritis have been described [2-4], so far only isolated cases have been reported. We present the MR findings and compare them with conventional radiographic and clinical findings in a series of patients with advanced rheumatoid arthritis.

Subjects and Methods

Twenty-three patients with severe neck problems caused by rheumatoid arthritis were studied. The patients were 31-79 years old (mean, 64); 17 were women and six were men. They had had rheumatoid arthritis for 2-48 years (mean, 23.3). All patients had severe neck pain, seven had different degrees of limb paresis (usually marked weakness in all four limbs), four had paresthesias, three had both paresis and paresthesias, and three experienced dizziness. Six patients had undergone posterior occipitocervical fusion with the use of stainless steel wires and pins, acrylic bone cement, and bone chips [5] 1-10 years before the MR examination. In one patient laminectomy had been performed at the C3-C5 levels.

For the present investigation, all patients were examined with conventional radiographs of the cervical spine, including lateral views in flexion and extension. MR was performed on a permanent resistive system with a vertical magnetic field operating at 0.3 T.* Both T1-weighted spin-echo 500/28 (TR/TE) pulse sequences were performed, as were T2-weighted 2000/56 sequences with the multislice technique. A head coil was used for evaluation of the craniocervical junction, and a solenoidal surface coil wrapped around the neck was used for the middle and distal parts of the cervical spine.

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The slice thickness was 5 mm, and the pixel size varied from 1 to 1.2 mm. All scans were obtained in the sagittal plane with the head in the neutral position. Destruction and dislocation of the cervical vertebrae were evaluated on the radiographs, and skeletal as well as paraspinous and intraspinal lesions were assessed on the MR images. The radiographic and MR findings were compared, and the relationship between the clinical status and MR findings was evaluated.

Results

The conventional radiographs revealed pronounced arthritic changes in the intervertebral joints in all patients. There was horizontal subluxation at the C1–C2 level in 16 patients, vertical subluxation of C2 relative to the skull and C1 in 17 patients, erosion of the odontoid process in 11 patients, and subaxial subluxations in 11 patients (Table 1). In five individuals, possible erosion of the odontoid process could not be assessed accurately on the radiograph because of superimposition of other skeletal structures.

In the MR examinations, the skeletal as well as paraspinous and intraspinal structures could be evaluated without exception (Table 1). Despite the neutral position during MR, horizontal atlantoaxial subluxation was seen in 11 patients. The 17 cases of vertical subluxation seen on plain radiographs were verified. Erosion of the odontoid process was also verified, and was apparent in another six patients (Fig. 1). In 14 patients, all with horizontal subluxation of the C1–C2 level, a soft-tissue mass 1–7 mm thick surrounded the odontoid process (Figs. 1 and 2). The size of the mass was largest in those patients who had pronounced C1–C2 instability, while it was small in those with moderate dislocation and in those who had been subjected to occipitocervical surgery. The mass had an intermediate signal intensity on T1-weighted images, and slightly increased signal intensity on T2-weighted images. At the level below C2 the subluxations seen on the radiographs were verified and, in addition, two previously undetected pronounced subluxations at the T2–T3 and C7–T1 levels were revealed (Fig. 3).

Compression of the medulla and/or spinal cord caused by dislocated vertebrae or the soft-tissue mass around the odontoid process was seen in 12 patients at the foramen magnum level (Fig. 1) and in six patients at the levels below C2 (Table 1). Isolated narrowing of the subarachnoid space, without involvement of the cord, was seen at the foramen magnum level in one patient (Fig. 2) and below the C2 level in three patients (Fig. 3). In five patients, increased signal intensity was seen in the cord on T2-weighted images at the level of the compression caused by the soft-tissue mass around the odontoid process. In seven patients with shortening of the cervical spine, caused by destruction of the intervertebral joint cartilage, as well as of the disks, the thecal sac was wrinkled.

The relationship between the clinical and MR findings is shown in Table 2. Compression of the cord was seen in two of six patients without neurologic symptoms, in 10 of 14 patients with paresis and/or paresthesias, and in three of three patients with dizziness. Isolated sac compression was seen in two of 14 patients with paresis and/or paresthesias, and there was no involvement of the sac or cord in four of six patients without neurologic symptoms or in two of 14 patients with paresis and/or paresthesias.

In five of the six patients who had been subjected to occipitocervical fusion, the stainless steel wires and pins caused artifacts in the area of the posterior arches and the posterior part of the spinal canal (Fig. 4). In only two of these patients did the artifacts also include the anterior arches and the anterior part of the spinal canal, making adequate analysis of the relationship between the anterior part of the cord and the spinal canal impossible. In one patient (Fig. 3), the fixation material had dislocated posteriorly, and therefore caused no artifacts.

Discussion

MR has already been established as the best method for the evaluation of the craniocervical region, and it has also been considered to be superior for examination of the middle and distal parts of the cervical cord and canal [2–4, 6–8]. Because of its very high contrast discrimination it shows both anatomy and disease of the paravertebral, vertebral, and intraspinal structures in great detail. Furthermore, the ease of imaging in any plane is a great advantage. As the magnetic field is vertical in the MR scanner used by us, solenoidal surface coils could be used. They were wrapped around the neck, giving more homogeneous signal than the planar surface coils used in most previous reports. However, when using a solenoidal coil wrapped around the neck, the signal-to-noise ratio decreases quickly cephalad and caudad [9]. Therefore, the best imaging of the craniocervical junction was obtained with a head coil, whereas the middle and lower spine were better imaged with the solenoidal coil (Fig. 5). As severe rheumatoid arthritic changes are most common in the upper cervical spine, imaging with low centering in the head coil was sufficient in most cases. To minimize the number of sequences, the choice of coil(s) and centering should be guided by the findings on conventional radiographs. Sagittal

TABLE 1: Conventional Radiographic and MR Findings in the Cervical Spine in Rheumatoid Arthritis

Level: Findings	No. of Patients with Findings (n = 23)	
	On Conventional Radiography	On MR Imaging
Occiput–C2:		
Horizontal subluxation, C1–C2	16	11
Vertical subluxation, C1–C2	17	17
Erosion of odontoid process	11	17
Soft-tissue mass at odontoid process	0	14
Cord compression	0	12
Isolated sac compression	0	1
Increased signal from cord on T2-weighted image	0	4
Below C2:		
Subaxial subluxation	11	13
Soft-tissue mass at dislocated vertebrae	0	6
Cord compression	0	6
Isolated sac compression	0	3

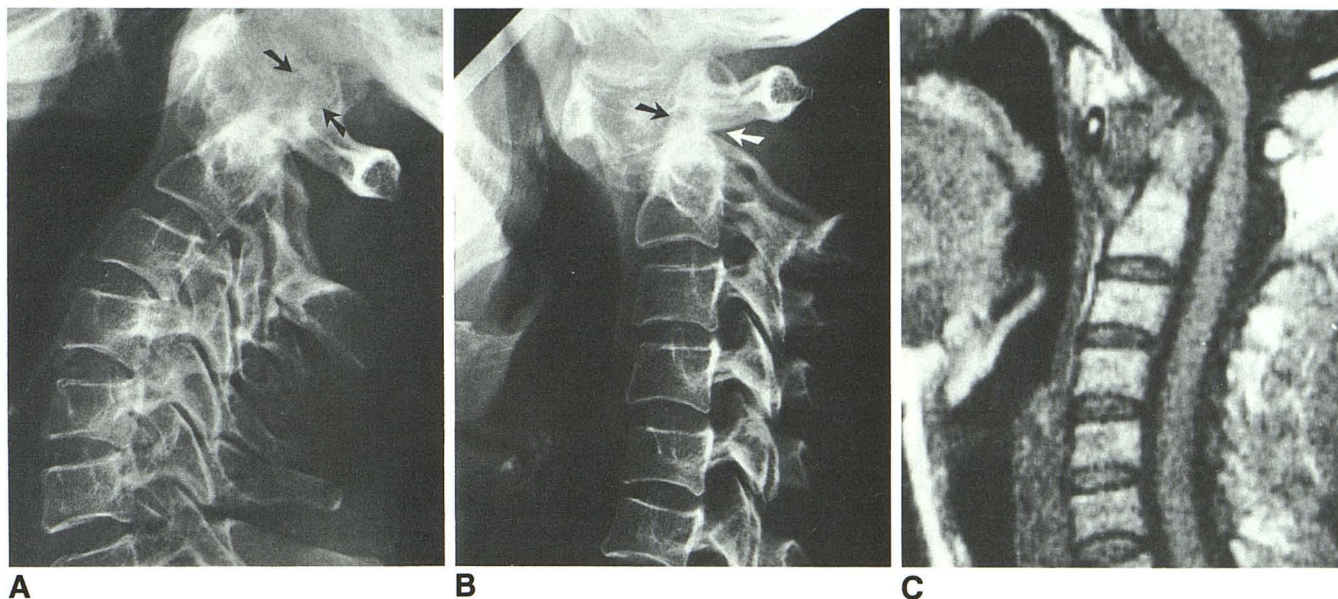


Fig. 1.—68-year-old woman with rheumatoid arthritis for 24 years. **A and B,** Lateral conventional views in extension (**A**) and flexion (**B**) reveal pronounced horizontal and moderate vertical subluxation at C1–C2 level. Shape of odontoid process is preserved, although cortical bone is thinner than normal (**arrows**) and there is generalized osteoporosis. **C,** T1-weighted MR image (500/28). C1–C2 subluxation is verified. Note apparent loss of cortical bone of odontoid process. Large soft-tissue mass is mostly anterior to odontoid process. Upper cervical cord is compressed.

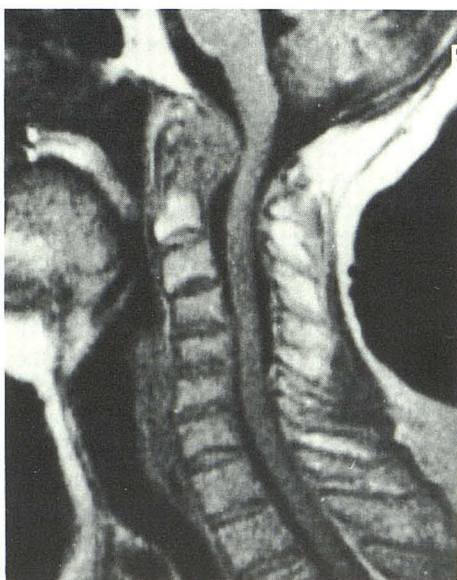


Fig. 2.—78-year-old woman with rheumatoid arthritis for 2 years. T1-weighted image. Large soft-tissue mass, situated mainly posterior to odontoid process, compresses subarachnoid space but not cord. Since the patient was examined with the head in neutral position, the horizontal C1–C2 subluxation was not visible. Cortical bone of odontoid process appears almost completely destroyed.

sections were sufficient in most of our cases, but when involvement of the lateral aspects of the spinal canal is suspected, coronal sections may provide important additional information. Most information was gained from the T1-

weighted images, while the T2-weighted images provided additional tissue characterization, giving information on the state of the compressed cord.

In our series, MR information was compared only with that from conventional radiographs of the cervical spine and the clinical state. It would have been of interest to also compare MR information with findings at myelography and especially CT myelography, as well as with those from histopathologic examination. However, as the MR examination provided all information necessary for further clinical management, it was considered unnecessary to perform myelography and CT myelography.

MR provides excellent information on the neural, vertebral, and paravertebral structures. However, it is well known that MR is inferior to CT and possibly to plain radiography for detecting calcification and ossification. Therefore, erosion of the odontoid process may be overestimated on MR examination, especially when the cortical bone is thinner than normal and there is generalized osteoporosis (Fig. 1). In addition, small osseous erosions may be difficult to detect on conventional radiographs in such cases. Granulating tissue possibly could extend into the bone through the erosion [8], thereby obscuring the margin of the odontoid process on MR.

The soft-tissue mass seen around the odontoid process on MR is of clinical importance, as in most cases it appeared to impinge on the spinal cord and medulla. The moderately increased signal intensity of the mass on T2-weighted images was consistent with an increased amount of water, as in edema. The mass could thus represent pannus formation. However, if it was composed of inflammatory tissue only, the signal on the T2-weighted image should have been more intense. Furthermore, the largest soft-tissue masses were

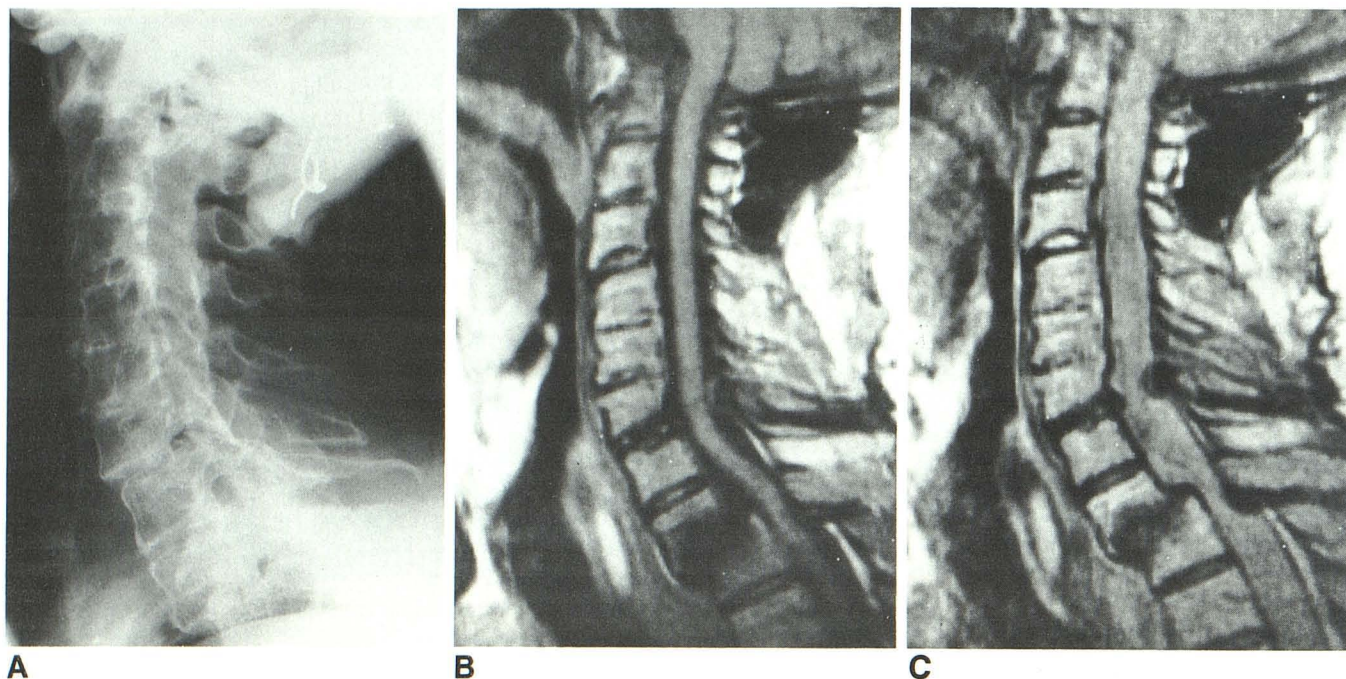


Fig. 3.—65-year-old man with rheumatoid arthritis for 18 years.
A, Lateral conventional view reveals pronounced arthritic changes throughout cervical spine. Subluxation at T2–T3 level was missed at initial interpretation of plain film.
B and **C**, T1- (**B**) and T2- (**C**) weighted MR images. Destruction of T2 and T3 vertebral bodies and subluxation are obvious. Pronounced compression of thecal sac is caused by subluxation, protruding ligaments, and bone, visible on T2-weighted image. Implantation material from surgical fusion does not cause artifacts in the spinal canal, as it has dislocated posteriorly from its initial position.

TABLE 2: Relationship Between MR Findings and Clinical Symptoms in Rheumatoid Arthritis

Clinical Symptom	MR Findings (<i>n</i> = 23)		
	No Involvement of Sac or Cord	Isolated Sac Compression	Cord Compression
No neurologic symptoms (pain only)	4	0	2
Paresis and/or paresthesias	2	2	10
Dizziness	0	0	3

found in those patients who showed the most advanced horizontal subluxation. The soft-tissue mass, therefore, may represent not only rheumatoid inflammatory tissue but also fibrous tissue caused by chronic mechanical irritation, as proposed by Sze et al. [10].

The MR examinations were performed in a neutral position, and therefore the number of horizontal subluxations seen with MR was less than noted on conventional radiographs. The latter were obtained with provoked extension and flexion of the cervical spine. If MR had been performed in flexion, more cases of cord compression probably would have been found. However, lying still in the neutral position for 10–30

min was quite painful for several patients with advanced rheumatoid arthritis. Therefore, we would not recommend routine examinations with the neck flexed. Table 2 shows that, in most patients with neurologic disturbances, compression of the cord already was obvious in the neutral position; thus, MR positioning with provocation should not be necessary and could be hazardous.

In advanced rheumatoid arthritis with severe destruction of the cervical spine, myelography may be very painful for the patient, and in some cases it even may be impossible to perform adequately. CT myelography has been the best technique, but it also has certain disadvantages when compared with MR imaging. CT myelography is an invasive examination, the soft-tissue contrast discrimination is inferior to that of MR, and for practical reasons it is difficult to cover the whole cervical spine with thin sections.

MR provides detailed information on the paraspinal, vertebral, and neutral structures, and depicts exactly the most important information: the location, type, and extent of cord compression. Combined with conventional radiography it provides all the information necessary for further clinical management.

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Fig. 4.—71-year-old woman with rheumatoid arthritis for 40 years.

A, Conventional lateral view.

B, T1-weighted image. Evaluation of cord and posterior part of spinal canal is impossible because of artifacts from fixation material. However, the area around the odontoid process is still visible.

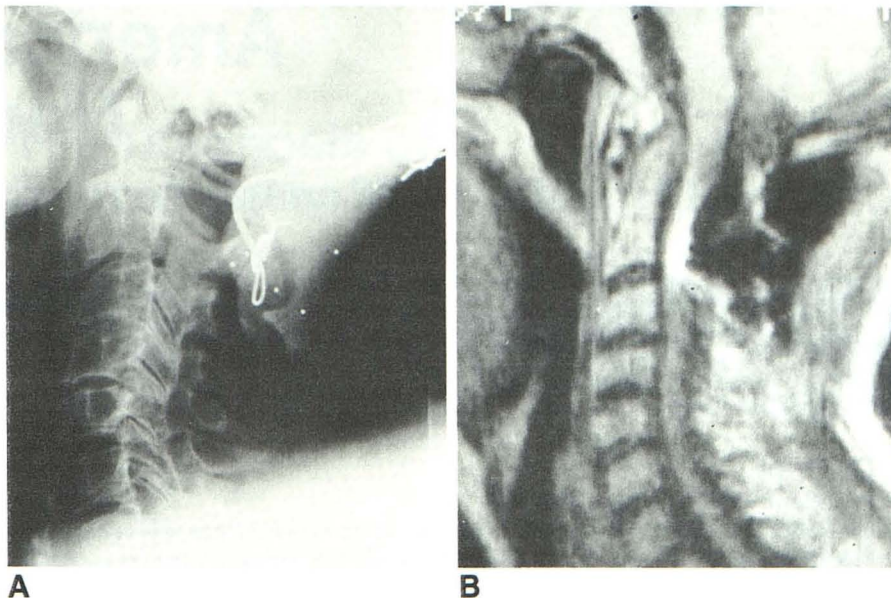
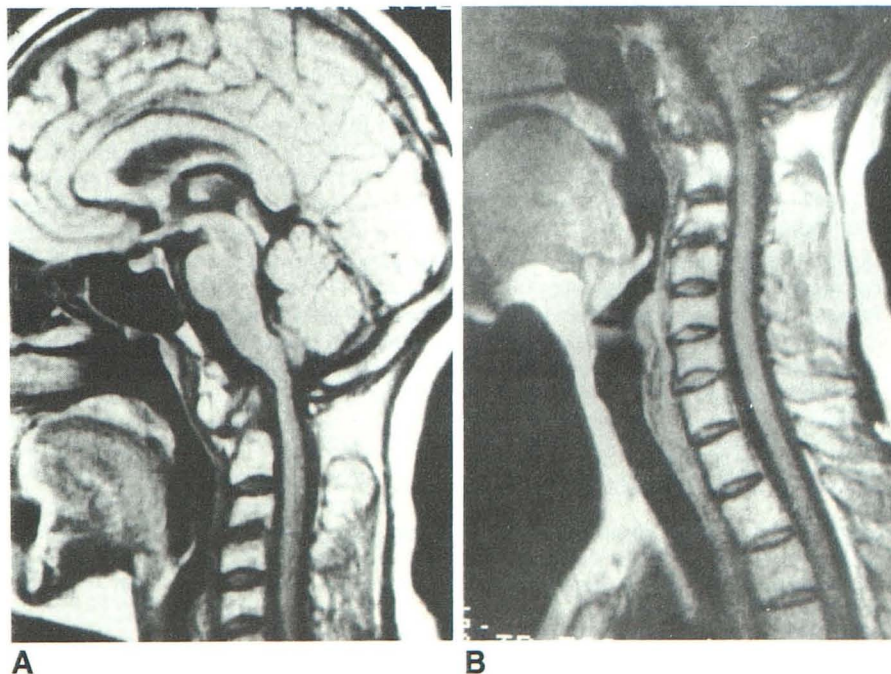


Fig. 5.—56-year-old man with rheumatoid arthritis for 20 years.

A, Head coil provides the best information on craniocervical junction and upper cervical cord.

B, Coil wrapped around neck gives additional information on middle and lower cervical cord, as well as upper thoracic cord.



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