

The Value of Magnetic Resonance Imaging in the Diagnosis and Treatment of Spinal Disorders

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Abstract : In this study, we examined the MRI scans of eight patients with divers spinal neurosurgical problems. The evaluations of pre-operative imaging correlated precisely with the operative findings in all of our cases. Finally, the superiority of the MRI over

CT and CT-myelography and its advantages in the diagnosis and treatment-planning of neurosurgical patient is discussed.

Key words: Computed tomography, Magnetic resonance imaging, Myelography, Spine.

INTRODUCTION

The current improvements in MRI technology (more powerful magnetic fields, better software, wide usage of contrast enhancement) have given its advantages over CT and CT - myelography (4,7). This has been clearly shown by the recent enormous increase of MRI usage compared to CT and CT-myelography as the procedure of first choice in the majority of spinal disorders (2,4).

The direct visualization of pathology and the better resolution as opposed to the indirect myelographic signs and poorer CT resolution, the sagittal and coronal slices which usually are not available with CT, the non-invasive technique, and the lack of radiation are some of the important contributors to MRI dominance over CT.

The usually mentioned MRI disadvantages (e.g., cost, time, length of procedure, metal and flow artifacts) can only slightly offset the advantages of MRI.

In this paper we compared the MRI and CT scans of eight patients with various spinal disorders, and evaluated critically the role of MRI in establishing

a preoperative diagnosis, in planning the operation, and in avoiding CT and conventional myelography.

PATIENTS AND RESULTS

In our study we analyzed the clinical findings and the pre-operative MRI evaluations in eight patients with the following spinal disorders: Lomber neurofibroma, extradural hematoma (due to AVM), cervical spondylosis, lumbar dermoid, thoracic arachnoid cyst, cervical trauma, rheumatoid atlanto-axial dislocation, and cervical hemangioblastoma.

First Patient: This thirty-nine year old man presented with ten-year history of intermittent low-back pain and a progressive six-month leg weakness. Clinical examination revealed cafe-au-lait spots and bilateral 12 and 13 motor and sensory signs. MRI (Figure 1a and b) showed a well-defined mass within the spinal canal which produced posterior scalloping of the 12 and 13 vertebra bodies. There was an expansion of the intervertebral foramen on the left and an associated large extraspinal mass displacing the psoas. These appearances were typical of a neurofibroma. The preoperative MRI diagnosis was very well correlated with the operative findings and the histological examination established the diagnosis of neurofibroma.

Second patient: This forty-one year old previously healthy man presented with an acute interscapular pain followed by paraparesis and a completed sensory loss below D1. The CT-myelogram was rather inconclusive showing some low density mass, posterior to the theca, and a complete block at C7 (Figure 2).



Fig. 1a and b (First patient) : Sagittal and axial T1 weighted images, show a well-defined mass within the spinal canal. This has produced posterior scalloping of the vertebral bodies of 12 and 13, expansion of the intervertebral foramen on the left, and a large extraspinal mass displacing the psoas. These appearances are typical of a neurofibroma.

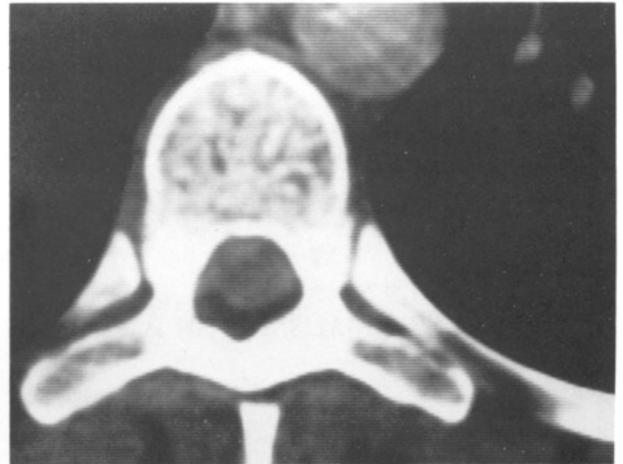


Fig. 2 (Second patient): Axial CT of the mid-dorsal spine shows bony abnormality and some apparent low-density area posterior to the theca. This is likely to represent epidural fat. The examination was performed at the end of the myelogram. The absence of contrast on the images indicates a spinal block at some level not defined.

The MRI (Figure 3a and b) showed a mass of intermediate signal intensity, lying anterior to the cord and displacing it posterior and to the left. The appearances, although not specific, were compatible with recent hemorrhage, which was confirmed by a decompressive laminectomy during which removal of an extradural clot with an underlying AVM was carried out.

Third Patient: This sixty-three year old man presented with a six-month history of bilateral paresthesiae in the fingers and gradual quadriparesis. History also revealed a hyperextension neck injury five days prior to the onset of the initial symptoms.

Plain x-rays showed C5/6 and C6/7 narrowing, of the disc space with osteophytosis and natural fusion. MRI (Figure 4) demonstrated a narrow canal with prominent anterior thecal impression at C3/4 and C5/6 with a minor one at C4/5. There were also posterior indentations from degenerated ligamenta flava. Our patient underwent an anterior decompression and fusion at the above mentioned levels with resultant marked improvement.

Fourth Patient : This fifty-eight year old man with the history of lumbar laminectomy in 1975 presented with a one-year history of low-back pain

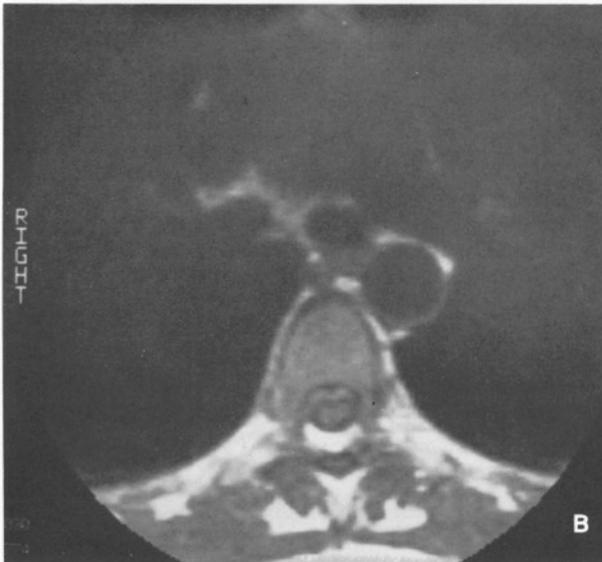


Fig. 3a and b (Second patient): Sagittal and axial T1 weighted MRI. There is a mass of intermediate signal intensity (isointense with the spinal cord) lying anterior to the spinal cord and displacing it posteriorly and a little to the left. The appearances are not specific, but are compatible with recent hemorrhage. Delayed images (more than three days) would show high signal from a hematoma, but in the acute state hematoma has a signal very similar to the spinal cord and brain.

and right sciatica. Examination revealed a cauda equina syndrome. The CT-myelography (Figure 5a

and b) showed expansion of the canal by a large rather fusiform filling defect, with several dilated vessels (due to hemodynamic disturbances from a

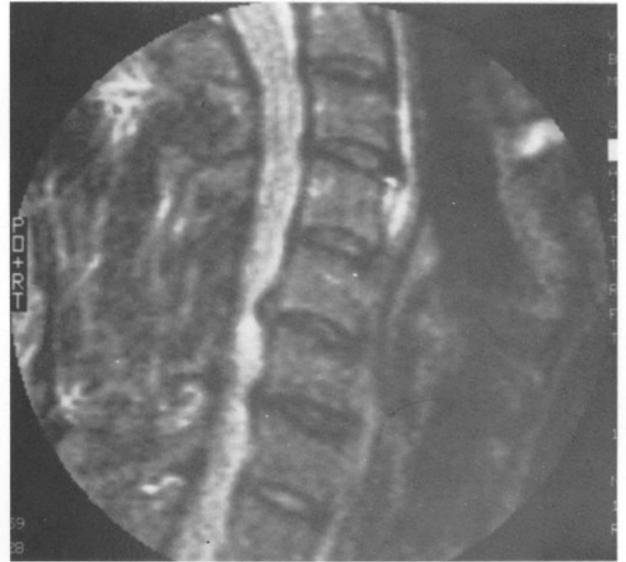


Fig. 4 (Third Patient) : There is a prominent anterior thecal impression at C 5/6 (T2 weighted sequence) causing marked narrowing of the canal. It appears to be associated with a little high signal within the cord consistent with trauma.



Fig. 5 (Fourth patient) : Myelogram shows a fusiform filling defect connected to the lower dorsal cord. Several dilated vessels are seen related to it but they relate more to hemodynamic disturbances from a large filling defect within the spinal canal.

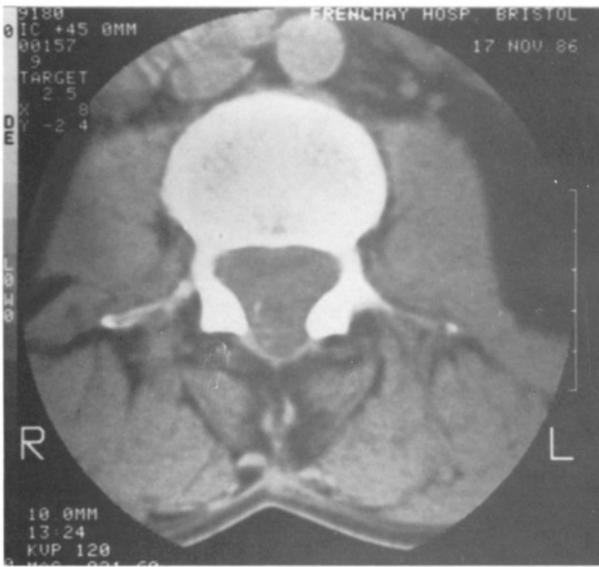


Fig. 6 (Fourth patient) : CT shows minor expansion throughout the canal.

large mass). MRI (Figure 7) disclosed a thickened filum terminale and an associated high-signal mass attached posteriorly. This was suggestive of a tumor containing fat, probably dermoid. Histological examination confirmed the diagnosis of dermoid.



Fig. 7 (Fourth patient): Sagittal MRI demonstrates thickening of the filum terminale and an associated high signal mass attached posteriorly. High signal on these T1 weighted images indicates the presence of fat or paramagnetic substances including blood, melanin, and gadolinium enhancement. In this case the appearances are of fat and the diagnosis is of a fat containing tumor, probably dermoid.

Fifth Patient : This forty-one year old woman initially presented in 1975 with low-back pain and sciatica which were treated with epidural enjections. This resulted in a meningitis and subsequent lumbar abscess formation which was surgically drained. In 1988, she presented with a nine-month history of left brachialgia, gradual paraparesis and incontinence.

The clinical examination showed tenderness at the upper dorsal spine and a Brown-Sequard syndrome at C6. A MRI (Figure 8) disclosed a well-defined low signal posterior to the cord at D1/2. The cord was less well-defined below and it contained a central cavity. The appearance suggested a CSF-containing cyst compressing the cord in the upper thoracic region, possibly associated with a series of septate syrinxes below the that level. The patient underwent a C7/D2 laminectomy and drainage of a left-sided arachnoid cyst.

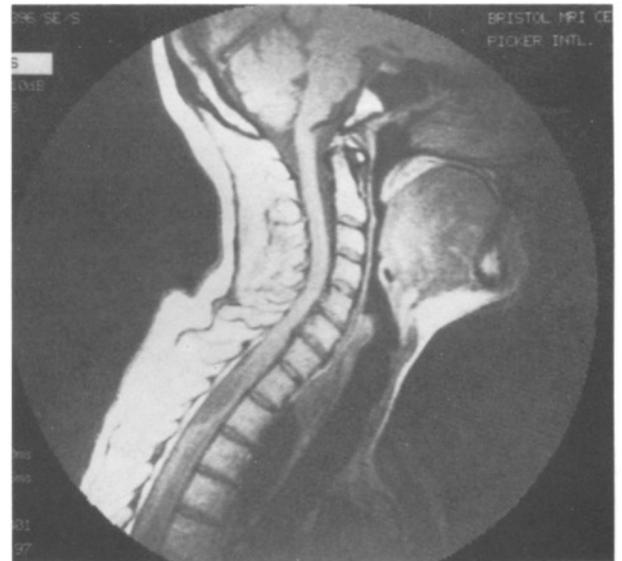


Fig. 8 (Fifth patient) : This sagittal images shows a well-defined low signal posterior to the cord at D1/2. The cord is less well-defined below and may contain a central cavity. The presence of a degree of cervical spondylosis at C 5/6 and 6/7 complicates the image in this case, but appearances suggest a CSF-containing cyst compressing the cord in the upper dorsal region with a possible associated syrinx.

Sixth Patient : This forty-three year old man was involved in a RTA with subsequent cervical spine injury and an incomplete motor and sensory level below C6. Plain X-rays were reported as normal. A MRI (Figure 9) disclosed a prominent anterior thecal impression at C5/6 which produced marked nar-

rowing of the canal and was associated with a little high signal within the cord.



Fig. 9 (Sixth patient) : This T2 weighted sagittal sequence demonstrates a narrow spinal canal with prominent anterior thecal impression at C3/4 and C5/6.. A minor impression is also present at C4/5. Posterior indentations from buckling of the ligamentum flavum are shown in association. These are the appearances of cervical spondylosis with cord compression.

Subsequent surgical exploration revealed a ruptured soft disc. The removal of the free fragment combined with a fusion-stabilization procedure enabled our patient to improve and be mobilized rapidly.

Seventh Patient: This sixty-seven year old lady with a ten-year history of rheumatoid arthritis presented with a two-year history of gradual spastic quadriparesis. Plain X-rays (Figure 10) showed sublux-

ation with irregular joint margins and only minimal osteophytosis. MRI (Figure 11) revealed cord compression from the posterior arch of C1 and displacement of the dens posteriorly with considerable surrounding pannus. A C1/2 fusion offered no improvement, we therefore, elected to perform a transoral decompression which resulted in a post-operative improvement.

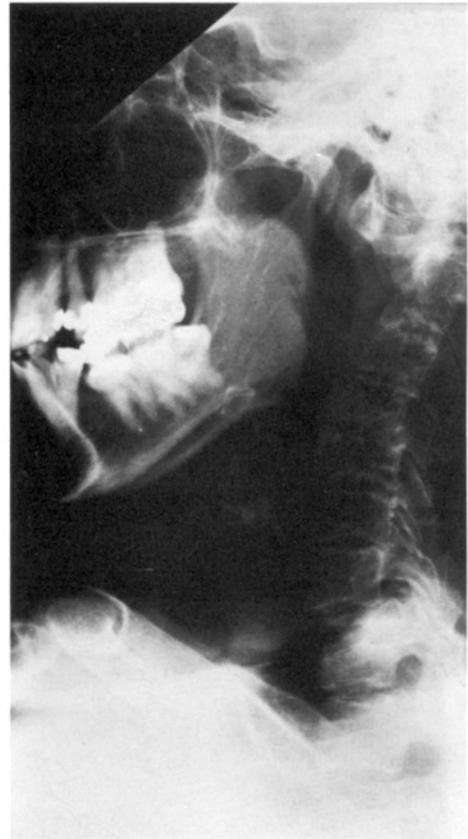


Fig. 10 (Seventh Patient) : Lateral plain radiograph shows atlantoaxial subluxation. The presence of irregular joint margins with only minimal osteophyte formation additional subluxation at C7/D1 all support this as rheumatoid disease.

Eighth Patient : This sixty-five year old man presented with a three-year history of gradual neck and left radicular arm pain. Clinical signs were suggestive of left C6,C7 and C8 radiculopathy and spastic paraparesis. CT-myelogram (Fig. 12a and b) showed expansion of the upper cervical cord with no informations as to the pathology. MRI (Fig. 13) disclosed a well-defined area of low signal within the cord, extending from the cervico-medullary junction down to C4. This produced some cord expansion which was more marked behind the body of C2.



Fig. 11 (Seventh patient) : The The sagittal T1 weigh MRI demonstrates a cord compression from the posterior arch of C1 and displacement of the dens posteriorly. There is considerable surraounding pannus. The minor degree of subluxation at C7/D1 is also apparent.

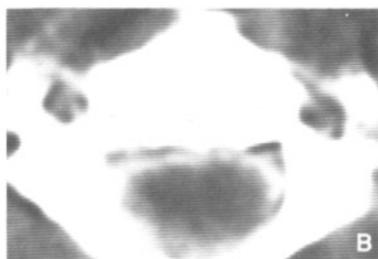
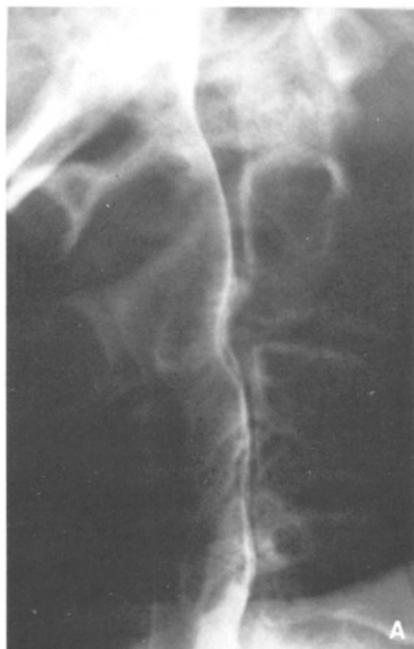


Fig. 12a and b (Eighth Patient) : CT-myelogram. Water soluble contrast within the cervical subarachnoid space demonstrates minor anterior thecal impression at C2/3 and C4/5. Striking feature is the expansion of the upper cervical cord (best shown on the CT image), but this gives no informations as to the pathology.

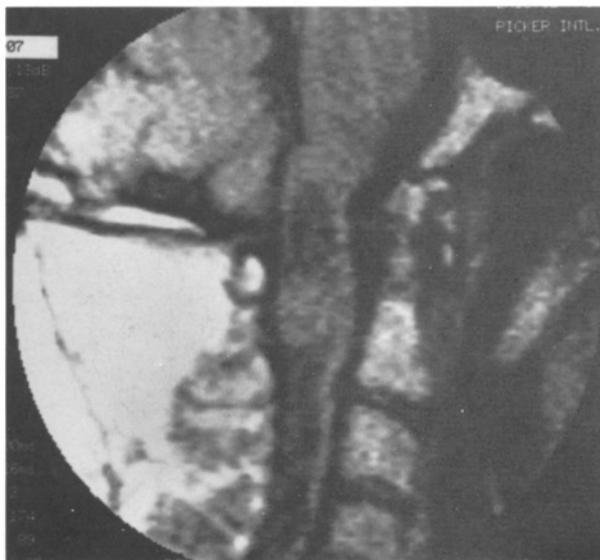


Fig. 13 (Eigth patient) : Sagittal T1 weighted sequence of the foramenmagnum region. Technical factors have produced degradation of image quality in the sequence but it clearly shows a well-defined area of reduced attenuation within the cervical cord extending from the cervicomedullary junction down to the lower image. This has produced some mild cervical cord expansion which is more marked behind the body of C2. These appearances strongly suggest a cyst with a small solid element behind C2. The do not give definite information concerning the pathology but indicate it to be an intrinsic tumor, and it is entirely consistent with the final diagnosis of a haemangioblastoma.

These appearances were strongly suggestive of a cyst with small solid element behind C2. Although the ingormation was not difinite, it was indicative of an intrinsic tumor.

Consequently, our patient underwent a C1/3 laminectomy and total excision of a tumor histologically proven subsequently to be hemangioblastoma.

DISCUSSION

Cervical Spine : MRI is more helpful then the CT in the evaluation of the cervical spine and spinal cord. More specifically, artifacts from dense bone which interfere with CT imaging of the spinal cord are not a problem for the MRI, which is also more sensitive in showing the detailed cord anatomy by using short spin-echo sequences. Therefore it is invaluable in revealing intramedullary pathology, such as tumors, cysts, demyelination, and hematomas.

Longer spin-echo sequences are useful in detecting mass lesions within or around the spinal cord (abscess, hematoma) (3). The same applies to the intervertebral disc herniations although the degenerating disc can be best shown on the short spin-echo sequences (3). The CSF is also seen relatively white compared to the vertebral body and disc.

Sagittal imaging is mandatory in all cases. It shows the entire cervical spine and cord, and consequently the extension of the pathology. Axial imaging is helpful in the lateral extension of the various lesions. Although it is still of lower quality compared to the high resolution CT-myelography particularly in delineating osteophytic changes compressing the theca and the roots.

Thoracic Spine : MRI of this region can demonstrate the above mentioned pathological conditions although they are much less common at this level. MRI techniques are superior to the CT-myelography in disclosing tumors, hematomas, discs, and vascular malformations, particularly after the use of contrast enhancement (Gadolinium).

Lumbar spine : Although CT is well established in detecting disc herniations and degenerative bony changes, recently MRI has become the examination of first choice in lumbar disease. CT is usually limited to the last three intervertebral spaces, it covers only the axial planes and its sagittal reformats are inferior. On the other hand MRI shows the detailed lumbar anatomy in the sagittal, and coronal slices, though bony detail is inferior to CT.

More specifically, MRI visualizes the minor changes in degenerating discs and can distinguish a postoperative scar and inflammation from a new prolapse. Braunsdorf et al (1), in a series of seventy-seven patients with failed back-surgery syndrome, clearly demonstrated the superiority of the MRI over the CT in differentiating between disc recurrence and scarring, by using the fast-field echo imaging technique. The often mentioned failure of the MRI to detect osteophytes and ossified discs can be overcome by demonstrating the indirect displacement of the soft tissue (extradural fat, theca, roots) caused by the bony outgrowths (3).

As far as the whole spinal cord is concerned Sanker et al (6), demonstrated that myelography is successful in diagnosing the location and CT in detecting the type of tumor, but MRI was good in identifying both the location and type in 78 % their cases.

Kiwit et al (5), confirmed that: "MRI is only diagnostic tool that enables us to differentiate between the various forms of syringomyelia and to demonstrate the underlying tumors in cases of secondary syringomyelia".

The general disadvantages of the MRI such as : high cost, longer imaging time, failure to detect calcifications, limitations due to metal implants, flow artifacts etc, will either gradually be overcome due to technical advances or counterbalanced against its very important advantages over conventional myelography and CT-myelography.

In conclusion, MRI is the most useful investigation for preoperative evaluation and surgical approach planning (level, extent, type of pathology).

In our study, the preoperative diagnosis correlated very successfully with the intraoperative and histological findings. In our first, third, fifth, sixth, and seventh patients, conventional myelography and/or CT-myelogram were not needed in establishing the diagnosis and preoperative planning. The second, fourth and eighth patients although underwent a CT-myelographic study prior to MRI, due to departmental policy reasons, this did not help in establishing the extent and type of lesion, which was successfully detected by the MRI.

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