Med. J. Cairo Univ., Vol. 62, No. 3, September: 727 - 736, 1994

616.832.8-07?

Cervical Canal Stenosis: Relative Merits of the Diagnostic Imaging Modalities

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Abstract

Twenty seven patients with cervical myeloradiculopathic symptoms were examined by MRI, myelography was done to 21 patients and is followed by CTM in 20 cases. Twenty patients were operated upon. Magnetic resonance imaging and CT myelography provided comparable information about the degree of narrowing of the spinal canal, cord compression and encroachment on lateral foramina, CT myelography is slightly more sensitive in detection of osseous component of a disc lesion and MRI is superior in detecting intrinsic cord lesions (gliosis and cavitation). Because MRI is not invasive and has several practical advantages it is recommended as the primary imaging modality in patients with myeloradiculopathic symptoms.

Introduction

CERVICAL spinal canal stenosis may be congenital or acquired, diffuse or localised. Congenital stenosis is more rare than acquired stenosis. Achodroplasia and Down syndrome are the two conditions that most commonly cause congenital stenosis [1].

Acquired cervical stenosis usually is associated with advanced spondylotic disease, it is most commonly seen at C4-5, C5-6 (20-30%) and C6-7 (60-70%), approximatly 90% of cervical disc herniations also are seen at these three levels [2]. Symptomatic central cervical stenosis is usually due to degenerative changes superimposed on underlying congenital spinal narrowing [3,4].

Various conditions involving the cranio-vertebral junction may lead to cervical stenosis, these include rheumatoid arthritis, ankylosing spondylitis, Paget's disease with basilar impression and Still's disease, metastatic tumor to the bones of the cervical spine lead to stenosis, calcification and ossification of the posterior longitudinal spinal ligament also may narrow the spinal canal and produce myelopathy [5,6,7].

Symptomatic central cervical stenosis can result in a variety of clinical myelopathic syndromes [8], the clinical dysfunction is related to contusion and ischemia and eventually leads to cavitary necrosis, gliosis and cord atrophy [9,10,11]. Rapid progression of symptoms may be related to vascular compromise and infarction [12].

Penning et al. [13] found that long tracts signs occurred only when cord cross section decreased to 30%.

Larsson et al. [14] define the degree of narrowing of the spinal canal caused by osteophytes and or disc and soft tissues as mild narrowing if their is reduction of less than 50% of the anterior subarachnoid space, moderate if the reduction is 50% or more without compression of the cord and severe narrowing when the cord is compressed whether these findings seen in myelogram, CT myelogram or MRI.

Magnetic resonance imaging has progressed to the point that it has replaced many of the previously used modalities in the evaluation of the spine [15]. The major advantages of MR imaging are the capacity to display the foramen magnum and cervical region in their entirety, the characterization of cord contour and delineation of signal alteration within the cord substance, high quality of the images that allowed easy evaluation of regions proximal or distal to severe stenosis or block, easy acquisition of multiple orthogonal planer images and depiction of neural foramina and ability to obtain images without the use of contrast material [16].

The aim of this work is to evaluate the role of magnetic resonance imaging in the assessment of cervical spinal canal stenosis relative to other diagnostic modalities.

Material and Methods

Twenty seven patients (24 males and 4 females) with an age between 29 and 70 years having radiculomyelopathic symptoms were subjected to the following examinations:

1- Plain X-ray for the cervical spine.

2- Magnetic resonance imaging.

Twenty one patients were examined by GE Signa 1.5 tesla super conducting magnet with the following pulse sequences and parameters with the use of surface coil:

Sagittal T1 weighted images RT 300 TE 20 256 X 256 NEX 4.

Sagittal T2 weighted gradient recalled technique with 15° flip angle GRE/15, TR 240,TE 15, 256 X 128, NEX 4.

Axial T2 gradient recalled images 15° flip angle TR 140, TE 15 156 X 128 NEX 4.

Six patients using Philips Gyroscan 1.5 tesla super conducting magnet using surface coil and the following pulse sequences and parameters:

Sagittal T1 weighted images TR 500 TE 20 204 X 256 NSA 4.

Sagittal T2 weighted gradient recalled technique with 15° flip angle FFE/15 TR 400 TE 15 204 X NSA 4.

Axial T2 weighted gradient recalled images 15° flip angle.

TR 400 TE 15 204 X 256 NSA 4.

3- Cervical myelography was done to 21 cases using Omnipaque 300 mg intrathecally injected via lumbar puncture.

4- CT myelography was done to 20 cases, 16 patients using GE 9800 Quick, four patients using Philips Tomoscan 350 and two patients using Siemens Somatom CR.

Results

Plain X rays (table 1) done to all (27) patients (162 discs) visualised discal narrowing in 65 level, 40% out of these 86% at C4-5,C4-6 and C6-7 discs. Posterior osteophytosis was detected in 47 discs 29% out of these 85% were C4-5,C5-6 and C6-7 discs.

Table (2) shows the number of discs examined by each modality, the number of discal lesions visualised and its percentage to the total number of discs examined, it also shows the degree of encroachment on the spinal canal with the number of the causative discs and their percentage to the total number of discs examined.

Table (3) shows the number of discal lesions visualised by MRI and CT myelography and whether the cause of compression is hard disc, soft disc or both hard and soft disc and the percentage of each type to the total number of the diseased discs.

Table (4) shows comparison between the results of MRI and CT myelography in 120 discs examined by both techniques, it shows comparison between the number of the discal lesions, degree of encroachment on the spinal canal and whether it is caused by soft, hard or both soft and hard discs.

In table (5) a comparison is made between MRI and CT myelography in the detection of lateral foramenal affection and whether it is encroached upon by hard disc, soft disc or both hard and soft discs.

Hypertrophy of the ligamentum flavum was detected in 30 levels out of 120 levels examined by both MRI and CTM, 23 of these 76.6% at C4-5 ,C5-6 and C6-7 disc levels.

Focal bright areas within the cord shadow were visualised in 2 cases by MRI only one of these was seen by delayed CTM.

Table (1): The Results of Plain X-Ray Examination of 27 Patients.

Disc level / Disc lesion	C2-3	C3-4	C4-5	C5-6	C6-7	C7-D1	Total
Narrowing		7	16	22	18	2	65
Posterior osteophytosis		6	12	15	13	1	47

Table (2): Comparison of the Results of the Diagnostic Modalities (MRI 162 Discs, CTM 120 Discs and CM 126 Discs) in Detection of Discal Lesions and the Degree of Encroachment on the Spinal Canal.

Technique used	Number of discs examined	Discal lesions visuyalised		Mild		Moderate		Sever	
MRI	162	79	48.7%	8	4.9%	42	25.9%	29	17.9%
CTM	120	57	47.5%	6	4.1%	31	25.8%	21	17.5%
CM	126	51	40.4%	6	4.7%	26	20.6%	19	15.0%

MRI = Magnetic resonance imaging
CTM = Computed tomography after intrathecal contrsat injection
CM = Conventional water soluable myelography

Table (3): The Number of Discal Lesions Visualised in 27 MRI and 20 CTM and Whether the Cause is Hard Disc, Soft Disc or Both.

Technique used	Number of disc affected	Hard disc	Soft disc	Both hard and soft
MRI	79	31 39.2%	16 20.3%	32 40.5%
CTM	57	23 40.3%	11 19.3%	23 40.3%

Table (4): Comparison of the Results of 20 Cases (120 Discs) Examined by both MRI and CTM Regarding the Number of Disc Lesions Visualised, Degree of Encroachment on the Spinal Canal and Wheather the Cause is Hard Disc, Soft Disc or both.

Technique used	Number of discs exmined	Number of discs affected	Mild	Moderate	Severe	Soft	Hard	Both hard and soft
MRI	120	58 48.3%	6 5%	31 25.8%	21 17.5%	13 10.8%	23 19%	22 18.3%
CTM	120	57 47.5%	5 4.1%	31 25.8%	21 17.5%	11 9.2%	23 19%	23 19.0%

Table (5): Comparison between MRI and CTM in Detection of Enroachment on the Lateral Foramina in 20 Cases (120 Disc) Examined by both Modalities and Whether the Casue is Hard Disc, Soft Disc or both.

Disc level affected	C3-4		C4-5		C5-6		C6-7		C7-D1	
Technique used	MR	CTM	MR	CTM	MR	CTM	MR	CTM	MR	CTM
Rt foramen	4	4	3	3	10	10	12	12		
Lt foramen	5	5	4	4	7	7	9	9		
Soft disc			1	1	1	1	1	1		
Hard disc	9	9	5	5	13	13	18	18	1	1
Both hard and soft			1	1	3	3	2	2		

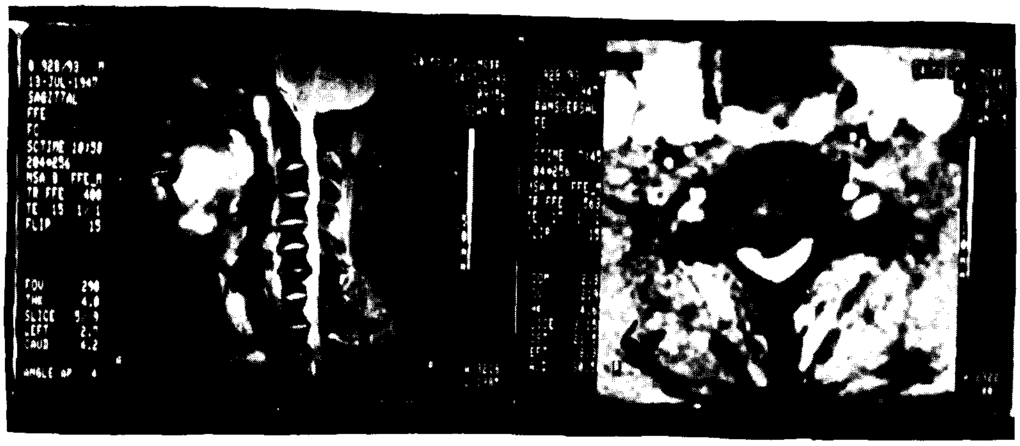

Fig. (1): Images of a 46 years male having achondroplasia and myelopoathic symptoms. (A) Mid sagittal FFE TR 400 TE 15 flip 15 NSA 8 204X256 matrix (T2 weighted) showing congenital narrowing of the spinal canal with superimposed multiple disc lesions soft and hard, the largest at C6-7 which is mainly bony. (B) Axial FFE image TR 563 TE 17 flip 15 NSA 4 204X256 matrix at C6 level showing narrowed canal, central osteophyte and narrowing of both lateral foramina.

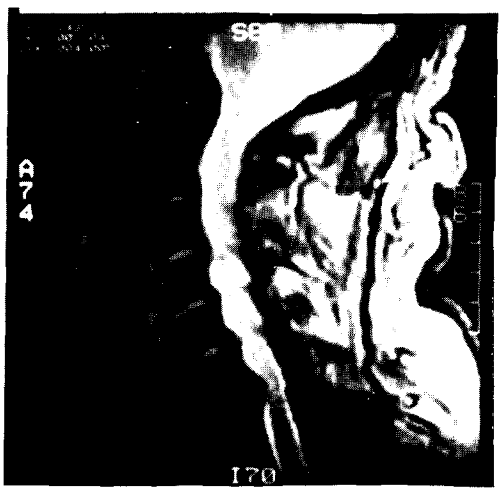

Fig. (2): Mid sagittal T2 image of a 54-year old male with myeloradiculopathy GRE 15 TR 240 TE 15 NEX 4 256X128 matrix showing degenerative changes of all the cervical discs, large posterior osteophytosis at C6-7 disc with cord compression, smaller posterior osteophytosis at C3-4, C4-5 and C5-6 intervertebral discs.

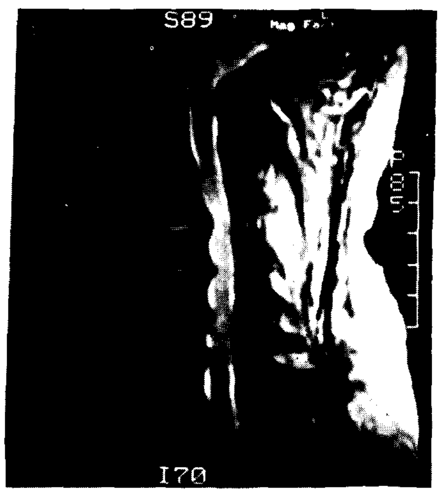

Fig. (3): Mid sagittal T2 image of a 48-year old male with myeloradiculopathy GRE 15 TR 240 TE NEX 4 256X128 matrix showing degenerative changes of all the cervical discs in the form of decreased height and decreased signal intensity and multiple hard discs (osteophytosis) causing multiple level cord compression. Localised bright area within the cord opposite C3-4 level cord oedema or gliosis.

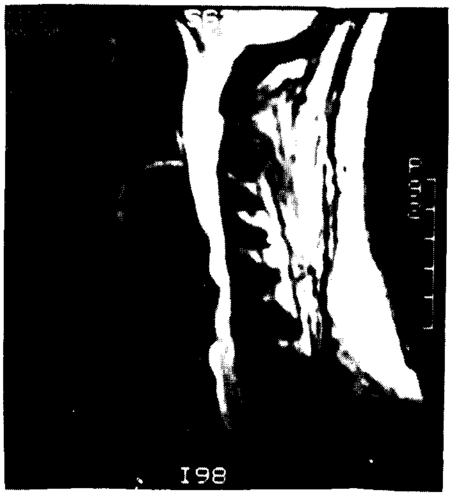

Fig. (4): Female 66 years with myelopathic symptoms. Midsagittal GRE 15 (T2) TR 240 TE 15 256X128 matrix 4 NEX. The image shows advanced spondylodegenerative changes from C3-4 down C6-7 discs with posterior osteophytosis and calcification of the posterior longitudinal ligament causing considerable cord compression.

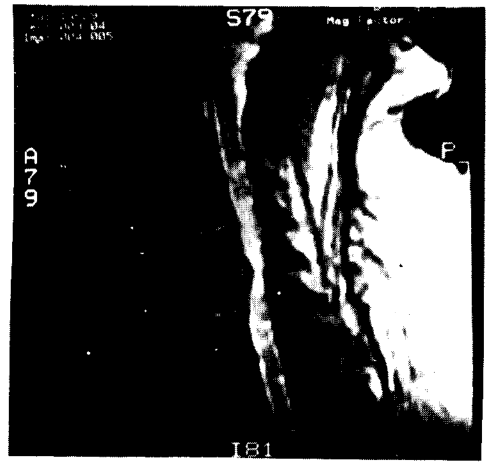

Fig. (5): Midsagittal T2 image of a 45 year old male with history of radicular symptoms with recent onset of myelopathic symptoms, GRE 15 TR 240 TE 15 NEX 4 256X128 matrix. The image shows degenerative changes of the cervical discs with large C5-6 posterior disc herniation and cord compression.

(A) (B)

Fig. (6): Images of a 30-year old male with myeloradiculopathy (A) Midsagittal image FFE TR 400 TE 15 Flip 15 NSA 8 (T2 weighted) showing C5 6 and C6 7 both hard and soft disc lesions with cord compression, associated narrowing of the spinal canal is seen. (B) Axial image at C5-6 level (T2) FFE 494 TE 18 Flip 15 NSA 4 showing the dark signal hard disc and the intermediated signal soft disc and the encroachment on the canal and right recess and foramen.

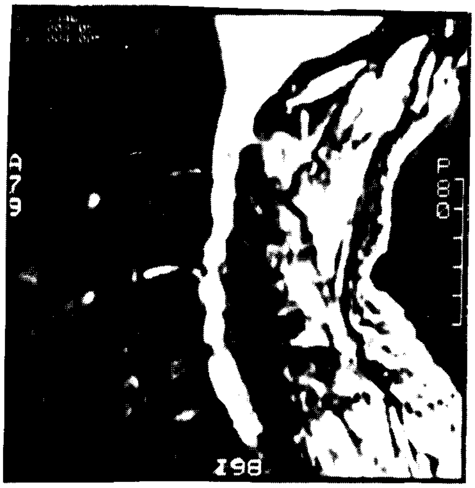

Fig. (7): An image of a 40 year old male having myeloradiculopathy (Midsagittal T2 image) GRE 15 NEX 4 256X128 matrix showing advanced degenerative changes of the cervical intervertebral discs, narrowed spinal canal from the level of C4-5 disc and posterior osteophytosis at C3-4 and C6-7 discs with cord compression, hypertrophied ligamentum flavum seen as areas of intermediate signal intensity in the posterior border of the spinal canal opposite C4-5, C5-6 and C6-7 discs.

Fig. (8): T2 midsagittal image of a 65 year old male with myeloradiculopathy TR 2800 TE 90 NEX 2 256X128 matrix. The image shows advanced degenerative changes of the cervical discs with severe degree of canal stenosis maximal at C & 6 and C6-C7 discs with marked cord compression.

(A) (B)

Fig. (9): T2 midsagittal image of a 70 years male with myelopathic symptoms and previous anterior fusion of C5, 6 and 7 vertebrae TR 2800 TE 90 NEX 4 256X128 matrix. There is spondylodegenerative changes at C3-4, C4-5, C7-D1 and D1-2 discs with opposing hypertrophy of the ligamentum flavum, considerable degenerative narrowing of the spinal canal at C3 and C4-5 disc levels with cord compression, focal bright area within the cord opposite C6 suggesting an area of gliosis or cavitation.

Discussion

In patients presenting with cervical radiculopathy and or myelopathy, the radiological evaluation is of utmost importance in establishing the type, extent and the location of disease if surgery is being considered. When spondylosis and disc herniation are diagnosed, agreement between the clinical symptoms and signs and the radiologial findings is essential because the number of patients with asymptomatic lesions continues to increase with advancing technology and increased sensitivity of the radiologic methods [14].

Conventional myelography and/or CT myelography have been the methods of choice in the preoperative radiologic evaluation of patients with cervical radiculopathy and myelopathy, both methods are, however, invasive with potential complications and they usually require hospitalization. Magnetic resonance imaging has progressed to the point that it has largely replaced other modalities in the evaluation of the spine [14,15,1].

In this study MRI examination was done to 27 patients having radiculomyelopathic symptoms, myelography was done to 21 cases of them and is followed by CT myelography in 20 cases, plain X rays were done to all the cases, the results are tabulated, compared to each other and to operative results of 20 cases.

In the assessment of the degree of narrowing of the spinal canal (tables 2,4) MRI was slightly superior to CTM in the detection of mild encroachment on the spinal canal (MRI 6 affected discs compared to 15 discs by CTM out of 120 disc levels examined by both modalities). In moderate and severe encroachment on the spinal canal both modalities give equal results. These findings fit with that of Larsson et al. [14].

In the differentiation between soft and hard discs MRI was slightly superior to CTM in the detection of small soft disc lesions (table 4). Both MRI and CTM showed equal results in the detection of hard discs. In disc lesions that have both hard and soft components MRI could diagnose the hard component in 22 out of 23 discs diagnosed by CTM, in one case MRI diagnosed a soft disc and proved to have an associated osseus component by CTM (table 4), these findings coincide with that mentioned by Larsson et al. [14], in his work MRI could not visulaize the osseous part of two disc lesions out of the 156 disc levels examined by both MRI and CTM.

In lateral foraminal affection (table 5) MRI and CTM give equivalent results whether the encroachment is due to soft disc, hard disc or both, Modic et al. [16] found that CTM is comparable to or slightly superior to MRI in the overall accuracy relative to surgical findings, however, Russel [12] mentioned that this slight superiority is due to the fact that this study was performed using echo technique and thicker slices, gradient echo images add to the diagnostic capabilities of MRI and increase the conspicuousness of extradural defects in the setting of degenerative disease. Figs. 1 (B) and 6 (B) showed axial gradient echoimages with hard disc in Fig. 1 and both hard and soft disc in Fig. 6 as well as the associated foraminal affection.

In detection of intrinsic cord lesions (Fig. 9) MRI could visualize cord gliosis cavitation as bright focal areas within the cord (in T2 images) in two cases while delayed CRM could visualize one case only. These findings match with that of Larsson et al. [14] and Bates and Ruggieri [15] that MRI is superior to CTM in detection of intrinsic lesions of the cord.

From the previous discussion and analysis of results it is obvious that both MRI and CTM are rather equivalent in the assessment of the degree of canal stenosis, extrinsic encroachment on the spinal canal and degree of cord compression as well as the encroachment on the lateral foramina, however, MRI is superior in detection of cord gliosis and cavitation. In the detection of the osseous component of disc lesion CTM was slightly more sensitive. MRI being noninvasive, displays the whole cervical spine, visualise areas distal to block, directly visualises the cord abnormalities and can easily get images at multiple orthogonal planes is recommended as the modality of choice for the assessment of patients presenting with myeloradiculopathy.

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