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Original Article

Radiology Section

Clinico-Radiological Correlation in a Cohort of Cervical Myelopathy Patients

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ABSTRACT

Objective: Though both clinical evaluation and MRI are complimentary in detection and precise localization of the level of lesion in patients with cervical myelopathy, there is paucity of data comparing segment specific clinical features with the MRI abnormalities in cervical myelopathy.

Materials and Methods: Thirty one patients with cervical myelopathy and abnormal MRI of the cervical spine (signal changes in the cord) admitted to the neurology and neurosurgery wards during the study period were included in the study. The patients were prospectively evaluated by a detailed neurological examination. Clinically, the site of lesion was determined by highest of the pyramidal, sensory or segmental features of involvement. The MRI lesions were categorized based on the vertebral level at which the abnormalities were seen. The patients were divided into three groups according to the site of lesion on MRI: (1) cervico-medullary (foramen magnum to C1) lesions (2) upper cervical (C2-C4) lesions and (3) lower cervical (C5-T1) lesions. Comparisons of clinical symptoms, signs and level of lesion with MRI abnormalities were done and the level of significance was set at $p < 0.05$.

Results: Clinical evaluation showed limb weakness in all, sensory loss in 90%, sphincter disturbances in 67.7%, scissoring gait in 32.2%, diaphragmatic weakness in 12.9% of patients. Based on clinical examination the site of lesion was cervico-medullary in 9, upper cervical region in 4 and lower cervical region of involvement in five patients. The maximal antero-posterior extent of the lesion and neurological deficits were concordant (p-0.05). As compared to pyramidal signs or sensory abnormalities, segmental features – segmental sensory loss, weakness, wasting or 'reflex' loss – were most concordant with the MRI level of lesion (p - 0.03). Among 'motor', 'sensory' and 'reflex' levels, the 'reflex (DTR)' levels were most concordant with the MRI level of lesion (p – 0.04).

Conclusion: Segmental features form the foundation for clinical localization of the level of lesion. Though the clinical level of lesion and MRI level of lesion were discordant in 14 patients, clinical evaluation may still provide useful information.

Keywords: Localization, MRI, Spinal cord

INTRODUCTION

Cervical myelopathy is a commonly encountered entity in neurological practice and the diagnosis of level of lesion is not always straight forward. It is caused by various etiologies like cervical spondylotic myelopathy (CSM), syrinx, multiple sclerosis, intramedullary tumors and trauma. In patients with cervical myelopathy, the presence of characteristic symptoms in the form neck pain, L'hermitte's sign, weakness and wasting in upper limbs etc would help to localize the lesion to cervical cord. Similarly clinical signs such as loss of reflexes, dissociated sensory loss in upper limbs, respiratory failure etc. would help to make segmental localization to cervical cord [1,2]. The clinical impression can be confirmed or negated using MRI of the cervical spine [3]. The latter has especially made diagnosis of cervical cord lesions easier as it depicts intramedullary lesions much better. However, as with other investigatory procedures, MRI also has limitations. Thus, MRI could be normal in the presence of unequivocal evidence of cervical cord lesion [4,5]. Further, when incidental lesions like spondylotic changes in the elderly or multiple lesions/pathologies are present, precise localization of the lesion responsible for patients symptoms becomes difficult [6-9].

Though both clinical evaluation and MRI are complimentary in detection and precise localization of the level of lesion in patients with cervical myelopathy, there is paucity of data comparing segment specific clinical features with the MRI abnormalities in cervical myelopathy which is essential for pre-operative evaluation as well as for intra-operative monitoring. The present study was undertaken to study and correlate the clinical features and MRI abnormalities of cervical myelopathies.

MATERIALS AND METHODS

This was a prospective study carried out at the Department of Neurology at a teaching hospital in Bangalore over a period of one year. Ethical clearance for the study was obtained from the institution Ethics Committee. Before recruitment into the study, informed consent was obtained from all the subjects of the study.

Non-consecutive patients with cervical myelopathy and abnormal MRI of the cervical spine (signal changes in the cord) admitted to the neurology and neurosurgery wards during the study period were included in the study. The exclusion criteria were – a) clinical or MRI evidence of involvement of neuraxis other than cervical cord b) patients with peripheral neuropathy detected during clinical examination and confirmed by nerve conduction studies

The patients were prospectively evaluated by a detailed neurological examination. Clinically, the site of lesion was determined by highest of the pyramidal, sensory or segmental features of involvement. The features that were made use of for determining level of lesion cord included in [Table/Fig-1]. When a combination of the findings mentioned in [Table/Fig-1] were present, the vertical extent of the lesion was ascribed to the highest and lowest level of lesion that was necessary to explain the neurological deficits.

All patients had been investigated with MRI of the cervical cord. Axial T1 and T2 weighted spin-echo sequences were performed at the level of lesion. Post-contrast (Gadolinium) images of the cervical cord were done in all patients. MRI brain (post contrast and FLAIR sequences) were done when felt necessary. MRI was interpreted by radiologist who was blinded to the clinical data. Lesions were defined as areas of unequivocally increased signal on T2-weighted

sequences or of decreased signal on T1-weighted sequences. Abnormalities were accepted only when identified on both sagittal and axial images.

The MRI lesions were categorized based on the vertebral level at which the abnormalities were seen. The patients were divided into three groups according to the site of lesion on MRI: (1) cervico-medullary (foramen magnum to C1) lesions (2) upper cervical (C2-C4) lesions and (3) lower cervical (C5-T1) lesions.

STATISTICAL ANALYSIS

SPSS (ver10) software was used for statistical analysis. Data were expressed using descriptive statistics, such as mean and standard deviation (SD) for continuous variables and frequency, percentages for categorical variables. Comparisons of clinical symptoms, signs and level of lesion with MRI abnormalities were done by using Independent sample t-test. Data were considered significant for p-values less than 0.05 ($p<0.05$).

RESULTS

During the study period, 40 patients with cervical myelopathy were seen. However, those meeting the study criteria among these were 31 patients who formed the subjects of this study. M:F was 22:9. The mean age was 38.5 ± 15.2 (Range: 26–68 years). These 31 patients recruited into the study had cervical myelopathy due to various neurological and neurosurgical disorders. The mean duration of illness at the time of recruitment into study was 272.45 ± 317.7 d (range 45-1080 d). The symptoms were non-progressive in 15, progressive in 12, and relapsing – remitting type in four patients.

Clinical Features

The patients presented with various combinations of motor, sensory and sphincter symptoms. The first symptoms were neck pain in 13 (41.9%), upper limb weakness in 6 (19.3%), lower limb weakness in 5 (16.1%), upper limb pain & paresthesias in 4 (12.9%) and gait disturbance in 3 patients (9.6%). With evolution and/or progression of the illnesses, existing symptoms worsened and new symptoms made their appearance.

Limb weakness was the commonest symptom reported by 29 patients and affected the lower limbs most often. Sphincter disturbance was the second commonest symptom (n=21). Fifteen patients complained of difficulty in walking. Neck pain was found in 13 patients. L'hermitte's phenomenon was present in 12 patients. 17 patients complained of pain and/or paresthesias, the distribution being radicular in 3, facial in 3, distal extremities in 4 and below a sensory level in 7 patients.

A detailed neurological examination was carried out in all patients. The various neurological signs in our patients are given in [Table/Fig-2]. Tendon jerks (DTRs) were brisk in lower limbs in 29 patients and in upper limbs in 28 patients. Sluggish to absent tendon jerks in upper limbs were found in 8 patients. The details are as follows: absent bilateral biceps and supinator jerk – 3/8; absent bilateral triceps jerk – 1/8; absent biceps jerk only – bilateral in1/8 and unilateral in 3/8 (right side - one; left side - two).

Examination showed limb weakness in all the 31 patients. Details of the distribution of weakness are given in [Table/Fig-3]. Examination of sensory system showed abnormalities in most of the patients. However, in three patients, there was no evidence of sensory loss. Sensory deficits in the remaining 28 patients are given in [Table/Fig-2].

The site of lesion (upper extent) was determined by the highest of the pyramidal, sensory or segmental involvement. The details of the various neurological deficits suggesting level of lesion are given in [Table/Fig-4].

Pyramidal signs helped to localize the highest level of lesion in only 12 patients. The level of lesion was above C2 (brisk Trapezius reflex)

1. Downbeat Nystagmus – cervico-medullary region
2. Onion-peel sensory loss over face – C1-C2 level
3. Sensory loss over occipital region – C2 level
4. Weakness of Sternomastoid/ Trapezius – C2/3 level
5. Sensory loss over neck area – C3-C4 level
6. Diaphragmatic weakness – C4 level
7. Radicular (non-pyramidal) distribution of weakness – segment affected
8. Loss of tendon jerk – segmental level of the reflex
9. Segmental distribution of wasting – segment affected
10. Sensory level – 1 segment above the sensory level
11. Suspended sensory loss – 1 to 2 segments above the upper margin of suspended sensory loss
12. Loss of vibration sense over spine – level affected
13. Severe impairment of position sense in upper limbs in a patient with myelopathy – Cervical cord
14. Pyramidal signs (brisk reflexes in all 4 limbs with extensor plantar response on one or both sides with or without spasticity and pyramidal type of weakness) in the presence of normal jaw jerk – cervical cord above C5. If the trapezius reflex was also brisk, the lesion was localized to above C2.
15. Lhermitte's sign – cervical cord
16. Horner's syndrome – cervical cord

[Table/Fig-1]: The clinical features that were made use of for determining level of cord lesion

SIGNS	Number (#) (%)
Nystagmus	4 (12.9)
Horner's syndrome	3 (9.6)
Motor deficits (n=31)	
Wasting of extensor muscles of neck	11 (35.4)
Trapezius muscle involvement	5 (16.1)
Sternocleidomastoid muscle weakness	2 (6.4)
Diaphragmatic weakness	4 (12.9)
Upper extremities	
Spasticity	18 (58.0)
Wasting of small muscles of hand	1 (9.6)
Exaggerated DTRs	24 (77.4)
Hypoactive or absent DTRs	18 (58.0)
Lower extremities	
Spasticity	22 (58.0)
Exaggerated DTRs	29 (93.5)
Babinski sign	31 (100)
Modality / Pattern of sensory loss (n=28)	
Loss of Joint position sense	23 (82.1)
Loss of vibration sense over spine	21 (75.0)
Pan-sensory loss below a 'level'	9 (29.0)
Dissociated Sensory loss	5 (16.1)
'Onion peel' sensory loss over face	5 (16.1)
Brown-Sequard type of loss	1 (3.5)

[Table/Fig-2]: Neurological signs (n=31)

Distribution of Weakness	Number of patients (#) (%)
Quadriparesis – symmetric	6 (19.3)
Quadriparesis – asymmetric (right > left) (left > right)	 2 (6.4) 2 (6.4)
Paraparesis + Segmental weakness in upper limbs	3 (9.6)
Triparesis (bilateral lower limb & one upper limb weakness)	2 (6.4)
Paraparesis – symmetric	5 (16.1)
Paraparesis- asymmetric (right > left) (left > right)	 2 (6.4) 2 (6.4)
Hemiparesis (sparing face) leg > arm: Right side leg > arm: Left side	 2 (6.4) 1 (3.2)
Hemiparesis (sparing face) arm > leg: Right side arm> leg: Left side	 1 (3.2) 1 (3.2)
Bilateral upper limb weakness	2 (6.4)

[Table/Fig-3]: Distribution of weakness: (n=31)

Patient No.	Age (yrs)	Highest level of LMN/ UMN weakness	Highest level of wasting	Highest level of segmental reflex loss	Highest Pyramidal (Reflex) level	Highest sensory level (spino-thalamic)	Highest sensory level (posterior column)	Clinical level of lesion
1	40	-	-	-	T6	-	-	Above T6
2	22	-	-	-	C2	C5	-	Above C2
3	50	T6	-	-	T6	T6	T6	AboveT6
4	56	C7	-	-	C7	-	T2	Above C7
5	45	C2	C2	-	C5	Onion-peel sensory loss over face	C8-T1	Cervcio-medullary
6	40	C2	C2	-	L1	-	L1	C2
7	60	C7-T1	C7-T1	C7	C5	-	T4	Above C5 Lower T1
8	63	C2	C2	-	C5	T4	T4	C2
9	49	T6	-	C5	C7	-	T6	C5
10	36	C5	-	-	C2	Onion-peel sensory loss over face	T4	Cervico-medullary
11	53	C7		-	C7	-	-	Above C7
12	30	C2	C2	C5	C7	-	C8-T1	C2 Lower level C5
13	42	C2	C2	-	T6	-	T4	C2
14	13	T6	-	-	C2	Onion-peel sensory loss over face	T6	Cervico-medullary
15	24	T6	-	-	C2	T4	T4	Above C2
16	47	C6	C6	-	C2	T6	T6	Above C2 Lower level C6
17	18	T6	-	C5	T6	Onion-peel sensory loss over face	-	Cervico-medullary
18	30	C5	-	-	C5	-	T10	Above C5
19	30	T6	-	C5	T6	C7-T1	-	C5
20	28	C5	-	-	C5	-	T6	Above C5
21	60	-	-	-	C5	-	C5	Above C5
22	16	C5	-	-	C5	-	C5	Above C5
23	30	C5	-	-	C5	-	T4	Above C5
24	55	T6	-	-	T6	T6	-	Above T6
25	25	C5	-	-	C5	T4	T4	Above C5
26	32	C5	-	-	C5	C5	-	Above C5
27	17	T6	-	-	C2	-	T6	Above C2
28	53	T6	-	C5	C7	L1	L1	C5 level
29	25	C5	-	-	C2	Onion-peel sensory loss over face	T4	Cervico-medullary
30	55	C5	C5	C5	C7	-	T6	C5 level
31	60	C5	C5	C5	C7	-	-	C5 level
Total		19-2	9	7	20	8	3	

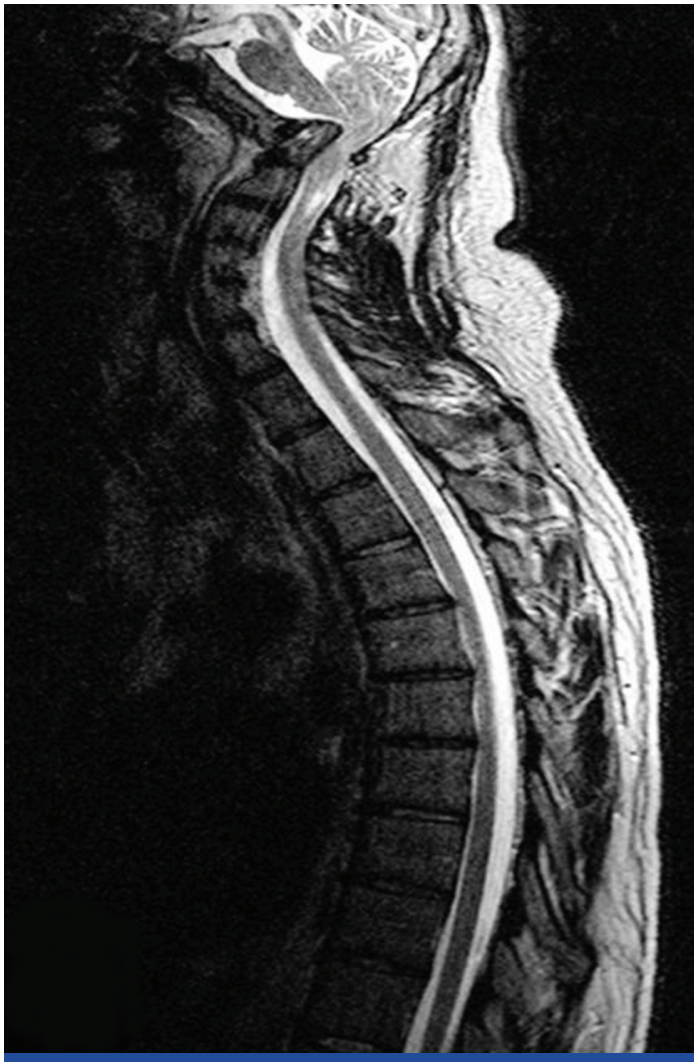
[Table/Fig-4]: Clinical Level of Lesion (n=31)
'–'Absent deficits/ exact level could not be determined; ("Text in bold" indicates clinical features used for determining highest level of lesion in each of the patient. The last row "Total"gives total number of patients in whom a clinical feature was useful to determine highest clinical level)

in four patients, above C5 in eight patients, above C7 in two patients and above T6 in one patient. Two other patients with pyramidal level above T6 also had sensory level at T6. The jaw jerk was normal (just elicited/ absent) in all the 31 patients. Lower motor neuron (LMN) features in the form of muscle weakness and wasting were present in nine patients and segmental reflex loss in eight patients. Together, they helped to localize the highest level of lesion in nine patients.

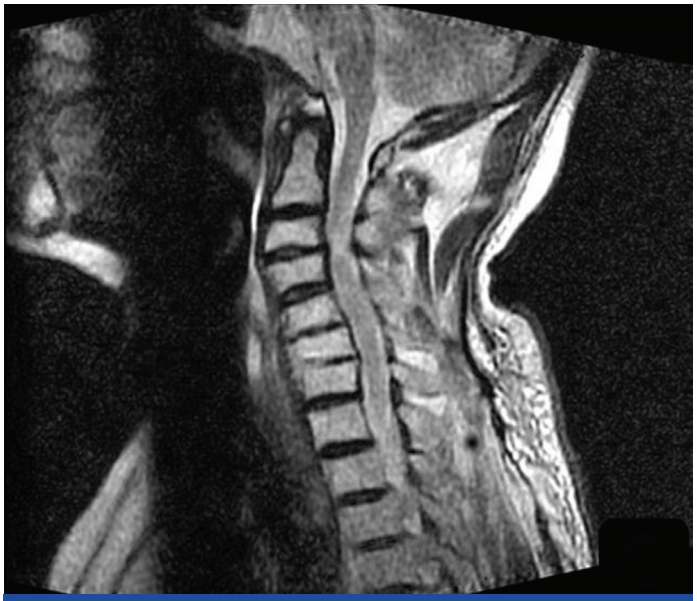
Sensory system involvement suggested the highest level of lesion in five patients. All of them had onion-peel sensory loss over face. In five other patients, the highest level was indicated by combined involvement of pyramidal and sensory system involvement.

As mentioned previously, the patients were divided into three groups 1) cervico-medullary region (foramen magnum to C1 level), 2) upper cervical region (from C2-C4), 3) lower cervical region (C5-T1).

The group with cervico-medullary region involvement included nine patients. Five patients demonstrated onion-peel sensory loss over face, localizing the lesion to cervico-medulary region (up to C1 level). One of them had downbeat nystagmus and another patient had suboccipital muscle wasting. Other findings in this group of patients included wasting of Trapezius muscle and C5 level reflex loss indicating extension of lesion to upper and lower cervical regions respectively. Four other patients had brisk trapezius reflex localizing the lesion to "above C2 level." In all these patients, the jaw jerk was

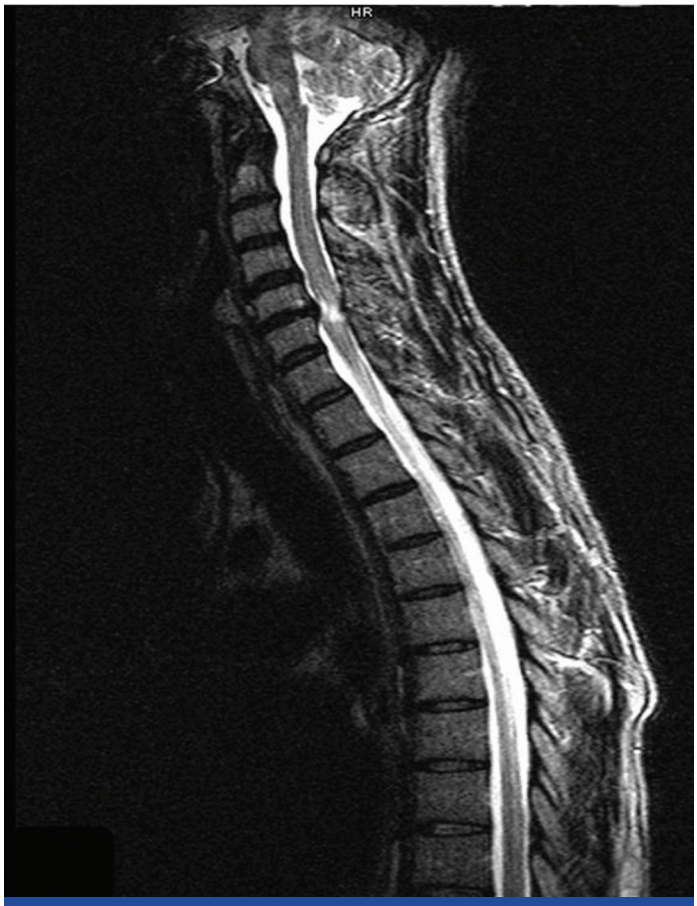


[Table/Fig-5]: The sagittal section of the cervical spinal cord MRI (T2 weighted) showed atlanto-axial dislocation with cervico-medullary compression



[Table/Fig-6]: The sagittal section of the cervical spinal cord MRI (T2 weighted) showed spondylotic cord compression with hyperintense cord signal change at the C3-4 level

normal and there were no other findings indicative of a lesion above foramen magnum. Hence, they were also included in this group. The other findings in these patients comprised of – spino-thalamic sensory level at C5 in one patient, paradoxical respiration along with sensory (spino-thalmaic and posterior column) and reflex level above T6 in one patient, and sensory (posterior column) and, reflex level above T6 in one patient. One other patient had C6 segmental



[Table/Fig-7]: The sagittal section of the cervical spinal cord MRI (T2 weighted) shows spondylotic cord compression with hyperintense cord signal change at the C5-6 level

muscle wasting indicative of extension of lesion to lower cervical region.

Four patients had clinical evidence of upper cervical cord lesion (C2-C4 level). Weakness of Trapezius with absent Trapezius reflex in all these four patients and paradoxical respiration with respiratory insufficiency in three patients was the signs which enabled us to localize the lesion to upper cervical region. All four of the patients also had suboccipital muscle wasting. One of the above patients had reflex loss at C5 indicating extension of lesion to lower cervical region. One other patient, included under cervico-medullary region, had weakness and wasting of Trapezius muscle indicating extension of lesion to upper cervical region.

Segmental wasting, weakness, reflex loss served as the most important signs to localize the lesion to the lower cervical level (C5-T1 level). Among the 31 patients, five patients had clinical evidence of lower cervical cord lesion – at C5 level in all the patients. Sensory level, seen in two of the patients was at much lower level (C7-T1 level in one patient and L1 level in another patient). One patient each listed above under cervico-medullary and upper cervical region respectively had C5 segmental reflex loss indicative of extension of the lesions to lower cervical region.

Clinically, 16 patients were considered to have extradural compressive myelopathy evidenced by the presence of neck pain (n=13), local tenderness over the spine (n=5), later involvement of bladder, hemiparetic type of weakness progressing to quadriparesis (n=5) and 'Elsberg' pattern of evolution of limb weakness (n=6). Five patients were clinically diagnosed to be having intramedullary lesion based on the combination of 'dissociated sensory losses', brisk reflexes in lower limbs with wasting of small muscles of hands and sluggish reflexes in upper limbs. 10 patients were diagnosed as non-compressive myelopathy by history of fever preceding myelopathy, absence of neck pain and a relapsing-remitting course of the illness (n=4).

MRI Abnormalities

With cord signal changes in the MRI being an inclusion criterion, MRI of cervical spine was abnormal in all the 31 patients. Gadolinium enhanced MRI sequences had been performed in all patients. 15 patients were also investigated with MRI brain (postcontrast and FLAIR sequences). MRI brain was normal in all of them. On axial MRI sections, there was no evidence of root compression in any of the patients.

The horizontal as well as vertical extent of the lesions was determined from T2 and Postcontrast images of the cervical cord. Based on the vertebral level at which the abnormalities were seen, the lesions were grouped into three groups: cervico-medullary (CM) (foramen magnum to C1) [Table/Fig-5]; upper cervical (UC) (C2-C4) [Table/Fig-6] and lower cervical (LC) (C5-T1) [Table/Fig-7] regions. The lesions involved single region in 13 patients (CM level – 2, UC level – 4, LC level – 7) and two regions in 17 patients (CM+UC – 2, UC+LC – 15). In one patient, MRI showed the lesion to be involving all three region (CM+UC+LC). The details of the T1 and T2 characteristics of the lesions, their contrast enhancement, vertical and horizontal extent and, plane of the lesions, and probable MRI diagnosis are depicted in [Table/Fig-8].

The various etiologies of cervical myelopathy (n=31) as revealed by MRI of the cervical spine were: cervical spondylotic myelopathy – 13 patients (40.6%), demyelination – nine patients (29%), syringomyelia – three patients (9.6%), intramedullary tumor (astrocytoma in one and ependymoma in one) – two patients (6.4%), vascular – two patients (AVM in one and ischemic myelopathy in one) (6.4%), traumatic (partial hanging) – one patient (3.2%) and atlantoaxial dislocation – one patient (3.2%).

The different MRI lesions and their common locations in the present study are as follows: a) post-infectious demyelination (n=3) involved the cervico-medullary junction/ upper cervical regions in three patients, b) vascular myelopathy (n=2) was seen in C3-C4 segments in two patients, c) traumatic myelopathy (n=1) was seen to be involving C3– C4 cord segments in one patient, d) intramedullary tumors (n=2) involved C3-5 segments in one patient and C4-7 segments in another patient, e) idiopathic demyelination (n=2) involved C4-5 in both patients f) demyelination of the Multiple sclerosis type (n=4) involved C3-C6 level in three patients and C6-T1 in one patient, g) cervical spondylotic myelopathy (n=12) involved C5-C6 segment in four patients; C4-5 segment in four patients and multiple segments in four patients, and h) syringomyelia (n=3)

Patient No.	T1W images	T2W images	Swelling of the Cord	Contrast enhancement	Level of lesion	Horizontal Extension of lesion	Plane of lesion	MRI Diagnosis
1	Isointense	Hyperintense	-	-	C4-5	Central	ED	CSM
2	Hypointense	Hyperintense	+	+	C3-5	Whole cord	IM	Intramedullary Neoplasm
3	Isointense	Hyperintense	-	-	C4-5	Central	ED	CSM
4	Isointense	Hyperintense	-	-	C3-4; C4-5; C5-6	Central	ED	CSM
5	Isointense	Hyperintense	-	-	Cervico-Medullary	Central	ED	AAD with cord compression
6	Hyperintense	Hyperintense	-	+	C3-4	Whole cord	ED	AVM
7	Isointense	Hyperintense	-	-	C2-3; C4-5; C6-7	Central	ED	CSM
8	Hypointense	Hyperintense	Atrophy	+	C3-4	Anterior	IM	Ischemic myelopathy
9	Isointense	Hyperintense	-	-	C5-6	Rt. Hemicord	ED	CSM
10	Hypointense	Hyperintense	-	-	Cervico-Medullary	Whole cord	IM	Demyelination
11	Isointense	Hyperintense	-	-	C5-6	Central	ED	CSM
12	Isointense	Hyperintense	-	-	C3-5; C6-7	Central	ED	CSM
13	Isointense	Hyperintense	-	-	C7-T1	Central	ED	CSM
14	Hypointense	Hyperintense	-	+	C1-3	Posterior	IM	Demyelination
15	Isointense	Hyperintense	-	-	C3-4	Lt. Hemicord	ED	Traumatic
16	Isointense	Hyperintense	-	-	C3-4	Central	ED	OPLL
17	Hypointense	Hyperintense	+	+	C1-T2	Central	IM	Syringomyelia
18	Hypointense	Hyperintense	-	-	C3-6	Whole cord	IM	Demyelination
19	Hypointense	Hyperintense	+	+	C4-6	Central	IM	Syringomyelia
20	Hypointense	Hyperintense	+	+	C4-5	Whole cord	IM	Demyelination
21	Isointense	Hyperintense	-	-	C4-5	Central	ED	CSM
22	Hypointense	Hyperintense	-	-	C4-6	Whole cord	IM	Demyelination
23	Hypointense	Hyperintense	-	+	C3-6	Whole cord	IM	Demyelination
24	Hypointense	Hyperintense	+	+	C5-T1	Central	IM	Syringomyelia
25	Hypointense	Hyperintense	-	+	C6-T1	Posterior	IM	Demyelination
26	Hypointense	Hyperintense	+	+	C4-7	Whole cord	IM	Intramedullary Neoplasm
27	Hypointense	Hyperintense	+	+	C3-6	Whole cord	IM	Demyelination
28	Isointense	Hyperintense	-	-	C5-6	Central	ED	CSM
29	Hypointense	Hyperintense	-	+	C1-2	Posterior	IM	Demyelination
30	Isointense	Hyperintense	-	-	C4-5	Central	ED	CSM
31	Isointense	Hyperintense	-	-	C5-6	Central	ED	CSM

(+: Present; - : Absent; IM- Intramedullary; ED- Extradural; CSM- Cervical spondylotic myelopathy; AAD- Atlanto-axial dislocation; AVM- Arterio-venous malformation; OPLL – Ossified Posterior Longitudinal Ligament)
[Table/Fig-8]: Details of MRI abnormalities (n=31)

Patient No.	Highest clinical level	Lowest clinical level	MRI level of lesion
1	Above T6	-	C4-5
2	Above C2	C5	C3-5
3	AboveT6	-	C4-5
4	Above C7	T2	C3-4; C4-5; C5-6
5	Cervico-medullary	C8-T1	Cervico- Medullary
6	C2	L1	C3-4
7	Above C5	T1	C2-3; C4-5; C6-7
8	C2	T4	C3-4
9	C5	T6	C5-6
10	Cervico-medullary	T4	Cervico- Medullary
11	Above C7	-	C5-6
12	C2	C5	C3-5; C6-7
13	C2	T6	C7-T1
14	Cervico-medullary	T6	C1-3
15	Above C2	T6	C3-4
16	Above C2	C6	C3-4
17	Cervico-medullary	T6	C1-T2
18	Above C5	T10	C3-6
19	C5	T6	C4-6
20	Above C5	T6	C4-5
21	Above C5	-	C4-5
22	Above C5	-	C4-6
23	Above C5	T4	C3-6
24	Above T6	-	C5-T1
25	Above C5	T4	C6-T1
26	Above C5	-	C4-7
27	Above C2	T6	C3-6
28	C5 level	L1	C5-6
29	Cervico-medullary	C5	C1-2
30	C5 level	T6	C4-5
31	C5 level	C7	C5-6

[Table/Fig-9]: Clinical levels and MRI level (n=31)

involved the whole of the cervical cord in one patient and multiple segments in two patients.

Clinical – Radiological Comparison: [Table/Fig-9]

The clinical diagnosis of compressive/ non-compressive myelopathy was concordant with MRI in all the 31 patients. There was moderate concordance between the maximal antero-posterior extent of the lesion and neurological deficits (p-0.05). The transverse extent of cord MRI abnormalities was further explored in relation to the distribution of sensory involvement. When the horizontal extent of cord MRI abnormalities was compared with sensory symptoms (paresthesias) and signs (sensory loss on examination), the latter showed a high degree of correlation (p – 0.05) than the former (p – 0.11).

As compared to pyramidal signs or sensory abnormalities, segmental features – segmental sensory loss, weakness, wasting or 'reflex' loss – were most concordant with the MRI level of lesion (p - 0.03). Segmental features form the foundation for clinical localization of the level of lesion.

Among 'motor', 'sensory' and 'reflex' levels, the 'reflex (DTR)' levels were most concordant with the MRI level of lesion (p – 0.04).

The MRI region of involvement was concordant with the clinical level of lesion in 10 patients (CM- 2; UC- 5; LC- 7). 12 patients demonstrated moderate concordance (CM- 3; UC- 7; LC- 3). There was no concordance in 6 patients (UC- 4; LC- 4).

DISCUSSION

After the advent of CT scan and MRI, detection of incidental or multi-segmental abnormalities especially related to cervical or lumbar spondylosis is being increasingly recognized. Hence, the need for segment specific abnormalities for pre-operative evaluation as well as for intra-operative monitoring became apparent. In this study, we have prospectively evaluated the diagnostic usefulness of a detailed clinical examination & MRI in patients with confirmed lesions of the cervical cord. Both are complimentary in detection and precise localization of the level of lesion in patients with cervical myelopathy.

All together, clinical localization of level of lesion was done using pyramidal signs. It is worth noting that the pyramidal, sensory and reflex levels were concordant in only 16.1% patients. Hence, the need for careful examination to detect segmental features.

Many earlier studies on cervical myelopathy have included patients of only single pathology like CSM [10], Syringomyelia [11] or intramedullary tumors [12]. We have included patients with various etiologies of cervical myelopathy such as CSM, demyelination, syringomyelia, tumor, trauma, vascular lesions and Atlanto-Axial Dislocation. This was basically done to ensure inclusion of patients with lesions at different levels of the cervical cord.

MRI of the cervical spine showed features of CSM in 14 patients. This reflects up on cervical spondylosis being a common cause of cervical myelopathy as in other parts of the world. Spondylotic myelopathy commonly involved C5-6 and C4-5 segments. Usually, spondylotic myelopathy involves C4-5, C5-6 and C6-7 segments because disc degeneration is greatest in the cervical spine at these levels [5]. The different levels of involvement in the present study may indicate selection bias by inclusion of in-patients with severe myelopathy admitted for cervical spine surgery.

The clinical diagnosis of compressive/ non-compressive myelopathy was concordant with MRI in all the 31 patients. It indicates reliability of clinical features for making a diagnosis of compressive or non-compressive myelopathy. However, the good concordance may also have been influenced by inclusion of patients in the study after MRI of the cervical spine.

In 26/31 patients, transverse extent of the lesion in MRI demonstrated good concordance with the presence of unilateral or bilateral sensory abnormalities. However, there was only a moderate concordance between clinical features and antero-posterior extent of the lesion in MRI. The less extensive clinical involvement as compared to the MRI extent of the lesion may be due to greater sensitivity of MRI for demonstrating the presence and extent of lesions. For example, it is well documented that imaging studies show many clinically silent lesions in patients with stroke, demyelinating process and many other neurological disorders [4]. On the contrary, among the four patients with MRI lesion apparently involving only the posterior cord, three patients had both sensory as well as motor abnormalities. This indicates that lesions to explain the neurological deficits are not always evident in the MRI. For most patients presenting with a spinal cord syndrome MRI has become the key investigation in establishing the diagnosis. However, myelopathy with normal spinal imaging remains a common clinical conundrum [13].

CONCLUSION

Segmental features form the foundation for clinical localization of the level of lesion. Though the clinical level of lesion and MRI level of lesion were discordant in 14 patients, clinical evaluation may still provide useful information and this can be confirmed by correlation with somatosensory evoked potential studies.

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