Original Article

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Evaluation of Clinical Significance of Two-Dimensional Single Thick-Slice Magnetic Resonance Myelography in Spine Imaging: A Clinico-Radiological Study in Tertiary Care Center

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Abstract

Background: Single-slice or multisclice both the techniques can be used to obtain MRM. The key difference between the two techniques is the time required; single-slice technique using thick-slab take less time, while multi-slice techniques require more time. The single-slice MRM technique, excellently suppresses the background signals (from fat or paravertebral veins) and it also significantly reduces the CSF flow artefacts. As a result, the aim of this study was to assess the effectiveness of routinely using single thick-slice 2-D MRM to provide further details in the spinal and extra-spinal regions. **Subjects and Methods:** TR (repetition time)/TE (echo time) used were infinite/1200-1400; ETL (echo-train length), 256; one signal averaged, and imaging period of 2.8 seconds were the imaging parameters for the cervico-thoracic spine. To completely eliminate the fat signal in the lumbar spine an inversion pulse was used. The parameters were TR/TE was infinite/1200-1600; inversion time was 150; ETL was 256; four signals averaged; and imaging period was 32 seconds. For the cervicothoracic the spatial resolution was 0.98x 0.98 mm (pixel size) and lumbar spines, it was 0.55x 0.55 mm. the slice thickness of 40-60 mm was used and for each patient three images were obtained in coronal and bilateral oblique coronal directions. Midsagittal T2-weighted MR images were used to view single-slice MR myelographic images, which allowed for better anatomic resolution. A 1.5-T unit was used for all MR imaging (Philips Achieva Medical Systems). While 180 patients underwent single thick slice two Dimensional MRM using T2 half Fourier acquisition SSTE (single shot turbo spin echo) method in addition to routine MR procedure for the spine. The evaluation of the images was done in the spinal and extra-spinal areas, for additional diagnostic details. The effectiveness of MRM in identifying spinal or extra spinal findings was graded using a three-point grading system. Grade 1 suggested that MRM made no contribution, whereas grade 3 indicated that it was valuable in positively identifying the findings. **Results:** MRM's spine utility was classified as grade 3 in 11% of cases (20/180), grade 2 in 21.7 percent of cases (39/180), and grade 1 in 67.3 percent of cases (121/180). As a result, the MRM in the spine was advantageous in 32.5 percent of cases (59/180). Additional spinal pathologies were found in 15.2 percent of cases (27/180). **Conclusion:** Thus we conclude that, when used in combination with routine MR sequences, 2D single thick slice MRM can provide more benefits in spinal imaging.

Keywords: Magnetic Resonance Imaging, Myelography, Spine, Degenerative Disk Disease, MRM, Magnetic Resonance Myelography.

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Introduction

Sagittal T1 and T2-weighted Turbo spin echo (TSE) images are commonly used to assess the vertebral discs, bones, and nearby soft tissue with MRI of the lumbar spine because of their spatial resolution and high signal-to-noise ratio. With these MR sequences, signal intensity changes toward the end plates of the vertebral bodies are predicted.[1,2] These progressions are related to highly dynamic vertebral-disk joint and signifies degenerative changes.[3] Furthermore, because of dehydration and degeneration, unusual signal intensities generally leads an abatement in T2-weighted pictures, of inter vertebral disks. Sometimes the water content in the disc will be amplified, as seen in diskitis, resulting in a hyper intense disc.[4]

MR myelography is a fast spin echo imaging (FSE) heavily T2-weighted MR sequence which intensifies the signal from water based structures (such as CSF) and suppresses the signal from solid non-water structures (fat). It has proved its worth in investigating the cases of spinal blocks and spinal canal stenosis in thoracic and lumber regions.[5] This procedure is now primarily used to assess nerve sheath impingement and spinal canal stenosis in conjunction with traditional MR imaging. The creation of MRM was done to measure the spinal subarachnoid space non-invasively. As compared to CT (computed tomography) myelography, MRM has the additional advantage of preventing the use of radiation or intrathecal contrast.[6–9] In this technique, heavily T2-weighted sequence is used which leads to hyper intense signal of CSF in subarachnoid space and filling defects or extrinsic compressions of abnormal or normal soft tissue structures. MRM can be obtained using multi or single slice techniques. The key difference between the two techniques is the time required; singleslice thickslab techniques take less time, while multislice techniques require more time. The single-slice MRM technique, excellently suppresses the background signals (from fat or paravertebral veins) and it also significantly reduces the CSF flow artefacts. As a result, the aim of this study was to assess the effectiveness of routinely using single thick-slice 2-D MRM to provide further details in the spinal and extra-spinal regions.

Subjects and Methods

Subjects

It was a record-based study, patients who attended the department of Radiodiagnosis, Shri Sathya Sai Medical College and Research Institute, Ammapettai, Chengalpet, Tamil Nadu. Total 180 cases were examined, over the period of 2 years after ethical committee approval.

TR (repetition time)/TE (echo time) used were infinite/1200-1400; ETL(echo-train length), 256; one signal averaged, and imaging period of 2.8 seconds were the imaging parameters for the cervico-thoracic spine. To completely eliminate the fat signal in the lumbar spine an inversion pulse was used. The parameters were TR/TE was infinite/1200-1600; inversion time was 150; ETL was 256; four signals averaged; and imaging period was 32 seconds. For the cervicothoracic the spatial resolution was 0.98x 0.98 mm (pixel size) and lumbar spines, it was 0.55x 0.55 mm. the slice thickness of 40-60 mm was used and for each patient three images were obtained in coronal and bilateral oblique coronal directions.

Midsagittal T2-weighted MR images were used to view single-slice MR myelographic images, which allowed for better anatomic resolution. A 1.5-T unit was used for all MR imaging (Philips Achieva Medical Systems). Although normal magnetic resonance imaging (MRI) scans were not included in the research, 180 patients' MRI data was analysed retrospectively. Patients of any age, sex, or clinical appearance who were referred for MR imaging were included in the study. There were 116 cases of degenerative disease ranging from mild to severe, 29 cases of spinal trauma, 14 cases of tuberculous spondylitis, 11 cases of congenital variants or defects and 10 cases of primary or secondary spinal tumours in the study population.

While 180 patients underwent single thick slice two Dimensional MRM using T2 half Fourier acquisition SSTE (single shot turbo spin echo) method in addition to routine MR procedure for the spine. The evaluation of the images was done in the spinal and extra-spinal areas, for additional diagnostic details. The effectiveness of MRM in identifying spinal or extra spinal findings was graded using a three-point grading system. Grade 1 suggested that MRM made no contribution, whereas grade 3 indicated that it was valuable in positively identifying the findings.

MRI technique

The 18 channel, 1.5T MR imaging examinations were carried out (Philips acheivia Medical Systems). In addition to the routine MR sequences, single thick slice MRM projection images were obtained in the coronal and midsagittal planes. With an extremely long echo period (TE) of 1200 ms and a repetition time (TR) of 8000 ms, the T2 half Fourier acquisition single shot turbo spin echo (SSTE) series was used. Echo train length = 369, slice thickness = 50 mm, field of view = 280400 mm, flip angle = 150, baseresolution = 512, phase resolution = 72, and other sequence parameters were echo train length = 369, slice thickness = 50 mm, field of view = 280400 mm, flip angle = 150, baseresolution = 512, phase resolution = 72.

Image interpretation

The MRM images were analysed by one radiologist, while the routine MR sequences were evaluated by a second radiologist with subspecialty training in Neuroradiology. Each radiologist was unaware of the other's photographs. We used a three-point grading scale adapted from that used by O'Connell et al.[8] (Table 1) to assess the additional benefits of MRM in the spinal and extraspinal regions.

Results

The most important considerations are patient positioning, coil selection, sequence selection, and image plane selection. The actual contrast between different tissues allows for the diagnosis of various lesions. MRI has mostly replaced myelography in many clinics due to its noninvasive nature and ability to provide excellent anatomic detail. There are many different combinations of sequences possible brain and spinal MR imaging. Most frequently used are: T2-weighted FSE, T1- and T2-weighted TSE, T1-weighted GE (gradient echo) and SE (spin echo), FLAIR (Fluid Attenuation Inversion

Table 1: Grading of magnetic resonance myelography findings

Grade	Description
1.	There was no additional contribution of MRM to detectionof findings
2.	MRM contributed to the ease of first look detection offindings compared to the routine sequences
3.	MRM was essential to the detection of findings

Table 2: Grading of Spectrums of Magnetic Resonance Myelography

Etiology spinal	Grade-1 (n=121)	Grade-2 (n=39)*	Grade-3 (n=20)
Congenital variants: Conjoined nerve roots Occult sacral meningoceles	0 4	0 1	6 0
Degenerative spine: No significant abnormality in spine Disc herniation/ spinal stenosis Synovial Neoarthrosis Facet joint effusion Perineural cysts / root sleeve dilatation Vascular congestion Post operative epidural scar/ arachnoid adhesions Sequestrated disc	16 42 2 2 4 4 1 2 4	0 8 16 16 17 0 1 1	0 0 0 0 5 3 1 0
Tuberculous spondylitis Findings in primary site of spinal involvement Detection of additional site of involvement	11 0	0 1	0 2
Trauma: Nerve root avulsion/small pseudomeningocele No nerve root avulsion Extent and multiplicity in primary/secondary tumors	0 23 7	0 2 3	3 0 0
***Some of the findings were seen together in one patient.** Extra-spinal Regional joint pathologies Pleural effusion, alveolar pulmonary lesions, ascites, hydronephrosis, cysts, iliac nodes, diaphragmatic hernia	25 5 20	0 0 0	0 0 0

Recovery), high-resolution three-dimensional (3D) sequences HASTE half-Fourier acquisition single-shot turbo spin echo and STIR (fat-suppressing short tau inversion recovery)

Although there was very strong agreement (k: 0.8–0.9) between traditional MRI and MR myelography in the classification of disc disease. McNemar tests revealed statistically significant differences at L1–L2, L2–L3, and L4–L5 levels for disk disease. The usefulness of MRM was classified as grade 3 in 10.9 percent (24/220) of the cases and grade 2 in 21.8 percent (48/220) of the cases [Table 2 & Figure 1]. As a result, the overall additional merit of MRM in the spine was observed in 32.7 percent of cases (72/220). The MRM did not contribute to the final diagnosis in 67.3 percent of cases (148/220). (Grade 1). MRM revealed extraspinal pathologies in 14.1 percent (31/220) of the cases.

Discussion

The difficulties related to lumbar punctures or intrathecal contrast infusions can be avoided by using single slice MR myelography as this technique is noninvasive. In spite of the fact that Magnetic Resonance myelogram has no significance as an independent sequence, its inborn benefit is that it finishes the outline of the spinal pathology, and adds basic three-dimensional data in 50-74% of cases.

Magnetic resonance imaging is an appropriate procedure for portraying irregularities of disk and bone marrow. The ordinary lumbar vertebral bodies have a transitional signal intensity in T1 and T2-weighted pictures because of the commitment of the hematopoietic bone marrow andfat.[10] The solid intervertebral plates show up generally homogeneous, with low sign force inT1 and moderately hyperintense in T2 successions, with a focal split. In this examination MRM has been contrasted with customary and CT myelography beforehand. Regular and CT myelography, in terms of pictorial accuracy and target in evaluating thecal sac and nerve roots, are superior to MRM.

MRM has been obtained using both multislice and singleslice techniques. Multislice techniques based on FSE sequences necessitate lengthy data acquisition time and post-

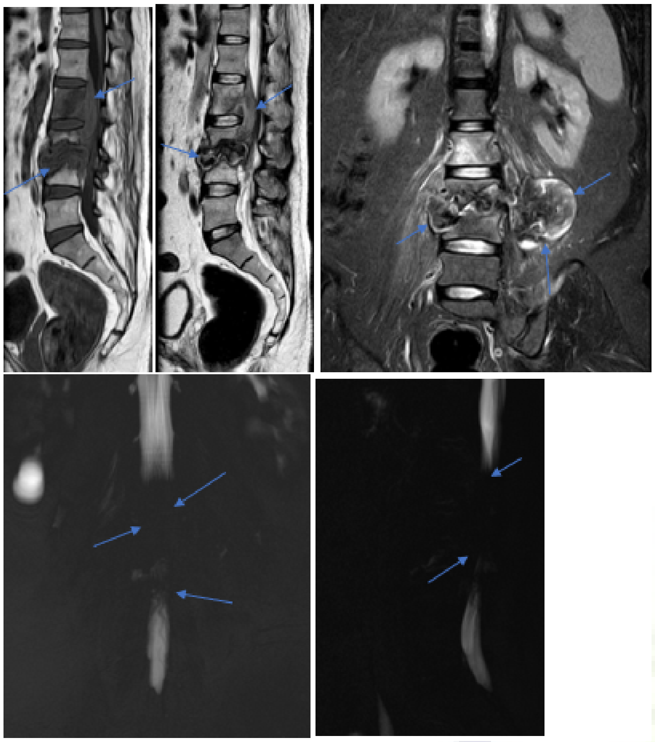

Figure 1: Non enhanced MRI lumbo sacral spine images in a 39 years old male with TB spine and psoas abscess(A)T1 TSE sagittal image showing the altered marrow and disc signal involving the L2, L3-L4 vertebral bodies along with large epidural component causing significant canal stenosis and cord compression(arrows).(B) T2 TSE sagittal image showing the heterointense signal of the involved vertebral bodies , disc space and epidural space(arrows).(C) T2 STIR coronal images showing the large heterointense collection in the left psoas muscle(arrows).(D&E) single thick slice MR myelogram lumbar spine image in posterior projection depicting the near total obstruction of the subarachnoid space and severe cord compression secondary to the epidural component of the infection (arrows).

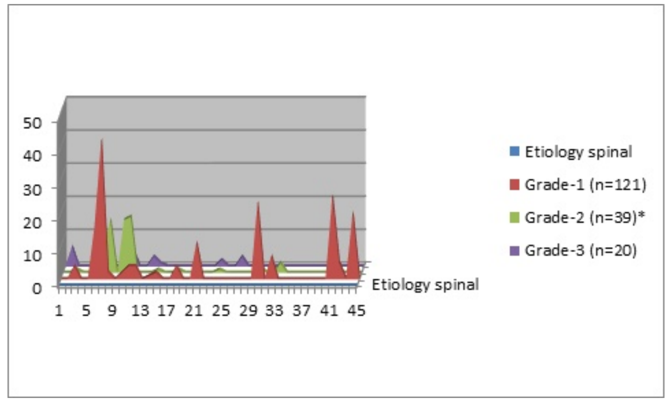

Figure 2: Gradings of MRM

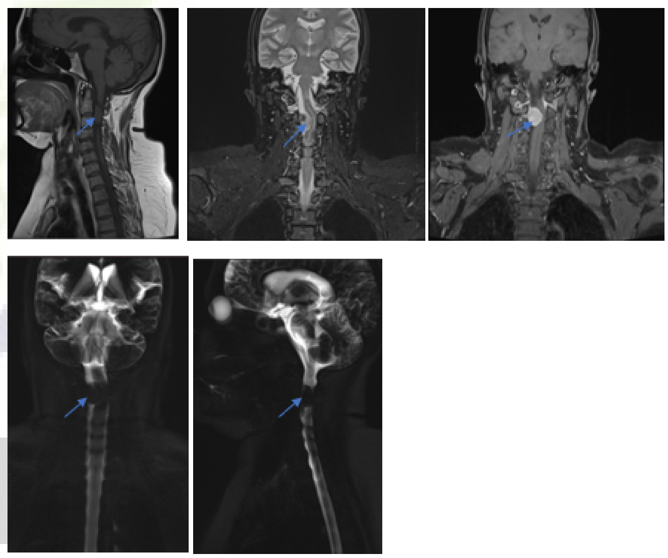

Figure 3: Non enhanced and contrast enhanced MR cervical spine images of 50 year old female with cervical cord meningioma. (A)T1 TSE sagittal image of cervical spine a well defined iso-hypointense intra dural extra medullary mass in the vertebral canal at the level of C2-C3 causing significant cord compression(arrows).(B)T2 STIR coronal image of C-spine showing hyperintense signal of the lesion with adjacent cord compression and myelomalacia changes (arrows).(C)T1 TSE post contrast fat supressed coronal image showing the broad based dural lesion with dural tail and homogenous post contrast enhancement(arrows) .(D & E) single thick slice MR myelography posterior & lateral view showing the obliteration of the sub aracnoid space and significant extrinsic cord compression with deviation to left (arrows).

processing.[11] Singleslice MRM has been tried with a variety of sequences, including RARE (rapid acquisition with relaxation enhancement),[7,12] single shot turbo spinecho(with long successful TE),[13] and T2 half Fourier acquisition SSTE.[14] Singleslice MRM is quicker, requires no post-processing, provides excellent background signal suppression, and has significantly reduced CSF flow artefacts. However, evidence on the additional benefits of single-slice MRM as a routine sequence in spinal imaging is minimal. In current study HASTE was used for retrieving single thick slice MRM images in two planes. O'Connell et al. also obtained MRM images using this

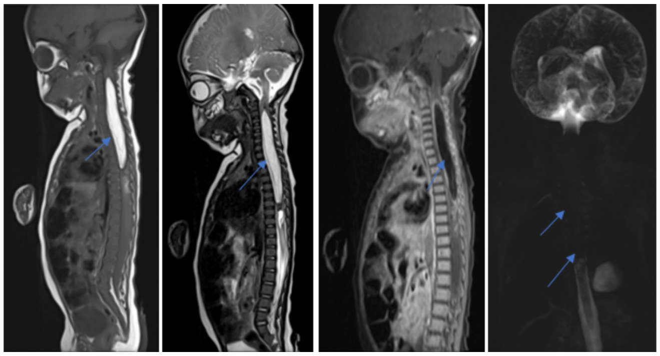

Figure 4: Non enhanced and contrast enhanced MR whole spine images of 5 year old male patient with spinal intramedullary lipoma. (A)T1 TSE sagittal whole spine image showing significant expansion of the cervico-thoracic segment of cord with large intramedullary hyperintense lesion(arrow).(B)T2 TSE sagittal whole spine image showing the lesion appearing hyperintense on both T1 &T2 indicating the presence of macroscopic fat(arrow) .(C)T1 TSE sagittal post contrast fat supressed whole spine image confirming the signal characteristics of the lesion as fat with loss of signal and no evidence of contrast enhancement (arrow).(D)Single thick slice MR myelogram posterior projection image showing significant expansion of the cord compressing the extra dural sub arachnoid space with loss of signal and also confirming the intramedullary location of the lesion (arrow)

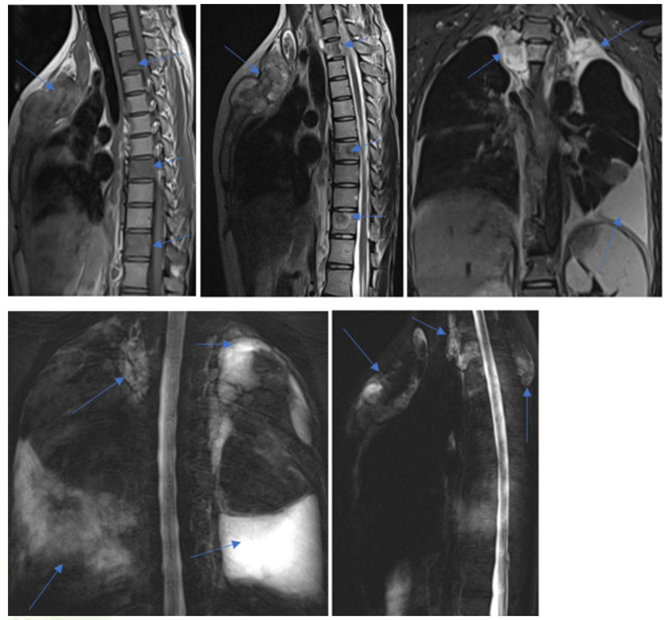

Figure 5: Non enhanced MR cervical spine images of 18 year old female with spinal and sternal TB. (A)T1 TSE sagittal image showing the hypointense marrow signal involving the T2, T7&T10 vertebral body levels along with soft tissue component and altered signal intensity involving the sternum(arrows).(B)T2 TSE sagittal image showing the heterointense marrow signal with preserved disc signal involving the T2, T7&T10 vertebral bodies and heterointense signal involving the sternum(arrows).(C)T2 STIR coronal image of the thorax showing the pulmonary manifestation of the tuberculosis i.e bilateral pleural effusion(L>R), and paravertebral collection(arrows) .(D & E) single thick slice MR myelogram in posterior and lateral projection depicting the extra spinal importance of the sequence in detecting and labelling the fluid collections in the paravertebral and pleural spaces (arrows).

series with the following parameters: cut thickness: 20 mm, echo train length: 256, FOV: 25cm, and a 3 min 20 sec season.[14]

In the present study the sequence parameters were changed and thicker slab i.e. 50 mm, as well as a longer echo train i.e. 369 cm and a larger FOV (field of view) i.e. 2840 cm were used. We were able to obtain high quality images with insignificant CSF pulsation rate facts and exceptional background signal suppression in a very short time of 34 seconds for a single area and 68 seconds for the entire spine using this protocol. The thicker slab and larger field of view reduced the image acquisition time, making it easier to look for irregular fluid signals in extra spinal areas, nearby organs, and joints.

Despite the role of MRM in assessing and diagnosing different spinal diseases ,its use is limited for routine investigation in spine due to long obtaining times and apparently restricted data.[2,3,5,6,8,11,12] MRM's expected use in assessing fluid signal in extraspinal regions has not been investigated previously. Nonetheless, we were able to add demonstrative data in a significant number of cases using this singleslice thickslab technique of MRM in two planes with no significant increase in imaging time or cost [Figures 1-5]. Conjoined nerve roots and traumatic nerve root avulsions could be studied separately on MRM in our study. [Figure 2, and 4].

MRM additionally exhibited indicative or possibly an underlying interpretative value in intrathecal vascular blockage, postoperative scars, arachnoid grips and sequestrated discs.

The intensely T2-weighted sequence and bigger FOV utilized in our examination brought about brief discovery of extra foci of coincidental or abnormal fluid signal in spinal or extraspinal areas. Perineural growths, synovial neoarthrosis and facetic radiations could be distinguished on MR even by the moderately unpracticed technicians.

Intrathecal vascular blockage, arachnoid grips, sequestrated discs and postoperative scars, all were likely suggestive of underlying interpretative value in MRM.

The use of a T2 weighted series and a larger field of view in our study resulted in the detection of additional foci of coincidental or irregular fluid signal in the spinal and extraspinal regions. Also moderately experienced technicians could differentiate perineural growths, synovial neoarthrosis, and facetic radiations on MR.[15,16]

In patients referred for spinal imaging, additional benefits such as possibility of revealing ascites, diaphragmatic hernia, lymphadenopathy and provincial joint pathologies was also feasible. These discoveries had significant clinical importance in certain patients. These extra-spinal findings were restricted in routine spinal imaging sequences in the primary look because of the restricted FOV and foremost immersion groups which brought about a sign drop anterior to the spine.[17]

Barriers of this study

There are few drawbacks of this study such as the images are only presented in two planes. This can result in a partial examination of the spinal canal and a struggle to detect the source of the fluid signal. In addition, if the plane is chosen wrongly, the sequence must be repeated. If a thicker slab is chosen, the data can be subjected to crosstalk; however, this was not observed in the current analysis.

Conclusion

MRM could be used for the normal spinal MRI protocol, based on the findings of this research. It could help in recognition of unusual fluid signals in the spinal and extra spinal regions and give extra data past the desired area without fundamentally delaying in general imaging time.

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