Original Article

MR Image Spectrum

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# MR IMAGE SPECTRUM OF SPINAL DYSRAPHISM IN A MILITARY HOSPITAL

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## ABSTRACT

***Objective:*** To demonstrate the spectrum of MR imaging findings in patients with suspected spinal dysraphism in a Military Hospital.

***Study Design:*** Descriptive study

***Place and Duration of Study:*** Department of Radiology, Military Hospital Rawalpindi from September 2005 to October 2007

***Patients and Methods:*** Patients were referred from neurology, neurosurgery and general surgery departments of Military Hospital and Combined Military Hospital Rawalpindi who presented with various neurological problems and skin stigmata having suspicion of spinal dysraphism. A total of 74 patients were evaluated over a period of two years.

***Results:*** All 74 (100%) patients suspected of spinal dysraphism showed one or multiple abnormalities out of the whole spectrum on plain MRI spine. Mean age was 6.4 years with the youngest patient sixteen days old and the eldest being 37 years old. Majority of the patients were under six years of age. A wide range of abnormalities were seen with Myelomeningocele found in 29 (39.2 %) and along with lipomatous component in 9 (12.2%). Thirty three (44.6 %) patients had diastometomyelia, 10 (13.5 %) having associated lipoma of filum terminale while syringomyelia was noted in 36 (48.6%) patients. Moreover, in the majority of patients, dysraphism was at the lower lumbar and upper sacral region.

***Conclusion:*** It was concluded that plain MRI spine is a single safe, non-invasive and quick method of describing the gamut of findings in patients of spinal dysraphism.

**Keywords:**, Magnetic Resonance Imaging, Neural tube defect, Spinal dysraphism.

## INTRODUCTION

Spinal dysraphism, or neural tube defect (NTD), is a broad term encompassing a heterogeneous group of congenital spinal anomalies related to improper closure of the caudal neuropore[1]. These conditions include spina bifida aperta, spina bifida occulta, meningocoele, myelomeningocoele, lipomyelomeningocoele, myeloschisis, and rachischisis - names given variably according to radiological or pathological findings. These variations can be grouped as open if the overlying skin is not intact, pending leakage of cerebrospinal fluid, and occult if the defect is well covered with full thickness skin.

Early detection and prompt neurosurgical correction of occult spinal dysraphism may prevent upper urinary tract deterioration, infection of dorsal dermal sinuses, or permanent neurologic damage[2]. Several studies have demonstrated that motor function, urologic symptoms, and urodynamic patterns may be improved by early surgical intervention in patients with occult spinal dysraphism[3]. The surgical outcome may be better if intervention occurs before the age of 3 years[4]. Spinal neuroimaging, therefore, has the important role of determining the presence or absence of an occult spinal dysraphic lesion so that appropriate surgical treatment can be instituted in a timely manner.

There is no consensus regarding the most appropriate neuroimaging modality to diagnose occult dysraphism. Some authors advocate spinal ultrasonography as the primary imaging modality for lower spine congenital anomalies because of its reasonable diagnostic performance at a low cost and without sedation[5]. Others emphasize the importance of spinal magnetic resonance imaging (MRI) examination because of its better diagnostic performance, excellent soft tissue characterization, and importance in presurgical planning[6].

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In our study we have emphasized that MRI is the imaging modality of choice to demonstrate the spectrum of findings in patients with suspected spinal dysraphism.

## PATIENTS AND METHODS

This descriptive study was carried out on 74 patients studied from Sep 2005 to October 2007. Consecutive patients coming to Radiology Department, Military Hospital Rawalpindi for plain MRI examination of spine with suspected anomalies from the spectrum of spinal dysraphism were included. These patients were referred from neurology, neurosurgery, pediatrics and general surgery departments of Military Hospital and Combined Military Hospital Rawalpindi. An informed consent was obtained from all subjects included in the study. MRI scanner used was 1.5 Tesla MRI machine (MAGNETOM symphony Version syngo MR 2002 A by Siemens). Patients were examined in supine position using spine array.

High spatial and contrast resolution images were obtained in shortest possible examination time. T-1 and T-2 weighted pulse sequences were acquired in sagittal as well as axial planes. T-1 weighted pulse sequences were used for evaluation of entire craniospinal axis helping to delineate the vertebral body marrow space, cord size and contour. T-2 weighted sequences were used to highlight the lesions in the cord parenchyma as well as to delineate cerebrospinal fluid and extradural interface. Both T-1 and T-2 weighted images were helpful when lipomatous component was present as it gives high signal intensity on both sequences.

Data was analyzed with SPSS version 10. Descriptive statistics were used to describe the data.

## RESULTS

Total 74 patients were included in the study with mean age of 6.4 ±7.745 years with minimum age of 16 days and maximum of 37 years. Fourteen patients (18.9%) presenting with various spinal anomalies were first born child in the family. Moreover in only 17 (23 %) cases the parents of the patients had history of cousin marriages.

Seventy-four consecutive patients with variety of cutaneous and neurological manifestations suspected of spinal dysraphism underwent MRI. These spinal deformities included 23 (31.1%) cases of congenital scoliosis with Cobb's angle falling between 0-19 degrees in 10 (13.5%) and between 20-40 degrees in 11 (14.9%). Two patients had scoliosis with Cobb's angle measuring more than 40 degrees. Physical examination findings and plain radiographs were reviewed in an attempt to correlate these findings with subsequent intraspinal pathologies depicted on MRI spine as shown in table I. Thirty eight (51.4%) patients presented with midline skin swelling in lumbosacral region with only 3 (4.1%) having swelling in cervical region. Six (8.1%) patients included in the study exhibited dermal sinus in the region to be questioned for suspected spinal dysraphism. All 74 (100%) patients showed one or multiple suspected intraspinal anomalies on MRI spine as shown in Fig. 1. Physical findings in the patients with spinal dysraphism are shown in Fig. 2. Twenty nine (39.2%) patients demonstrated meningocele (Fig. 3) with another 9 (12.2%) patients showing lipomatous component signifying lipomeningocele (Fig. 4). Most of the cases revealed this abnormality in lumbosacral region with 22 (29.7%) in lumbar and 16 (21.6%) in sacral region. Thirty-six (48.6%) patients revealed syringomyelia (Fig 3). Low lying cord was seen in 42 (56.8%) patients with 16 (21.6%) exhibiting tethering of cord as well. Thirty-three (44.6%) patients had diastematomyelia (Fig. 5) with well formed hemi-cords seen on axial MRI spine.

Three (4.1%) patients in our study demonstrated associated Arnold-Chiari malformation.

## DISCUSSION

The first 2 months of embryogenesis can be divided into 23 stages. Around day 18 at stage 8, the neural plate is formed, followed by neural folds and their subsequent fusion. The notochord forms in the midline of the embryo. The ectoderm overlying the notochord is induced to form the neuroectoderm. The neuroectoderm folds dissociate from the superficial ectoderm in a process termed

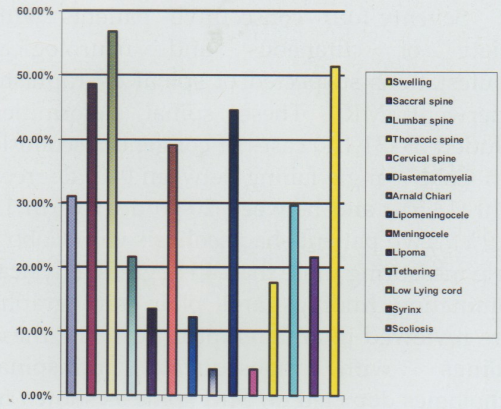


Figure 1: Percentages of spinal anomalies in our study

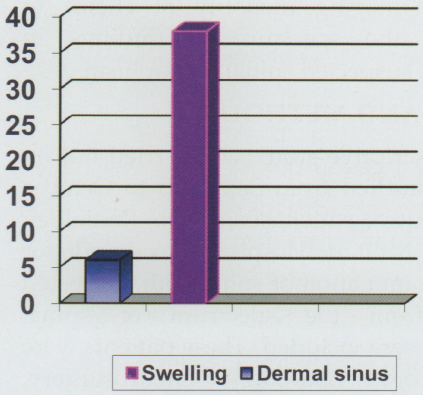


Figure 2: Physical findings in patients with spinal dysraphism

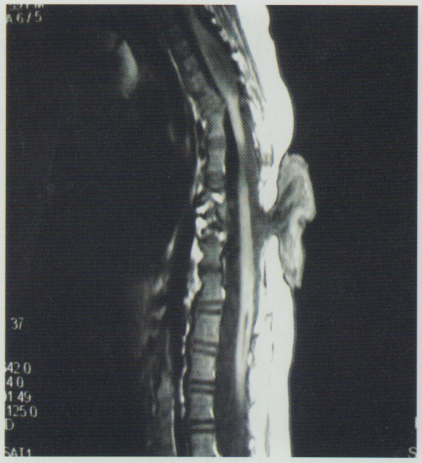

**Figure 3: Thoracic meningocele with syringomyelia**

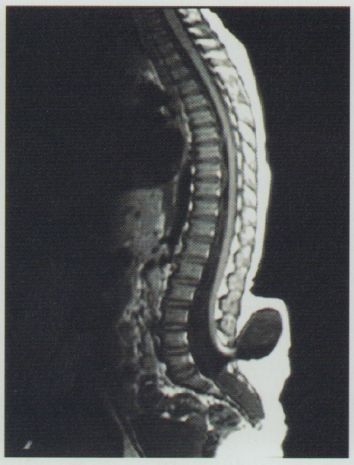

**Figure 4: Lipomeningocele**

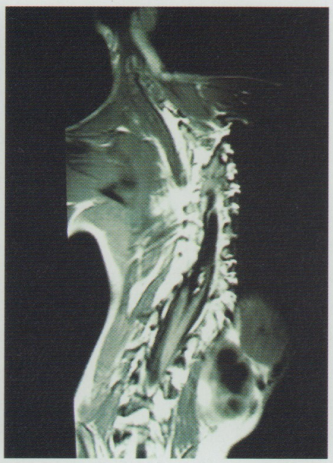

**Figure 5: Diastematomyelia with bony spur separating two hemicords**

primary neurulation. This process explains the formation of most of the spinal cord. Neuropore closure is to follow and completed by stage 12 around day 28. When caudal neuropore fails to close, open dysraphism ensues[7]. Defective secondary neurulation results in occult dysraphism in which the caudal part of the spinal cord remains connected with the epidermis by tissues of mesenchymal origin - the ultimate cause for tethering later on in life.[8,9]

A meningocele is a defect consisting of a herniation of Meningeal tissue through a defect in the skull and/or spine. Myelomeningocele is a defect consisting of a herniation of meningeal tissue and nervous tissue through a defect in the skull and/or spine.[2,11]

A large fairly well defined abnormal signal intensity lesion is noted in subcutaneous tissues of cervical, dorsal or lumbosacral regions appearing hypointense on T-1 and hyperintense on T-2 weighted images. A communication is seen with the spinal canal through anatomical defects in posterior elements of vertebral bodies excellently depicted on T-1 weighted MR images in sagittal and axial planes.

Lipomyelomeningocele consists of a skin covered back mass that contains neural tissues,

CSF, meninges and presence of lipoma or lipomatous component that extends from the subcutaneous tissue of back through the back mass into the spinal canal.[11,12]

Abnormal signal intensity area appearing hyperintense on both T-1 and T-2 weighted images is seen within the spinal canal which is continuous externally with subcutaneous fat at the level of the anatomical defect.

Spinal cord is split into two hemicords, each having one set of dorsal and ventral nerve roots. Each has its own dural sheath. They are separated by fibrous, bony, or cartilaginous septae associated with bony abnormalities such as split or fused vertebrae[13].

A sagittal hyperintense cleft is seen dividing the spinal cord into two hemicords. The bony spur is well seen on T1-weighted MRI when fatty marrow is present. Less well-developed spurs are seen as low-signal-intensity splitting the high-signal-intensity thecal sac on T2-weighted images. Widening of dural space may be found at this level. Two hemicords typically unite below the cleft.

A dermal sinus is a tract of cutaneous ectoderm which extends to varying degrees through the underlying mesenchymal tissues, sometimes as far as the dura of the neural tube[14].

A linear abnormal signal intensity area is seen extending from the level of anatomical defect and traversing the subcutaneous tissue while reaching the skin. It appears hypointense and is best seen against the high signal intensity fat on T-1 weighted sequences.

Intra-dural lipoma consists of a localized collection of fat within the intradural space. It is connected to spinal cord in subpial location however does not infiltrate the cord. The cord is low-lying and is tethered to the lipomatous component when lipoma occurs in lumbosacral region[14,15].

A fairly well defined lenticular or rounded abnormal signal intensity area is seen in the spinal cord. The lesion appears hyperintense on both T-1 and T-2 weighted sequences.

Low lying tethered spinal cord: A condition in which the spinal cord is fastened to an immovable structure, such as a lipoma, vertebra, dura, or skin. Always associated with spina bifida occulta and manifests it as low conus. By the age of 2 months, a conus below L2-L3 is considered abnormal[7, 16].

Axial T1-weighted images are most accurate in determining the conus level. Cord is seen ending at lower level and is seen attached posteriorly to spinal canal, vertebral bodies, lipoma or skin.

A study conducted at the Radiology Department of the Children's Hospital and the Institute of Child Health, Lahore by Rehman and. Qureshi showed that majority of the children were under six years of age. Spina bifida was found in all 25 (100%). Thirteen (52%) patients had diastematomyelia, with 08 (32%) having associated intraspinal lipomata while hydromyelia was noted in 07 (28%) patients. Moreover, in the majority of patients, dysraphism was at the lower lumbar and upper sacral region[17].

Another study conducted at Shaheed Beheshti University of Medical Sciences, Tehran, Iran by Sharifian et al. revealed that urinary complications are common in patients with spinal dysraphism[18].

The study conducted by Altman et al. showed the correlation of surgical findings in 17 of 18 abnormal examinations and metrizamide myelography with CT in 6 of these cases indicated that accurate diagnosis was provided by MR in all instances[19].

A prospective study at NUR Research Centre Institute of Nuclear Medicine and Allied Sciences, Lucknow Marg, Delhi, Dept of Neurosurgery GB Pant Hospital New Delhi was carried out in 100 cases of suspected occult spinal dysraphic anomalies with MRI in order to determine its diagnostic efficacy as the initial imaging modality. MR imaging provided accurate preoperative information in 91 out of 92 cases (98.9%). It is concluded that MRI is an excellent primary diagnostic tool, together with a plain radiograph, for complete preoperative evaluation of mid-line spinal anomalies[20].

The study conducted at Nuclear Medicine Research Centre, Institute of Nuclear Medicine and Allied Sciences, Delhi in which MR imaging of the spine was performed as the initial imaging technique in 20 children when spinal dysraphism was suspected clinically and plain radiographs showed spina bifida. The correlation with surgical findings indicated that MR provided accurate information preoperatively in all the cases[21].

A study conducted at Department of Pediatric Neuroradiology, G. Gaslini Children's Research Hospital, Genova revealed that MRI is the imaging method of choice for investigation of complex group of spinal disorders[22, 23].

The study conducted by Barnes et al. also revealed that MRI is a reliable and noninvasive procedure to screen patients for lumbosacral dysraphism[24].

Comparing with the above mentioned studies our study revealed that MRI is imaging modality of choice to demonstrate the spectrum of findings in patients with suspected spinal dysraphism.

## CONCLUSION

Spinal dysraphism is one of the most common causes of disability in infants and children. MRI is an excellent imaging modality for visualizing the spinal cord at all ages and is the imaging modality of choice for defining complex spinal dysraphism. It is considered as an accurate screening modality in the initial diagnosis of occult spinal dysraphism.

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