

## Research Article

# Spinal dysraphism: MRI evaluation

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### ABSTRACT

**Background:** Spinal dysraphism refers to the entire range of spinal column and neuraxis anomalies. The objective was to evaluate the role of magnetic resonance imaging (MRI) in characterizing the congenital and developmental disorders of spine.

**Methods:** Fifty (50) patients with clinically suspected spinal dysraphism were included in the study. All the patients were made to undergo MRI spine using 1.5 Tesla MRI, manufactured by GE, SIGNA HDX MACHINE. The findings of MRI spine were assessed and analyzed.

**Results:** Out of 50 patients included in the study; 24 were male (48%) and remaining 26 were female (52%). Congenital spinal lesions were more prevalent in the age group 0-20 years (70%). Lesions without subcutaneous masses (62%) were more common than the lesions with subcutaneous masses (38%). The commonest location for the congenital spinal lesions was lumbar region (54%). Congenital spinal lesions without spinal curvature abnormalities (58%) were more common than the lesions with spinal curvature abnormalities (42%). Vertebral anomalies (78%) were the commonest spinal anomalies in patients with congenital spinal lesions; spina bifida was the commonest (46%). Diastematomyelia was more prevalent in the age group 0-10 years (41.66%) and in female population (58.33%).

**Conclusion:** Thus we conclude that Spinal dysraphism were common in young females, with commonest anomaly being vertebral anomaly (Spina bifida), commonest location is lumbar region, Diastematomyelia common in young aged female. Magnetic resonance imaging is an accurate, noninvasive, safe and advanced modality for evaluation of the congenital spinal disorders and help in better management of these patients with prompt and accurate diagnosis.

**Keywords:** Spinal dysraphism, Neural tube defects (NTD), Congenital spinal disorders, MRI spinal dysraphism

### INTRODUCTION

Spinal cord development occurs through three consecutive stages, gastrulation (gestational weeks 2-3) with formation of notochord, primary neurulation (weeks 3-4) produces the upper most nine tenths of the spinal cord and secondary neurulation and retrogressive differentiation (weeks 5-6) result in formation of the conus tip and filum terminale.<sup>1</sup>

Defects in these early embryonic stages produce spinal dysraphism. Spinal dysraphism refers to the entire range of spinal column and neuraxis anomalies.<sup>2</sup>

Spinal dysraphic abnormalities are broadly classified as open (not covered by skin or aperta) and closed (covered

or occult) lesions.<sup>1</sup> Open spina bifida /aperta includes myelocele, myelomeningocele (Figure 1) and hemimyelomeningocele and hemimyocele.

Occult spinal dysraphism includes skin-covered masses such as lipomyelomeningocele (Figure 2), skin-covered meningoceles or myelocystoceles and the group of spinal dysraphism without an associated mass. This group encompasses dorsal dermal sinus (Figure 3), spinal lipoma, tethered cord (tight filum terminale syndrome), and fibrolipoma of the filum terminale, diastematomyelia and anterior-sacral-meningocele.

**Prevalence:** The estimated incidence of spinal dysraphism is about 1–3/1000 live births.<sup>3</sup> The prevalence of spinal dysraphism has been in decline the world over in the last

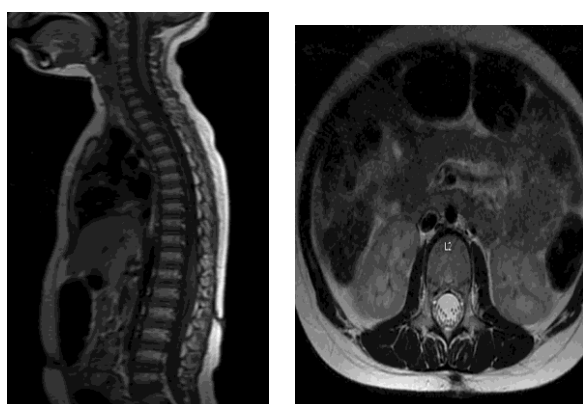
few decades due to the better nutrition for women, folic acid supplementation, improved antenatal care and high-resolution ultrasound for prenatal screening and biochemical markers.<sup>4</sup>



**Figure 1: Myelomeningocele: sagittal T2 and axial T2-weighted MR image shows neural placode extending above skin surface due to expansion of underlying subarachnoid space.**



**Figure 2: Lipomyelomeningocele: sagittal T1-weighted and Axial T2-weighted MR image shows lipomyelomeningocele that is differentiated from lipomyelocele by location of placode-lipoma interface outside of spinal canal due to expansion of subarachnoid space.**



**Figure 3: Dorsal dermal sinus: sagittal T1 and axial T2 weighted MR image revealing a dermal sinus tract that extends from the skin and which is not connected to the spinal cord.**

Plain X-ray is not a sensitive investigation to exclude spinal dysraphism. It is possible to perform spinal ultrasonography in the newborn, owing to the lack of ossification of the predominantly cartilaginous posterior elements of the spine. Spinal sonography is usually not possible after the age of 6 months except in cases of a persistent posterior spinal defect; in such cases, sonography may be performed at any age.<sup>5</sup>

Diseases of spine and spinal cord in pediatric patients were traditionally have been evaluated with myelography and contrast enhanced CT. These techniques provide detailed anatomic information but are invasive with some recognized risks.

MR was equal or superior to CT myelography in categories of cord swelling, cord atrophy, and cord compression. It provides additional information because of improved tissue characterization.

For the evaluation, Magnetic Resonance Imaging (MRI) can be extremely useful. Due to its multiplanar capabilities, the lack of ionizing radiation and its superior soft tissue contrast, MRI allows for the delineation of the spinal cord, the subarachnoid space, the vertebral bodies and the intervertebral discs and can be employed in infants and children without harmful effects. MRI of spine is also useful for evaluation of the cord lesions, diseases of foramen magnum, syringohydromyelia, etc.<sup>1</sup>

Hence MRI is emerging as an advanced imaging modality in assessing the diagnostic role of MRI in patients with suspected congenital spinal disorders.

## METHODS

Data was collected from patients clinically suspected and advised to undergo MRI spine at S.C.B. Medical College, Cuttack, over a period of 2 yrs (from September 2010 to September 2012.) Sample size was 50. Patients had MRI spine examination at our department with 1.5 TESLA GE SIGNA HDX MACHINE MRI machine. Information was collected on standard data collection forms. Relevant information regarding age, sex, birth history, developmental history, presenting complaints and radiological findings were recorded.

## Imaging Protocol

Imaging was done using an FOV of 300-500, 512 x 512 matrix sizes and 3-4 mm slice thickness.

Patients were made to lie supine in the magnet during the procedure. The protocol included sagittal and axial images of cervical, thoracic and lumbar regions.

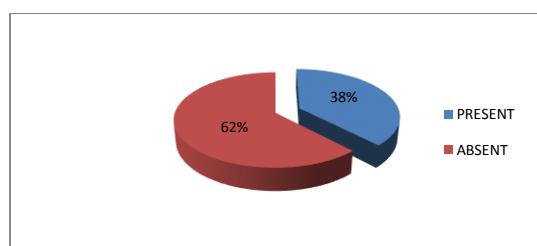
T1 & T2 weighted sequences in sagittal orientation with a slice thickness of 3 to 4mm was used. The T2-weighted assessment is often referred to as “MR-Myelography”.

These sequences can be performed with and without fat saturation, as in selected cases fat suppression is helpful for assessment of intra-spinal fatty lesions (e.g., lipoma).

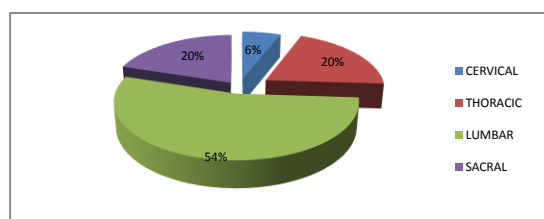
These sequences are followed by axial acquisitions of the affected area; the angulation of these axial sections should parallel the vertebral discs.

Particularly in oncologic disease – intravenous Gadolinium administration with post contrast T1-weighted acquisitions with and without fat saturation in sagittal and axial orientation were used.

## RESULTS



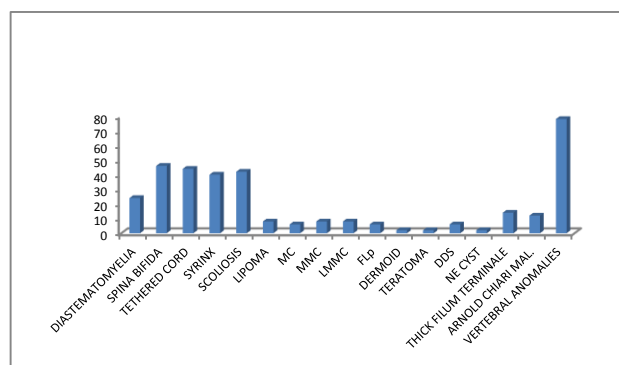
**Graph 1: Distribution of patients based on clinical presentation of subcutaneous mass in patients with congenital spinal lesions**



**Graph 2: Distribution of patients based on the level of spine involvement in patients with congenital spinal lesions.**

Out of 50 patients included in the study; 24 were male (48%) and remaining 26 were female (52%). Congenital spinal lesions were more prevalent in the age group 0-20 years (70%). Out of 50 patients who underwent MRI spine, congenital spinal lesions without subcutaneous masses (62%) were more common than the lesions with subcutaneous masses (38%) as shown in Graph 1. The commonest location for the congenital spinal lesions was lumbar region (54%) as shown in Graph 2. Congenital spinal lesions without spinal curvature abnormalities (58%) were more common than the lesions with spinal curvature abnormalities (42%) and abnormalities were more prevalent in adolescents (age > 10 years). Vertebral anomalies (78%) were the commonest spinal anomalies in patients with congenital spinal lesions followed by spina bifida, tethered cord, scoliosis/kyphosis, syrinx and diastematomyelia as shown in Graph 3. Of all the vertebral anomalies, spina bifida was the commonest (46%). Diastematomyelia was more prevalent in the age group 0-10 years (41.66%) and in female population (58.33%) with female to male ratio being 7:5. In the

study, spina bifida (68.18%) was commonly associated with tethered cord, followed by syringohydromyelia, diastematomyelia, thick filum terminale and others. Spina bifida (55%) and tethered cord (55%) were commonly associated with syringohydromyelia.



**Graph 3: Distribution of spinal anomalies in patients with congenital spinal lesions.**

## DISCUSSION

Congenital abnormalities of the spine and spinal cord are referred to as spinal dysraphisms.<sup>1</sup>

Spinal dysraphism includes a spectrum of congenital disorders caused by incomplete or abnormal closure of the neural tube during early embryogenesis. As a result, fusion of the midline spinal elements is either absent or incomplete. These disorders range from mild, asymptomatic lesions such as spina bifida occulta (a small benign bony cleft in the L5 or S1 spinous process) to severe defects such as the meningocele (an open neural tube defect).<sup>6</sup>

Spinal dysraphism is a birth defect that causes different kinds of secondary impairments, including joint deformities. Symptoms include bladder and bowel incontinence, back and leg pain, scoliosis, lower extremity weakness, a limp, limb atrophy, spasticity and vague lower extremity sensory changes and foot abnormalities (e.g. pes cavus).<sup>7</sup>

Congenital anomalies of spine are broadly classified as open and closed types, the detailed classification is shown in Table 1.<sup>1</sup>

The present study was conducted to study the various spinal dysraphism reported in the institute. In this present study female predominance was found (52%). Previous researchers are found that females are affected with myelomeningocele (Figure 1) more than males.<sup>8</sup>

It was observed that spinal dysraphism was common in younger age group with peak age group 0- 20 yrs (70%). Previous study by has shown that, range of the children with spinal dysraphism was 2 months to 16 years (mean 6.9 years).<sup>9</sup>

**Table 1: Clinical-neuroradiological classification of spinal dysraphism.**

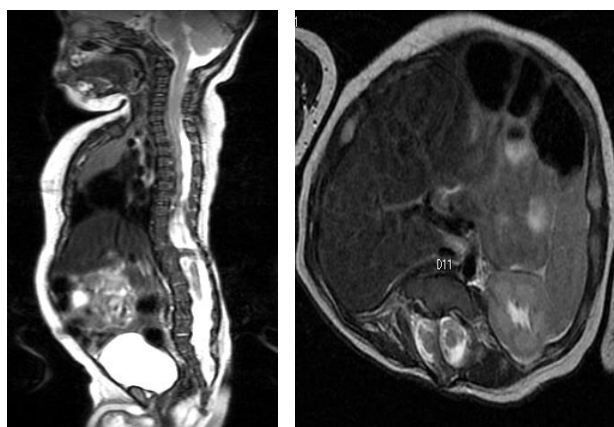
Open spinal dysraphisms	Closed spinal dysraphism
1. Myelomeningocele 2. Myelocele 3. Hemimyelomeningocele 4. Hemimyelocele	With subcutaneous mass
	1. Lipomas with dural defect -Lipomyelomeningocele -Lipomyelocele 2. Terminal myelocystocele 3. Meningocele
	Without subcutaneous mass
	1. Simple dysraphic states -Intradural lipoma -Filar lipoma -Tight filum terminale -Persistent terminal ventricle -Dermal sinus 2. Complex dysraphic states a. Disorders of midline notochordal integration -Dorsal enteric fistula -Neuroenteric states -Diastematomyelia b. Disorders of notochordal formation -Caudal regression -Segmental spinal dysgenesis

In our study, lumbosacral spine level is involved more commonly than thoracic and cervical spine level. Similar observations were also reported by previous researchers.<sup>10,1</sup>

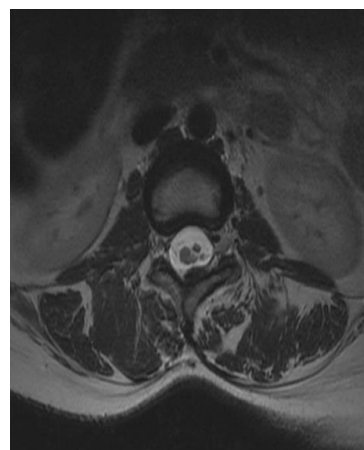
In our study, spinal dysraphism with sub cutaneous mass seen in 16 cases (38%) and without sub cutaneous mass seen in rest of the cases.

#### **Occult spinal dysraphism**

In present study, 12 cases with Diastematomyelia (figure 4) were included. Diastematomyelia are of two types, namely type-I the two hemicords are located within individual dural tubes separated by an osseous or cartilaginous septum as shown in [figure 4] and type-II there is a single dural tube containing two hemicords, sometimes with an intervening fibrous septum as shown in [Figure 5].<sup>14</sup> Peak occurrence of diastematomyelia was in 0-10 yr age group and common in female. Study by previous researchers<sup>10,11</sup> state that spit cord malformations common in females.



**Figure 4: Diastematomyelia: Type 1 diastematomyelia: sagittal T2 and Axial T2-weighted images show two dural tubes separated by osseous bridge.**



**Figure 5: Type 2 diastematomyelia: Axial T2-weighted MR image shows splitting of distal cord into two hemicords within single dural tube.**

One researcher stated that, dermal sinus is epithelium lined fistula that extends inward from skin surface and can connect with central nervous system and the meningeal coating and is shown in Figure 3.<sup>8</sup> A total of 3 patients of dorsal dermal sinus were included in this study.

Spinal lipoma detected in 2 cases appeared hyper intense on both T1 and T2 WIs in agree with previous study which stated that, lipomas appear as masses that are iso-intense with to subcutaneous fat in all sequences.<sup>12</sup>

In this study, tethered cord was seen in 22 patients, spina bifida in 15 cases, Diastematomyelia in 8 cases and thick filum terminale in 4 cases. Previous study stated that tethered cord syndrome involves traction on a low lying (below L3 vertebral level) conus medullaris.<sup>13</sup>

Six patients with chiari II Malformation were included in this study 3 were females and other 3 were male.

In this study, most common congenital anomaly of spine was vertebral anomalies (78%), among spina bifida was most common type (46%) followed by block vertebrae (12%) and hemi vertebrae (11%).

In present study spinal curvature abnormality (kyphoscoliosis) was seen in 21 (42%) cases.

#### **CONCLUSION**

Thus we conclude that spinal dysraphism were common in young females, with commonest anomaly being vertebral anomaly (spina bifida), commonest location is lumbar region, Diastematomyelia common in young aged female.

Magnetic resonance imaging is an accurate, noninvasive, safe and advanced modality for evaluation of the congenital spinal disorders and help in better management of these patients with prompt and accurate diagnosis.



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