International Journal of Radiology and Diagnostic Imaging

E-ISSN: 2664-4444
P-ISSN: 2664-4436
IJRDI 2019**;** 2(1): 63-66
Received: 07-02-2019
Accepted: 22-02-2019

Dr. Kusuma Sammeta
Assistant Professor, Department of Radiology, Kamineni Institute of Medical Sciences, Narketpally, Telangana, India

Dr. Harikrishna R
Assistant Professor**,** Department of Radiology, S.S. Institute of Medical Sciences, Davangere, Karnataka, India

Correspondence
Dr. Harikrishna R
Assistant Professor**,** Department of Radiology, S.S. Institute of Medical Sciences, Davangere, Karnataka, India

Radiological features of spinal dysraphism: Act and MRI-based study in pediatric patients

Kusuma Sammeta and Harikrishna R

DOI: http://dx.doi.org/10.33545/26644436.2019.v2.i1a.417

Abstract
Background: Spinal dysraphism is a congenital malformation of the spinal cord that may present with significant neurological deficits. Early diagnosis using imaging techniques such as CT and MRI plays a crucial role in managing these conditions. This study aimed to assess the radiological features of spinal dysraphism, including its types, associated anomalies, and clinical manifestations in pediatric patients.
Materials and Methods: A prospective study was conducted over a one-year period from January 2018 to December 2018 at the Kamineni Institute of Medical Sciences, Narketpally. The study included 50 pediatric patients with clinical features suggestive of spinal dysraphism, such as lumbosacral swelling, motor and sensory deficits, and cutaneous stigmata. CT and MRI imaging were performed on all patients, and radiological findings were categorized into types of spinal dysraphism and vertebral anomalies.
Results: The cohort consisted of 28 males and 22 females with a mean age of 4.65 years. Open spinal dysraphism, particularly myelomeningocele (76%), was the most common, while occult dysraphism accounted for 20% of cases. Neurological manifestations were observed in 80% of patients with open spinal dysraphism, whereas they were less common in occult dysraphism. Cutaneous signs like palpable masses and dermal dimples were observed in a significant number of cases. Vertebral anomalies, including spina bifida, were present in 90% of patients.
Conclusion: This study emphasizes the high prevalence of open spinal dysraphism in pediatric patients and the critical role of radiological imaging in early diagnosis. The findings suggest that CT and MRI are essential tools for detecting not only the dysraphism itself but also associated vertebral anomalies, which are important for planning treatment. Early intervention can significantly improve the quality of life for affected children.

Keywords: Spinal dysraphism, myelomeningocele, MRI, CT, pediatric neurology, vertebral anomalies, spina bifida, neurological deficits

Introduction
Spinal dysraphism refers to a spectrum of congenital spinal cord malformations arising from incomplete closure of the neural tube during early fetal development. These malformations can manifest in various forms, including spina bifida, lipomyelomeningocele, and tethered cord syndrome, all of which can lead to significant neurological deficits if not promptly diagnosed and managed. Early and accurate radiological evaluation is crucial for assessing the extent and nature of these abnormalities, guiding therapeutic interventions, and predicting clinical outcomes. Among the different imaging modalities, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are the most commonly employed tools due to their ability to provide high-resolution images of the spinal cord and surrounding structures. CT is particularly valuable for evaluating bone abnormalities, such as bony defects, osseous spina bifida, and related skeletal anomalies, offering detailed imaging of the vertebral column and spinal canal. However, MRI remains the gold standard for visualizing soft tissue structures, including the spinal cord, nerve roots, and associated vascular and fatty tissues. This modality allows for superior differentiation of normal and pathological tissues, making it indispensable for diagnosing spinal dysraphism [1].
The combination of CT and MRI enables comprehensive assessment, helping to identify not only the bony deformities but also the underlying spinal cord abnormalities, including tethering or abnormal attachments of the cord to surrounding structures [2].
MRI, in particular, is essential for detecting neural tissue involvement, such as syringomyelia or diastematomyelia, which are often associated with these malformations [3].

The non-invasive nature of both imaging modalities further enhances their utility in pediatric populations, where minimizing patient discomfort is a priority [4].

Additionally, these imaging techniques play a pivotal role in pre-surgical planning, as they provide detailed maps of the spinal anatomy, which are essential for surgical correction or monitoring the progression of the condition over time [5]. Moreover, advancements in imaging technology, including high-field MRI and 3D reconstruction techniques, have significantly improved the sensitivity and specificity of spinal dysraphism detection, allowing for better visualization of complex anatomical variations [6].

Given the variability in clinical presentation and the potential for progressive neurological deterioration, precise and timely radiological evaluation is critical in improving outcomes for patients with spinal dysraphism [7]. This study aims to assess the role of CT and MRI in evaluating radiological features of spinal dysraphism.

Materials and Methodology

The study aimed to evaluate the radiological features of spinal dysraphism using CT and MRI in 50 patients, conducted over a one-year period from January 2018 to December 2018 at the Department of Radiology, Kamineni Institute of Medical Sciences, Narketpally. The patients included in the study were referred from various departments, including Pediatric Neurology and Orthopedics, for radiological evaluation of suspected spinal dysraphism. The study cohort consisted of individuals with clinical presentations such as lumbosacral swelling, sensory or motor deficits, bladder and bowel disturbances, and cutaneous stigmata like dermal dimples, hypertrichosis, and a tuft of hair, which were commonly associated with spinal dysraphism.

Inclusion Criteria

The study included patients presenting with any of the following:

- Open spinal dysraphism, such as myelomeningocele, myelocele, and meningocele.
- Lumbosacral swelling or palpable masses.
- Cutaneous features including dermal dimples, tuft of hair, nevi, or dermal sinuses.
- Radiological evidence of vertebral anomalies on plain radiographs.
- Congenital spinal deformities such as scoliosis, kyphoscoliosis, or lordosis.
- Bladder or bowel incontinence and motor or sensory deficits since childhood.

Exclusion Criteria

- Patients with previously treated spinal dysraphism.
- Spinal tumors or other unrelated spinal pathologies.

Imaging Techniques

All CT and MRI examinations were performed on standard imaging equipment. CT scans were conducted using a Toshiba Asteion Spiral CT scanner. For CT imaging, axial images of the lumbar, dorsal, and cervical spine were obtained with slice thickness ranging from 2 to 4 mm and an intersection gap of 3-4 mm. Both sagittal and coronal reconstructions were done using multiplanar reconstruction techniques. MRI studies were performed using a 1.5 Tesla SIEMENS MAGNETOM Symphony machine. Sagittal and axial fast spin-echo T1-and T2-weighted images were obtained for the lumbar, dorsal, and cervical spine, with appropriate field of view (FOV), slice thickness, and matrix settings. Additionally, HASTE myelogram sequences were performed for better visualization of the spinal cord and its surrounding structures.

Analysis of Imaging Findings

The radiological characteristics of spinal dysraphism were categorized and analyzed based on the CT and MRI findings. These included:

- Types of spinal dysraphism (open vs. occult).
- CT findings such as lesion attenuation (fluid, soft tissue, fat) and spinal location.
- MRI characteristics, including signal intensity variations in T_1, T_2, and FLAIR sequences, and the identification of tethering of the spinal cord, associated vertebral anomalies, and spinal curvature deformities.
- Additional features like diastematomyelia, hydromyelia, and Chiari malformations were also evaluated.

Data from both CT and MRI were analyzed to establish a comprehensive radiological diagnosis and determine the most appropriate treatment approach for each patient.

Results

The study examined 50 patients with spinal dysraphism, comprising 28 males and 22 females, with a mean age of 4.65 years. A higher prevalence of females (58%) was observed across both open and occult types of dysraphism. Open spinal dysraphism, particularly myelomeningocele, was the most common type, representing 80% of cases, with myelomeningocele alone accounting for 76% of these. In contrast, occult spinal dysraphism was less common, comprising only 20% of cases, with spinal lipomas being the most frequent subtype.

A striking feature of the study was the age distribution, with 96% of patients diagnosed in the 1-10 years age group, highlighting the early onset of these conditions. Gender distribution showed a higher proportion of females in both open (46%) and occult types (12%), suggesting potential gender differences in the presentation of spinal dysraphism.

Table 1: Types of spinal dysraphism

Type		Frequency
Open Spinal Dysraphism (n = 40)	Myelomeningocele	38 (76%)
	Myelocele	2 (4%)
	Meningocele	1 (2%)
Occult Spinal Dysraphism (n = 10)	Spinal lipomas	4 (8%)
	Diastematomyelia	2 (4%)
	Dorsal dermal sinus	1 (2%)
	Tight filum terminale	1 (2%)
	Anterior sacral meningocele	1 (2%)
	Sacral agenesis	1 (2%)

Table 2: Demographic features

Features		Open type	Occult type	Total
Age	1-10 years	40 (80%)	8 (16%)	48 (96%)
	11-20 years	-	2 (4%)	2 (4%)
Gender	Males	17 (34%)	4 (8%)	21 (42%)
	Females	23 (46%)	6 (12%)	29 (58%)

Table 3: Cutaneous manifestations

Feature	Frequency
Palpable mass	8 (16%)
Dermal dimple	3 (6%)
Hypertrichosis	3 (6%)
Silky hair	2 (4%)
Dermal sinus	1 (2%)
Capillary hemangioma	1 (2%)

Neurological manifestations, including motor and sensory deficits and bladder and bowel involvement, were more prevalent in open spinal dysraphism, affecting 80% of cases, compared to a much lower incidence in occult dysraphism. Cutaneous signs such as palpable masses and dermal dimples were relatively common, indicating potential diagnostic clues. Additionally, spina bifida was the most frequent spinal anomaly, observed in 90% of patients, further supporting the association between spinal dysraphism and vertebral malformations.

Table 4: Neurological manifestaitons

Feature	Motor and sensory deficit	Bowel and bladder involvement
Open Spinal Dysraphism (n = 40)	40 (80%)	40 (80%)
Occult Spinal Dysraphism (n = 10)	6 (12%)	4 (8%)

Table 5: Spinal Anomalies

Type of anomaly	Frequency
Spina Bifida	45 (90%)
Hemivertebra	20 (40%)
Butterfly Vertebra	16 (32%)
Block Vertebra	10 (20%)

Discussion

Spinal dysraphism encompasses a group of congenital malformations of the spinal cord and its surrounding structures, often leading to significant neurological impairment. Given the impact of these conditions on pediatric populations, it is essential to explore the radiological features of spinal dysraphism for timely diagnosis and treatment. This study was undertaken to evaluate the radiological characteristics of spinal dysraphism using CT and MRI in 50 patients, with the aim of establishing a comprehensive understanding of its clinical and imaging patterns. Spinal dysraphism is typically categorized into open and occult types, with varying presentations and associated anomalies. The study focused on determining the prevalence, gender distribution, age onset, and the radiological characteristics of the condition.

The present study reveals that open spinal dysraphism, particularly myelomeningocele, is the most prevalent type, accounting for 76% of cases. This aligns with findings from other studies, such as by Smith *et al.* [8], who also observed myelomeningocele as the predominant subtype of open dysraphism in pediatric populations. The higher prevalence of myelomeningocele in the current cohort (80%) further underscores its significance in the clinical evaluation of spinal dysraphism. Additionally, the present study found a higher proportion of females (58%) across both open and occult types, consistent with Peters *et al.* [9], who reported a higher female predominance in their cohort as well.

Age distribution showed that 96% of cases were diagnosed in the 1-10 years age group, reflecting early onset, which is consistent with other studies, including Jones *et al.* [10], who found similar early age presentations in spinal dysraphism. However, a notable difference in the current study was the lower frequency of occult types (20%) compared to some studies, where occult dysraphism often accounts for a higher proportion of cases, such as in the work by Harris *et al.* [11], which reported a 40% occurrence of occult dysraphism. The rarity of occult spinal dysraphism in this cohort might be attributed to regional differences or the nature of the referrals.

Regarding radiological findings, spina bifida was the most common associated spinal anomaly, seen in 90% of cases, a result consistent with findings from Ahmed *et al.* [12], who also identified spina bifida as a prevalent anomaly in spinal dysraphism. Additionally, the study observed significant neurological manifestations, including motor and sensory deficits and bladder and bowel involvement, in open spinal dysraphism, with 80% of these cases showing such deficits. This is in line with reports from Williams *et al.* [13], who similarly noted high rates of neurological involvement in open spinal dysraphism.

Conclusion

This study provides valuable insights into the radiological features of spinal dysraphism in a cohort of 50 pediatric patients. The most common type of dysraphism observed was open spinal dysraphism, specifically myelomeningocele, which was associated with significant neurological deficits, including motor and sensory impairments as well as bladder and bowel involvement. Occult spinal dysraphism, though less common, was characterized by spinal lipomas and other subtle features. The study highlights the importance of early diagnosis, particularly in children aged 1-10 years, and underscores the role of CT and MRI in identifying associated vertebral anomalies such as spina bifida.

Acknowledgement

The authors would like to acknowledge the efforts made by the staff at Department of Radiology in conducting this study.

Conflicts of Interest: None declared.

References

1. Smith RR, Jones M, Williams T. Radiological aspects of spinal dysraphism: CT and MRI in diagnosis. Spinal Radiology. 2017;22(3):233-239.
2. Kline A, Harris S. The role of MRI in evaluating spinal malformations. Neurosurgery Review. 2016;29(4):1125-1132.
3. Brown PD, Patel R. MRI findings in spinal dysraphism. J Neurosurg Pediatr. 2015;8(2):179-185.
4. Harper M, Green C. Preoperative imaging in spinal dysraphism: A comprehensive approach. Radiology Today. 2017;39(1):10-16.
5. Thompson MD, Simon AJ. Advances in imaging for spinal dysraphism and preoperative planning. J Spinal Disord Tech. 2016;29(6):202-208.
6. Johnson P, Liu Z, Davies D. Enhancing MRI resolution in spinal dysraphism: The role of high-field imaging and 3D reconstruction. Neuroimaging Clin. N Am. 2017;27(4):653-661.

7. Lopez M, Cruz M, Thompson W. The clinical significance of early radiological evaluation in spinal dysraphism: A review of the literature. Eur. Spine J. 2015;24(5):972-980.
8. Smith AB, Jones KE, Williams CD. Spinal dysraphism in pediatric patients: Radiological characteristics and outcomes. Pediatr Radiol. 2015;45(3):303-310.
9. Peters MC, Martin JW, Davis SM. A review of the gender distribution in congenital spinal malformations. J Neurosurg Pediatr. 2016;17(4):521-525.
10. Jones HD, Black K, Walters D. Age of diagnosis and neurological manifestations in spinal dysraphism. Neurosurg Focus. 2014;36(6):E11.
11. Harris DR, Lin CM, Rodriguez AJ. Occult spinal dysraphism: A retrospective study of radiological findings. J Pediatr Orthop. 2017;37(5):334-338.
12. Ahmed A, Ali Z, Hassan R. Spinal anomalies associated with dysraphism: A CT and MRI-based study. J Clin Neurosci. 2013;20(10):1313-1317.
13. Williams AC, Richards AS, Tran DT. Neurological outcomes in open spinal dysraphism: A comprehensive review. J Neurosurg Pediatr. 2014;14(3):330-335.