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ORIGINAL ARTICLE

Magnetic Resonance Imaging in the Diagnosis of Spinal Dysraphism

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ABSTRACT:

Background: Spinal dysraphism comprises a spectrum of congenital spinal anomalies with varied clinical presentation and prognosis. MRI has emerged as the imaging modality of choice for comprehensive evaluation. **Aim:** To assess the role of MRI in identifying, characterizing, and providing a composite diagnosis of spinal dysraphism and associated anomalies. **Methods:** A descriptive observational study was conducted on patients with suspected spinal dysraphism who underwent MRI evaluation, and lesions were classified based on imaging findings. **Results:** Closed spinal dysraphism was more common than open dysraphism. Tethered cord syndrome and myelomeningocele were the predominant subtypes. MRI enabled precise lesion characterization and detection of associated anomalies. **Conclusion:** MRI plays a critical role in the accurate diagnosis and comprehensive evaluation of spinal dysraphism, facilitating effective clinical management.

Keywords: Spinal dysraphism; Magnetic resonance imaging; Tethered cord; Congenital spinal anomalies

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INTRODUCTION

Spinal dysraphism represents a heterogeneous group of congenital anomalies resulting from defective closure of the neural tube and surrounding mesenchymal structures during early embryogenesis. These anomalies encompass a wide spectrum of disorders ranging from open spinal dysraphism, such as myelomeningocele, to closed spinal dysraphism including lipomyelomeningocele, tethered cord syndrome, diastematomyelia, and dermal sinus tracts [1]. The clinical presentation of spinal dysraphism varies widely, from overt neurological deficits at birth to subtle cutaneous markers or progressive neurological deterioration later in life, making early and accurate diagnosis essential for optimal management [2].

Advances in imaging have significantly improved the understanding and detection of spinal dysraphism. Among available imaging modalities, magnetic resonance imaging (MRI) has emerged as the investigation of choice due to its superior soft tissue contrast, multiplanar capability, and lack of ionizing radiation [3]. MRI allows detailed visualization of the spinal cord, nerve roots, vertebral anomalies, and associated intraspinal and extraspinal abnormalities, which are crucial for precise lesion characterization and surgical planning [4].

MRI plays a pivotal role in differentiating various forms of spinal dysraphism by demonstrating specific imaging features such as the level of conus medullaris termination, presence of split cord malformations, lipomatous components, syringohydromyelia, and associated vertebral segmentation defects [5]. Identification of these features is critical, as different types of dysraphism have distinct prognostic and therapeutic implications. Moreover, MRI facilitates detection of associated anomalies such as Chiari II malformation, hydrocephalus, scoliosis, and genitourinary abnormalities, which significantly influence patient outcomes [6].

Closed spinal dysraphism, in particular, poses diagnostic challenges due to its often subtle external manifestations. MRI has proven invaluable in identifying occult lesions and tethering pathologies before irreversible neurological damage occurs [7]. Early MRI evaluation in suspected cases allows timely intervention, reducing the risk of progressive motor deficits, sensory disturbances, and bladder or bowel dysfunction [8].

With continuous refinements in MRI techniques, including high-resolution sequences and advanced imaging protocols, radiologists can now provide comprehensive assessments that integrate anatomical, pathological, and developmental information [9]. Such detailed radiological evaluation not only aids in diagnosis but also enhances interdisciplinary communication between radiologists, neurosurgeons, and pediatric specialists.

In this context, the present study aims to assess the role of MRI in the identification of various forms of spinal dysraphism, characterize the lesions along with their associated anomalies, and provide a composite diagnosis based on specific imaging findings, thereby emphasizing the indispensability of MRI in the comprehensive evaluation and management of spinal dysraphism [10].

MATERIAL AND METHODS

A hospital-based descriptive observational study was conducted in the Department of Radiodiagnosis of a

tertiary health care centre over the study period. The study included a total of 30 patients who were clinically suspected or referred for evaluation of spinal dysraphism. Patients of all age groups and both sexes were included. Individuals with a prior history of spinal surgery or contraindications to magnetic resonance imaging were excluded from the study.

All patients underwent magnetic resonance imaging of the spine using a high-field strength MRI scanner. Imaging was performed in supine position using standard spine coils. The MRI protocol included sagittal and axial T1-weighted and T2-weighted sequences, with additional sequences such as STIR or fat-suppressed images wherever necessary. Imaging coverage extended from the craniovertebral junction to the sacrum to ensure complete evaluation of the spinal cord and associated structures.

MRI images were systematically analyzed for the identification and classification of various forms of spinal dysraphism. Specific imaging features assessed included the level of termination of the conus medullaris, presence of tethered cord, split cord malformations, lipomatous lesions, dermal sinus tracts, syringohydromyelia, and vertebral segmentation anomalies. Associated intracranial and spinal anomalies such as Chiari malformations, hydrocephalus, scoliosis, and other congenital abnormalities were also evaluated wherever present.

Findings were documented and categorized based on established MRI classification systems for spinal dysraphism. A composite radiological diagnosis was formulated for each case by correlating the observed imaging features. Data were compiled and analyzed using descriptive statistical methods, with results expressed as frequencies and percentages.

Ethical approval for the study was obtained from the Institutional Ethics Committee prior to commencement of the study, and informed consent was obtained from all participants or their guardians. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

RESULTS

Table 1 describes the distribution of spinal dysraphism based on gender among the studied patients. Out of 30 cases, males constituted 18 patients (60.0%), while females accounted for 12 patients (40.0%). This indicates a male predominance in the overall occurrence of spinal dysraphism in the present study.

Table 2 presents the overall distribution of spinal dysraphism based on type. Closed spinal dysraphism was more frequently observed, seen in 19 patients (63.3%), whereas open spinal dysraphism was identified in 11 patients (36.7%). This highlights the predominance of closed spinal dysraphism in patients evaluated using MRI.

Table 3 shows the distribution of open spinal dysraphism based on specific types. Among the 11 cases of open spinal dysraphism, myelomeningocele was the most common subtype, observed in 6 patients (54.5%), followed by meningocele in 3 patients (27.3%). Myeloschisis was the least common type, seen in 2 patients (18.2%).

Table 4 illustrates the distribution of closed spinal dysraphism based on type. Of the 19 patients with closed spinal dysraphism, tethered cord syndrome was the most frequently identified lesion, accounting for 7 cases (36.8%). Lipomyelomeningocele was observed in 5 patients (26.3%), diastematomyelia in 4 patients (21.1%), and dermal sinus tract in 3 patients (15.8%). These findings emphasize the varied spectrum of closed spinal dysraphism detected on MRI.

Table 1: Distribution of spinal dysraphism based on gender (n = 30)

Gender	Number of cases	Percentage (%)
Male	18	60.0
Female	12	40.0
Total	30	100.0

Table 2: Distribution of spinal dysraphism based on type (n = 30)

Type of spinal dysraphism	Number of cases	Percentage (%)
Open spinal dysraphism	11	36.7
Closed spinal dysraphism	19	63.3
Total	30	100.0

Table 3: Distribution of open spinal dysraphism based on type (n = 11)

Type of open spinal dysraphism	Number of cases	Percentage (%)
Myelomeningocele	6	54.5
Meningocele	3	27.3
Myeloschisis	2	18.2
Total	11	100.0

Table 4: Distribution of closed spinal dysraphism based on type (n = 19)

Type of closed spinal dysraphism	Number of cases	Percentage (%)
Tethered cord syndrome	**7**	**36.8**
Lipomyelomeningocele	**5**	**26.3**
Diastematomyelia	**4**	**21.1**
Dermal sinus tract	**3**	**15.8**
Total	**19**	**100.0**

DISCUSSION

The present study highlights the pivotal role of magnetic resonance imaging in the evaluation of spinal dysraphism by demonstrating its ability to accurately identify lesion types, characterize complex anatomical details, and detect associated anomalies. A male predominance was observed in the study population, which is consistent with earlier reports suggesting a slightly higher incidence of spinal dysraphism among males, particularly in closed dysraphism variants [11]. MRI provides a non-invasive and highly sensitive modality for early diagnosis, which is essential given the varied clinical presentations and potential for progressive neurological deterioration.

Closed spinal dysraphism was more frequently encountered than open spinal dysraphism in the present study. This finding aligns with recent imaging-based studies reporting an increasing detection of occult spinal dysraphism owing to widespread MRI availability and heightened clinical awareness [12]. Closed dysraphism often lacks overt external markers and may present later with subtle neurological or urological symptoms, underscoring the importance of MRI in identifying these lesions before irreversible damage occurs.

Among open spinal dysraphism, myelomeningocele emerged as the most common subtype, followed by meningocele and myeloschisis. MRI enables precise delineation of neural tissue herniation, sac contents, and associated abnormalities such as Chiari II malformation and syringomyelia, which are crucial for surgical planning and prognostication [13]. The ability of MRI to visualize both neural and non-neural components provides a comprehensive assessment that cannot be achieved with other imaging modalities.

In cases of closed spinal dysraphism, tethered cord syndrome was the most frequently identified lesion, followed by lipomyelomeningocele, diastematomyelia, and dermal sinus tracts. MRI plays a decisive role in identifying low-lying conus medullaris, thickened filum terminale, split cord malformations, and associated vertebral anomalies [14]. Accurate characterization of these entities is essential, as timely surgical intervention can prevent progressive neurological decline and improve long-term outcomes.

The composite diagnostic approach based on specific MRI findings, as applied in this study, enhances diagnostic confidence and aids multidisciplinary decision-making. Recent advances in MRI techniques, including high-resolution imaging and multiplanar reconstructions, have further refined the evaluation of spinal dysraphism, allowing detailed anatomical mapping and improved detection of associated anomalies [15]. Thus, MRI remains indispensable in the comprehensive radiological evaluation of spinal dysraphism.

CONCLUSION

The study concludes that MRI is an indispensable imaging modality for the evaluation of spinal dysraphism, offering accurate identification of lesion types, detailed characterization of anatomical features, and reliable detection of associated anomalies. Closed spinal dysraphism was more prevalent than open dysraphism, with tethered cord syndrome and myelomeningocele being the most common subtypes in their respective categories. MRI-based composite diagnosis plays a crucial role in guiding clinical management and surgical planning, emphasizing the importance of early and comprehensive radiological assessment.

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