EVALUATION OF PAEDIATRIC SPINAL DYSRAPHISMS BY ULTRASONOGRAPHY AND MAGNETIC RESONANCE IMAGING

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ABSTRACT

BACKGROUND

Congenital malformations of spine and spinal cord are referred to as spinal dysraphisms. They are caused by incomplete closure of neural tube around third and fourth week of embryonic development. Spinal dysraphisms are spectrum of disorders in which there is defective midline closure of neural, bony or other mesenchymal tissues. Spinal USG and MRI play an important role in determining the presence or absence of spinal dysraphism.

Aims and Objectives

1. To study the role of ultrasound and magnetic resonance imaging in neonates and infants, and to determine the degree of agreement between ultrasound and magnetic resonance imaging findings.
2. To identify and classify the spectrum of lesions of spinal dysraphisms.

MATERIALS AND METHODS

This was hospital-based study conducted over a period of one year from October 2017 to September 2018. Clinical and radiological findings of 42 cases suspected of spinal dysraphisms were studied and identified.

Out of 42 cases, 35 consecutive infants had spinal ultrasound done and 40 patients had follow-up MRI. Ultrasound and MRI findings were correlated retrospectively.

RESULTS

Statistical data analysed using percentage and data tables. Our study consists of 42 cases of suspected spinal dysraphisms in which most of them are below one month of age and most of them are females. Most common location in our study is lumbosacral and most common dysraphism is myelomeningocele.

CONCLUSION

Ultrasound and MRI are adjuvant in evaluating cases of spinal dysraphism. MRI is excellent in characterizing the soft tissue spinal anomalies of spinal dysraphism whereas ultrasound is an excellent initial imaging modality in infants for evaluation of spinal dysraphism. MRI imaging-based classification of spinal dysraphism helps in surgical planning and prognostication.

KEYWORDS

Spinal Sonography, MRI Imaging, Spinal Dysraphisms.

HOW TO CITE THIS ARTICLE: Suneetha KS, Venkateswarlu M, Radharani K, et al. Evaluation of paediatric spinal dysraphisms by ultrasonography and magnetic resonance imaging. J. Evid. Based Med. Healthc. 2019; 6(2), 111-115. DOI: 10.18410/jebmh/2019/21

BACKGROUND

Spinal dysraphism refers to combined malformation of vertebral column and spinal cord. It occurs between 20 to 28 days of (embryonic life) intrauterine gestation period. Failure of closure of neural folds at caudal end of neural tube, followed by failure of closure of caudal somites, resulting in the gap of spine. Various varieties of spinal dysraphisms occur as a result of time and extent of failure of neural tube closure. It can be defined as an incomplete fusion of midline mesenchymal, bony and neural structures.[1] Spinal dysraphisms broadly categorized in to open and closed types. This can be grouped as open if overlying skin is not intact and occult if the defect is well covered with full thickness skin. Closed dysraphism further divided by presence or absence of subcutaneous mass. Most recent classification in use was Tortori Donati et al in 2000.[2] The

Financial or Other, Competing Interest: None.
Submission 22-12-2018, Peer Review 25-12-2018,
Acceptance 09-01-2019, Published 14-01-2019.
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DOI: 10.18410/jebmh/2019/21

incidence of spinal dysraphism about 1-3/1000 live births. Spinal dysraphisms are one of the most common congenital disorder associated with significant morbidity and mortality. Early detection of these spinal dysraphisms are very helpful in prevention of permanent neurological damage. Spinal neuroimaging plays an important role in the determining presence or absence and classification of the spinal dysraphic lesions.

Ultrasonography is a well-established method for evaluation of the neonatal spinal canal and its contents.[3] Because of predominately cartilaginous and incompletely ossified spinal arches in infants.

Magnetic Resonance Imaging (MRI) offers several advantages in the evaluation of spine in children with suspected spinal dysraphism.[4]

Aims of the Study

Aim of the study was to assess the role of spinal ultrasound and MRI in the identification of various forms of spinal dysraphism, characterization of the lesions and associated anomalies, giving a composite diagnosis based on specific Imaging findings.

MATERIALS AND METHODS

Data was collected from patient's clinically suspected spinal dysraphism and advised to undergo consecutive ultrasound and MRI spine at Rangaraya Medical College, Kakinada over a period of 1 yr. (from October 2017 to September 2018). Sample size was 42.

MRI performed on a 1.5 T General Electrical Medical Systems. Standard pediatric spinal MR sequences are performed includes axial and sagittal T1WI & T2WI, images with and without fat saturation. Coronal T2 & STIR sequences often are performed, as they are particularly helpful in patients with scoliosis.

Our routine MRI studies of the brain are performed in T1 and T2 axial planes and T2 sagittal or T1 coronal planes with Slices thickness of 5-10 mm to rule out associated intracranial anomalies.

Spinal ultrasound is performed with a high-frequency 12 MHz linear-array transducer and alternately with 8- to 10-MHz curved-array transducer. Ultrasound images are acquired in prone position in the longitudinal (sagittal) and transverse (axial) planes from the craniocervical junction through the conus medullaris and cauda equina.

Para median scanning done in some patients with partially ossified vertebra. The vertebral bodies are carefully numbered by counting down from the lowest rib and/or the craniocervical junction, and numbering is confirmed by counting up from the lumbosacral junction. This dual technique of numbering allows one to avoid misdiagnosing a low-lying, possibly tethered spinal cord.

Simultaneously brain sonographic examinations are performed through the anterior fontanelle in both the coronal and the sagittal planes to look for associated anomalies like hydrocephalus, Chiari malformations, and agenesis of corpus callosum. Scanning also done through the posterior and mastoid fontanelles, for better visualization of cerebellum, 4th ventricle, and cisterna magna.

Inclusion Criteria

1. All infants presenting with open spinal dysraphism.
2. All infants presenting with lumbosacral swelling.
3. All infants presenting with Dimple, tuft of hair, nevi.

Exclusion Criteria

1. Cases above 1 year.

RESULTS

42 patients who presented with various neurological problems and skin stigmata suspicious of spinal dysraphism were referred to our department and underwent ultrasound and Magnetic Resonance Imaging of the spine were included in our study. Age of the patients ranged from 0 days to 1 yr. Most of the children are below 1 month of age (table 1) .Of these 22 were female patients and 20 were male patients (table 2). Of the 42 patients, 12 were open type and 30 were closed type of spinal dysraphism (table 3).

Age Group	No. of Cases	Percentage
1 day - 30 days	26	61.90
2-6 months	9	21.42
7-12 months	7	16.66

Table 1. Age Distribution of Spinal Dysraphism

Gender	No. of Cases	Percentage
Male	20	47.61
Female	22	52.38

Table 2. Gender Distribution of Spinal Dysraphism

Type	No. of Cases	Percentage
Open	12	28.57
Closed	30	71.42

Table 3. Distribution of Type of Spinal Dysraphism

Myelomeningocele followed by meningocele were the commonest presentations in our study. One case was lip myelomeningocele and diastematomyelia and two cases were dorsal dermal sinus & sacral agenesis (table 4). Location of spinal dysraphisms of the 42 patients in our study, 3 were noted in the cervical region, 9 in the dorsal region, 10 in the lumbar region, 6 in the sacral region, 12 in lumbosacral region and 2 in dorsolumbar region (table 5) . Associated findings include such as Chiari I, Chiari II, Hydrocephalus, Agenesis of corpus callosum syrinx, tethered cord and low-lying cord (table 6, 7).

Imaging Findings	No. of Cases	Percentage
Meningocele	10	23.80
Myelomeningocele	26	61.90
Lipomeningomyelocele	1	2.38
Diastematomyelia	1	2.38
Dorsal Dermal Sinus	2	4.76
Sacral Agenesis	2	4.76

Table 4. Summary of Cases

Location	No. of Cases	Percentage
Cervical	3	7.14
Dorsal	9	21.42
Dorsolumbar	2	4.76
Lumbar	10	23.80
Sacral	6	14.28
Lumbosacral	12	28.57

Table 5. Location of Spinal Dysraphism

Associated Findings	Chiari I	Chiari II	Hydrocephalus
Meningocele	2		1
Myelomeningocele	14	18	13
Lipomyelomeningocele		1	1
Diastematomyelia	2		1
Dorsal Dermal Sinus			

Table 6. Associated Findings with Spinal Dysraphism

Associated Findings	Agenesis of Corpus Callosum	Syringohydromyelia	Tethered Cord/Low-Lying Cord
Meningocele		3	
Myelomeningocele	3	15	11
Lipomyelomeningocele			
Diastematomyelia			
Dorsal Dermal Sinus			1

Table 7. Associated Findings with Spinal Dysraphism

Cases and Imaging Findings

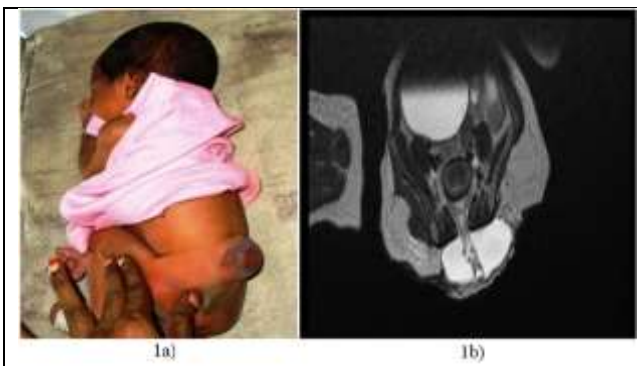

Figure 1a) Clinical Photograph of Lumbosacral Myelomeningocele. 1b) Axial T2 Weighted MR Demonstrates Herniation of Meninges and Nerve Roots in to Subcutaneous Planes

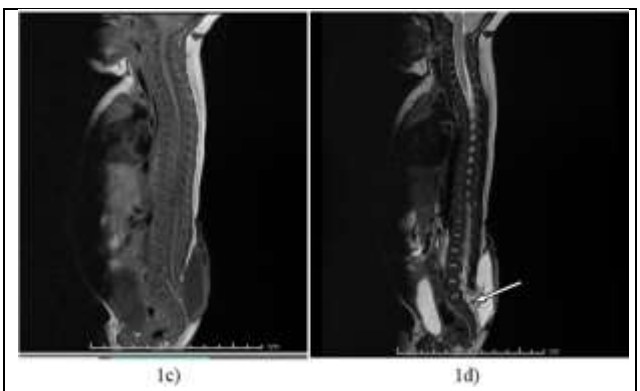

Figure 1c) Sagittal T1-Weighted and 1d) T2-Weighted MR Demonstrates Closed Lumbosacral Myelomeningocele. Dorsal Extent of Neural Placode is Seen Clearly (Arrow)

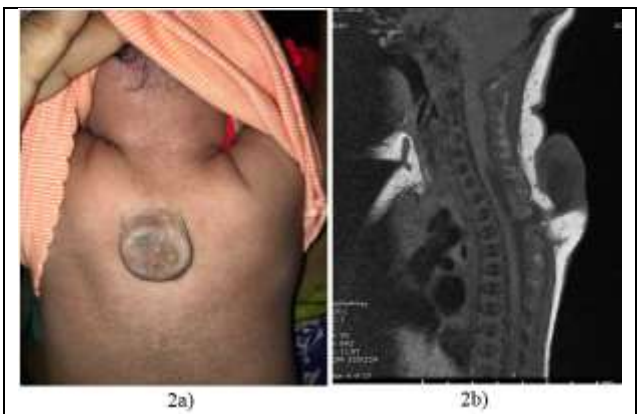

Figure 2a) Clinical Picture of Dorsal Myelomeningocele. 2b) Sagittal T1-Weighted MR Demonstrates Dorsal Myelomeningocele with Dorsal Extent of Neural Placode

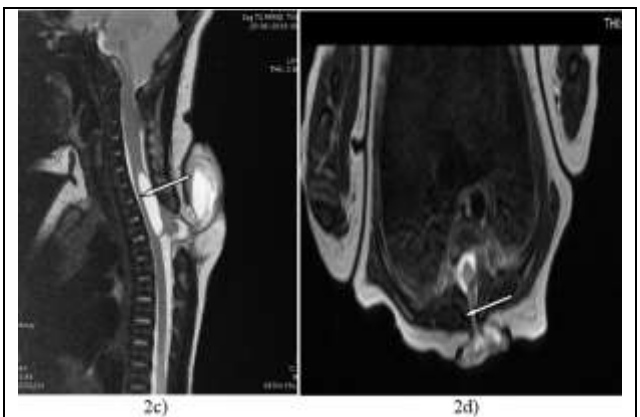

Figure 2c) Sagittal and 2d) Axial T2WI Images Showing the Herniation of Meninges and Nerve Roots (arrow) into the Subcutaneous Plane with Associated Syringohydromyelia (Arrow)

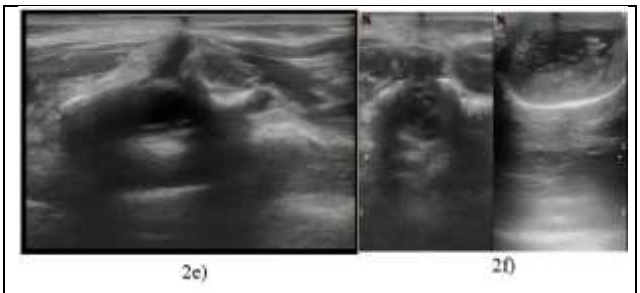

Figure 2e & f) Axial Ultrasound Demonstrates Divergence of the Posterior Arches at the Site of the Osseous Defect

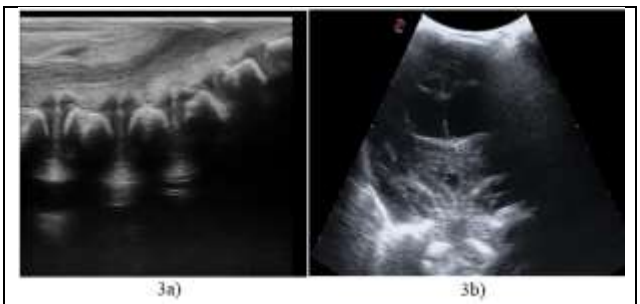

Figure 3a) Sagittal Ultrasound Spine at Lumbosacral Level Demonstrates Open Spinal Dysraphism Associated with 3b) Hydrocephalus

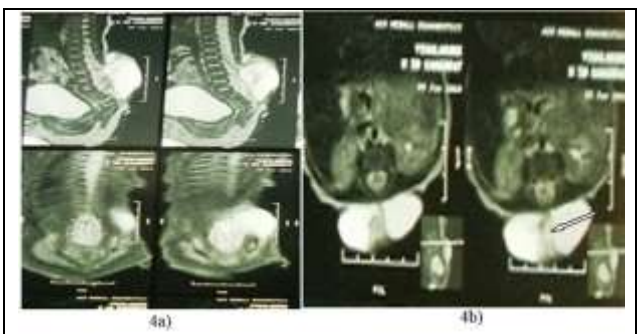

Figure 4a) Sagittal, Coronal and 4b) Axial T2-Weighted MR Demonstrates Open Lumbosacral Lipomyelomeningocele. Dorsal Extent of Meninges and Nerve Roots Seen Clearly (Arrow)

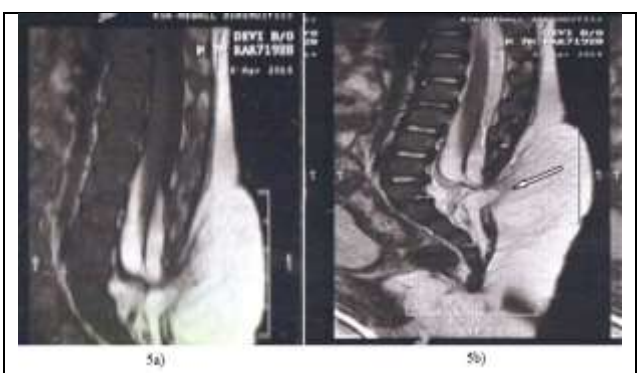

Figure 5a) Sagittal T1-weighted and 5b) T2-Weighted MR Demonstrates Lumbosacral lipomyelomeningocele. Dorsal Extent of Neural Placode is Seen Clearly (Arrow)

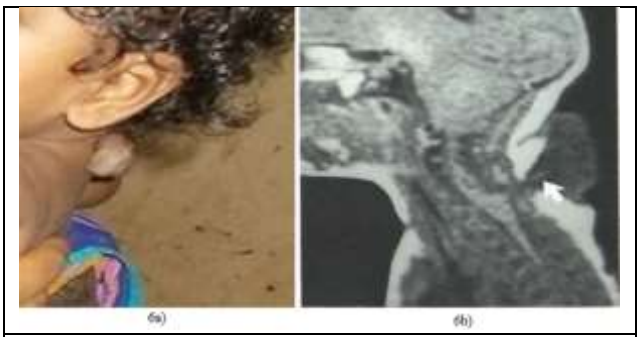

Figure 6a) Clinical Photograph of Cervical Myelomeningocele. 6b) Sagittal T1-Weighted MR Demonstrates Neural Placode (Arrow) Extending into Cervical Myelomeningocele

DISCUSSION

Paediatric spinal cord imaging is a complex and interesting area that relies heavily on ultrasound in infants younger than 6 months of age and magnetic resonance imaging (MRI) thereafter.[5]

Our study is to evaluate the role of Ultrasound and MRI in cases of suspected spinal dysraphism consisted of 42 patients who presented to our department of radiodiagnosis, Govt. General Hospital.

The age group of the patients in our study ranged from birth to 1 yr. Most of them are below 1 month of age.

In a study, of 42 patients, 22(52.38%) were females and 20 (47.61%) were males similar to study by Mohamed Fathy Dawodh et al., in which 18 are females and 14 are male patients.[6]

In our study, 12 (28.57%) are classified as open and 30 (71.42%) are classified as closed spinal dysraphisms.

Children with suspected spinal dysraphism were presented with swelling on the back as commonest clinical feature which constituted 32 (76.19%). In a study by Kumar R, Singh SN, et al. swelling in the back is the commonest clinical feature which constituted 89 (57%).[7]

In our study myelomeningocele is the commonest variant constituted 26 cases (61.90%). In a study by Muhammed Nafees, et al. myelomeningocele is the commonest dysraphism which constituted 29 (39.2%).[8]

Location of myelomeningoceles out of the 42 cases we studied, lumbosacral region is the commonest, which constituted 12 cases (28.57%).

Associated findings with spinal dysraphism in our study includes, 18 cases showing Chiari I and in 19 cases Chiari II malformations being most common, hydrocephalus (16 cases), 3 cases showing agenesis of corpus callosum, 18 cases showing syringohydromyelia, and 12 cases showing tethered cord.

In comparison with the above-mentioned studies, our study revealed that MRI is modality of choice to evaluate the spectrum of imaging findings in cases of suspected spinal dysraphism. Twenty five of 40 (62.5%) ultrasound examinations showed full agreement with MRI, ten of 40 (25%) had partial agreement and five of 40 (12.5%) had no agreement.

Correlation between ultrasound and MRI was good. MRI was particularly use full in differentiating between

myelomeningocele and myelocele. The neural placode protrudes above the skin surface in myelomeningocele whereas in myelocele neural placode flush with the skin surface. But MRI is particularly challenging when performed in infants, neonates who often are unable to cooperate for the entire examination. So, MRI imaging needs sedation to avoid motion related artefacts. In these cases, ultrasound can be used as first line screening test without need of sedation.

MRI is study of choice when surgical therapy is required it provides anatomic details of spinal cord, intervertebral disc space, CSF with in the subarachnoid space.

CONCLUSION

In our study, spinal dysraphisms were common in females, with commonest anomaly being myelomeningocele and commonest associated finding is Chiari malformation, and commonest location is lumbosacral region.

MRI is the modality of choice with excellent soft tissue characterization and ultrasound as the initial investigation of choice.

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