BENHA MEDICAL JOURNAL bmj
Print ISSN 1110-208X.
Online ISSN 2357-0016

Original article

Diagnostic Value of Spinal Ultrasound in Diagnosis of Spinal Anomalies in Pediatrics in Comparison to MRI

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Received: 9 December 2023

Accepted: 23 December 2023

Abstract:

Background: Pediatric spinal anomalies often necessitate accurate and timely diagnosis for effective management. This study aimed to assess the diagnostic value of spinal ultrasound as initial modality for screening of pediatrics spinal anomalies in comparison to MRI. **Methods:** This cross-sectional study was conducted on pediatric patients suspected of spinal cord disorders. A detailed clinical examination, spinal ultrasound using high-frequency linear array transducers, and MRI scans were performed on all participants. **Results:** The 23.44 ± 32.02 days, 93.33% were less than 60 days old. Females comprised 68.9%, males 22.2%, and 8.9% had ambiguous genitalia. Common clinical presentations included back swelling (57.78%), hair tuft (31.11%), and sacral dimple (24.44%). Most anomalies involved the lumbosacral region (80%). Ultrasonography exhibited high diagnostic validity, showing perfect agreement with MRI for myelomeningocele, dorsal dermal sinus, tethered cord, myelocele, disyomatomyelia with segmental spinal dysgenesis, dermal sinus, myelocystocele, and retethering of the cord (Kappa > 0.9). However, for caudal regression syndrome, the Kappa value was 0.656, indicating moderate agreement. The overall diagnostic accuracy of ultrasound compared to MRI was above 95.56% across findings. **Conclusion:** Spinal ultrasound demonstrates substantial diagnostic accuracy comparable to MRI in identifying pediatric spinal anomalies, particularly for various conditions such as myelomeningocele, dorsal dermal sinus, and tethered cord.

Keywords: Pediatrics; Spinal Ultrasound; MRI; Diagnostic Efficacy; Pediatric Spinal Anomalies.

Introduction

Spinal dysraphism encompasses various congenital disorders resulting from imperfect fusion of midline bony, mesenchymal, and neural structures due to incomplete closure of the neural tube in early embryonic development. These anomalies occur between weeks 2 to 6 of gestation, ranging from mild asymptomatic conditions like spina bifida occulta to severe open neural tube defects like meningomyelocele [(1).]

They are categorized into three main groups: spina bifida aperta (posterior protrusion of neural tissue through a bony vertebral defect without skin covering), and spina bifida occulta with and without a skin-covered back mass. While evident open or large malformations are easily identified, closed or smaller herniation anomalies may only manifest as skin abnormalities overlying the defect, necessitating screening to exclude occult spinal dysraphism [(2).]

Ultrasonography of the spinal cord is employed in children showing high suspicion based on clinician referral. There are two primary groups for screening: infants with syndromes associated with spinal dysraphism (such as anorectal or urogenital malformations) and infants with cutaneous markers suggesting spinal dysraphism (e.g., lower lumbar skin tags, lumbar capillary hemangiomas associated with a dorsal dermal sinus, lower lumbar dorsal dermal sinus located well above the anus and gluteal folds, lumbosacral masses, and hair tufts) [(3).]

Spinal ultrasonography serves as both a screening and diagnostic tool for occult and non-occult spinal dysraphism, assessment of spinal cord tumors, vascular malformations, and birth-related trauma. It offers high-resolution visualization of the entire spectrum of intraspinal anatomy and pathological conditions using high-frequency linear- and curved-array transducers in sagittal and axial planes from the cranio-cervical junction to the sacrum [(4).]

When sonographic findings are abnormal or equivocal, or when normal skeletal maturation limits the visualization of intracanalicular contents due to bony shadowing, spinal MRI becomes essential. However, MRI is time-consuming, costly, invasive (often requiring sedation or general anesthesia in infants), and its resolution can be affected by factors like patient motion, cerebrospinal fluid pulsation, and vascular flow, which do not impact spinal ultrasound [(5).]

Conversely, spinal ultrasound is safe, non-invasive, cost-effective, does not necessitate sedation, and can be performed portably. It also provides a real-time view of normal cord and nerve root movements and pulsations, which standard spinal MRI protocols cannot capture [(6).]

The purpose of this study was to assess the diagnostic value of spinal ultrasound as initial modality for screening of pediatrics spinal anomalies in comparison to MRI.

Patients and methods

Patients:

This comparative cross-sectional study was conducted to assess the diagnostic value of spinal ultrasound as an initial modality for screening of pediatrics spinal anomalies in comparison to MRI. The study was carried on (45) pediatric patients. The study was carried out in the radiology department Benha University Hospital during the period from 1st November 2022 to 30 September 2023.

Approval code: Ms.25-9-2022

An informed consent was obtained from all parents before enrollment in the study. An approval from Research Ethics Committee in Benha Faculty of Medicine was obtained.

Inclusion criteria were infants and children of both sexes on (45) pediatric patients with clinically suspected spinal cord disorders with the previously mentioned cutaneous spinal manifestations referred by their physicians for spinal MRI and spinal ultrasonography.

Exclusion criteria were neonates with suspected spinal cord injury related to birth, and absolute contra indication to MRI.

This study included all patients referred from pediatric outpatient clinic from the start of 1st November 2022 to 30 September 2023, who fulfill the inclusion criteria and who agree to be to participate in the study were involved.

Methods:

All studied cases underwent a comprehensive examination protocol that comprised various elements:

A. Detailed History Taking: This encompassed personal details such as age and sex, personal medical history, and a clinical inquiry into any skin-covered masses or midline cutaneous malformations of the back. Additionally, it involved gathering information about neurological manifestations like urinary incontinence and any associated congenital anomalies.

B. Full Clinical Examination: This involved an extensive evaluation that included recording vital signs, taking anthropometric measurements, conducting a systemic examination, and performing a detailed neurological assessment.

C. Spinal Ultrasound: Each participant in the study underwent spinal ultrasonography. This procedure was carried out using two different machines: (a) the LOGIC P6 utilizing a high-frequency linear array, and (b) the Sonoscape P30 Pro employing a high-frequency linear array.

D. Assessment of Spinal Anatomy via MRI Examination: All patients underwent lumbar MRI scans using a 1.5 Tesla MR scanner (Siemens MAGNETOM).

Spinal Ultrasonography Technique Protocol:

Patient Preparation: To ensure optimal conditions, infants were kept warm and fed shortly before the examination to minimize discomfort and reduce potential motion.

Positioning**:** Typically, imaging was performed with the patient lying prone. Flexing the hips and knees facilitated a wider interspinous space, aiding the detection of clear ultrasonographic images. Placing a small towel or bolster under the lower abdomen accentuated the lumbosacral curvature, facilitating appropriate vertebral body numbering. In some cases, imaging in the lateral decubitus position was necessary, particularly for patients with abdominal wall defects like an omphalocele or unrepaired gastroschisis. Upright positioning might be required to visualize specific conditions such as a diminished cerebrospinal fluid (CSF) post-lumbar puncture or to adequately demonstrate a pseudomeningocele. Additionally, this position could be beneficial in managing irritable infants. For particularly fussy infants in the prone position, a caregiver could hold them, either in their lap or against their body.

Technique:

Routinely, sagittal and axial scans of the spinal cord were obtained using high-frequency ultrasound. A high-frequency (9–12 MHz or higher) linear-array transducer should be used in most circumstances, unless deeper visualization is required [2]. A typical imaging depth is 3–5 cm, with the focal zone set to 1.5–2.5 cm. The optimal gain setting will vary for individual operators and different patients but should allow clear differentiation of intrathecal structures such as the cord and nerve roots. US imaging in the longitudinal plane facilitates overall spine assessment, and panoramic views are especially helpful for vertebral numbering.

Examination was done to assess (1) the spinal cord from the cranio-cervical junction to the conus medullaris, filum terminal and cauda equina; (2) bony vertebrae and its spinous process, whether there is a defect or no; and (3) any masses and whether (solid, cystic or heterogeneous).

Magnetic Resonance Imaging (MRI)

Patient Preparation: Prior to the MRI examination, patients underwent specific preparation measures. They were instructed not to consume food or liquids for a period of 4 hours preceding the examination due to the sedation required for the procedure. Additionally, all metallic objects were removed, and patients were positioned in a supine posture. For children below the age of 2 years, sedation was administered using chloral hydrate.

MRI Protocol and Technique: The MRI procedure involved specific protocols and techniques tailored to evaluate the spinal condition. Sagittal, fast spin-echo T1- and T2-weighted sequences with 3-mm-thick slices were performed for the entire spine. Sagittal T1-weighted images were acquired with a repetition time (TR) of 600 ms and an echo time (TE) of 30 ms. Axial and sagittal T2-weighted images were obtained with a TR of 3000 ms and a TE of 120 ms. The images were acquired with an interslice gap of 5.2 mm, a slice thickness of 4 mm, and a matrix size of 512 × 512.

Specific Image Acquisition: In cases involving abnormalities, axial T1- and T2-weighted images were acquired to investigate any potential irregularities. Children with conditions like scoliosis and suspected spinal dysraphism routinely underwent axial T1-weighted imaging through the conus and filum terminale, regions that might not be clearly visible on sagittal imaging. Additionally, all patients underwent sagittal and coronal Short Tau Inversion Recovery (STIR) sequences with a TR of 3000 ms and a TE of 40 ms. These sequences were specifically aimed at detecting lipomas of the filum terminale.

Statistical analysis

The collected data underwent meticulous processing, involving revision, coding, and tabulation through the Statistical Package for the Social Sciences (IBM Corp. Released 2017, IBM SPSS Statistics for Windows, Version 25.0, Armonk, NY: IBM Corp.). Analysis was tailored to the data type for each parameter. To gauge data distribution normality, the Shapiro-Wilk test was employed. Descriptive statistics, encompassing mean, standard deviation (± SD), range for numerical data, and frequency along with percentage for non-numerical data, offered a comprehensive overview. Analytical statistics, particularly the Chi-Square test, investigated relationships between qualitative variables. A significance

threshold of $p < 0.05$ at a 95% confidence interval determined the relevance of results.

Results:

The mean age of studied patients was 23.44 ± 32.02 days. The majority of cases (93.33%) were less than 60 days old while 6.7% were more than 60 days old. Females represented 68.9%, males were 22.2% and 8.9% had ambiguous genetalia. Table 1

Back swelling was the most common clinical presentation, observed in 57.78% of the patients, followed by hair tuft (31.11%) and sacral dimple (24.44%). Other notable presentations included hydrocephalus (17.78%), Chiari syndrome (15.56%), and discharge (13.33%). It is worth noting that several presentations had lower frequencies, such as muscle weakness, abnormal shape lower limb, and post-correction of meningocele, each occurring in only 2.22% of the patients. Figure 1

According to site of spinal anomalies, 80% had lumbosacral involvement. The next most commonly affected site was the sacral region, observed in 8.89% of the patients. Dorsolumbar involvement was present in 6.67% of the patients, while sacrococcygeal anomalies were found in 4.44% of the cases. Table 2

According to type of spinal dysraphism, 51.1% of subjects had open spinal dysraphism, while 44.4% had closed spinal dysraphism. Additionally, a small proportion of patients, 4.4%, presented with both open and closed spinal dysraphism. Among the studied patients with open spinal dysraphism, the subtypes observed were myelomeningocele in 35.56% of total subjects followed by dorsal dermal sinus in 13.33% and myelocele in 2.22%. Among the closed spinal dysraphism cases, the most common subtype was tethered cord, accounting for 13.33% of the patients. Disyomatomyelia with segmental spinal dysgenesis, myelocele, and myelomeningocele had equal frequencies, each occurring in 6.67% of the patients. Dermal sinus was observed in 4.44% of the cases, while caudal regression syndrome, myelocystocele, and retethering of the cord each had a frequency of 2.22%. Among 2 patients with both open and closed spinal dysraphism, the subtypes observed were myelomeningocele in one case and two myelomeningoceles in the other case. Table 3

Table 1. Demographic data in the studied patients.

		Total patients (n=45)
Age (days)	Mean ±SD	23.44 ± 32.02
	Range	3.0 – 180.0
Gender, n (%)	Female	31(68.9%)
	Male	10(22.2%)
	Ambiguous	4(8.9%)

Table 2. Site of spinal anomalies

		Total patients (n=45)
Site involved, n (%)	Lumbosacral	36(80%)
	Sacral	4(8.89%)
	Dorsolumbar	3(6.67%)
	Sacrococcygeal	2(4.44%)

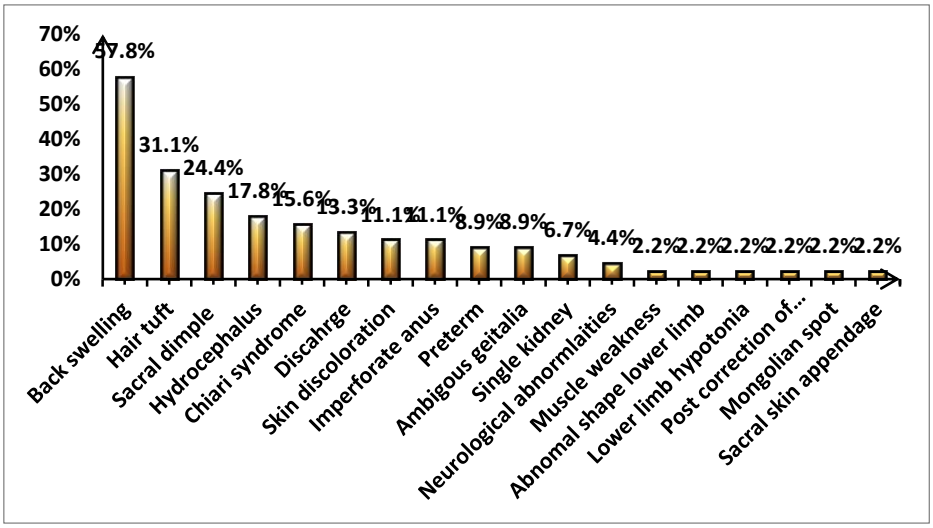

Figure 1. Distribution of associated anomalies in the studied patients.

Table 3. Type of spinal dysraphism in the studied patients.

		Total patients(n=45)
Type of spinal dysraphism, n (%)	Open spinal dysraphism	23(51.1%)
	Closed spinal dysraphism	20(44.4%)
	Both open and closed spinal dysraphism	2(4.4%)
Open spinal dysraphism	Myelomeningocele	16(35.56%)
	Dorsal dermal sinus	6(13.33%)
	Myelocele	1(2.22%)
	Tethered cord	6(13.33%)
	Disyomatomyelia with segmental spinal dysgenesis	3(6.67%)
Closed spinal dysraphism	Myelocele	3(6.67%)
	Myelomeningocele	3(6.67%)
	Dermal sinus	2(4.44%)
	Caudal regression syndrome	1(2.22%)
	Myelocystocele	1(2.22%)
	Retethering of the cord	1(2.22%)
Both open and closed spinal dysraphism, n (%)	Myelomeningocele	1(2.22%)
	Two Myelomeningocele	1(2.22%)

Ultrasonography showed high validity in predicting accurate diagnoses for most of the conditions assessed. For myelomeningocele, dorsal dermal sinus, tethered cord, myelocele, disyomatomyelia with segmental spinal dysgenesis, dermal sinus, myelocystocele, and retethering of the cord, ultrasonography achieved perfect diagnostic indices. These conditions had Kappa values (more than 0.9), indicating excellent agreement between ultrasonography and MRI diagnoses. However, for caudal regression syndrome, the Kappa value was 0.656, suggesting moderate agreement between the two diagnostic methods. Table 4 and Figure 2

The diagnostic accuracy of ultrasonography compared to MRI showed high accuracy on all findings (more than 95.56%) with statistically significant agreement between ultrasound and MRI findings. Table 5

Case presentation:

Case 1: illustrated in Figure 3.

Case 2: illustrated in Figure 4.

Case 3: illustrated in Figure 5.

Table 4. Agreement analysis between MRI results and ultrasonography**.**

	MRI diagnosis (n)	US diagnostic indices (n)					
		TP	TN	FP	FN	Kappa	p
Myelomeningocele	22	20	23	2	0	0.911	**<0.001***
Dorsal dermal sinus	6	6	39	0	0	1.000	**<0.001***
Tethered cord	7	6	38	1	0	0.910	**<0.001***
Myelocele	4	4	41	0	0	1.000	**<0.001***
Disyomatomyelia with segmental spinal dysgenesis	3	3	42	0	0	1.000	**<0.001***
Dermal sinus	2	2	43	0	0	1.000	**0.001***
Myelocystocele	1	1	44	0	0	1.000	**0.022***
Retethering of the cord	1	1	44	0	0	1.000	**0.022***
Two Myelomeningocele	1	1	44	0	0	1.000	**0.022***
Caudal regression syndrome	2	1	43	1	0	0.656	**0.044***

TP: True positive; FP: False positive; FN: False negative; TN: True negative; * p<0.05.

Table 5. Diagnostic accuracy of ultrasonography in different spinal anomalies diagnosis.

	Accuracy %
Myelomeningocele	95.56%
Dorsal dermal sinus	100.00%
Tethered cord	97.78%
Myelocele	100.00%
Disyomatomyelia with segmental spinal dysgenesis	100.00%
Dermal sinus	100.00%
Myelocystocele	100.00%
Retethering of the cord	100.00%
Two Myelomeningocele	100.00%
Caudal regression syndrome	97.78%

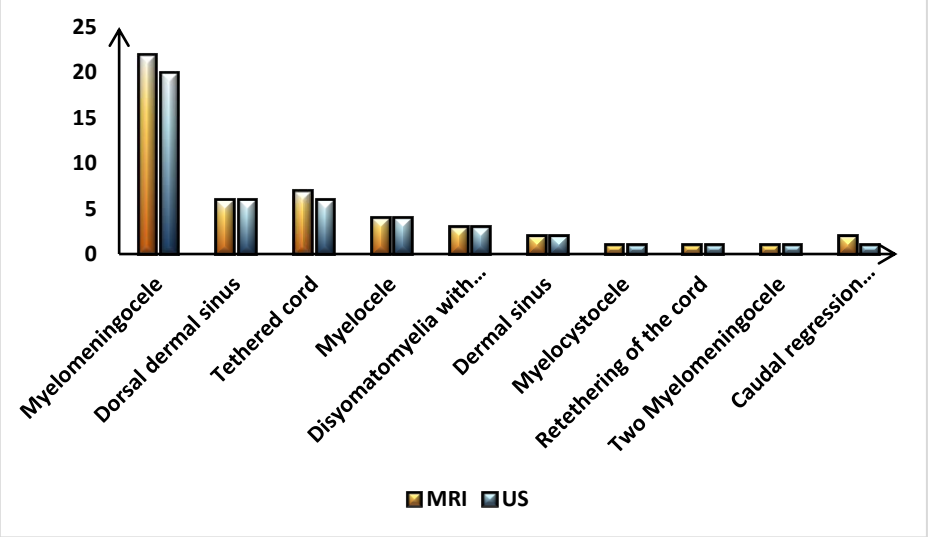

Figure 2. Results of ultrasonography compared to MRI.

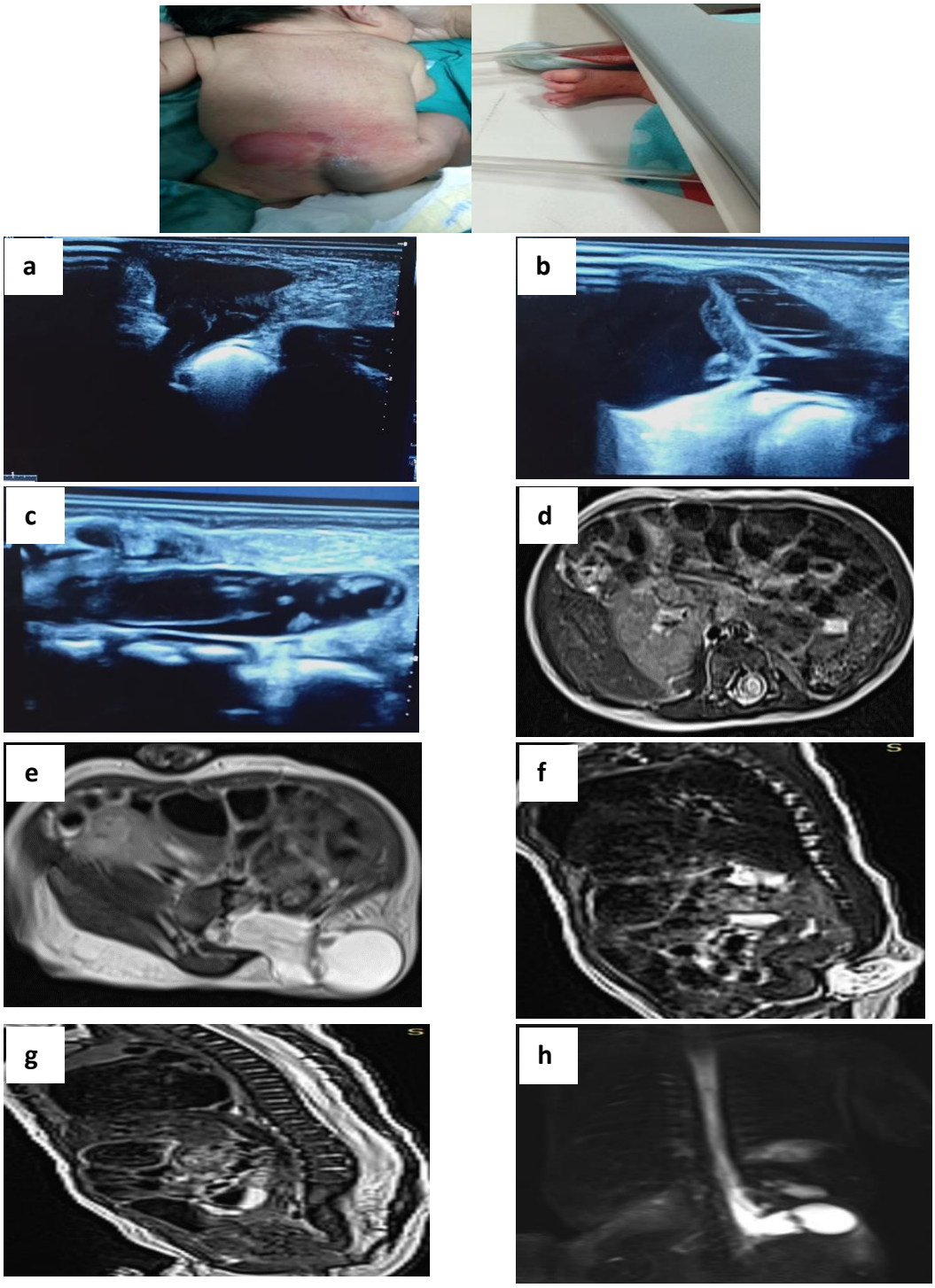

Figure 3: case 1: preterm 7days neonate with ambiguous genitalia, imperforate anus, para midline left lower back pigmented swelling, single kidney and fused toes. A) Transverse USG at site of swelling showed lower lumber posterior arch defect through which a skin-covered left para midline cystic lesion contains spinal cord, nerve roots and CSF as well are seen protruded. b) Longitudinal USG showed the defect with the cord, nerve roots, neural placode and CSF are seen within skin covered cyst(myelomeningeocele). C) Longitudinal USG showed dilated central spinal canal with fluid at dorsal and lumber regions (hydromyelia). D) Axial T2W MRI show right single kidney. E) Axial T2W MRI show posterior arch defect at level of L2 down to L5 with para vertebral cystic lesion protruded through contain spinal cord, nerve roots, neural placode and CSF. (myelomeningeocele). F) Sagittal T2W MRI show the para midline lesion. G) Sagittal T2W MRI show dilatation of central spinal canal at dorsal and lumber region(hydromyelia). H) Coronal T2 HASTE MRI show the para midline previously described lesion. Final diagnosis is (myelomeningeocele with syringohydromyelia). Agreement frequency between USG and MRI finding =100%.

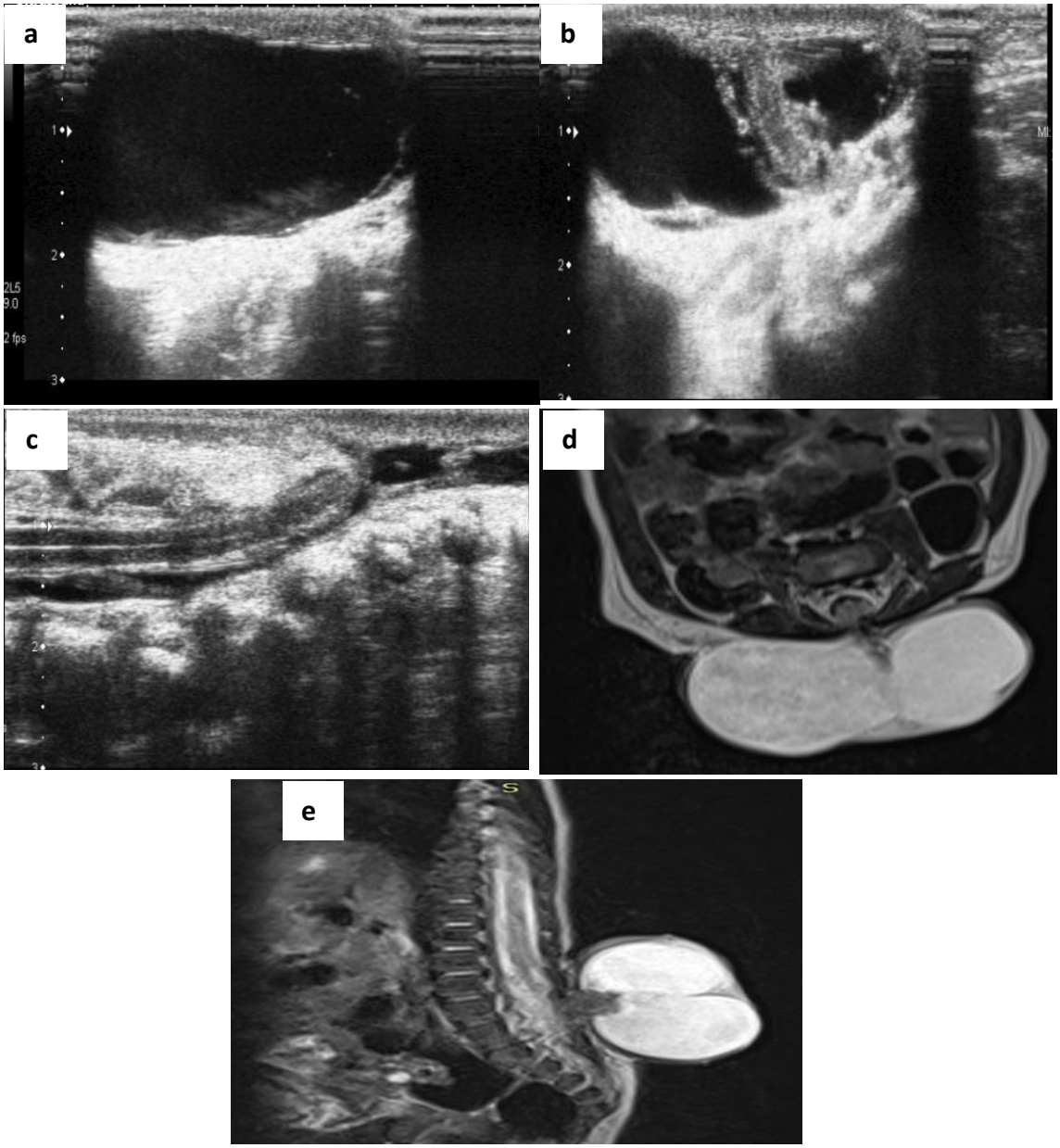

Figure 4: Case 2: preterm 3o day female with lower back swelling and paraplegia.
A) Transverse USG showed large lumber cystic lesion contain CSF. B) Transverse USG showed that the previous mention cyst contains spinal cord, some nerve roots and neural placode passing through lumber defect. (myelomeningeocele). C) Longitudinal USG shows a posterior arch defect at lumber region through which the cord passing to the cystic lesion. (tethered cord). D) Axial T2W MRI shows large cystic lesion protruded through posterior arch defect at L4 and L5 contains spinal cord, neural placode, nerve roots and CSF. (myelomeningeocele). E) Sagittal T2W MRI show the same of axial cuts. Final diagnosis in both MRI and USG was myelomeningeocele with tethered cord Agreement frequency between the two modalities used =100%.

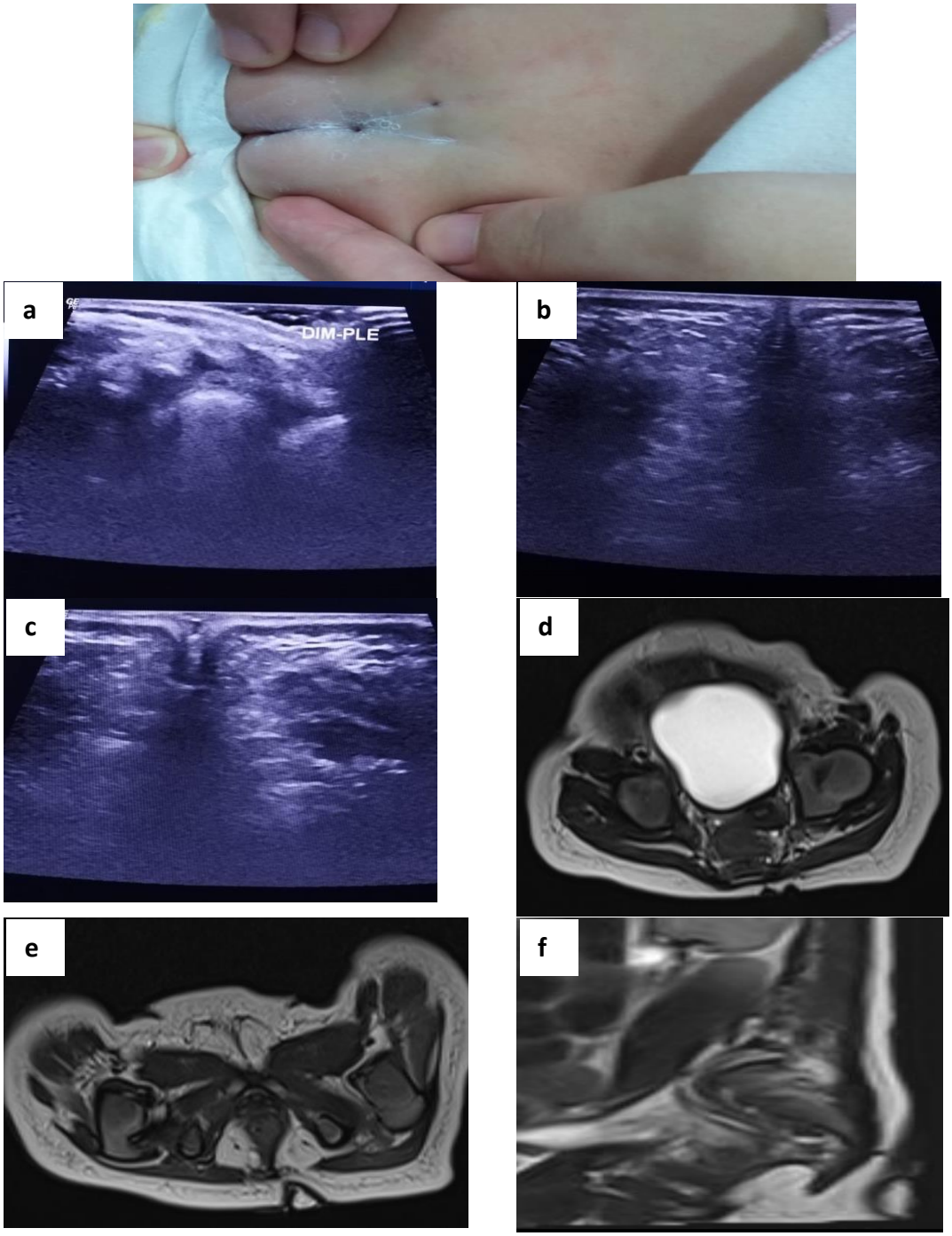

Figure 5: Case 3: 40day female with two sacral dimples of high risk one is seen of midline and the other above the gluteal fold by more than 2.5cm. Another sacral dimple also is seen.
A) Transeverse USG at site of the midline sacral dimple showed ashallow dimple with no deep tract connect it to the cecal sac. B) Transverse USG at site of para midline dimple show a shallow dimple with no tracts connect it to cecal sac. C) Transverse USG at site of the sacral dimple also as the brevious images. D) Axial T2W MRI show the two nearby sacral dimples with no deep tract (dimple with no dorsal dermal sinus). E) Axial T2W MRI shows sacral dimple totally superficial with no evidence of dorsal dermal sinus. F) Sagittal T2W MRI with two dimples sacral and coccygeal.
N.B: the hyperintense T2 signal at both axial and saggital coccygeal dimple returns to the vitamin A capsule which we use as a marker. Final diagnosis of both Ultrasound and MRI is sacrococcygeal dimples. Agreement frequency between the two used methods =100%.

Discussion:

In the current study, the mean age of studied patients was 23.44 ± 32.02 days. The majority of cases (93.33%) were less than 60 days old while 6.7% were more than 60 days old. Females represented 68.9%, males were 22.2% and 8.9% had ambiguous genetalia.

Parallel with our findings, a study assessed the diagnostic value of spinal USG in the diagnosis of spinal dysraphism in pediatrics compared to MRI as a gold standard technique. Their prospective, cross-sectional study involved 45 infants and children with suspected spinal dysraphism. The patients were subjected to our study with age range of 2 months – 12 years and a mean age of 15.6 ± 13 months. The patient group of ≤ 2 years old involved 30 patients, while the patient group of > 2 years old involved 15 patients. Study population represented 26 females (57.8%) and 19 males (42.2%) [(1).]

According to our study, back swelling was the most common clinical presentation, observed in 57.78% of the patients, followed by hair tuft (31.11%) and sacral dimple (24.44%). Other notable presentations included hydrocephalus (17.78%), Chiari syndrome (15.56%), and discharge (13.33%). It is worth noting that several presentations had lower frequencies, such as muscle weakness, abnormal shape lower limb, and post-correction of meningocele, each occurring in only 2.22% of the patients.

Comparable to our study, where the age group of the studied patients ranged from 2 days to 16 years, 84.21% patients were < 10 years old, and the neonatal period was the most common presenting age group accounting for 39.47% of total cases. The most common clinical finding at presentation was also midline back swelling (60.53%); however, the next common finding was urinary incontinence (47.37%), followed by skin dimple in back (28.95%), fecal incontinence (21.05%), hair tuft (3.33%), and dermal sinus (3.33%) [(7).]

According to site of spinal anomalies, 80% had lumbosacral involvement. The next most commonly affected site was the sacral region, observed in 8.89% of the patients. Dorsolumbar involvement was present in 6.67% of the patients, while sacrococcygeal anomalies were found in 4.44% of the cases.

We shared comparable results with a study found that the lumbosacral spine was the most commonly involved spinal segment found in 52.63% of patients, followed by sacrococcygeal region (34.21%). The next common region was sacrococcygeal, involved in 13 (34.21%) patients. The cervical and dorsal regions were involved in 4 (10.52%) and 1 (2.63%) patient, respectively [(7).]

Also, a study reported that Lumbosacral spine was the most common region involved in 32 patients (71.1%). The dorsolumbar region was involved in 8 patients (17.8%) and the sacrococcygeal region in 5 patients (11.1%) [(1).]

Consistency with our findings, a study assessed the diagnostic accuracy of spinal USG as a screening modality in comparison with MRI in infants with closed spinal dysraphism. It was observed that lumbosacral involvement was most frequently encountered in 7 patients (35%), after which was the lumbar spine in 6 patients (30%), sacrococcygeal in 5 patients (25%), and lastly dorsolumbar in 2 patients (10%) [(8).]

According to type of spinal dysraphism, 51.1% of subjects had open spinal dysraphism, while 44.4% had closed spinal dysraphism. Additionally, a small proportion of patients, 4.4%, presented with both open and closed spinal dysraphism.

In agreement with our study, a study noted that open spinal dysraphism was found in 27 patients (60%). Closed SD was found in 14 patients (31.1%). Four cases shared both closed and open SD (8.9%) [(1).]

The results were similar to study by a study showed that of the 66 patients, 38 (57.5%) had open spinal dysraphisms and 28 (42.4%) are closed dysraphisms (9). However, another study found that closed spinal dysraphism (63.16%) was more common than open (36.84%) [(7).]

Among the studied patients with open spinal dysraphism, the subtypes observed were myelomeningocele in 35.56% of total subjects followed by dorsal dermal sinus in 13.33% and myelocele in 2.22%.

In line with our findings, a study documented that in open type of spinal anomaly, it was found only meningomyelocele (MMC), which was also the most common anomaly overall, accounting for 14 (36.84%) cases. The second most common anomaly was LipoMMC which was also the most common in closed type, seen in 9 (23.68%) [(7).] Similar to our study, a study registered that among different types of dysraphism myelomeningocele is the commonest. Myelomeningocele constituted 38 (57.5%) [(9).]

Furthermore, a study concluded that according to the ultrasound, myelomeningocele (30%) and sacral agenesis (25%) had the highest prevalence. However, according to the MRI, the most common anomaly found after tethered cord was dural ectasia (30%); then, myelomeningocele, sacral agenesis, and hydromyelia and syringomyelia had the highest prevalence (each 25%) [(10).]

Among the closed spinal dysraphism cases, the most common subtype was tethered cord, accounting for 13.33% of the patients. Disyomatomyelia with segmental spinal dysgenesis, myelocele, and myelomeningocele had equal frequencies, each occurring in 6.67% of the patients. Dermal sinus was observed in 4.44% of the cases, while caudal regression syndrome, myelocystocele, and retethering of the cord each had a frequency of 2.22%.

Our study results as regards spinal ultrasound are comparable with study by another study which showed that the most common anomaly was tethered cord seen in 23 (79.31%) patients, syrinx (62.06%), MMC (48.27%), and lipomyelomeningeocele (27.58%) [(7).]

Among 2 patients with both open and closed spinal dysraphism, the subtypes observed were myelomeningocele in one case and two myelomeningoceles in the other case.

In our study, ultrasonography showed high validity in predicting accurate diagnoses for most of the conditions assessed. For myelomeningocele, dorsal dermal sinus, tethered cord, myelocele, disyomatomyelia with segmental spinal dysgenesis, dermal sinus, myelocystocele, and retethering of the cord, ultrasonography achieved perfect diagnostic indices. These conditions had Kappa values (more than 0.9), indicating excellent agreement between ultrasonography and MRI diagnoses. However, for caudal regression syndrome, the Kappa value was 0.656, suggesting moderate agreement between the two diagnostic methods.

It was found that the accuracy of spinal ultrasound in the diagnosis of spinal dysraphism in patients aged ≤ 2 years old are as the following: specificity levels ranging from 94.5–100%, sensitivity ranging from 81.8–100%, positive predictive value ranging from 84.3–100% and negative predictive value ranging from 86.7–100%, as compared to MRI. The accuracy of spinal ultrasound in diagnosis of spinal dysraphism in comparison with MRI in patients (aged > 2 years old) was as the following; spinal USG displayed specificity of 100% and sensitivity of 33.3%, positive predictive value of 66.7%, and negative predictive value of 49%, as compared to MRI [(1).]

In another study which evaluated the role of spinal ultrasound in detecting occult spinal dysraphism (OSD) in neonates and infants and determined the degree of agreement between ultrasound and magnetic resonance imaging (MRI) findings. Eighty-five consecutive infants had spinal ultrasound over 31 months. Of these, 15 patients (age 1 day–7 months, mean 40 days; nine male) had follow-up MRI. Ultrasound showed full agreement with MRI in 6 of 15 patients (40%), partial agreement in 7 of 15 patients (47%) and no agreement in 2 of 15 patients [(11).]

The diagnostic accuracy of ultrasonography compared to MRI showed high accuracy on all findings (more than 95.56%) with statistically significant agreement between ultrasound and MRI findings.

We agreed with a study which showed that 23 out of 29 patients (79.31%) showed full agreement between spinal USG and MRI examinations, and 6 out of 29 patients (20.69%) showed partial agreement. In these six cases with partial agreement; spinal USG missed tethered cord and syrinx in three cases, small lipomatous component in one case of lipomyelomeningeocele, one case of intradural lipoma, and one case of split cord associated with myelomeningocele [(7).]

There is an agreement between USG and MRI in the diagnosis of each subtype of spinal dysraphism and segmentation/vertebral spine anomalies, respectively. As a rule of thumb, ($\kappa = 1$) indicates perfect agreement, (0.8–1) excellent agreement, (0.6–0.8) good agreement, (0.4–0.6) fair agreement, (0–0.4) poor agreement, and ($\kappa = 0$) indicates agreement by chance alone. The overall accuracy of spinal USG compared to MRI in the diagnosis of spinal dysraphism were as follows: specificity ranging from 98.6–100%, sensitivity ranging from 66.6–91.6%, PPV ranging from 90–100%, and NPV ranging from 94.1–98.7%. There was compelling overall accuracy of the detailed imaging findings of USG compared to MRI ($\kappa = 0.973$) [(8).]

A study revealed that Spinal US had an overall sensitivity of 91% and specificity of 75% compared to MRI for detecting spinal cord anomalies in children with ARM (12). Another study found that using MRI findings as the standard reference, the sensitivity of LUS in detecting a thickened filum was 77.8% preoperatively and 62.5% postoperatively, with a specificity of 100% [(13).]

Conclusion

Spinal ultrasound proved to be a valid and reliable initial screening modality for pediatric spinal anomalies, exhibiting high diagnostic accuracy compared to MRI. Its non-invasiveness, lack of ionizing radiation, and potential for bedside application make it a valuable tool for early detection.

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To cite this article: Hamada M. Khater, Sherif A. Elrefaey, Gehad W. Soliman. Diagnostic Value of Spinal Ultrasound in Diagnosis of Spinal Anomalies in Pediatrics in Comparison to MRI. BMFJ 2024;41(1):7-20.