Journal of Cardiovascular Disease Research

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 01, 2022

ORIGINAL RESEARCH

Role of fetal MRI in evaluation of congenital anomalies

Karanbir Singh Bajwa[1], Amanpreet Kaur[2]

[1]Department of Radiodiagnosis, NKP Salve institute of Medical sciences and Research Centre LataMangeshkar Hospital Nagpur.
[2]Department of Radiodiagnosis, Govt. Medical College, Amritsar, Punjab, India

Corresponding author: Dr AmanpreetKaur, Department of Radiodiagnosis, Govt. Medical College, Amritsar, Punjab, India, Email: apkwaraich@gmail.com

ABSTRACT

Background: Antenatal imaging is required to diagnose fetal abnormalities prior to delivery so that in utero interventions can be planned and post- delivery management of the infant can be decided. The study was done to determine the role of MRI in fetal abnormalities.

Material and methods: This study was performed over a period of 2 years in the Department of Radiodiagnosis at SSIMS & RC, Davangere. All the pregnant females in second and third trimester who were suspected of having fetal anomalies were subjected to MRI after undergoing a USG in the department. A total of 41 cases were studied. MRI was performed in multiple planes using SSFSE, FIESTA and SPGR sequences. Findings of MRI were recorded and post-natal follow up was obtained wherever possible.

Results: A total of 41 cases suspected of having fetal anomalies on USG were studied. 15 cases had cranio-spinal anomalies, 3 cases had gastrointestinal anomalies, 4 cases had Miscellaneous anomalies, 4 cases had genitourinary anomalies, 9 cases had multiple anomalies and 3 cases each were diagnosed as normal and having chest anomalies. Fetal MRI provided additional information as compared to ultrasound in 18 (43.9 %) cases and confirmed the findings of Ultrasound in 23 (56.1 %).

Conclusion: Fetal MRI serves as a useful adjunct in confirming ultrasound suspected pathologies. In addition, prenatal MRI can better delineate fetal anatomy and accurately characterize pathologies irrespective of patient's gestational age (in 2nd and 3rd trimester), maternal body habitus and quantity of amniotic fluid. MRI may also provide valuable added information prenatally, that could add to early evaluation and treatment of fetal anomalies, particularly central nervous system malformations and thoracic lesions and may enhance treatment for some life-threatening anomalies. Thus, it is concluded that prenatal MRI is evolving as a powerful tool in cases where ultrasound findings are inadequate or inconclusive for diagnosing fetal anomalies.

Keywords: fetal anomalies, MRI, ultrasound

Introduction

Antenatal imaging is required to diagnose fetal abnormalities prior to delivery so that in utero interventions can be planned and post- delivery management of the infant can be decided. Out of the available imaging modalities, ultrasound is the most commonly used modality as it is relatively safe, involves no ionising radiation, is easily available and needs simple equipment. For advanced imaging, magnetic resonance imaging (MRI) is the next logical choice as fetus is unexposed to ionising radiation.[1]

MR imaging was sometimes used for fetal imaging in the past, its usefulness was limited by fetal motion owing to the long acquisition times of the conventional spin-echo technique.[2] With the advent of ultrafast sequences in the 1990's, fetal MRI is becoming a non-invasive method complementary to ultrasound, useful in the detection of fetal anomalies, which is helpful in formulating prognosis and perinatal management. Single-shot fast spin-echo sequence significantly reduces motion artifact. With this technique, T2-weighted images of the fetus are obtained in less than one second[3] per section without image degradation.[3]

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Fetal MRI is increasingly used in clinical practice, partly because of the increasing interest in fetal surgery and fetal medicine.[4] MRI is considered a suitable fetal imaging technology as it is non-invasive, avoids the use of ionising radiation, and is not hampered by maternal obesity or fetal position. Moreover, fetal MRI offers the promise of contributing to our understanding of normal and abnormal fetal development with continued advances in MRI techniques. However, its use is limited because of complicated equipment required, involvement of trained personnel and limited availability only at major referral centres.[5] The present study determined the role of magnetic resonance imaging in detection of fetal abnormalities.

Materials & Methods

This study was conducted on second and third trimester pregnant females, referred to the Department of Radio diagnosis and Imaging, SSIMS & RC, Davangere for fetal MRI after taking a written & informed consent. Inclusion criteria were all patients with suspected anomaly on Ultrasound scan and patients with previous history of fetal congenital anomalies.
Exclusion criteria were patients having a history of claustrophobia, patients having a history of metallic implants insertion, cardiac pacemakers and metallic foreign body in situ and patients who require sedation.
MRIwas performed on a GE HDXT 16 channel (1.5 T). The patient was scanned in a supine position, feet first. Those patients who were not comfortable, were scanned in a left lateral decubitus position especially during late pregnancy to prevent inferior vena cava compression by the gravid uterus. After acquiring a localizer, sequences were obtained in planes anatomic to the fetus. T2-weighted images are useful to assess both anatomy and pathology. For most cases in our studies, we acquired single-shot rapid acquisition T2-weighted images with refocused echoes in the axial, coronal, and sagittal planes. Due to fetal motion image degradation was seen during acquisition or resulted in images that are not in true anatomic planes. Therefore, repetition of some sequences was required. Fat and hemorrhage may be seen at T1 -weighted images. Fetal bowel content may also be of high TI signal intensity, and this finding can be used to identify the gastrointestinal tract. Lateralization of fetal anatomy as right or left was based on analysis of fetal position relative to the mother because fetal landmarks may be unreliable as a result of transposition. Data thus obtained were subjected to statistical analysis. P value < 0.05 was considered significant.

Results

Table 1: System wise anomalies detected on MRI

		Frequency	Percent
Anomalies	Chest	3	7.3
	CNS	15	36.6
	GIT	3	7.3
	Gut	4	9.8
	Miscellaneous	4	9.8
	Multiple	9	22.0
	Normal	3	7.3
	Total	41	100.0

Table 1 shows that Majority i.e. 37% were CNS anomalies, 22% of anomalies involved multiple systems, 9.8% were GIT and GUT anomalies, 7.3% were Chest, Miscellaneous anomalies and Normal.

Table 2: Different types of CNS anomalies by MRI

CNS anomalies on MRI	Yes	Percentage
Arnold Chiari Malformation	5	23
Anencephaly	4	18.5
Spinal deformity due to hemi vertebrae or split cord malformation	1	4.5

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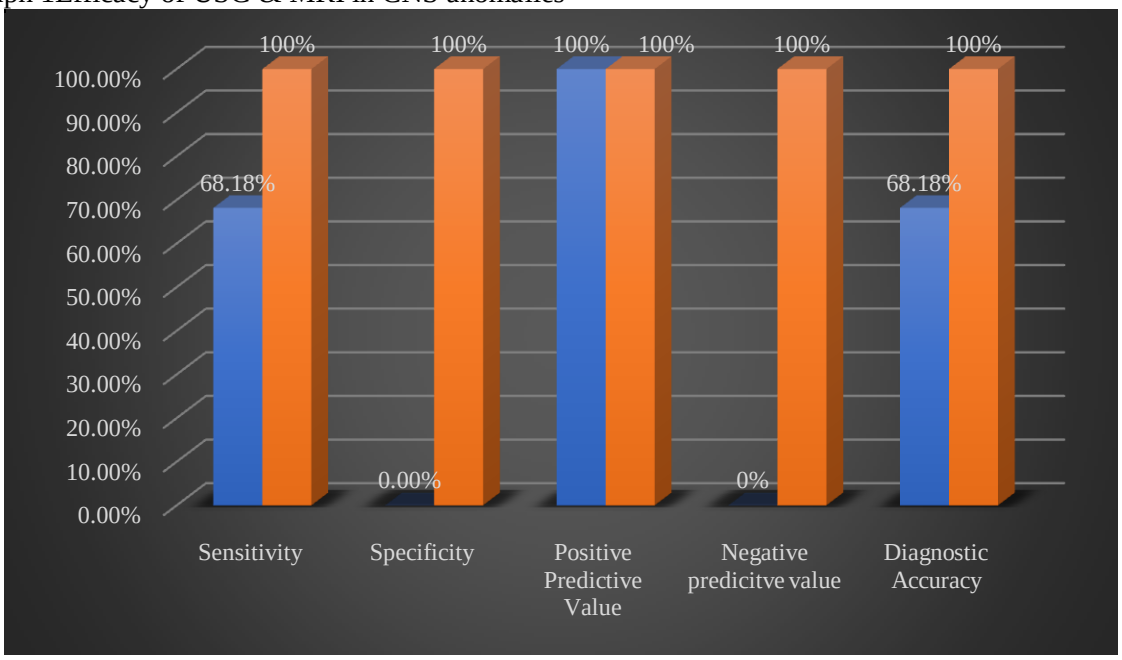
Arachnoid cyst	1	4.5
Dilated lateral ventricles with fetalhydrops	1	4.5
Dolichocephalic head, Mild hypoplasia of inferior cerebellar vermis,	1	4.5
Kyphosis with low signal intensity in dorsolumbar spine - probably fat.	1	4.5
Lissencephaly with abnomalgyri	1	4.5
Microcephaly with atrophic cerebral parenchyma, corpus callosaldysgenesis, Colpocephaly, Left side pyelactasis	1	4.5
Neural tube defect in lumbosacral region	1	4.5
Occipital encephalocele	1	4.5
Paucity of fetalgyri and cortical sulci - Agyria/Lissencephaly	1	4.5
Prominent dependent lateral ventricles	1	4.5
Semilobarholoprosencephaly	1	4.5
Twins - One fetus is normal, another fetus shows gastroschisis, moderate to gross hydronephrosis, Kyphoscoliosis deformity	1	4.5
Total	22	100%

Table 2 shows different types of CNS anomalies detected by MRI. The most common was Arnold Chiari Malformation in 5 (23%) and Anencephaly in 4 (18.5%).

Graph 1Efficacy of USG & MRI in CNS anomalies



Graph 1shows that MRI had 100% sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy.

Table 3: Role of MRI in CNS anomalies

		CNS anomaly		Total
		Absent	Present	
MRI helpfulness	No	8	15	23
	Yes	11	7	18
Total		19	22	41

Among 22 CNS anomalies, USG detected 15 cases correctly and MRI diagnosed all the CNS anomalies. MRI was helpful in 7 cases for diagnosis.

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Table 4: Efficacy of USG & MRI in GUT anomalies

	USG findings	MRI Findings
Sensitivity	40%	100%
Specificity	0	100%
Positive Predictive Value	100%	100%
Negative predictive value	0	100%
Diagnostic Accuracy	40%	100%

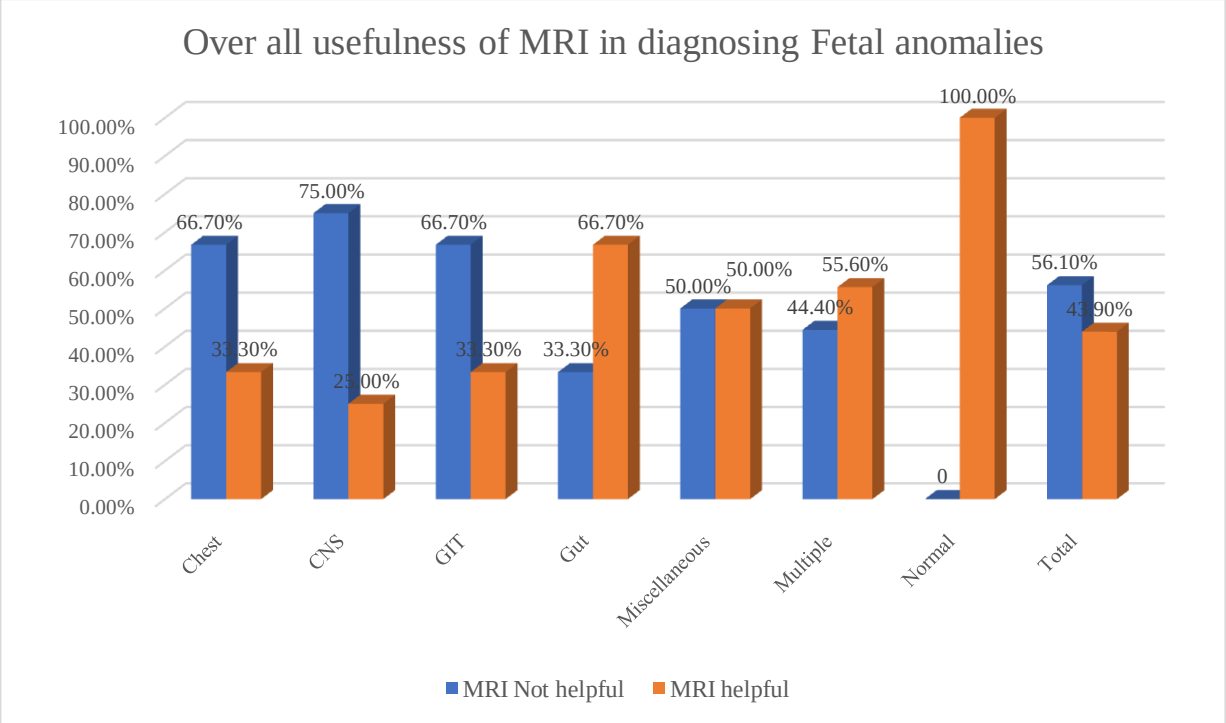
Table 4 shows that that MRI had 100% sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy in GUT anomalies.

Table 5:Efficacy of USG & MRI in chest anomalies

	USG	MRI
Sensitivity	66.7%	100%
Specificity	0	100%
Positive Predictive Value	100%	100%
Negative predictive value	0	100%
Diagnostic Accuracy	66.7%	100%

Table 5 shows that that MRI had 100% sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy in chest anomalies.

Graph 2 Over all Usefulness of MRI in diagnosing Fetal anomalies



Graph 2 shows that Over all MRI was helpful in detecting 43.9% of fetal anomalies.

Table 6:Efficacy of USG & MRI in GIT anomalies

	USG	MRI
Sensitivity	50 %	100%
Specificity	0	100%
Positive Predictive Value	100%	100%
Negative predictive value	0	100%
Diagnostic Accuracy	50 %	100%

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 01, 2022

Table 6 shows that that MRI had 100% sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy in GIT anomalies whereas USG revealed 50% sensitivity and 100% PPV.

Discussion

Fetal MR imaging has higher contrast resolution than prenatal sonography and allows better differentiation of normal from abnormaltissue.[6] Structural abnormalities such as cerebral malformations and destructive lesions can be sonographically occult on prenatal sonography yet detectable by fetal MR imaging. Moreover, fetal MR imaging is not susceptible to many of the limitations of sonography.[7] In addition, there are continued advances in MR techniques, such as diffusion- weighted and parallel imaging.Fetal MR imaging offers the promise of contributing to our understanding of normal as well as abnormal brain development.[8]

All pregnancies carry a baseline risk of birth defects. There has been a rapid evolution of imaging techniques for fetal diagnosis. The modality most commonly used for pregnancy evaluation is ultrasonography that is considered safe, cost-effective and is a real time imaging modality. Nowadays, three dimensional/four-dimensional USG is becoming increasingly available and has been successfully used for detection of fetal structural anomalies involving the central nervous system, face, limbs, thorax, and spine.[9]

Fetal MRI has revolutionized diagnostic imaging by providing good spatial resolution, multiplanar imaging, with excellent soft tissue contrast even in situations where diagnosis by USG is limited, especially in case of oligohydramnios, obese patients, or during late gestation.[10,11]In our prospective study, we studied the role of magnetic resonance imaging for detecting fetal anomalies in 41 patients referred to our hospital over the course of two years. Detailed fetal MRI examination was performed in these patients after an ultrasound diagnosis of fetal structural anomaly. Out of the 41 cases, 17 cases were referred to us with suspected CNS anomalies, 3 with suspected gastrointestinal tract, 5 with suspected miscellaneous anomalies, 4 with suspected genitourinary tract, 3 suspected thoracic and 9 with multiple anomalies.

24 patients with suspected CNS anomalies were evaluated for craniospinal anomalies detected on ultrasound. In 22 of the cases, MR imaging confirmed the findings, 2 of the patients were found to be normal on MRI.MRI confirmed USG diagnosis in 15 cases, which included five cases ofArnold Chiari malformation type II, 4 cases of Anencephaly and rest of the cases included various anomalies ranging from cerebellar vermis hypoplasia, dilated lateral ventricles to kyphoscoliosis of the spine.

MR added additional information in 7 cases of craniospinal anomalies. These included one case of Lissencephaly, one case of isolated dilated lateral ventricles which was suspected of having corpus callosal agenesis on USG, two case of Arnold Chiari malformation, one case of twins where one fetus was normal and the other showed kyphoscoliosis of spine with multiple other anomalies as well, one case of dilated lateral ventricle with atrophy of cerebral parenchyma and one case of kyphosis of spine with fat signal in the lumbar vertebral region. 3 cases in which MRI negated the USG findings included one case of suspected Lissencephaly and two cases of suspected meningocele of lumbar spine on USG. MR imaging helped to delineate the entire spine and brain parenchyma in all the three cases.

Whitby et al[12] performed a comparison of ultrasound and magnetic resonance imaging in 100 singleton pregnancies with suspected brain abnormalities. They found that in 52 of cases, ultrasound and magnetic resonance gave identical results and in a further 12, magnetic resonance provided extra information that was judged not to have had direct effects on management. In 35 cases, MRI either changed the diagnosis or gave extra information that could have altered management. In 11 of the 30 cases where brain anomalies were suspected on USG, magnetic resonance changed the diagnosis as the brain was described as normal.

In our study six (14.6%) of 41 fetuses were detected on ultrasound with gastrointestinal anomalies. Of 6 patients, one came with suspicion of cyst in abdomen on USG with MRI confirming the diagnosis of Mesenteric cyst, one case of Caroli Disease, one case of

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 01, 2022

Choledochal cyst, one case of gastroschisis, one case of gut duplication cyst and one case of Duplication/Choledochal cyst. Veyrac C[13] studied MRI of fetal GI tract abnormalities in 32 patients and concluded MR imaging can demonstrate normal bowel in intraperitoneal anomalies and MR imaging is informative in the diagnosis of GI tract abnormalities, especially the severe malformations, with much more accuracy than sonography.

In the present study, 10 (24.4 %) fetuses were evaluated by fetal MRI for genitourinary abnormality. In three cases echogenic bilateral kidneys were observed. Polycystic kidneys was observed in three cases and four cases of hydronephrosis were observed. MRI was particularly helpful in diagnosing one case where USG showed large duplication cyst but MRI confirmed it as hydronephrosis with PUJ obstruction. Marie Cassart and Anne Massez[14] did a study to evaluate the contribution of MRI in patients with inconclusive sonographic data, when assessing fetal urinary tract anomalies as well as to determine how this addition may affect the management of pregnancy in 10 patients between May 1998 and January 2002. They concluded that MRI can accurately show many urinary tract anomalies in third-trimester fetuses. It may be a useful complementary tool in the assessment of bilateral urinary tract anomalies of fetuses, particularly in cases with inconclusive sonographic findings.

In our study we studied 10 patients with suspected GU anomalies. MRI confirmed suspected USG findings and gave additional information in 6 patients. Hence MRI has a supplemental role to ultrasound in fetal genitourinary anomalies specially in patients with oligohydramnios.

In our study, three (7.3 %) out of 41 fetuses were evaluated for thoracic abnormalities. MRI was helpful in diagnosis of one case of eventration of diaphragm. Two cases of CPAM/Sequestration suspected on USG were confirmed on MRI. Eight out of 41 cases of fetal anomalies were evaluated for miscellaneous anomalies. MRI was helpful in identifying 3 miscellaneous anomalies in addition to five diagnosed by MRI. These included fetalhydrops, polydactyly, club foot, absent foot, taillgut duplication cyst and Thanatophoric dysplasia.

Conclusion

Authors found that prenatal MRI is evolving as a powerful tool in cases where ultrasound findings are inadequate or inconclusive for diagnosing fetal anomalies.

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