ORIGINAL RESEARCH PAPER

Radio-Diagnosis

"ROLE OF FETAL MRI IN EVALUATION OF CONGENITAL ANOMALIES"

KEY WORDS: HASTE, BTFE, fetography, sacrococcygeal teratoma

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ABSTRACT

When US evaluation of the second and third-trimester foetus is limited, MR imaging might be used as a supplemental test. Due to a lack of an acceptable acoustic window, US is often limited in cases of oligohydramnios or breech presentation. In both cases, however, MR imaging can clearly show the foetal anatomy in detail. Ossification of the calvaria[1], which inhibits view of the posterior fossa at US, can also impede third trimester foetal assessment. US frequently suggests intracranial pathologic abnormalities such as posterior fossa anomalies (Chiari II syndrome, cerebellar aplasia or hypoplasia). MR imaging can corroborate the US findings, and it can also provide a diagnosis in some circumstances, such as neuronal migrational anomalies. MR imaging certainly has the advantage of being able to analyse the foetus in many planes within a greater field of view. T1-weighted MR imaging can show acute and chronic germinal matrix bleeding, as well as ischemia alterations. Although ultrasound is helpful in detecting corpus callosum abnormalities, it can miss many of the central nervous system problems associated with corpus callosum agenesis. Because the prognosis of agenesis of the corpus callosum is so unpredictable, detecting concomitant central system defects on MR imaging can help with prenatal and postnatal medical care. Although the majority of prenatal MR imaging applications are related to the cranial nervous system, new developments in foetal surgical intervention have expanded the utility of foetal MR imaging in thoracoabdominal illness detection. Fetal MR imaging can help diagnose abnormalities such congenital cystic adenomatoid malformation, congenital diaphragmatic hernia, cystic hygroma, and bronchopulmonary sequestration. Accurate assessment of foetal lung and liver sizes is critical in foetal surgical planning and postnatal prognosis in the case of congenital diaphragmatic hernia. Some high-risk pregnancies may also benefit from obstetric MR imaging, according to preliminary research. With a combination of foetal weight estimates and liver volume measurements, birth weight may be correctly predicted and the diagnosis of intrauterine growth retardation or macrosomia can be made with confidence.

INTRODUCTION

Because of recent advancements in magnetic resonance (MR) imaging, the role of obstetric MR imaging has grown in circumstances where ultrasonography results are ambiguous. T2-weighted fast spin-echo (SE), half-Fourier single-shot fast SE, 0.5-signal acquired single-shot fast SE, and echoplanar imaging are examples of fast MR imaging sequences that have essentially removed the requirement for foetal premedication while also improving picture resolution and reducing blurring. The anatomic detail that may be demonstrated using MR imaging is no longer limited by artifacts linked to mother respiratory motion and foetal motion. With the advancements in obstetric MR imaging, understanding normal foetal architecture is critical for detecting disease in utero. The brain, chest, abdomen, pelvis, and vascular may all be seen in great detail using MR imaging. Targeted rapid MR imaging can be used to assess major developing structures of the foetus as early as the second trimester, including the central nervous system, naso and oropharynx, lungs, and major abdominal viscera. Heart MR imaging, on the other hand, is still limited. Because of biosafety concerns, prenatal MR imaging during the first trimester is contentious and limited due to foetal size. Knowledge of normal foetal anatomy at MR imaging is critical to diagnose disease in utero, thanks to improvements in obstetric MR imaging.

AIMS AND OBJECTIVES

1. To determine whether foetal MRI adds to the information provided by USG results.
2. To confirm anomalies discovered on the USG
3. To look for other diseases.

MATERIALS AND METHODS

The main source of the data for the study are pregnant women coming to Department of Radio Diagnosis, Kurnool medical college, Kurnool from November 2019 to 2021.

Technique

Imaging done with PHILIPS INGENIA 1.5 Tesla WITH D-STREAM TECHNOLOGY machine and the following sequences were acquired :

1) T2 weighted half Fourier-acquisition single-shot turbo spin echo (HASTE) in axial, coronal, and sagittal planes adjusted to fetal axis – provide the highest SNR and resolution, and fast. This sequence is most useful for anatomic detail.

2) Balanced turbo field echo (BTFE) in axial, coronal and sagittal planes adjusted to fetal axis – demonstrate bright blood imaging. Useful for cardiac chambers, great vessels and fluid - filled structures.

3) T1 weighted imaging of the fetal abdomen in coronal plane – for fetal bowel.

4) Diffusion-weighted imaging (DWI) (b value 400– 700 s/mm2) in an axial and coronal planes including both fetal kidneys

5) Echo planar imaging of fetal brain in suspected intracranial hemorrhage in axial plane

6) MR fetography (thick slab heavily T2 weighted images) - for static fluid assessment.

RESULTS

Table 2: Age Distribution

AGE IN YEARS	NUMBER OF PATIENTS
<20	1
20-25	22
26-30	8
31-35	4

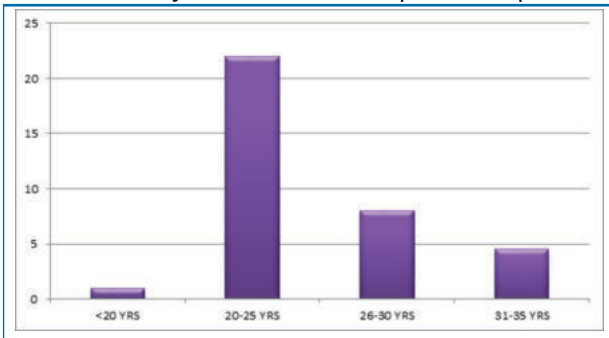


Chart 1: Age Distribution

MAJORITY OF THE PATIENTS WERE IN THE AGE RANGE OF 20-25YEARS

Table 3: Gestational Age Distribution

GESTATIONAL AGE IN WEEKS	NUMBER OF PATIENTS
<20	4
20-25	10
26-30	16
31-35	4
>35	1

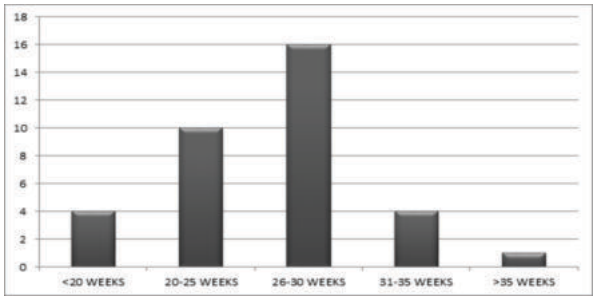


Chart 2: Gestational Age Distribution

MAJORITY OF THE PATIENTS WERE BETWEEN 26-30 WEEKS AT THE TIME OF MR IMAGING

Table 4: Detected Anomalies

SYSTEM	NUMBER OF CASES	PERCENTAGE
CENTRAL NERVOUS SYSTEM	19	54%
CHEST	6	17%
HYDROPS	3	8%
GENITO URINARY SYSTEM	2	5%
SPINE	2	5%
MUSCULOSKELETAL	1	2%
TUMOR	1	2%
ISOMERISM	1	2%
CYSTIC HYGROMA	1	2%
NORMAL	2	5%

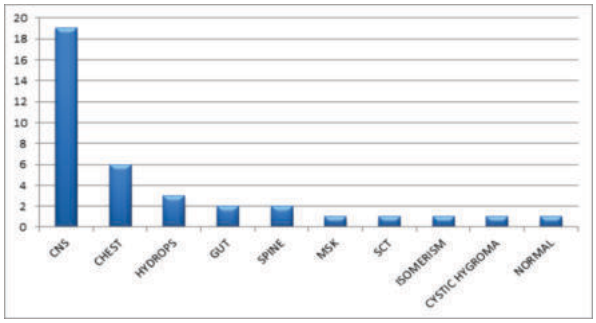


Chart 3: Detected Anomalies

MOST COMMON FETAL ANOMALIES WERE NEUROLOGICAL DISORDERS (54%) FOLLOWED BY CHEST DISORDERS (17%)

Table 5: Cns Anomalies

TYPE OF ANOMALY	NUMBER OF CASES	PERCENTAGE
CHIARI 1 MALFORMATION	1	2%
CHIARI 2 MALFORMATION	11	31%
ACRANIA	3	8%
HYDRANENCEPHALY	1	2%
HYDROCEPHALUS	1	2%
SEMILOBAR HOLOPROCENCEPHALY	1	2%
BLAKES POUCH CYST	1	2%

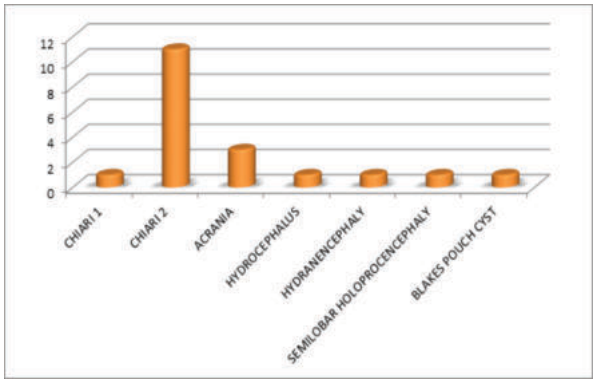


Chart 4: Cns Anomalies

CHIARI 2 MALFORMATION IS THE COMMONEST ANOMALY (n=11) DETECTED IN THE CNS FOLLOWED BY ACRANIA (n=3) IN OUR STUDY

Table 6: Chest Anomalies

TYPE OF ANOMALY	NUMBER OF CASES	PERCENTAGE
CONGENITAL DIAPHRAGMATIC HERNIA	4	11%
CONGENITAL CYSTIC ADENOMATOID MALFORMATION	2	5%

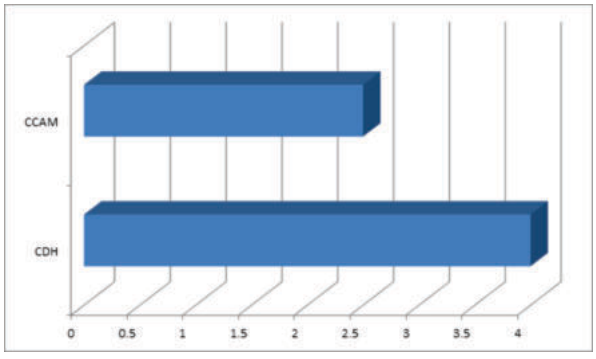


Chart 5: Chest Anomalies

CDH (n=4) IS THE MOST COMMON ANOMALY DETECTED IN OUR STUDY

Table 7: Hydrops

ANOMALY	NUMBER OF CASES	PERCENTAGE
HYDROPS WITH PUJ OBSTRUCTION	1	2%
HYDROPS WITH CYSTIC HYGROMA	1	2%
HYDROPS ALONE	1	2%

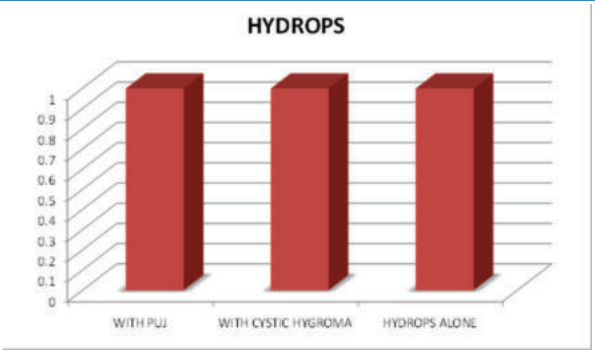


Chart 6: Hydrops

Table 8: Genito-urinary Anomalies

TYPE OF ANOMALY	NUMBER OS CASES	PERCENTAGE
BILATERAL PUJ OBSTRUCTION	1	2%
BLADDER EXSTROPHY	1	2%

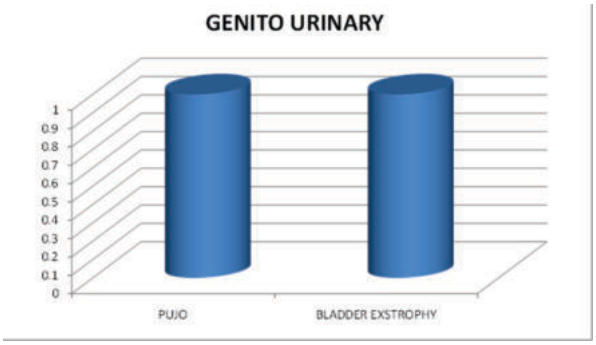


Chart 7: Genito-urinary Anomalies

Table 9: Other Anomalies

TYPE OF ANOMALY	NUMBER OF CASES	PERCENTAGE
SPINE	2	5%
MUSCULOSKELETAL	1	2%
NORMAL	2	5%
SCT	1	2%
ISOMERISM	1	2%
CYSTIC HYGROMA	1	2%

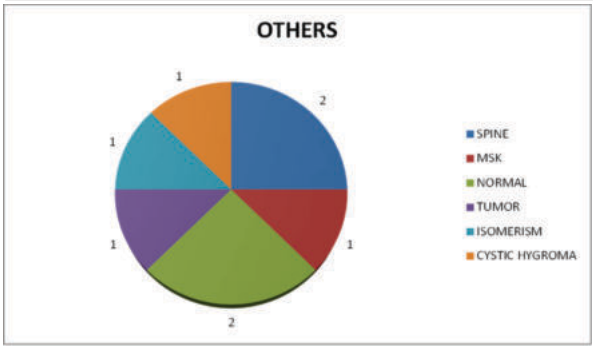


Chart 8: Other Anomalies

Table 10: Multiple Anomalies

TYPES OF ANOMLAIES	NUMBER OF CASES	PERCENTAGE
CYSTIC HYGROMA AND HYDROPS	1	2%
ACRANIA AND CCAM	1	2%
PUJ OBSTRUCTION AND HYDROPS	1	2%

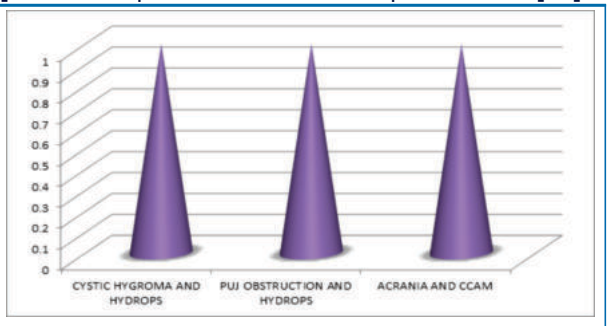


Chart 9: Multiple Anomalies

Representative Images Of Study Patients

Case 1: 22 year old patient with 32 weeks of GA

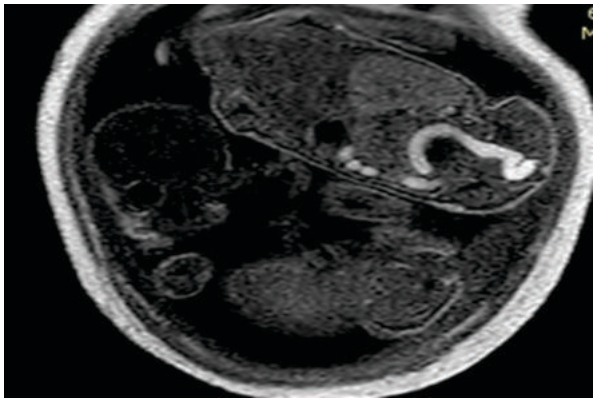
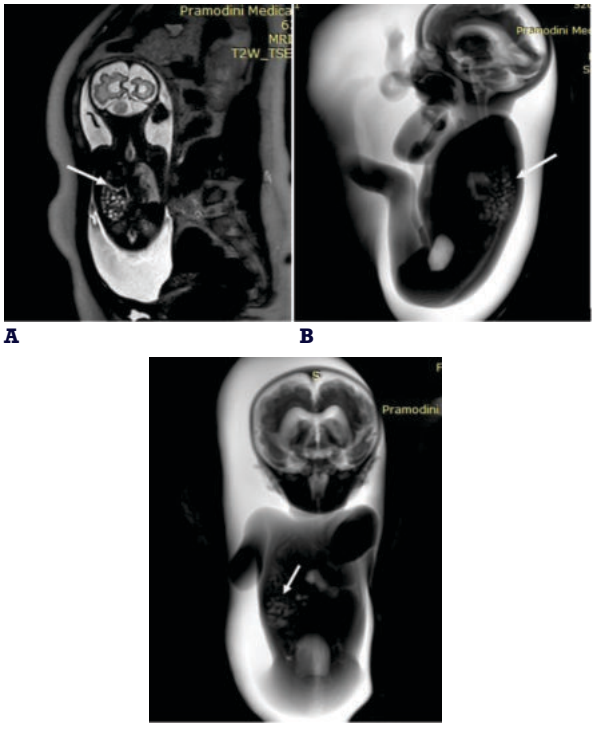


Fig.8 Coronal T1W imaging in a twin gestation shows normal T1 hyperintense signal of colon in twin B (arrow). This is normal appearing bowel.

Case 2: 21 year old patient with GA of 30 weeks

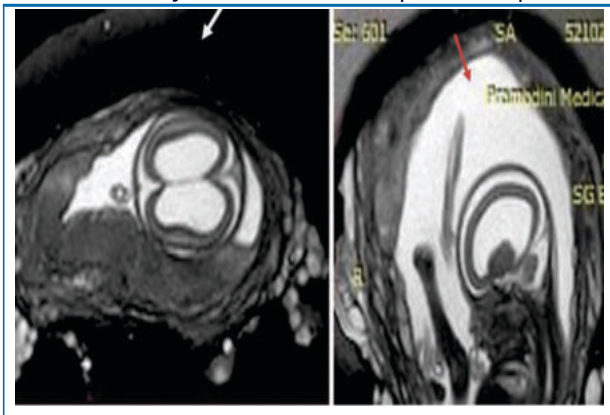


A **B**

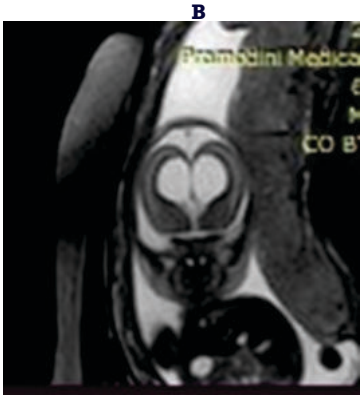
C

Fig.9 Coronal HASTE (a), sagittal (b), and coronal (c) MR hydrography images showing herniated bowel loops into thoracic cavity (arrows). Congenital diaphragmatic hernia is the diagnosis. LHR – 28%.

Case 3: 22 year old patient with GA of 18 weeks

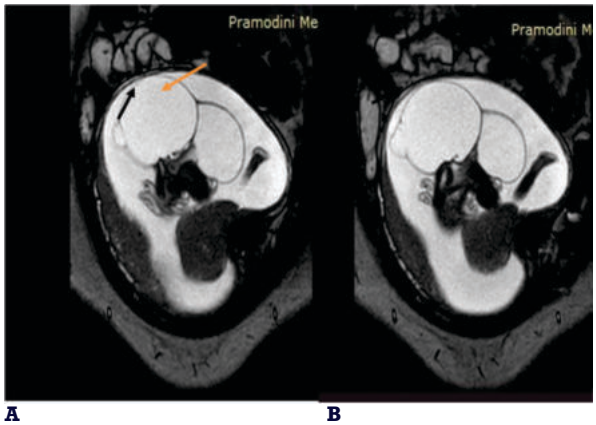


A B

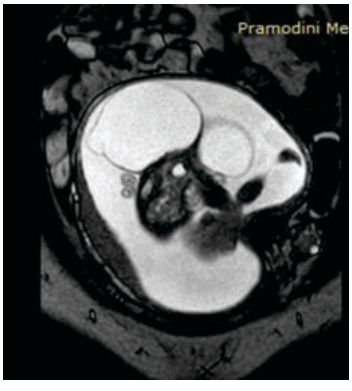


C

Fig. 10 axial (a), sagittal (b), and coronal (c) HASTE images showing dilated bilateral lateral ventricles (arrows). S/O hydrocephalus.



A B

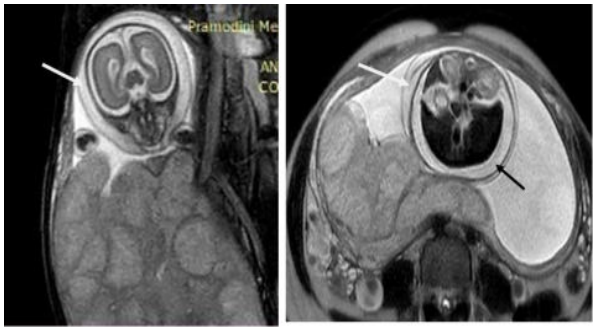


C

Fig.11 sagittal HASTE images showing a lobulated cystic lesion with internal septations (black arrows) in the lumbosacral region with communication to the spinal canal (orange arrow). S/O lumbosacral myelomeningocele Case 5: 25 year old patient with GA of 28 weeks

Fig.12 sagittal HASTE image showing crowding of posterior fossa and lumbosacral myelomeningocele (arrows). The diagnosis is Chiari 2 malformation.

Case 6: 25 year old patient with GA of 30 weeks



A B

Fig.13 coronal HASTE image of the fetal head (a) and axial HASTE image of the fetal abdomen at the level of liver showing subcutaneous tissue edema (white arrows) and ascites (black arrow). This is Hydrops fetalis.

Case 7: 24 years old female with GA of 18 weeks

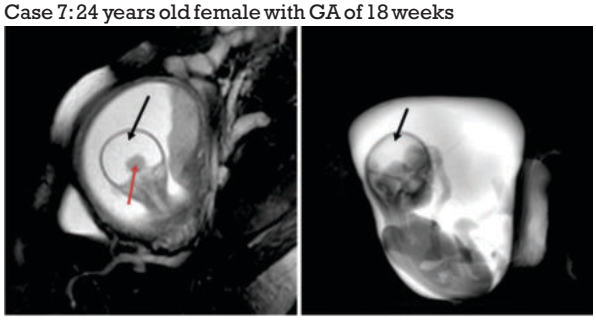
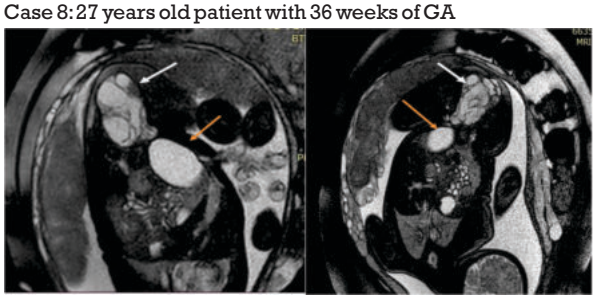


Fig.14 coronal HASTE (a) and MR hydrography images (b) shows fluid filled cranium (black arrows). Bilateral cerebral hemispheres are absent. Bilateral basal ganglia (brown arrow) are present. S/O Hydranencephaly.

Case 8: 27 years old patient with 36 weeks of GA



A B

Fig.15 sagittal (a) and coronal (b) BTFE images and MR

hydrography image (c) shows a lobulated cystic lesion with internal septations in presacral region (white arrows). The bladder is pushed antero-superiorly (orange arrows). Sacro-coccygeal teratoma type 4 is the diagnosis.

CONCLUSION

The overarching aim of this thesis was to evaluate the diagnostic performance of fetal MR imaging as an adjunct to USG for the diagnosis of fetal abnormalities. The significance of diagnosing a fetal abnormality prenatally is potentially huge. The expectant mother has to choose between continuing the pregnancy with uncertainty about the ultimate effects of the diagnosed abnormality or to terminate the pregnancy. An accurate and confident diagnosis is therefore vital. The immediacy and ability of USG to visualize the fetus is invaluable and, as it is safe and easily accessible, it is the undisputed primary method for screening during pregnancy. Despite this, the technical and patient-related limitations of USG, such as high maternal body mass index, reverberation artifacts and oligohydramnios, can all prevent adequate visualization of the fetal anomalies.

Diagnostic test performance is not based solely on diagnostic accuracy but a hierarchal model that has the technical efficacy of a diagnostic test at its foundation and ultimately how the test influences the outcome for the patient. The technical efficacy of routine foetal MRI is proven, having been used as an adjunct to ultrasonography for several years but its additional value in clinical practice had not been established. Although findings of previous research suggested that fetal MRI improves diagnostic accuracy, the results were considered biased due to poor study design which compromised their validity. In addition it was unclear if those studies had investigated the further impact of fetal MR imaging in the diagnostic pathway.

Summary

Our present study evaluated the use of MRI in pregnant patients who had abnormalities in antenatal USG to look for any other associated findings. The current study included 35 patients who had abnormal antenatal USG and presented to the department of Radio-Diagnosis and Imaging within a span of 2 years (November 2019 to November 2021), which included outpatients, inpatients, referral patients of Government general hospital, Kurnool medical college, Kurnool.

The conclusions drawn from our study were:

- The maximum incidence of anomalies was seen in first pregnancy and in the age group of 20 to 25 years.
- Central nervous system abnormalities were the commonest anomalies detected in the 35 patients followed by chest abnormalities.
- The most common CNS anomaly observed in our population is posterior fossa malformations ie: Arnold Chiari type 2 malformation.
- Congenital diaphragmatic hernia was the commonly observed chest anomaly in our study.
- Addition of MRI to the antenatal USG changed the provisional diagnosis in 3 patients.
- Tumors and musculoskeletal anomalies were the least detected.
- T2W imaging is the workhorse of fetal MRI.
- Use of HASTE sequence decreases the artifacts related to fetal motion and maternal breathing due to fast acquisition.
- Diffusion weighted imaging is useful in suspected renal agenesis because kidneys have restricted diffusion usually.
- Hydrography (heavily T2 weighted sequence) imaging, provides high-quality imaging contrast between fluid and background and is invaluable in studying static fluid (cerebrospinal fluid, urine in the collecting system, bile in the hepatobiliary system and cysts in any organ) pathologies. The drawback of hydrography is increased scan time.
- Because MR can provide imaging with a large field-of-view, multiplanar construction and high soft-tissue contrast while avoiding image deterioration caused by maternal habitus or presence of oligohydramnios, this modality is extremely helpful.
- Because of fetal motion, limb anomaly detection is limited using MRI. Advances in technical aspects may overcome this problem in future.

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