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The Role of Fetal MRI in Prental Diagnosis: A Comparative Study with Antenatal Ultrasound.

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ABSTRACT

Background: Comparative Study was conducted to find out role of fetal MRI in antenatal anomalies detected by ultrasound. **Methods:** Study conducted in Department of Radiology, Manipal Hospital, over 36 months including all pregnant women with suspected fetal Central Nervous System anomalies on US. **Results:** 36 patients underwent MRI for different indications all of who were referred after US. In 5/ 36 patients detailed US report was not available. In 23/ 31 cases (74.2%), the US findings and MRI findings were similar .MRI imaging provided more information than did US in 5 / 31 cases(16.1%) and there were 3/31(9.6%) cases in which US provided additional information to that provided with MRI in terms of IUGR , Rhabdomyomas in case of tuberous sclerosis, Cleft lip, Cleft palate, limb anomalies. Discrepancies occurred in 8/31 cases (25.8%). **Conclusions:** Major role for fetal MRI is confirmation of inconclusive sonographic findings and the evaluation of sonographically occult diagnoses.

Keywords: Fetal MRI, Fetal anomalies, Ultrasound correlation.

INTRODUCTION

Ultrasonography (US) is the most commonly used screening modality for fetal imaging however, there are limitations, including small field of view, limited soft tissue acoustic contrast, beam attenuation by adipose tissue, poor image quality in oligohydramnios and limited visualization of posterior fossa in advanced gestational age, because of calvarial calcification.[1-3]

MRI (Magnetic Resonance Imaging) is a valuable complement to US when additional information is needed to confirm diagnosis during pregnancy. Recently, MRI with fast sequences has allowed images to be obtained during maternal breath-holding, without fetal or maternal sedation. It gives superior soft tissue contrast resolution, because of which we are able to distinguish individual fetal structures such as lung, liver, kidney, and bowel.[4] Moreover, it provides multiplanar imaging as well a large field of view, facilitating examination of fetuses with large or complex anomalies, and visualization of the lesions within the context of the entire fetal body.[5] It allows better fetal imaging in situations such as maternal obesity and oligohydramnios, where it may be difficult to obtain clear images by US due to technical limitations.[6] MRI has also proved to be useful for a wide variety of disorders, mainly those involving the central nervous system; especially in late gestation when, the ossification of the calvarium limits a good visualization of the encephalic structures. However, fetal MRI study may give limited diagnostic information in early gestational age due to the small size of the fetus and fetal movement.[7]

Safety is important in evaluating the fetus. MRI is a non-invasive that does not involve ionizing radiation with no known associated side effects or reported delayed sequels.[8] No known harmful effects to the developing human fetus have been documented at 1.5 Tesla or less. However, safety has not been dogmatically proven. In-utero MRI has not shown any effect on fetal growth.[9]

The American College of Radiology (ACR) states that fetal MRI can be done at any stage of pregnancy if the risk-benefit ratio to the patient warrants the same and only if US is inadequate. However,[10] it is wise to wait until 17-18 weeks of gestation because of the potential risk to the developing fetus and excessive motion of younger fetuses.[11] A written informed consent is usually required from the pregnant woman prior to fetal MRI.

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MATERIALS & METHODS

Study was conducted in the Department of Radio Diagnosis and Imaging MANIPAL HOSPITAL Bangalore, 800 bedded multispecialty tertiary care hospital, over a period of 36 months from July 2012 to July 2015. All pregnant women with suspected fetal anomaly on US scan and above 18 years of age; pregnant women with previous history of fetal

congenital anomalies; & Pregnant women with confirmed diagnosis of congenital anomalies of foetus in-utero who are less than 18 weeks and are scheduled for termination were included in study. Pregnant women having a history of claustrophobia, metallic implants insertion, cardiac pacemakers and metallic foreign body were excluded from study. MRI was also avoided in pregnant women who require sedation. Total of 36 patients underwent fetal MRI examination in our hospital during the study period.

GE 1.5 Tesla TWIN SPEED, HDX MRI machine was used. The non–imaging data was collected in prescribed format. 12 channel Body coil was used with small field of view as possible. 3-5 mm thick slices were taken. Multiple sequences were taken predominantly T2 Single Shot Fast Spin Echo (SSFSE) in three orthogonal planes. The mother was kept NPO for 4 hrs prior to the MRI exam in order to reduce fetal motion. Written informed consents were obtained prior to study in all cases. The mother lied supine during the course of the exam in comfortable position possible during the MR exam in order to minimize fetal motion. MRI exam can be performed with the mother lying on her left side, although this results in lower image quality.

Most fetal MRI is primarily performed using an initial localizer obtained in three orthogonal planes with respect to the mother, using 6- to 8-mm thick slices with a 1-to 2-mm interslice gap and a large field of view. The localizer is used to visualize the position of the fetus and determine fetal sidedness, as well as to ensure that the coil is centred over the region of interest. Typically, 3-mm thick ultrafast T2-W images of the fetal brain were then prescribed from the localizer with no skip. Images were acquired in the axial, sagittal, and coronal planes.

Diffusion-weighted imaging (DWI) was also used to identify focal areas of injury as well as to assess brain development using a b value of 0 s/mm2 and 600 s/mm2. The data was collected on pre-designed study performa. All the data were entered in Microsoft Excel Program and checked for any inconsistencies. Data was presented in terms of percentages and proportions.

RESULTS

36 patients underwent MRI in our department for different indications all of who were referred after US. In 31/ 36 cases MRI was done within 15 days of US. Age of the patients included in this study ranged between 19-37 years with an average age of 30 years.All MRI examinations were done in the second and third trimester .MRI examination was avoided in first trimester in accordance to ACR guidelines to avoid potential risk to the developing foetus. All pregnant women included in this study were of 19-36 weeks of gestation with average gestational age of 26 weeks.

History of previous pregnancy with congenital anomalies was elicited in 7 patients. In our study we have studied fetal anomalies involving central nervous system. In 4 / 7 patients central nervous system abnormality was found in present pregnancy.

In 5/36 patient's detailed US report was not available. 2/36 cases were twin pregnancies. In one twin pregnancy laser ablation of umbilical artery of one foetus was done for Twin Twin Transfusion Syndrome (TTTS). Thus in 31/ 36 cases comparison between US and MRI reports was made.

In 23/ 31 cases (74.2%), the US findings and MRI findings were similar. MRI imaging provided more information than did US in 5 / 31 cases (16.1 %) and there were 3/ 31(9.6%) cases in which US provided additional information to that provided with MRI in terms of IUGR, Rhabdomyomas in case of tuberous sclerosis, Cleft lip, Cleft palate, limb anomalies. Discrepancies occurred in 8 /31 cases (25.8%). [Figure 1]

The criteria used in our study to measure ventricles was considered mild when it measured 10 to 12 mm; moderate when 12 to 15 mm & Severe ventriculomegaly [Figure 6] when > 15 mm.

In our study we found ventriculomegaly in 14/ 31 (45.1%) cases. 10/14 cases (71%) were bilateral, and rests 4/14 (29%) were unilateral.

3/14 cases of ventriculomegaly were of severe category. 5/14 were of moderate category while 6/14 cases had mild ventriculomegaly.[Figure 2]

In 10/14 cases (71%) we have found various associated central nervous system anomalies which included Sulcation abnormality, Agenesis of corpus callosum, Arnold-chairi malformation, and TORCH infection.

1 / 14 case lost follow up, which had associated partial agenesis of corpus callosum. 5/14 cases of mild ventriculomegaly and no associated anomaly continued pregnancy, all of which had normal delivery with normal postnatal neurosonogram. 2/14 cases of mild ventriculomegaly and no associated anomaly and 6/14 with moderate to severe ventriculomegaly with congenital anomalies underwent termination of pregnancy.

In 6 /31 (19.3%) corpus callosum was not visualized on US or had suspected corpus callosal abnormality. In 5 / 6 cases MRI confirmed US findings. In 1 / 6 cases MRI disproved US diagnosis of agenesis of corpus callosum.

2/31(6.4%) cases had intracranial haemorrhage, 1/31 (3.2%) had Alobar holoprosencephaly, 2/31 (6.4%) had Arnold-chiari malformation, and 2/31(6.4%) had Aqueductal Stenosis. 2/31(6.4%) had TORCH infection [Figure 3 & 4].

Sulcation pattern was normal for age in 30/ 31cases. In single foetus there was time lag of 2 -3 weeks [Figure 5].

1/31cases had Schizencephaly (Fig.7). 1/31fetuses had tuberous sclerosis. In 1/31 case unilateral deep

asymmetric calcarine sulcus (CS) was found. In all these cases diagnosis was made on MRI.

5/31 cases had posterior fossa malformations. 2/5 cases showed Dandy Walker continuum (Fig.8), One case was of isolated inferior vermian hypoplasia, one of unproven partial Rhombencephalosynopsis, and one of arachnoid cyst.

2/31 cases were twin pregnancies. In 1/2 twin pregnancy feto-reduction by laser ablation of umbilical artery was done, emergency LSCS was done and surviving foetus was normal. Other twin pregnancy was terminated. In 13/31 cases pregnancy was continued. In 16/ 31 cases patient underwent termination or pregnancy terminated spontaneously or pregnancy had terminate due to maternal indication.

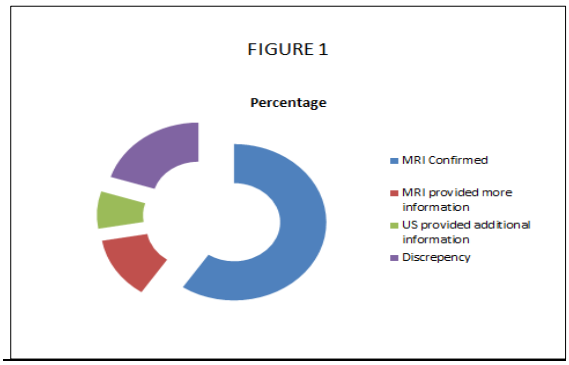

Figure 1: Percentage.

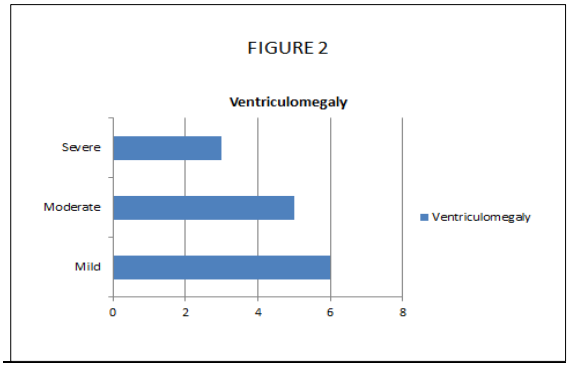

Figure 2: Ventriculomegaly.

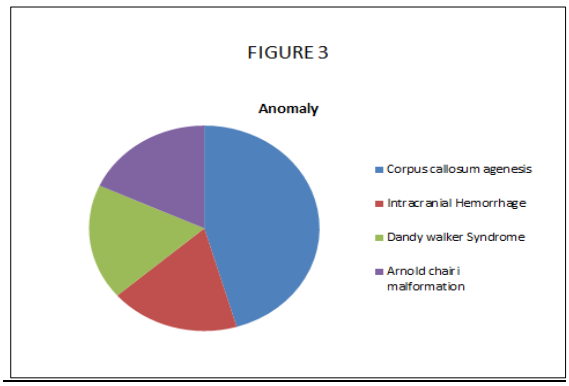

Figure 3: Anomaly.

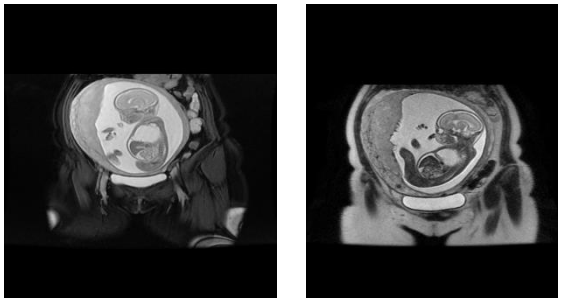

Figure 4: T2 W and T2W fatsat coronal images showing fetal ascities, pleural effusion, nuchal oedema and mild hydrocephalus in 27 weeks fetus with TORCH infection.

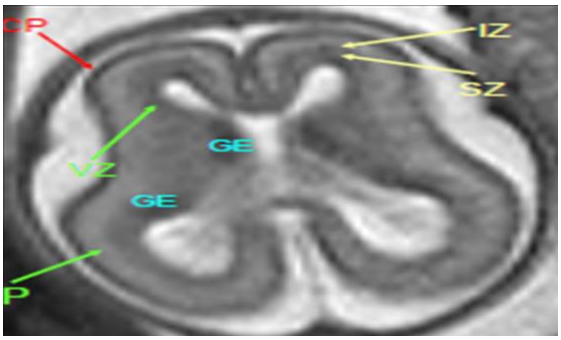

Figure 5: Different layering patterns observed in fetal brain MR; VZ: ventricular zone; GE: Ganglionic eminence; IZ: Intermediate Zone; SZ:Subventricular zone; SP: subplate ;CP: Cortical Plate.

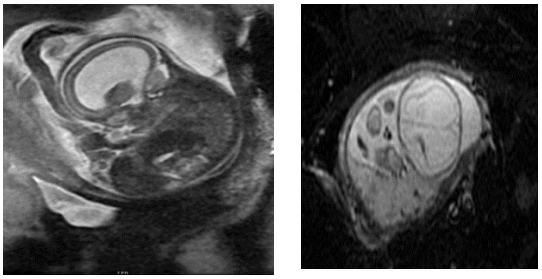

Figure 6: SSFSE T2W sagittal images showing Bilateral severe ventriculomegaly (arrowhead) involving the lateral ventricles.

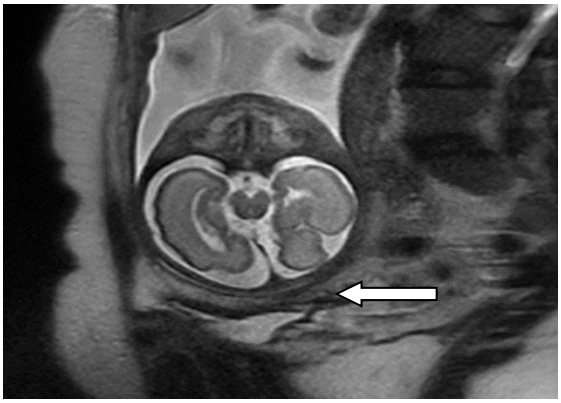

Figure 7: T2W images of 23 weeks Fetus with gray matter lined tract (arrow) in the left parietotemporal region communicating with left lateral ventricle with associated dimpling of the left lateral ventricle suggestive of schizencephaly.

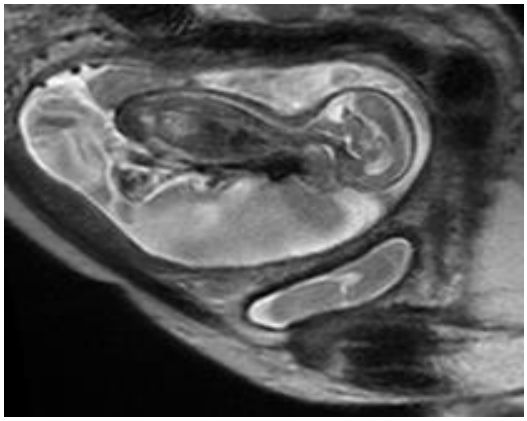

Figure 8: T2W Saggital images showing Vermian agenesis, cystic dilatation of the fourth ventricle, abnormally high tentorium with enlargement of the posterior fossa suggestive of Dandy Walker Malformation.

Table 1: Comparison of different study results with our study.

	Elespeth whitblyet et.al 2003(12)	Frates MC et.al 2004(14)	Hosny IA et.al 2010(13)	Our study
Discrepancy	47.6	25	28	25
MRI provided Additional information /changed US diagnosis	23.8	35.7	16	16
US provided additional information				9.6
MRI and US agreed	28.6	25	72	74

DISCUSSION

Major indications for fetal MRI were confirmation of inconclusive sonographic findings and the evaluation of sonographically occult diagnoses.

Elspeth Whitby, Martyn N. Paley et al 2003 did a prospective,[12] observational study of 21 pregnant women of 19–36 weeks of gestation whose fetuses were thought to have a central nervous system abnormality on the basis of antenatal US. They found that MRI report was different to the US in 10/21 (47.6%); MRI provided information additional to the US in 5/21 (23.8%) &US and MRI results agreed in 6/21 (28.6%).[Table 1]

In our study 13/31 cases (46.4%), the diagnoses established by US were confirmed by MRI. There were 7/31(22.5%) cases in which US provided additional information to that provided with MRI in terms of IUGR, Rhabdomyomas in case of tuberous sclerosis ,Cleft lip ,Cleft palate, limb anomalies. This can be explained by the advances in US technology like 3D, 4D, software like Omni view, TUI, and the radiologist's operative and interpretation skills.

MRI imaging provided more information than did US in 8 / 31 cases (25.8%). In 25% cases MRI gave additional information in our study which was 23.8% in study done by Elspeth Whitby et al indicating improved MRI diagnosis also. Superior soft-tissue contrast resolution and development of fast T2W sequences like steady state free precession sequence (SSFSE) has made MRI faster with excellent soft tissue details.

Discrepancies occurred in 8/31 (25.8%) cases which was 47.6% in their study, significantly reducing incorrect interpretation rates. This again can be explained by improvements in ultrasound equipment and skills along with advances in MRI & their interpretation.

Hosny IA, et al in 2010 (13) examined 25 pregnant women with MRI in whom US detected fetal congenital anomalies .MRI findings altered the diagnosis of 2/25(8%) cases. MRI added additional findings two out of four cases. In the remaining 18/25(72%) cases MRI confirmed the diagnosis of US. Compared to this study where US and MRI was in agreement in up to 72% case, in our study it was found it to be 46%. As in our study they also didn't include postnatal follow up like autopsy or imaging.

Evaluation of corpus callosum, Aqueductal Stenosis, morphological abnormalities is much better with MRI where it is directly visualized unlike US which relies on indirect signs. In our study where corpus callosum was not visualized on US or had suspected corpus callosal abnormality, MRI was superior and confirmed the diagnosis.

In posterior fossa abnormalities ultrasound and MRI are complimentary to each other. In our study 60% of posterior fossa abnormalities were diagnosed on ultrasound, which were later confirmed on MRI

Detection rate for ventriculomegaly were same for both ultrasound and MRI, however MRI was superior in diagnosing the associated anomalies which were occult or operator dependent on ultrasound.

CONCLUSION

Recent advances and developments in MR based sequences and ultrasound applications , have helped in making tremendous progress in the field of prenatal imaging , both the imaging modalities are complimentary to each other and play an important role in diagnosis and management in prenatal care.

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