METHODOLOGY
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The study has two parts. The first was a prospective comparison of sonography and MRI in the detection of fetal abnormalities. The second part, namely, Signal intensity measurements was done as a retrospective analysis of the collected data. Institutional review board approval was obtained for this study. Written informed consent was obtained from each patient. Patients with abnormal USG findings related to fetal head or trunk were recruited into the study. Suspected or proved fetal anomalies on sonography, patients who came for MR evaluation of placental abnormalities were also included in the study.

INCLUSION CRITERIA

1. 2nd and 3rd trimester pregnancy
2. Suspected or proven head and trunk anomalies on USG
3. Patients who came for MR evaluation of placental or lower abdominal pathologies complicating pregnancy like uterine fibroids

EXCLUSION CRITERIA

1. First trimester
2. Severely destroyed brain like anencephaly, holoprosencephaly
3. Fetuses with orbital pathologies
4. Un-cooperative / Claustrophobic patients
5. Patients with known contraindication to MRI

Sonography examination was performed on a high resolution US scanner (GE Voluson or Aloka SSD 5500 with 3.5-5 MHz transducer) by a Radiologist (R1) who had more than five years experience in high risk obstetric
US. Fetal MR imaging was performed on 110 pregnant women between April 2005 and March 2010 in whom there was some abnormality on the initial US. Gestational age ranged from 18 to 38 weeks (mean 26.9 weeks).

MR imaging was performed using 1.5T superconductive system (Signa HDX; GE Health Care, Milwaukee) and an 8 element Torso Array Coil. Neither the fetus nor the mother was sedated. Patients were positioned supine with the feet entering the magnet bore first to minimize feeling of claustrophobia. The basic MRI examination consisted of Single shot Fast Spin Echo (SSFSE) sequence to obtain T2 weighted images (650/90 repetition time msec/echo time msec; bandwidth-31.25; No. of excitation-1; 5 mm section thickness; spacing 0.5 mm; 25-40 cm field of view; 256x160-256 acquisition matrix). Images were acquired in the axial, coronal and sagittal planes relative to the head and trunk of fetus for interpretation. A representative image from each sequence was used as a scout to align the subsequent sequences. The transverse images of the fetal brain were used for placing region of interest cursors (ROI) and obtaining signal intensity measurements.

Additional T1 weighted axial images were obtained using FSPGR (Fast spoiled gradient echo) with following parameters. (100/2.6 repetition time msec/echo time msec; Flip angle 80\(^\circ\); bandwidth-31.25; No. of acquisition-1; 5 mm section thickness; spacing 0.5 mm; 25-40 cm field of view; 256x160-256 acquisition matrix). Imaging time was 20-30 seconds per sequence. The whole
body specific absorption rate was maintained under 3.0W/kg. The duration per examination was less than 30 minutes.

A second radiologist (R2) with more than five years experience in MR imaging used sonographic data to plan the MR and to obtain additional images. Subsequently, the final report for each patient was given following analysis of the ultrasound and MRI data.

We prospectively compared antenatal sonography and MRI in the diagnosis of fetal head and trunk anomalies. Fetal MR images were read by the third radiologist (R3) with more than five years experience in MR imaging. The sonographic data was not disclosed. This radiologist (R3) was however told that the region of interest was (1) Head-neck or (2) Trunk or (3) Both. Fetal sonographic and MR imaging findings were compared with postnatal findings. Postnatal work up consisted of physical examination, plain radiograph, US, CT, MRI, surgery and autopsy.

We retrospectively studied the signal intensity measurements of the images of the fetuses. Only transverse images found suitable for interpretation were taken up for signal intensity measurements. Images with motion or any other artifacts were excluded. Region of Interest (ROI) cursors were placed in designated regions and signal intensities of the tissues were measured. ROI of size 0.20cm² were placed in the following areas

- Vitreous humour
- Cerebellar vermis
- Thalamus
- Frontal white matter
- Corona radiata
- Periventricular region
- Genu of corpus callosum
- Grey matter

- The lateral ventricle diameter of the fetuses were also obtained

Signal intensity of a tissue depends on its distance from the receiver coil. A ratio comparing the signal intensity of the brain with another structure of similar depth like vitreous could provide a correction factor. Hence the Signal Intensity Ratio of the tissue/ vitreous was obtained (SIR). The signal intensity measurements of all the fetuses were obtained by the second Radiologist (R2). The second and third Radiologists (R2 and R3) calculated randomly the SIR measurements of each region in 25 fetuses. Inter-observer mean variability in the SIR measurements of each region was also calculated.

**Vitreous signal intensity**
Vermian Signal intensity Ratio = \frac{\text{Vermis signal intensity}}{\text{Vitreous signal intensity}}

Frontal white matter Signal intensity Ratio = \frac{\text{Frontal white matter SI}}{\text{Vitreous signal intensity}}

Thalamic Signal intensity Ratio = \frac{\text{Thalamic signal intensity}}{\text{Vitreous signal intensity}}

Corona radiata Signal intensity Ratio = \frac{\text{Corona radiata signal intensity}}{\text{Vitreous signal intensity}}

Periventricular Signal intensity Ratio = \frac{\text{Periventricular signal intensity}}{\text{Vitreous signal intensity}}
Grey matter Signal intensity Ratio = $\frac{\text{Grey matter signal intensity}}{\text{Vitreous signal intensity}}$

One hundred and ten fetal brains were studied by MRI. Nine had to be excluded due to destroyed brain. 50 had CNS anomalies. 51 had normal CNS and were used as controls. They had thoracic or abdominal anomalies or were normals. Normative values (control values) of the various regions were obtained for the 18-40 weeks fetuses. Signal intensity ratio measurements in controls compared with the following conditions and statistical analysis was done using Independent Samples T test

- Fetuses having hydrocephalus
- Fetuses having Arnold Chiari type 2 Malformation
- Ventriculomegaly
- Partial agenesis of corpus callosum
- Fetuses with miscellaneous CNS anomalies
**Figure 4.1:** Sonography examination was performed with GE Voluson scanner. MR examination was performed using GE Signa HDX.
Figure 4.2: Patient is positioned supine with the feet entering the magnet bore first. Squeeze ball is given. Torso array Coil is applied.
STATISTICAL ANALYSIS METHODS

SPSS 11.5 statistical software (SPSS Inc) was used for statistical analyses. Comparison of Signal intensity ratio measurements was done using Independent Samples T test. P value of <0.05 was considered significant. Calculations were performed to determine sensitivity and specificity of selected tests.

Definitions of Parameters:

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<th>Disease</th>
<th>Test</th>
<th>Present</th>
<th>Absent</th>
<th>n</th>
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<td>False Positive</td>
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<tr>
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<td>b</td>
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1. Sensitivity : Probability that a test result will be positive when the disease is present (true positive rate, expressed as percentage). = a / (a+b)

2. Specificity : Probability that a test result will be negative when the disease is not present (true negative rate, expressed as percentage). = d / (c+d)
3. **Positive predictive value (PPV)**: Probability that the disease is present when the test is positive (expressed as percentage). \( \frac{a}{a+c} \)

4. **Negative predictive value**: Probability that the disease is not present when the test is negative (expressed as percentage). \( \frac{d}{b+d} \)

5. **Receiver Operating Characteristic (ROC) curve**: In a ROC curve the true positive rate (Sensitivity) is plotted in function of the false positive rate (100-Specificity) for different cut-off points. Each point on the ROC plot represents a sensitivity/specificity pair corresponding to a particular decision threshold. A perfect test has a ROC plot that passes through the upper left corner (100% sensitivity, 100% specificity). Therefore the closer the ROC plot is to the upper left corner, the higher the overall accuracy of the test.
PROFORMA

Patient’s name : 
Age : 
Hosp No. : 
LMP : 
Gravida : 
Weeks of Gestation : 
Single / Multiple : 
Previous Obstetrics History: 
Consanguineous Marriage : 
Any Specific Complaints
   Diabetes : 
   Hypertension : 

ULTRASOUND

Date : 
GA, Presentation : 
Liquor Volume : 
Umbilical Cord : 
Insertion : 
Placenta
   Position : 
Fetal Cardiac Activity : 
Anomalies
   CNS : 

54
CVS : 
GIT : 
GUT : 
LIMBS : 
Chest : 
Miscellaneous : 
Diagnosis

**MRI**

Date : 
Sequences performed : 
Anomalies

**CNS :**

**Signal Intensity :**

<table>
<thead>
<tr>
<th>Signal intensity</th>
<th>SIR</th>
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<tr>
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<tr>
<td>Vitreous</td>
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<td>Genu</td>
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<td>Thalamus</td>
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<td>Periventricular region</td>
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<td>Corona Radiata</td>
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**Lateral ventricle diameter:**

- GIT :
- GUT :
- Chest :
- Miscellaneous :

**Diagnosis**

**Patient Management** :

**Post natal Diagnosis** :
- Modality used :
- Concordant :
- Discordant :