Predictive value of MRI and US in the detection of fetal posterior fossa anomalies

Poster No.: C-0517
Congress: ECR 2014
Type: Scientific Exhibit
Authors: S. T. Hamed, R. S. M. Ibrahim, R. M. Kamal; Cairo/EG
Keywords: Obstetrics (Pregnancy / birth / postnatal period), Foetal imaging, Neuroradiology brain, MR, Ultrasound, Ultrasound-Colour Doppler, Technical aspects, Computer Applications-3D
DOI: 10.1594/ecr2014/C-0517

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Aims and objectives

The study aimed to evaluate the accuracy and the predictive values of fetal MRI and US in the detection of PF anomalies comparing their end results with the post delivery scans. Review the normal US and MRI landmarks of the developing fetal PF according to the GA. Review the technique of fetal brain US and MRI. Highlight the signs highly predicting of PF anomalies.
Methods and materials

This study was approved by the hospital research ethics committee. All patients were counseled and signed a consent form.

From March 2011 to March 2013 forty-five pregnant females were referred from fetomaternal unit in Kasr Al-Aini Hospital.

Preliminary US examination was done in all cases using 3.5-5MHz curvilinear 2D transducer, 3D and 4D studies were done for selected cases.

Fetal MRI was performed in all cases as a complementary examination. Using 1.5 T MR magnet with a multi-channel phased array coil to allow increased coverage of the fetal head.

Prenatal results were correlated with postnatal (MRI or CT) imaging.

Fetal MRI was performed starting from the 2nd trimester. Patients were advised to fast for 4 hours before the examination to reduce bowel peristalsis artifacts and to prevent postprandial fetal motion. Patients were advised to empty the urinary bladder immediately before undergoing MRI to prevent urinary urge during the examination. All metallic objects were removed. No contrast agents or sedation (maternal or fetal) were used. Patients were positioned in the supine position feet first and ear plugs were offered. The body coil was used for radio-frequency transmission and pelvic phased array surface coil for receiving signal. An initial localizer is obtained to visualize the position of the fetus, determine fetal sidedness and ensure that the coil is centered over the ROI; using single-shot fast spin-echo (SSFSE) T2-W sequence in three orthogonal planes with respect to the mother. A coronal localizer was obtained to determine fetal position and subsequent sequences were prescribed in (axial, coronal and sagittal) planes (fig. 1).

Balanced Fast Field of Echo (B-FFE) weighted fetal brain images were the mainstay of the examinations and were acquired during maternal breath holding. The following imaging parameters were used:

- TE= shortest (2ms),
- TR= shortest (4ms),
- Slice thickness of 4 mm with a 2 mm gap,
- large FOV that cover the entire fetal brain (FOV=450 mm),

- Flip angle=60°,

- Number of excitations= 6,

- Matrix yielding about 1.5-mm in-plane resolution with 18-20 sequentially acquired imaging slices to cover the entire fetal brain,

- The entire examination time (including patient positioning and localizing scan) was ranged 20-30 minutes.

Interpretations of MRI images were done blind to the US reported findings to evaluate the diagnostic ability and accuracy of each modality individually.

The mid-sagittal section of the fetal brain is the mainstay for accurate anatomic assessment of PF using the following schematic approach for the detection and classification of PF anomalies (table 1):

- Position of the tentorium cerebelli. - Volume of the PF. - Mass effect. - Shape of the 4th ventricle. - Primary fissure of the vermis & the ratio of posterior/anterior lobe. - Shape of cerebellar hemispheres. - Dimensions of the cerebellum. - Pontine bulge. - Associated supratentorial abnormalities. - Assessment of the fetal face and head.

* Case 1:

- Clinical background: A 29 year old pregnant female 34th WG, gravida 2, negative consanguinity.

- (fig. 2) Prenatal US revealed: (A) 2D US axial views of the fetal brain show: a large PF fluid cyst is seen, measuring= 4.08cm. Hypoplastic cerebellar hemispheres and vermian agenesis (white arrow). (B) 2D US coronal view of the fetal abdomen shows bilateral enlarged dysplastic kidneys. (C) 2D and (D) 3D US images show polydactyl (white arrows).

- (fig. 3) T2*B-FFE MRI of the fetal brain & abdomen shows: (A) Coronal and (B) sagittal images demonstrate hypoplastic cerebellar hemispheres with a winged appearance. The 4th ventricle is communicating with widened retrocerebellar subarachnoid space. High insertion of tentorium and thinned occipital bone. An associated small occipital meningocele and bilateral enlarged dysplastic kidneys were also noted. (C) Axial section of the fetal abdomen shows bilateral enlarged dysplastic kidneys.

- Diagnosis: Meckle Gruber syndrome associated with DWM and occipital meningocele.
* Case 2: 

- **Clinical background:** A 33 year old pregnant female, 16th WG, primi gravida, and positive consanguinity.

- (fig. 4) **Prenatal 2D & 3D US of the fetal brain revealed:** (A) Sagittal and (B) axial views 2D US. (C) Three-D US demonstrate: A well defined small occipital meningocele (white arrows).

- (fig. 5) **T2*-WI B-FFE fetal MRI of the same fetus at 22th WG:**

  (A) Sagittal and (B) axial images show a small well defined occipital meningocele (white arrows).

- (fig. 6) **Postnatal CT scan of the neonatal head:** Confirmed the diagnosis. An axial CT of the neonatal head shows a small well defined occipital meningocele protruding from a small skull defect (white arrows).

- **Diagnosis:** A small well defined occipital meningocele.

* Case 3: 

- **Clinical background:** A 30 year old pregnant female, 24th WG, primi gravida, and negative consanguinity.

- (fig. 7) **Prenatal 2D, colour Doppler, spectral Doppler and 3D US of the fetal brain revealed:** (A) Two-D US demonstrates an elongated, anechoic midline cystic structure which extends posteriorly toward the occiput. (B) Colour Doppler shows turbulent flow. (C) Spectral Doppler waveform analysis shows low resistance arterial wave form. (D) Three-D US MPR US shows the vein of Galen aneurysmal malformations (VGAMs).

- (fig. 8) **T2* B-FFE MRI of the fetal brain revealed:** (A) Coronal and (B) sagittal images show inter-hemispheric dilated vein of Gallen malformation.

- (fig. 9) **Postnatal MRI of the neonatal head 2 days after delivery revealed:** (A) T2-W (B) Fluid attenuated inversion recovery (FLAIR) -W images show subarachnoid hemorrhage due to rupture of vein of Galen. Patient had potnatal lethargy then died.

- **Diagnosis:** VGAMs.

* Case 4: 

- **Clinical background:** A 25 year old pregnant female 26th WG, gravid 3, positive consanguinity.
- (fig. 10) **Prenatal 2D US of the fetal brain revealed:** (A) Sagittal and (B) axial views demonstrate severe supratentorial hydrocephalus (thin white arrow) with hypoplastic cerebellum and vermian agenesis (thick white arrow) (suggestive of DWV).

- (fig.11) **T2* B-FFE WI MRI of the fetal brain:** (A) Axial and (C) sagittal image show severe supratentorial hydrocephalus with thinning cerebral mantle. (B) Coronal shows inferior vermian defect. Normal sized 4th ventricle communicating with cisterna magna was also noted.

- **Diagnosis:** DWV associated with aqueduct stenosis.

* *Case 5:*

- **Clinical background:** A 34 year old pregnant female 22nd WG, with a previous history of abortion, positive consanguinity.

- (fig.12) **Prenatal 2D US of the brain and the spine:**

  (A) Transthalamic view shows a lemon sign of skull vault. (B) Transcerebellar view shows a small crowded PF with a banana sign of cerebellum. (C) Transventricular view shows a supratentorial hydrocephalus with colpocephaly. (D) Sagittal view of the spine shows a lumbosacral meningocele.

- (fig.13) **T2*B-FFE fetal MRI of the brain& spine at 24th WG revealed:** (A) Sagittal images demonstrate a small crowded PF is noted along with inferior herniation of the cerebellum through the foramen magnum associated with supratentorial hydrocephalus, colpocephaly. (C) axial image of the spine demonstrate lumbosacral meningocele.

- **Diagnosis:** Chiari II Malformation.
Fig. 1: Scout scan in three orthogonal planes show the position of the fetus within the womb.

Table 1: Classification of the Fetal Posterior Fossa Anomalies

<table>
<thead>
<tr>
<th>(A) Cystic PF malformations</th>
<th>(B) Non-cystic PF malformations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dandy–Walker Malformation</td>
<td>Vermian agenesis</td>
</tr>
<tr>
<td>Blake's Pouch Cyst</td>
<td>Rhombencephalosynapsis</td>
</tr>
<tr>
<td>Mega Cisterna Magna</td>
<td>Joubert syndrome</td>
</tr>
<tr>
<td>Dandy-Walker Variant</td>
<td>Cerebellar hemispheric abnormality</td>
</tr>
<tr>
<td>Retrocerebellar arachnoid cyst</td>
<td>Pontocerebellar atrophy/hypoplasia</td>
</tr>
<tr>
<td></td>
<td>Chiari II malformation</td>
</tr>
<tr>
<td></td>
<td>Cephalocele</td>
</tr>
<tr>
<td></td>
<td>Vascular malformations</td>
</tr>
<tr>
<td></td>
<td>Posterior fossa tumors</td>
</tr>
</tbody>
</table>

Table 1: Classification of fetal posterior fossa anomalies.

© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."
Fig. 2: Case 1: Prenatal US

© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."

Fig. 3: Case 1: T2* B-FFE MRI of the fetal brain & abdomen
Fig. 4: Case 2: Prenatal 2D & 3D US of the fetal brain.

Fig. 5: Case 2: T2*-WI B-FFE fetal MRI of the same fetus at 22th WG.
Fig. 6: Case 2: Postnatal CT scan of the neonatal head.
© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."

Fig. 7: Case 3: Prenatal 2D, colour Doppler, spectral Doppler and 3D US of the fetal brain
© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."
Fig. 8: Case 3: T2* B-FFE MRI of the fetal brain.

© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."

Fig. 9: Case 3: Postnatal MRI of the neonatal head.

© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."
Fig. 10: Case 4: Prenatal 2D US of the fetal brain.

© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."

Fig. 11: Case 4: T2* B-FFE WI MRI of the fetal brain.

© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."
Fig. 12: Case 5: Prenatal 2D US of the brain and the spine.
© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."

Fig. 13: Case 5: T2*B-FFE fetal MRI of the brain & spine at 24th WG.
Results

A total of 45 pregnant female (table 2) were participated in the study, 

23/45 (51%) fetuses were suspected to have PF anomalies on prenatal US, however, fetal MRI diagnosed 32/45 fetuses (71%) with PF anomalies. Postnatal imaging confirmed 30/45 cases (67%) with PF anomalies (table 3 & 4).

Regarding the associated CNS and Non-CNS Anomalies; US detected 27 cases (60%) having other CNS anomalies, while 31 cases (68%) were identified on fetal MRI. Associated non-CNS anomalies were identified by prenatal US in 12 cases (26%) compared to 6 (13%) cases only by fetal MRI (fig. 14). Therefore, fetal MRI was beneficial than prenatal US in the detection of the associated CNS anomalies.

the association between the results of prenatal US and those of fetal MRI in diagnosing fetal PF anomalies showed that there is a statistically significant difference between prenatal US and fetal MRI in diagnosing fetal PF anomalies; having a P-value of 0.016. This is demonstrated in (table 5).

However, there was no significant effect of the maternal age, GA, parity or consanguinity on the discrepancies between U/S and MRI findings.

Upon correlating the prenatal US findings to the final diagnoses, 9 case results were found to be false negative (FN) (20%) illustrated in (Table 6), 3 were false positive (FP) (6%) diagnosed as DWV, 13 were true negative (TN) (28.88%) and 20 were true positive (TP) (44.44%).

Upon correlating the fetal MRI findings to the final diagnoses, MRI did not miss the diagnosis in any of the cases. Two cases were FP (4.44%) diagnosed as DWV; which were diagnosed postnatally to have a normal PF. In 1 case fetal MRI changed the diagnosis to be MCM rather than DWV. Thirteen cases were TN (28.88%) and 30 cases were TP (66.66%).

The results of this study showed superior diagnostic performance of fetal MRI compared to prenatal US, as shown in (Table 7).
Table 2: Demographic details of the pregnant female participated in the study.

© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."

Table 3: Distribution of PF anomalies and normal PF comparing prenatal imaging to postnatal imaging findings.

© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."
<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Number of lesions</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meckle Gruber Syndrome</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>Hypoplastic Cerebellum</td>
<td>5</td>
<td>16.6</td>
</tr>
<tr>
<td>CM II</td>
<td>4</td>
<td>13.33</td>
</tr>
<tr>
<td>DWM</td>
<td>4</td>
<td>13.33</td>
</tr>
<tr>
<td>Inferior Vermian Hypoplasia</td>
<td>2</td>
<td>6.66</td>
</tr>
<tr>
<td>MCM</td>
<td>2</td>
<td>6.66</td>
</tr>
<tr>
<td>Cerebellar and Vermian Hypoplasia</td>
<td>2</td>
<td>6.66</td>
</tr>
<tr>
<td>CM I</td>
<td>1</td>
<td>3.33</td>
</tr>
<tr>
<td>Dysplastic Cerebellum</td>
<td>1</td>
<td>3.33</td>
</tr>
<tr>
<td>DWv</td>
<td>1</td>
<td>3.33</td>
</tr>
<tr>
<td>Isolated Occipital Encephalocele</td>
<td>1</td>
<td>3.33</td>
</tr>
<tr>
<td>Vein of Galen malformation</td>
<td>1</td>
<td>3.33</td>
</tr>
</tbody>
</table>

**Table 4:** Final diagnosis within the PF anomalies group.

© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."
Fig. 14: Other associated CNS and non CNS anomalies detected by US and MRI.

© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."
Table 5: Cross table comparing the prenatal US& fetal MRI in diagnosing fetal PF anomalies.

© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."
Table 6: FN cases diagnosed by Prenatal US.

© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."

<table>
<thead>
<tr>
<th>FN Cases</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM II</td>
<td>2</td>
</tr>
<tr>
<td>Vermial hypoplasia</td>
<td>1</td>
</tr>
<tr>
<td>Dysplastic normal sized cerebellum</td>
<td>1</td>
</tr>
<tr>
<td>Meckle Gruber syndrome</td>
<td>2</td>
</tr>
<tr>
<td>Cerebellar and vermial hypoplasia</td>
<td>1</td>
</tr>
<tr>
<td>CM I</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 7: Diagnostic indices of prenatal US & fetal MRI in the studied group.

© "Department of Radiology, Kasr Alaini Hospital, Faculty of Medicine, Cairo 2013."

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
<th>LR+</th>
<th>LR-</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI</td>
<td>(30/30) 100%</td>
<td>(13/15) 87%</td>
<td>(30/32) 94%</td>
<td>(13/13) 100%</td>
<td>(43/45) 95%</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>US</td>
<td>(20/29) 69%</td>
<td>(13/16) 81%</td>
<td>(20/23) 87%</td>
<td>(13/22) 59%</td>
<td>(33/45) 73%</td>
<td>6.66</td>
<td>0.69</td>
</tr>
</tbody>
</table>
Conclusion

This study has highlighted the superiority of MRI over antenatal US in detection and characterization of PF anomalies, owing to its excellent sensitivity and NPV with its good PPV, specificity and accuracy.

The detection and evaluation of PF anomalies can be improved with fetal MRI. However, from the perspective of the clinician counseling parents when critical decisions regarding the future management of the pregnancy are often made, important limitations of the technique and its interpretation persist and need to be considered carefully. Therefore, our findings strongly support the need for postnatal MRI follow-up in cases with suspected PF anomalies by fetal MRI.

To sum up, both prenatal US and a fetal MRI are two valuable complementary tools for better imaging of fetal CNS anomalies particularly PF anomalies with increasing awareness, training and experience of radiologists for these useful tools. Both prenatal US and a fetal MRI should go hand in hand with each other providing better potentials for imaging of the fetal CNS anomalies particularly PF anomalies thus, allowing more accurate diagnosis, and better counseling.
Personal information

Ibrahim R.S.* M.B.B.Ch., M.Sc
Assistant lecturer radiology department.
raniasaberm@hotmail.com

Kamal R.M.* M.B.BCH., M.Sc., MD
Professor radiology department (women imaging unit).
rashaakamal@hotmail.com

Hamed S.T.*.* M.B.BCH., M.Sc., MD
Professor radiology department (women imaging unit).
sohathamed@yahoo.com

* Department of Radiodiagnosis, Kasr Al-Aini faculty of medicine, Cairo University, El manial, Cairo, Egypt.
References