

Obstetrics; *Maternal-Fetal Medicine and Perinatology*

# Fetal Brain Pathology: A Comparison of MR Imaging and Ultrasound Screening

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**OBJECTIVES:** To compare prenatal MR imaging and ultrasound screening for the diagnosis of fetal brain pathology.

**STUDY DESIGN:** Retrospective multicenter study of 62 fetuses diagnosed with brain pathology at 2<sup>nd</sup> trimester ultrasound scan during the period 2003-2008. In these fetuses prenatal MR imaging was performed.

**RESULTS:** In 38 of 53 (71.7%) cases the ultrasound diagnosis was isolated ventriculomegaly (Group A), while in the rest 15 of 53 (28.3%) cases other brain abnormalities were diagnosed (Group B). Ultrasound scan and MR imaging findings were similar in 35 of 38 (97.2%) fetuses from Group A and in 11 of 15 (73.3%) from Group B. In a total 46 of 53 (86.8%) cases, no significant discrepancy between US and MR imaging findings was observed.

**CONCLUSION:** MRI providing ascertainment or a differential diagnosis of an abnormal US finding in brain pathology. However, in most of the cases, it seems that MR imaging does not provide additional information concerning fetal brain pathology than ultrasound scan alone.

**Key Words:** Fetus, Brain abnormalities, MR imaging, Ultrasound scan screening

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## Introduction

Ultrasound is the primary screening modality of choice in evaluation of fetal brain. This is because it is a safe method for both fetus and mother, is relatively inexpensive, widely available, has real-time capability and can identify the vast majority of clinically significant fetal anomalies. However, there are cases, like oligohydramnio or when an anomaly has been identified on ultrasound where alternative imaging modalities are useful.<sup>1,2</sup>

Fetal magnetic resonance (MR) imaging was initially described in 1983. However, slow acquisition times as well as artefacts due to fetal movements, substantially decreased image quality and limited the usefulness of method.<sup>4</sup> The rapid development in the technology exceeded the above limitations

and a positive effect of fetal MR imaging on clinical treatment of the mother and fetus have been demonstrated by several studies.

The aim of this study was to compare prenatal ultrasound scan (US) and magnetic resonance (MR) imaging for the diagnosis of fetal brain abnormalities.

## Material and Method

Between 2003 and 2008, 62 fetuses who had sonographically suspected brain abnormalities, underwent MR imaging examination following 2<sup>nd</sup> trimester ultrasound scan. Our study was retrospective - multicenter.

9 of our cases were excluded from our study, as was not possible to recover any data. The remaining cases were divided in 2 groups. In group A, were included 38/53 (71.7%) fetuses, who had sonographically diagnosed with isolated ventriculomegaly (defined as this was the only ultrasound finding) and in group B, were included 15/53 (28.3%) fetuses with other brain abnormalities. Concretely, in group B were included 9/15 (60%) fetuses with posterior fossa anomalies, 5/15 (33.3%) fetuses with abnormal endocranium cystic formations and 1/15 (0.07%) fetus with craniosynostosis of frontal and metopic sutures (Table 1). In both groups of fetuses, ultrasound scan assessment was acquired by transabdominal sonography (Voluson 730 Expert, GE Medical Systems) routinely during the 2<sup>nd</sup> trimester scan.

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Table 1: Overall ultrasound findings and comparison of US and MR imaging findings

		n	Agreement US/MRI	Disagreement US/MRI
Group A	Isolated ventriculomegaly	38 (71.7%)	35 (92.1%)	3 (7.9%)
Group B	Other brain abnormalities	15 (28.3%)	11 (73.3%)	4 (26.7%)
	Abnormal appearance of <i>posterior fossa</i>	9	7	2
	<i>Abnormal endocranium cystic formations</i>	5	4	1
	<i>Craniosynostosis of frontal and metopic sutures</i>	1	0	1
Overall		53 (100%)	46 (100%)	7 (100%)

MR imaging was performed between 22 and 26 weeks of gestation (with the exception of the craniosynostosis which was held on 32 weeks). Fetal MRI was typically performed at 1.5T. The results of US were available and known to the MR imaging radiologist at the time of acquisition and at the time the MR images were interpreted.

Both ultrasound and MR imaging diagnosis were compared by the same person (A.A.).

Data analyzed using the statistical software SPSS 12.0 (Chicago, Illinois, USA) for Windows (Microsoft Corp., Redmond, WA, USA).  $P < 0.05$  was considered statistically significant.

## Results

In our study the mean age of women was  $32.1 \pm 4.9$  years. The mean gestational age, at the time of ultrasound assessment, was  $23. \pm 3.5$  weeks and the mean gestational age at the time of MR imaging was  $26.7 \pm 4.0$  weeks.

In group A, in 35 of 38 (92.1%) fetuses, the diagnosis established by ultrasound scan was correct when it was compared with MR imaging (Table 1). Although, in 1 of 38 (2.8%) case was detected significant difference in the estimate diameter of posterior ventricles between ultrasound scan and MRI assessment (9.5mm versus 14mm). However, should be highlighted that in this case MR imaging was performed roughly 4 weeks after ultrasound scan.

Additional information were provided by MR imaging in 2 (two of 38) cases from group A. In the first case, ultrasound scan detected moderate ventriculomegaly with additional displacement of medium line to the right and talipes, while the MR imaging showed decreased thickness of cerebral parenchyma and pathological signal of white substance at 26 weeks of gestation. In the second case, ultrasound scan assessment detected dilatation of the right posterior ventricle, while

the MR imaging showed pathological signal of white substance of the brain, with additional hypoplasia of brain parenchyma, suggesting brain atrophy at 25 weeks of gestation.

In Group B, in 7 (%) of 9 cases with posterior fossa abnormalities the diagnosis established with both modalities, while in the remaining 2 cases the diagnosis was significant different. In one case ultrasound scan was unable to detect the cerebellar vermix, while the MR imaging detected normal view of it. In the second case ultrasound scan detected partial agenesis of the lower segment of pons and dilatation of cisterna magna (14mm) with additional cystic enlargement that communicated with the 4<sup>th</sup> ventricle, while the MR imaging showed normal appearance of both cerebellum and cisterna magna.

At the same group, in 4 out of 5 cases with abnormal endocranium cystic formations, diagnosis established with both modalities. Although, in 1 case ultrasound scan performed by two different sonographers suggested dilatation of 3<sup>rd</sup> ventricle, however MR imaging showed an arachnoid cyst.

In one case ultrasound scan assessment detected craniosynostosis of frontal and metopic sutures. However, radiographers reported that the MR imaging has no sensitivity in the detection of craniosynostosis, regardless that several studies are supported that the MR imaging is capable to detect abnormality.<sup>5</sup>

## Discussion

Smith et al., in 1983, reported the first study regarding the indications of MR imaging in pregnancy.<sup>3</sup> During the same period many authors investigated the role of computerized tomography (CT) in obstetrical management.<sup>6</sup> However, due to possible teratogenic effects of ionizing radiation, the use of computerized tomography has been limited.

In the past, fetal motion and longer acquisition times lim-

ited the role of fetal MR imaging. With the advent of shorter acquisition times, magnetic resonance imaging (MRI) is being increasingly used as a correlative imaging modality in pregnancy and more specific in evaluation of fetal brain pathology. The ultrasound evaluation of the fetal CNS can be limited by a nonspecific appearance of some anomalies, by technical factors that make visualization of the posterior fossa difficult with advanced gestation and by parenchymal abnormalities that usually cannot be demonstrated sonographically.<sup>7</sup> Due to these limitations, MRI has been suggested to be useful in cases where sonography is nonspecific as provides excellent soft-tissue contrast, has multiple planes for reconstruction and a large field of view, allowing better visualisation of fetal anatomy.

MR imaging can be considered safe for fetal evaluation after the first trimester because it uses no ionizing radiation, but its use should be limited to cases in which complex anomalies are suspected and the ultrasound results are equivocal or incomplete.<sup>8</sup> No teratogenic effects on the developing fetus have been seen when a clinical-strength magnet (1.5 T) is used.<sup>9</sup>

In our study, in most of cases, ultrasound scan findings were in complete agreement with MR imaging diagnosis. In fetuses with isolated ventriculomegaly (Group A), was found complete agreement in regard to the diagnosis made by ultrasound scan assessment and MR imaging. However, in fetuses with associated brain lesions (Group B), MR imaging added valuable information beyond that obtained by ultrasound scan. MR imaging, compared to ultrasound scan assessment has also proved to be useful in the evaluation of the cerebral cor-

tex for ischemic changes and appear as increased T2WI and decreased T1WI signals due to subcortical leucomalacia.

Levine et al., suggested that MR imaging provided additional information in the central nervous system in 46 of 145 (31.7%) fetuses, which have been diagnosed by ultrasound scan assessment to have a brain abnormality.<sup>9</sup> Glenn et al., in their study found that in 8 of 10 (80%) cases, all sonographically identified brain abnormalities were confirmed by fetal MR imaging.<sup>11</sup> Furthermore, in 63% (5 out of 8) of cases with a brain abnormality on both ultrasound scan and fetal MR imaging, additional brain abnormalities were detected by fetal MR imaging that were not found on ultrasound scan. In addition, Frates et al. in their study included 16 (57%) of 28 cases with brain abnormality. In 10 (62%) of 16, the diagnosis established with both sonography and MR imaging was correct when it was compared with postnatal diagnosis (Table 2). Additional information was provided by using MR imaging in half (5 of 10) of the cases with a correct diagnosis.<sup>12</sup>

Although MR imaging provides additional information beyond that available with ultrasound, it should not replace ultrasound scan for the diagnosis of fetal anomalies. It is clear from our results that less commonly results in replacement of ultrasound results or alterations in pregnancy outcome.

In conclusion, we believe that MR imaging should be considered in fetuses with brain abnormalities for further evaluation of structures that are sub-optimally visualized in ultrasound scan providing additional information necessary for prenatal counselling as well as obstetric management.

Table 2: Gestation age at which US and MRI performed in Group A and Group B as well as in subgroups of US/MRI agreement and disagreement

		Agreement between US and MRI		Disagreement US/MRI		p*	p**
		US	MRI	US	MRI		
Group A	Isolated ventriculomegaly	24.3±3.6	26.7±3.4	22.1±1.2	27.7±1.4	0.328	0.329
Group B	Other brain abnormalities	22.4±3.3	25.7±2.1	20.9±2.5	27.8±8.2	0.624	0.624
	Abnormal appearance of posterior fossa	24.3±2.4	25.7±2.6	19.9 ± 3.6	23.0±0.8		
	Abnormal endocranium cystic formations	19.6±2.0	25.7±2.2	21.1±0.0	25.1±0.0		
	Craniosynostosis of frontal and metopic sutures	-	-	22.9±0.0	40.0±0.0		
Overall		23.8±3.6	26.5±3.1	21.2±2.3	27.8±7.1		

p\* : Statistical significant value at gestation age at the time of sonographic assessment between cases with US/MRI agreement and case with US/MRI disagreement (Mann-Whitney - U Test).

p\*\* : Statistical significant value at gestation age at the time of MR imaging between cases with US/MRI agreement and case with US/MRI disagreement (Mann-Whitney - U Test)

- The values are the gestation age of fetuses in weeks.

## Fetal Beyin Patolojisi: MR Görüntüleme ve Ultrason Taramasının Karşılaştırılması

**AMAÇ:** Fetal beyin patolojisini teşhis etmek için prenatal MR görüntüleme ve ultrason taramasının karşılaştırılması amaçlanmıştır.

**GEREÇ VE YÖNTEM:** Bu çalışmada 2003-2008 tarihlerinde 2. trimesterde beyin patolojisi tanısı alan retrospektif çok merkezli 62 fetus ve bunların prenatal MR görüntüleri kullanılmıştır.

**BULGULAR:** Çalışmanın sonucunda; 53 vakanın 38'inde (%71.7) ultrasonla tanı, ventrikülomegali (Grup A) olarak izole edilmiştir. Geriye kalan 15 (%28.3) vaka beyin anomalilerinden farklı olarak tanı almıştır ve Grup B'yi oluşturmuştur. Ultrason taraması ve MR görüntüleme bulguları; Grup A'dan 38 fetusun 35'inde (%97,2) ve Grup B'den 15 fetusun 11'inde(%73.3) benzerdi. Toplam 53 vakanın 46'sında (%86.8); ultrasonografi ve MR görüntüleme bulguları arasında anlamlı "discrepancy" bulunmadı.

**SONUÇ:** MRI beyin patolojisinde anormal US bulgularından farklı tanı veya "ascertainment" sağlar. Ancak birçok vakada MR görüntüleme fetal beyin patolojisi gözöznüne alındığında tek başına ultrason taramasına ek bilgi sağlamaz gibi görünmektedir.

**Anahtar Kelimeler:** Fetus, Beyin anomalileri, MR görüntüleme, Ultrason taraması

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