Assessment of the Additional Value of Fetal Magnetic Resonance Imaging to Prenatal Ultrasound in a Single Institution

Fetal Manyetik Rezonans Görüntülemenin Ultrasonografi ile Tespit Edilen Fetal Anomalilerin Değerlendirilmesindeki Katkısı

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Abstract: Fetal magnetic resonance imaging (MRI) is a useful addition to prenatal ultrasonography especially for advanced evaluation of fetal brain abnormalities. The aim of this study is to investigate the indications, diagnostic accuracy and added diagnostic value of fetal MRI. This study is a retrospective cohort conducted at our institution between October 2014 and December 2017. Total number of fetal MRIs during study period was 50. Ninety percent (n=45) of the fetal MRIs were performed with an indication of fetal central nervous system anomaly. In 56% of cases fetal MRI confirmed the ultrasonographic diagnosis without any additional anomaly; in 24% of the cases fetal MRI provided additional diagnosis to the prenatal ultrasound and altered the management of the patients. In our institution, fetal MRI has provided additional diagnosis that is not seen in ultrasound in almost a quarter of the patients with suspected brain abnormalities.
Key Words: Fetal MRI; fetal brain anomalies; neurosonography; prenatal ultrasound

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Özet: Fetal manyetik rezonans görüntüleme (MRG), prenatal ultrasona ek olarak kullanılan bir fetal tanı yöntemidir. Bu çalışmanın amacı kliniğimizdeki fetal MRG'lerin endikasyonlarını, tanısal doğruluğunu, ultrasonda tespit edilemeyen anomalilerin görülmesi sıklığını incelemekti. Bu çalışma, kliniğimizde Ekim 2014 – Aralık 2017 tarihleri arasında değerlendirilen olguların dahil edildiği bir retrospektif kohort çalışmasıydı. Çalışma süresince 50 olgu fetal MRG ile değerlendirilmiştir. Fetal MRG'lerin %90'I (n=45) fetal santral sinir sistemi anomalisi nedeniyle çekilmişti. Olguların %56'sında fetal MRI ultrasonografi ile tespit edilen anomalileri doğrulamış ve herhangi bir ek tanı sağlamamıştır. Olguların %24'ünde ise fetal MRG, ultrasonografide görülmeyen anomaliler tespit etmiş ve hastaların yönetiminde değişikliğe sebep olmuştur. Fetal MRG kliniğimizde olguların %24'ünde ultrason ile görülemeyen anomalileri tespit etmiş ve hasta yönetiminde değişikliğe yol açmıştır.
Anahtar Kelimeler: Fetal MRG; fetal beyin anomalileri; nörosonografi, prenatal ultrasonografi

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1. Introduction

Fetal magnetic resonance imaging (MRI) is an important imaging tool in the contemporary fetal medicine adjunct to ultrasonography (1, 2). Assessment of fetal brain abnormalities is the main area of use for fetal MRI (3). The techniques of image acquisition, image quality and the experience of the operators and reporters differ significantly between different centers and these differences affect the accuracy of the fetal MRI (1, 4).

Fetal MRI currently being used as a complement to ultrasound examination performed by an expert (5). The goal of its use is either confirmation of ultrasound findings or to find additional information about the suspected fetal anomaly which could alter or modify patient management (1). It is advised that fetal MRI should be performed after an expert ultrasound examination rather than a second trimester basic brain assessment (1).

The diagnostic value and accuracy of fetal MRI has been well documented (1). In a recent prospective cohort study it has been shown that adding fetal MRI in the diagnostic workup increased the diagnostic accuracy of ultrasound for cranial abnormalities from 64-70% to 92-94% (6). This accuracy also documented for specific cranial anomalies like ventriculomegaly, posterior fossa abnormalities and failed commissuration (7-9).

The aim of the current study was to elucidate the indications, gestational age at acquisition, diagnostic accuracy and added diagnostic value of fetal MRI in our fetal medicine center.

2. Materials and Methods

This study is a retrospective cohort conducted at Eskisehir Osmangazi University Research Hospital, Fetal Medicine Department. Our center is a tertiary referral center for routine anomaly scans as well as prenatal diagnosis and management of fetal and neonatal pathology. The patients' digital files and obstetric image databases were reviewed for the study. Cases between October 2014 and December 2017 were included for analysis. The study was performed in accordance with ethics granted by the Institutional Ethical Board.

All patients were first scanned systematically according to the international guidelines and all anomalies were noted. The patients who had a suspicion of brain abnormality was further scanned by an experienced fetal medicine expert with additional planes of the fetal brain were obtained (midsagittal and coronal) by transabdominal and/or transvaginal approaches according to the fetal position and image quality. The patients with a suspected brain abnormality and others with an indication of MRI were directed to the Radiology Department of our institution. Fetal MR images were obtained by axial plate single shot FSE (CUBE) technique in 3T MR (GE, Discovery 750W, Milwaukee, WI) and reconstructed in the sagittal plane.

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 20.0 (IBM Corp., Armonk, NY, USA). The normality of distribution for continuous variables was assessed by the Kolmogorov-Smirnov test. Variables with a normal distribution were presented as means and standard deviations, non-parametric continuous variables were presented as medians and interquartile ranges.

3. Results

During the study period 17023 patients were attended to the anomaly scan at our fetal medicine center. A total of 50 patients were referred for fetal MRI investigation with an incidence of 0.29%. Mean age and median gravida of the patients were 28.4 (± 5.4) and 2 (1 – 3) respectively. Mean gestational age when the patients were referred to the MRI was 26.9 (± 5) weeks. Fetal MRI scans were performed at 30.5 (± 2.8) weeks in average. Ninety percent (45/50) of the fetal MRIs were performed for advanced assessment of fetal brain

anomalies (Table I). The indications for the remaining patients were intraabdominal cystic mass, congenital toxoplasmosis, intrauterine demise in monochorionic twins and thoracal mass. The most common indication for fetal MRI was isolated ventriculomegaly on the ultrasound (n=25; 50%) (Table 1). Two sample case figure were presented in figures 1 and 2.

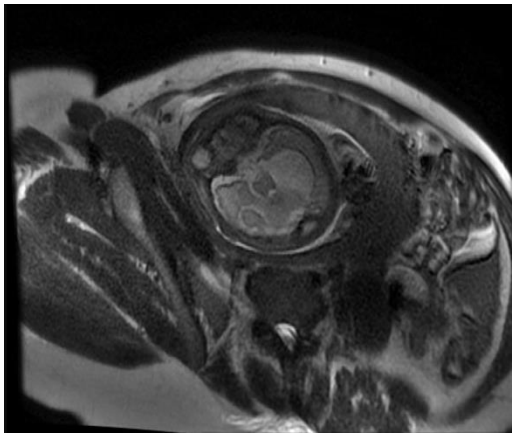

Figure 1. *The Sagittal SS-FSE T2 image shows a signal loss field compatible with aneurysmatic dilatation associated with confluent and falsian sinus in the galen vein in 32 weeks gestation.*

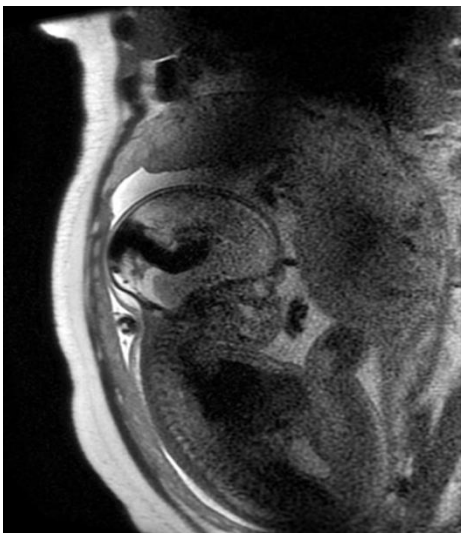

Figure 2. *Axial SS-FSE image shows an arachnoid cyst next to the tentorium and pressing to the brain stem and left temporal and occipital lobes.*

Table 1.
Demographic characteristics and fetal MRI indications

Age, y (mean, , ± SD)	**28.4 (± 5.4)**
Gravida (median, IQR)	2 (1 – 3)
Gestational age at referral, weeks (mean, ±SD)	26.9 (± 5)
Gestational age at MRI scan, weeks (mean, ±SD)	30.5 (± 2.8)
Indication, (n, %)	
Ventriculomegaly	25 (50%)
Posterior fossa abnormality	11 (22%)
Mid-brain anomalies	5 (10%)
Space occupying lesion in brain	3 (6%)
Macrocephaly	1 (2%)
Single fetal demise in monochorionic pregnancy	2 (4%)
Abdominal mass	1 (2%)
Thorocal mass	1 (2%)
Congenital toxoplasmosis	1 (2%)

IQR: interquartile range; MRI: magnetic resonance imaging; SD: standard deviation

Table 2.
Additional diagnoses obtained by fetal MRI

No	**Age**	**Gestational age at fetal MRI (weeks)**	**Ultrasound diagnonsis**	**Fetal MRI diagnosis**
1	32	32	Mild ventriculomegaly	CC agenesis, arachonid cyst at temporal lobe
2	30	32	Mild ventriculomegaly	Cavum septi pellucidi et vergae
3	17	34	Severe ventriculomegaly	Cerebellar hypoplasia, holoprosencephaly
4	32	34	Ventriculomegaly and megacysterna magna	CC dysgenesis
5	27	35	Mild ventriculomegaly	Abnormal myelinization, gliosis
6	29	30	Mild ventriculomegaly	Cavum septi pellucidi et vergae, CC hypoplasia
7	30	37	Megacysterna magna	Arachnoid cyst
8	29	26	Blake's pouch cyst	Megacysterna magna
9	26	33	Megacysterna magna	Megacysterna magna, ventriculomegaly
10	23	35	Blake's pouch cyst	Inferior vermian hypoplasia, Blake's pouch cyst
11	19	34	CC agenesis, colpocephaly	CC agenesis, cerebellar herniation, abnormal sulcation
12	28	35	Parietotemporal brain mass	Arachnoid cyst

CC: corpus callosum; MRI: magnetic resonance imaging

In 56% (n=28) of the cases fetal MRI confirmed the ultrasonographic diagnosis without any additional anomaly. Fetal MRI provided additional diagnosis to the ultrasound examination in 24% of the cases (n=12). The characteristics and details of these patients are presented in table II. The anomaly which MRI provided the highest percentage of additional anomaly was posterior fossa defects (36.4%). Magnetic

resonance imaging provided additional data 24% of fetuses with isolated ventriculomegaly on the ultrasound examination. The fetal MRIs that revealed no abnormality were performed for posterior fossa (n=2) and mid-cerebral anomaly suspicion (n=2), single demise of monochorionic twins (n=2), possible congenital toxoplasmosis (n=1) and abdominal mass (n=1).

4. Discussion

The current study demonstrated that fetal MRI could provide additional diagnosis and alter the management of the patient in %24 of cases with fetal abnormalities. This contribution was 36% in fetuses with posterior fossa abnormalities.

Fetal MRI is an important diagnostic imaging adjunct to prenatal ultrasonography (1). The safety of fetal MRI has been discussed and studied elsewhere. In general, fetal MRI was considered as a safe procedure for the fetus and the mother as long as it is performed by the limits set by International Electrotechnical Commission (10, 11).

Fetal brain assessment is the most common indication for fetal MRI because of the high sensitivity of MRI to visualize the structure of brain tissue (12). It has been reported in numerous studies that, fetal MRI is a valuable addition to ultrasound in the detection of fetal brain anomalies, including posterior fossa anomalies, midbrain anomalies and further assessment of fetal ventriculomegaly (6-9, 13). The two main advantages of MRI images over ultrasound are the absence of shadowing artefacts and better resolution which provides more detailed imaging (14).

In our study we have demonstrated that fetal MRI can provide additional diagnosis to prenatal ultrasound in 24.4% of brain anomalies. Posterior fossa anomalies were the group that most additional diagnosis obtained by the fetal MRI (36.4%). Our additional diagnosis rate of the fetal MRI is similar to the reported series in literature. Van Doorn and colleagues reviewed 1184 patients which fetal neurosonogram and fetal MRI performed in their meta-analysis (15). They have reported that fetal MRI provided different or additional pathology in 26% of cases with brain abnormalities. In their report, the pathology which fetal MRI provided the most additional diagnosis was corpus callosum atresia and hypoplasia. Rossi and Prefumo published another systematic review in 2014 (16). They have reported that fetal MRI has provided additional information in 22% of cases with central nervous system anomalies on the ultrasound. More importantly, they revealed that MRI can revise the ultrasound results and changed the management and parental counseling in 30% of the cases.

In the most recent prospective, multi-center cohort, the MERIDIAN study, Griffiths and colleagues reported that fetal MRI could provide additional diagnosis in almost half of the cases which a brain abnormality suspected with prenatal ultrasound (6). They have also reported that fetal MRI could change the prognostic information in 20% of the cases and led to changes in clinical management in more than a third of cases. Although the MERIDIAN study has reported strikingly high rates of additional diagnosis with fetal MRI that study had some limitations like the prenatal ultrasound performed to the patients was a regular scanning sonography rather than a neurosonogram. Malinger et.al. were pointed out this issue in their comment (17). In our study, the patients with a suspicion of fetal brain abnormalities were reviewed by an experienced fetal medicine expert with neurosonography including sagittal and coronal views of the fetal brain. This may be the reason why our additional diagnosis rate of fetal MRI was lower than the MERIDIAN study.

Another common indication for fetal MRI is the intrauterine single demise in monochorionic twin pregnancies. The survivors of intrauterine co-twin death have an increased risk of brain injury and neurodevelopmental impairment (18, 19). The fetal MRI can diagnose pathologies that are overseen in ultrasound in 24-33% of the cases (19, 20). In our study there were two patients with intrauterine co-twin demise of monochorionic twin and the MRI revealed no brain abnormality in the surviving fetuses.

To conclude, fetal MRI is a valuable addition to prenatal ultrasound to provide additional diagnosis and can alter the management of patients with fetal brain abnormalities. In our institution, fetal MRI has provided additional diagnosis that is not seen in ultrasound in almost a quarter of the patients with suspected brain abnormalities.

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