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Investigation of fetal magnetic resonance imaging indications

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Abstract

Objective: Although ultrasonography is the preferred screening method for examining fetal anatomy, fetal magnetic resonance imaging (MRI) has been used more widely upon the advancements in rapid screening techniques. MRI provides a better tissue contrast, and unlike sonography, it is not affected significantly by maternal obesity, fetal position, oligohydramnios, or bone artifacts. Fetal MRI is usually indicated for confirming uncertain sonographic findings, or for the further evaluation of fetal malformations. Our purpose is to investigate fetal MRI indications preferred by the clinicians in our tertiary center.

Methods: We retrospectively evaluated 112 cases which underwent fetal MRI during a three-year period. We classified fetal lesions according to the organ systems, and determined the reasons why clinicians employed this method and the preferred indications.

Results: Of 112 fetuses which required fetal MRI examination, 68 had intracranial anomalies, 23 had maternal obesity, 8 had intraabdominal anomaly, 5 had intrathoracic anomalies, 4 had spinal cord anomaly, 1 had neck anomaly, 1 had genitourinary anomaly and 2 had other anomalies.

Conclusion: Intracranial pathology was the major indication for fetal MRI examination, as ventriculomegaly was the most frequently observed sub-group. We found additional findings changing the perinatal management in three (8.3%) of the cases which underwent further examination with MRI due to ventriculomegaly.

Keywords: Fetal, indication, magnetic resonance imaging.

Özet: Fetal manyetik rezonans görüntüleme endikasyonlarının incelenmesi

Amaç: Fetal anatomiyi değerlendirmede ultrasonografi tercih edilen tarama yöntemi olmasına rağmen, hızlı tarama tekniklerinin gelişmesiyle fetal manyetik rezonans görüntüleme (MRG) giderek daha fazla kullanılmaktadır. MRG, daha iyi doku kontrastı sağlar ve sonografiden farklı olarak, maternal obezite, fetal pozisyon, oligohidramniyos veya kemik artefaktlardan önemli ölçüde etkilenmez. Fetal MRG genellikle kesin olmayan sonografik bulguları teyit etmek veya fetal malformasyonların ileri değerlendirilmesinde endikedir. Amacımız, üçüncü basamak merkezimizde klinisyenler tarafından tercih edilen fetal MRG endikasyonlarını incelemektir.

Yöntem: Üç yıllık dönemde fetal MRG yapılan 112 olguyu retrospektif olarak inceledik. Fetal lezyonları organ sistemlerine göre sınıflandırdık ve klinisyenlerin bu yönteme başvurma nedenleri ile tercih edilen endikasyonları ortaya koyduk.

Bulgular: Fetal MRG incelemesine 112 fetüsten; 68'inde intrakraniyal anomaliler, 23'ünde maternal obezite, sekizinde intraabdominal anomali, beşinde intratorasik anomaliler, dördünde spinal kord anomalisi, bir olguda boyun anomalisi, bir olguda genitoüriner anomali ve iki fetüste de diğer anomaliler için başvurulmuştur.

Sonuç: İntrakraniyal patoloji, en sık saptanan alt grup ventrikülomegali olmak üzere, fetal MRG değerlendirmesi için majör endikasyondu. Ventrikülomegali nedeniyle MRG ile ileri değerlendirme yapılan olguların üçünde (%8.3) perinatal yönetimi değiştiren ek bulgular tespit edilmiştir.

Anahtar sözcükler: Endikasyon, fetal, manyetik rezonans görüntüleme.

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Introduction

Ultrasonography (USG) is a preferred primary screening method compared other modalities in terms of characteristics such as being cheaper, having no harmful impact on mother and fetus and enabling real-time imaging.[1,2] However, it has some restrictions such as narrow field of view, fetal position dependency, decreased image quality in case of maternal obesity and oligohydramnios as well as difficulty in imaging intracranial structures due to the ossification during advanced weeks of gestation.[1–3] Therefore, when ultrasonography findings are uncertain or incomplete or when sufficient imaging cannot be achieved, magnetic resonance imaging (MRI) can provide a better perinatal consultancy and may play a substantial role in terms of management.

Today, with the development of ultra-fast MRI techniques and minimization of fetal movement artifacts, fetal MRI has become a more common practice. MRI provides a better tissue contrast and multiplane imaging opportunity, and unlike sonography, it is not affected significantly by maternal obesity, fetal position, oligohydramnios, or bone artifacts.[4,5]

Fetal MRI is usually indicated for confirming uncertain sonographic findings, or for the further evaluation of fetal malformations. In this study, our aim is to investigate MRI indications preferred during antenatal period by the clinicians in our tertiary center.

Methods

Fetal MRI cases, which were referred to the Department of Gynecology and Obstetrics at Süleyman Demirel University during 17–35 weeks of gestation due to different indications between 2014 and 2018, were retrospectively investigated in the medical database. The demographics, prenatal ultrasound findings, and prenatal and postnatal MRI results of a total of 112 cases were recorded.

All sonographic examinations were performed by the clinicians, who had experience on obstetric sonography, by using Voluson 730 and E6 ultrasonography device (General Electric, Tiefenbach, Austria) with 2–7 mHz convex abdominal probe.

MRI examinations were done on supine or left-side decubitus position without maternal-fetal sedation and contrast substance but using phased-array body spiral according to the week of gestation by 1.5 Tesla MRI device (Magnetom Avento; Siemens Medical Solutions, Erlangen, Germany). The interpretations were done by the same radiologist who was experienced on fetal MRI.

Fetal lesions were classified according to the organ systems. Sonography and MRI results were analyzed in terms of conformity or inconsistencies. The reasons of clinicians for employing this modality and preferred indications were determined.

Results

The mean gestational age of the cases was 26.2 (range: 17 to 35) weeks. Of 112 fetuses which required fetal MRI examination, 68 (60.7%) cases had intracranial anomalies, 23 (20.5%) cases had maternal obesity, 8 (7.1%) cases had intraabdominal anomaly, 5 (4.4%) cases had intrathoracic anomalies, 4 (3.5%) cases had spinal cord anomaly, 1 (0.8%) case had neck anomaly, 1 (0.8%) case had genitourinary anomaly and 2 (1.7%) cases had other anomalies (**Fig. 1**). Intracranial pathology was the major indication for fetal MRI examination, as ventriculomegaly was found to be the most frequently observed sub-group.

Intracranial anomalies

Of 68 patients, 36 (53%) were planned for the further evaluation of ventriculomegaly found sonographically. Seventeen cases referred to this modality for the evaluation of posterior fossa anomalies (mega cisterna magna, cerebellar hypoplasia/atrophy, Dandy-Walker malfor-

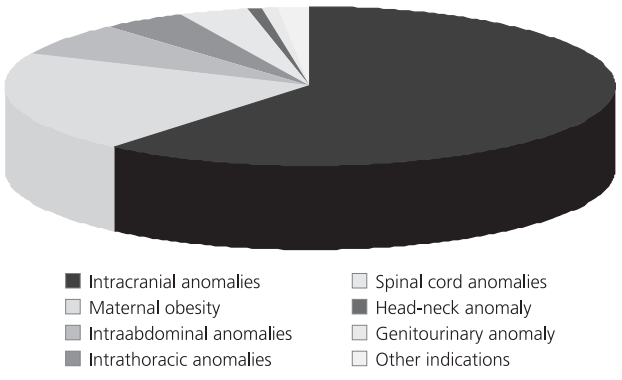

Fig. 1. The distribution of fetal MRI indications.

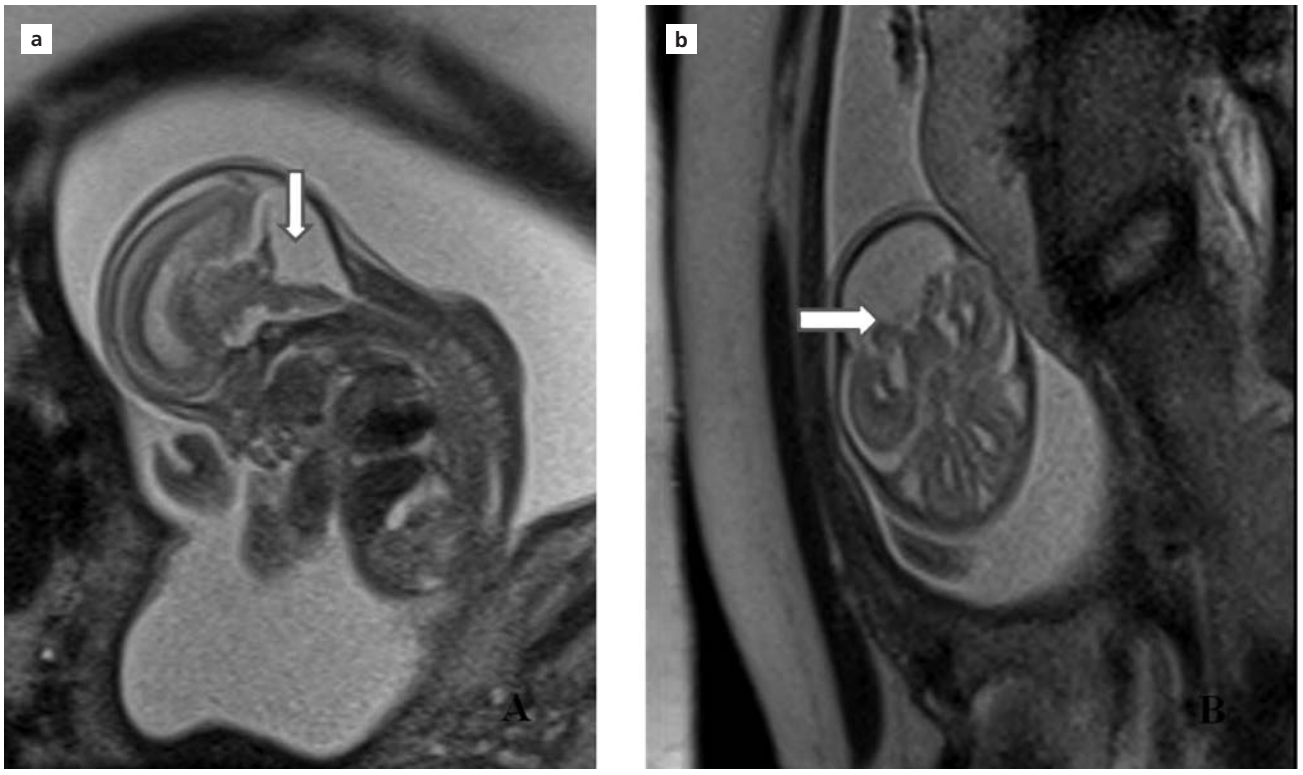

Fig. 2. In the fetus with Dandy-Walker malformation, wide posterior fossa and cerebellar vermian agenesis (**arrow**) in (**a**) sagittal and (**b**) transaxial sections.

mation) (**Fig. 2**), 9 cases for the further evaluation of cavum septi pellucidi and corpus callosum anomalies, 2 cases for the evaluation of intracranial calcification and one case for the evaluation of suspected space occupying formation, and remaining 3 cases for the evaluation of macrocephalus/dolichocephalic development (**Fig. 3**).

Of 68 cases, fetal MRI findings were found to be correlated with USG in 42 cases, and the findings in addition to antenatal sonography were found in 3 cases. Gyral anomalies (lissencephalia and polygyria) which could not be found by sonography in two cases and corpus callosum agenesis in one case were established by fetal MRI (**Fig. 4**).

In terms of postnatal results, additional imaging was performed for the confirmation of 26 cases which were established normal by MRI; 8 out of 16 cases who were found to have isolated mild ventriculomegaly were established normal in the postnatal imaging. Ten of 42 cases were recommended termination, and the termination was carried out in five cases; one of them was the case with corpus callosum agenesis which could not be found in the prenatal sonography but established by MRI. The case found to have lissencephalia was recommended termination, but the family decided to continue the pregnancy. Distal trisomy 15q syndrome was diagnosed in the case which was evaluated due to dolichocephaly and mild ventriculomegaly and found to have also polygyria in fetal MRI; however, the family was not

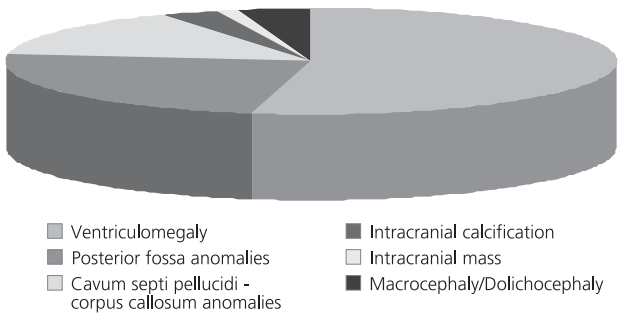

Fig. 3. The distribution of the indications associated with intracranial reasons.

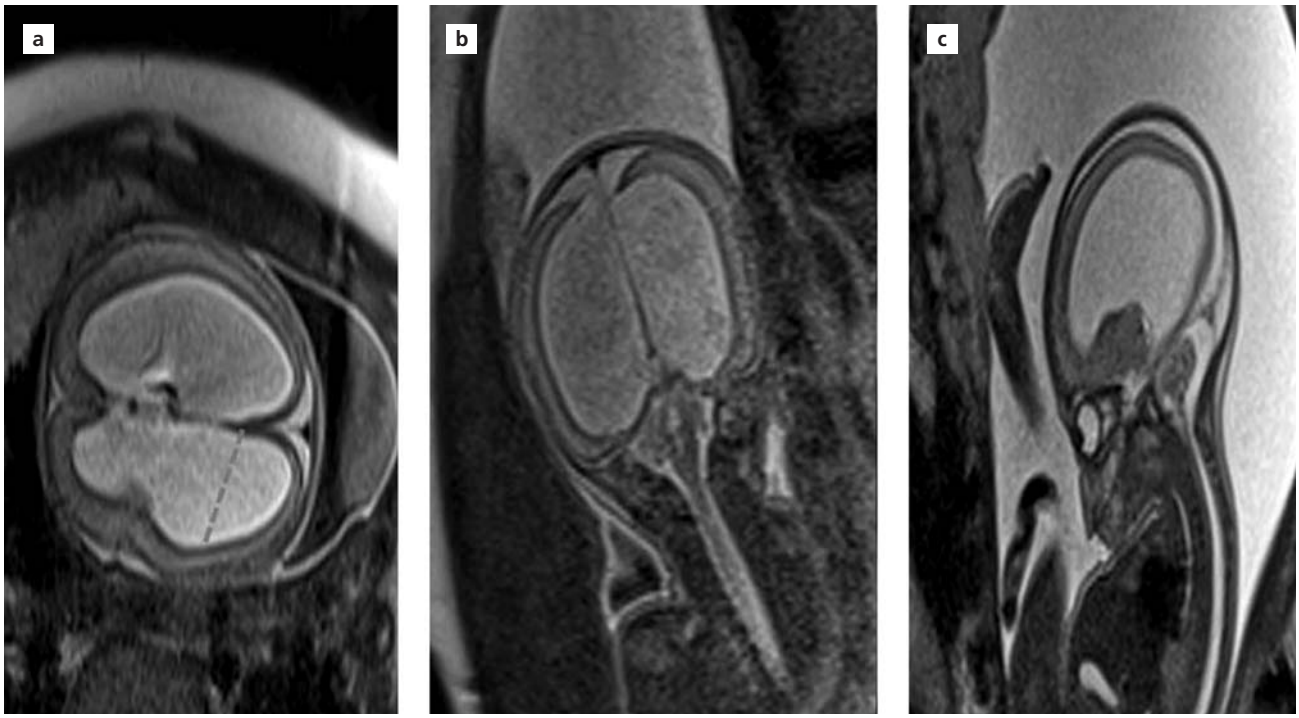

Fig. 4. Severe ventriculomegaly and lissencephaly views in (**a**) axial, (**b**) coronal and (**c**) sagittal sections.

recommended termination due to the advanced week of gestation.

Intrathoracic anomalies

This method was employed for the pulmonary volume evaluation due to the congenital diaphragmatic hernia in 3 out of 5 cases and for the suspected pulmonary sequestration confirmed by MRI in two cases. While termination was carried out in one of the cases with diaphragmatic hernia due to the poor prognostic factors confirmed by MRI, follow-up was decided in other two cases after informing family.

In three cases with intraabdominal anomalies, the cyst/mass suspected in different locations within fetal abdomen during sonographic examination could not be confirmed by MRI. In one case, this modality was referred in terms of gastroschisis/ruptured omophalocele distinction for the further evaluation of abdominal anterior wall defect and the case was determined to have gastroschisis. Fetal MRI was requested in four cases, in terms of tracheoesophageal fistula/atresia examination in cases with polyhydramnios whose stomach was imaged as small/could not be imaged by sonography, and when esophageal atresia was found in one of these cases, consultation and operation planning were carried out with pediatric surgery clinic during prenatal period.

In two of the four cases with spinal cord anomalies, this modality was employed in order to determine the width of neural tube defect observed in the sonography for prognosis purposes and for the mass suspicion in remaining two cases, while diastematomyelia was found in one of these cases. This modality was used in one case with neck anomalies, due to the suspected fetal goiter which could not be confirmed by MRI. Fetal MRI was requested for renal evaluation in one case with oligohydramnios as well as urogenital tract anomalies, and polycystic kidney was found (**Fig. 5**). This case was lost with intrauterine loss in the further weeks.

Other indications

MRI was requested in 23 cases when it was considered that sonography was insufficient for fetal evaluation due to maternal obesity. Elevated alpha-feto protein (AFP) was found in the eight of these cases during the triple screening test, but fetal dorsal evaluation was insufficient. Ventriculomegaly was observed in one of 23 cases,

but no anomaly was found in other cases during fetal MRI. MRI method was referred in one case found to have placenta previa in order to evaluate placental adhesion anomalies (**Fig. 6**) as well as for the further evaluation in one case observed to have wide amniotic sheet.

Discussion

Although ultrasonography is always the basis of antenatal imaging, fetal MRI has becoming a significant complementary method for prenatal diagnosis. Unlike X-ray and computed tomography screenings, MRI does not use ionizing radiation. Many studies even including pregnant MRI technicians have shown that MRI is safe and does not have adverse clinical effects.[6–8] Although the safety of MRI has been still investigated, there is no evidence that it has harmful effects on human embryos or fetuses.[9–11] However, in practice, it is preferred to

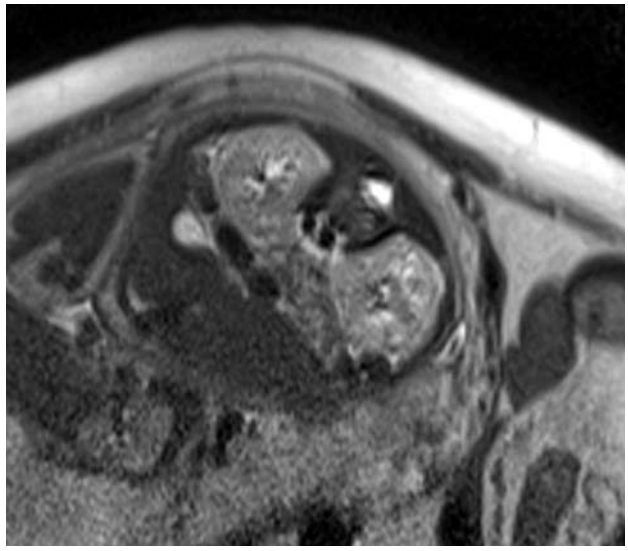

Fig. 5. MRI image consistent with bilateral polycystic kidney.

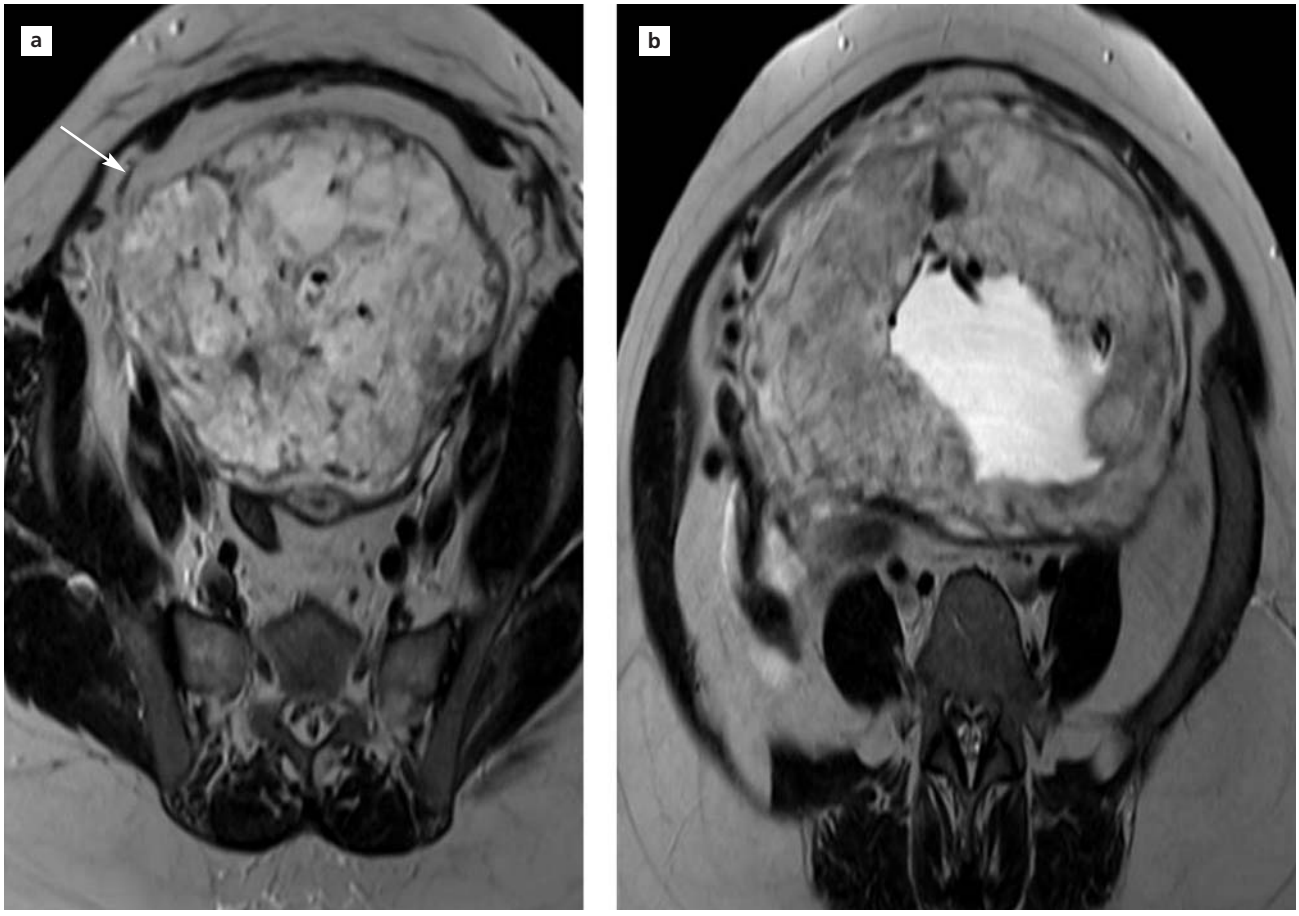

Fig. 6. The view consistent with focal invasion area (**arrow**) in the case with placenta previa (**a** and **b**).

wait until second trimester due to cautious approach in terms of teratogenicity, low signal-to-noise ratio in younger fetuses, increased fetal movement and insufficient organ development for evaluation. It is avoided to use intravenous contrast substance since there is no proven safety level.[12,13] In our center, the earliest examination was done at 17 weeks, and fetal MRI method was not employed for any case during first trimester.

Fetal MRI is used primarily to confirm the presence of an anomaly suspected sonographically. In addition to the characterization of the anomaly, it may provide additional findings which are not found by ultrasonography. Fetal MRI indications may vary among centers due to various factors such as regional differences in perinatal management, experience of physician and technician, presence of appropriate device and access to fetal surgery.[3] In some centers, fetal MRI is used even in the presence of normal ultrasound when it is considered that fetus is under great risk.[14]

Suspicious central nervous system anomalies, brain anomalies in particular, are the most common indications for fetal MRI. Ventriculomegaly, posterior fossa and corpus callosum anomalies have been determined as the most common three indications for fetal cerebral MRI.[3–5,15] In our study, intracranial pathology was the major indication for fetal MRI examination, as ventriculomegaly was the most frequently observed sub-group.

In a significant number of fetuses found to have ventriculomegaly may have a concomitant structural or chromosomal abnormality. Since those with isolated ventriculomegaly have a better neurodevelopmental result, presence or absence of a concomitant anomaly has an important impact on the prognosis.[2,6] Although ventriculomegaly can be seen better by ultrasound, concomitant anomalies cannot be observed by sonographic examination. It is considered that the additional benefit of fetal MRI compared to USG can be observed in two different areas; first one is that additional diagnostic data are obtained without making any change in the treatment plan of pregnancy, and second one is that the additional diagnostic data obtained by MRI leads to changes on further approach for pregnancy. For example, Rossi and Prefumo confirmed USG findings by MRI in 65.4% of the cases while they obtained additional findings in 22.1% of the fetuses. In as high as 30% of the cases, MRI and sonography were highly different from each other, and this difference led to change in perinatal management. The disagreement was observed mostly on midline anomalies.[16] In the study of Amini et al., the authors confirmed sonography results by MRI in 55% of the cases without any additional finding, found additional findings in 35% of the cases which did not change perinatal management, and they found additional findings in 10% of the cases which changed gestational approach. The pregnancies were terminated in these cases in the light of new data.[17] In our study, we found additional anomalies in 3 of 36 cases which underwent fetal MRI due to ventriculomegaly, and MRI contributed to the consultancy for fetal prognosis. While we offered the termination option in two of these cases, we ruled out this option in other case due to the advanced week of gestation, but planned the postnatal management of newborn during prenatal period in consultation with related departments.

In corpus callosum and posterior fossa anomalies, the multiplane characteristics of MRI enable the detailed evaluation of these structures, and it is also beneficial to identify concomitant anomalies which are important for the prognosis.[15] Pulmonary hypoplasia in fetuses with congenital diaphragmatic hernia is the most important factor affecting neonatal mortality and morbidity.[1–3] As we preferred in our clinic, pulmonary volume measurements by fetal MRI contributes to the perinatal management via neonatal survival prediction. In the study of Lee et al. where the authors investigated the congenital diaphragmatic hernia by total pulmonary volume obtained via fetal MRI, they reported that the survival rate was 90% in the patients with total pulmonary volume higher than 40 mL, and 35% in those with less than 20 mL. A significant relationship has been observed between total pulmonary volume and need for extracorporeal membrane oxygenation.[18] In one of the three cases with diaphragmatic hernia in our study, we planned termination in the light of the data we obtained by MRI, and we decided to follow up other three cases considering the good prognosis.

Despite the significant technical improvements in obstetric ultrasonography, there are difficulties encountered for the fetal sonography in this patient group due to the negative impacts of maternal obesity on the dispersion of sound waves.[19] The previous studies have focused on the difficulties for obtaining sufficient images for the evaluation of cardiac and cerebrospinal fluids in particular. It is suggested to use complementary imaging modalities such as fetal MRI in order to overcome the negative impacts of obesity on the obstetric imaging .[20]

In our center, we referred to fetal MRI method for the evaluation of abdominal anterior wall and fetal dorsal imaging in 23 cases for which fetal sonography was insufficient due to obesity and AFP values used particularly for the screening of neural tube defect were high. MRI is not superior to fetal echocardiography for the evaluation of fetal cardiac structures. Therefore, its additional contribution for this patient group is controversial.[3] We found no patient which underwent MRI examination due to cardiac anomaly.

Conclusion

In conclusion, fetal MRI has been used more widely for proper perinatal management and consultancy in cases where sonography is insufficient. More availability of MRI devices, increased expertise in this field and further advancements in MRI technology will lead to more common use of this modality in the perinatology field. However, unnecessary use of fetal MRI is associated with the anxiety of patient and increased cost burden. The collaboration of clinicians, who play a role in the obstetric management, with radiologists is beneficial for the selection of proper indications and the prevention of unnecessary practices.

Conflicts of Interest: No conflicts declared.

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