Thai Journal of Obstetrics and Gynaecology
December 1997, Vol. 9, pp. 255-262

OBSTETRICS

Fetal Imaging : MRI Versus Ultrasound

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ABSTRACT

Objective To compare the ultrasound images with magnetic resonance imaging (MRI) in demonstrating abnormal fetal structures.

Design Case series.

Setting Division of Maternal-Fetal Medicine, Faculty of Medicine, Chulalongkorn University.

Subjects and methods Five patients whose gestational ages ranged from 31 to 38 weeks. All had previously undergone a transabdominal or transvaginal ultrasound examination showing fetal anomalies, then all patients were imaged with standard spin echo sequences T_1 -weighted image. Fast spin-echo sequences were performed on T_2 -weighted images.

Results Three cases had abnormality of the brain, ie. microcephaly with encephalocele, occipital encephalocele and porencephaly. The other two cases were omphalocele and phocomelia. MRI gave more information than ultrasound in case of occipital encephalocele, microcephaly with encephalocele and porencephaly.

Conclusion Ultrasound remains the first choice of screening method for imaging the fetus in utero. MRI is a valid second-step diagnostic tool in pregnancy for further assessment of sonographically detected malformation especially those involving central nervous system.

Key words : Magnetic resonance imaging, Ultrasound, Malformation

Experienced sonologists and obstetricians are well aware of the limitations of sonography in certain difficult diagnostic situations, such as rare and subtle malformations, very obese women, or severe oligohydramnios. In such circumstances, alternative imaging techniques would be helpful. Computerized tomography has never been considered for use in pregnancy as it involves ionizing radiation which could produce cytogenetic damage. The only biological changes induced by the static magnetic field and the radiofrequency radiation are in general, harmless and with mild increase in body temperature and heart rate.[1-4]

The use of magnetic resonance imaging for the study of fetal anomalies was first reported in the literature in the early 1980.[5-7] More recently its potential for examining the normal fetus in uterus has been demonstrated.[8] In 1985 McCarthy and colleagues[8] reported their first experience with MRI of maternal and fetal anatomy. No adverse effect from the technique has been reported. The guideline for imaging has been published by the British National Radiological Protection. The Board has laid down the safety limits and indicated that patients with cardiac pacemakers and ferromagnetic implants should be excluded. It is advised that pregnancy in the first trimester should not be imaged unless that pregnancy is to be terminated. But in the second and third trimesters when organogenesis is complete, no contraindication to imaging exists. At present the potential of this new imaging system is being explored in pregnancy. Fetal activity did, however, make it difficult to acquire clear images. Other experimental studies of the same period reported that fetal motion resulted in image degradation.[9-12]

Earlier, there has been reports on temporary ultrasound-guided intramuscular or intravenous fetal curarization which allowed better imaging of abnormalities of both brain and other organs.[10,11] More recently alternative procedures have been explored to minimize image degradation by fetal movement to avoid using invasive techniques such as fetal curarization. This is the first report of MRI in obstetrics in Thailand. The purpose of our study was to compare the ultrasound images with MRI in demonstrating abnormal fetal structures.

Materials and Methods

We investigated 5 patients whose gestational age ranged from 31 to 38 weeks (Table 1). All had previously undergone a transabdominal or transvaginal ultrasound examination showing fetal anomalies at the Division of Maternal-Fetal Medicine, Faculty of Medicine, Chulalongkorn University. The ultrasound machine used was Acuson Aspen with 4, 5 and 7 MHz curvilinear probes for transabdominal examination and 5, 7 MultiHertz frequency probe for transvaginal examination.

The use of MRI for further investigation was discussed with the parents after informing them of the clinical and scientific aims of the study. Informed consent was obtained from each mother, stating that additional information to the ultrasound data could be obtained with MRI analysis. All the MRI examinations were performed with a 1.5 tesla super conducting magnet with a body coil and version 5.4 software (Sigma; General Electric Medical Systems, Milwaukee, WI). All patients were initially imaged with standard spin echo sequences T_1 -weighted image in the coronal plane to evaluate position of fetus and interested organs. Fast spin-echo sequences were performed on T_2 -weighted images and standard spin-echo sequences T_1 -weight images with variable planes depend on interested organs or structural anomalies for studying in detail.

Table 1. Materials and results

Cases	Weeks	Ultrasound findings	MRI findings	Outcome of pregnancy
1	36	Microcephaly	Microcephaly encephalocele	- Born alive and died 10 days after birth
2	32	Occipital meningocele	Occipital encephalocele	- Born alive, excision and repair of encephalocele 7 days after birth, still alive
3	38	Porencephaly	Porencephaly	- Born alive and died 2 months after birth
4	31	Omphalocele	Omphalocele	- Born alive and artificial sac was done after birth, still alive
5	36	Osteogenesis imperfecta	Phocomelia	- Born alive with handicap

The pictures of ultrasonographic scan were compared with the pictures of MRI.

Results

Fetal movement artifacts occasionally degraded the images. However, some images from multiple planes were taken during relative motion free period. In general, all the MRI examination were obtain with good quality.

The time required for an examination was between 15 and 30 min (mean 20 min). This depended on the number of sequences that were degraded by the fetal movement artifacts. The most striking feature of MRI is the clarity with different soft tissue structures are demonstrated. Unlike ultrasound, no artifacts from bone or bowel gas occurred.

Case 1 Case of microcephaly with encephalocele.

The ultrasound findings were considered not sufficiently informative for intracranial structures (microcephaly) eventhough transvaginal ultrasound was used to image the cephalic part of the fetus (Fig. 1). The MRI perfectly defined the brain anomaly and also recognized the skull defect compatible with encephalocele which ultrasound failed to demonstrate, (Fig. 2).

T_1 weighted image (SE 640/16) in sagittal plane of 36 weeks fetus in cephalic presentation demonstrated small cranial vault. There was a defect of the subcutaneous fat coveraging the brain which could be the defect of the cranial vault. The brain tissue of the encephalocele could not be seen in this case which might be due to limited pelvic space.

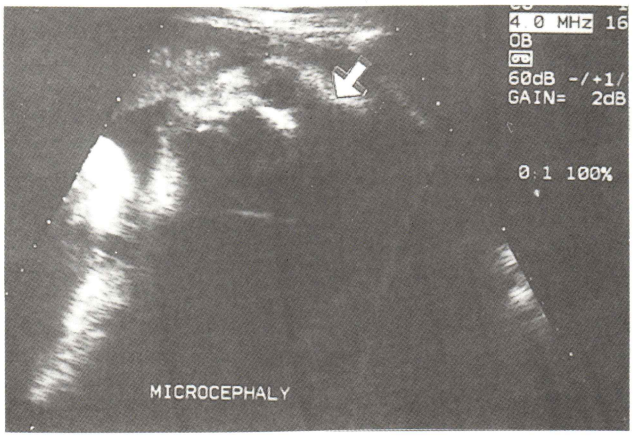

Fig.1. Ultrasound image of microcephaly.

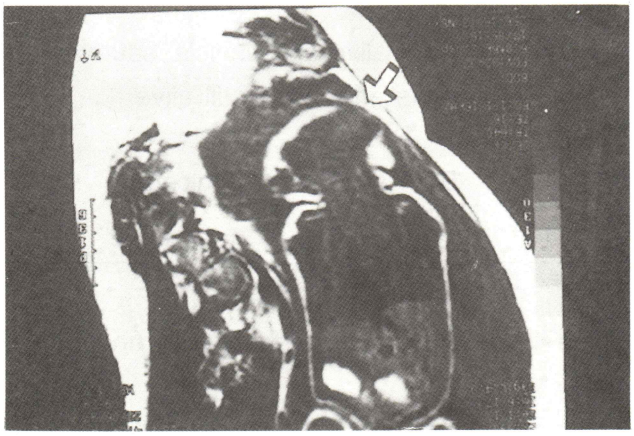

Fig. 2. MRI image of microcephaly with encephalocele.

Fig. 3. Newborn case 1.

Newborn microcephaly with encephalocele was shown in Figure 3.

Case 2 Case of occipital meningoencephalocele.

This case was sonographically labelled as occipital meningocele (Fig. 4). MRI showed the defect at the occipital bone with some part of brain tissue and CSF herniation through this bony defect suggesting occipital meningoencephalocele

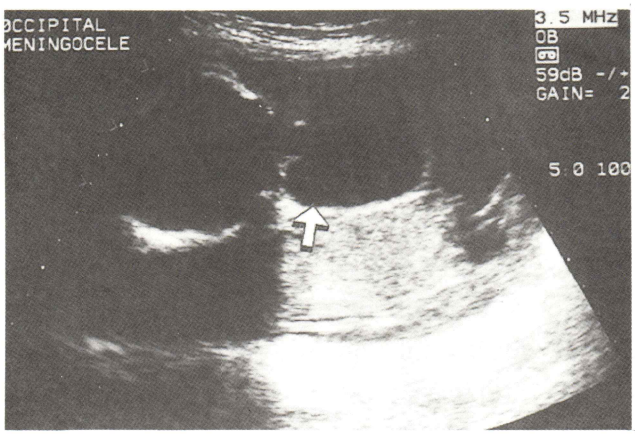

Fig. 4. Ultrasound image of occipital menigocele.

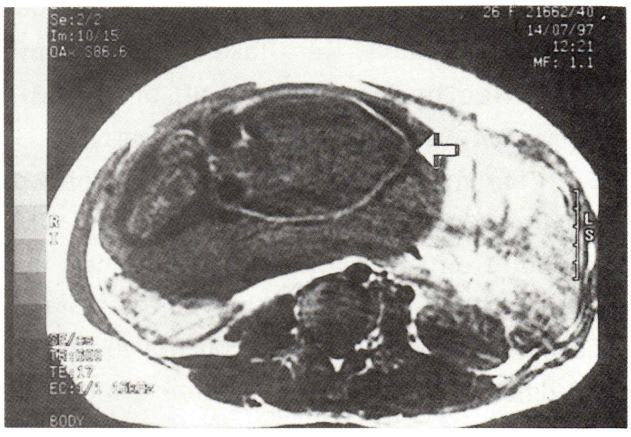

Fig. 5. MRI image of occipital meningoencephalocele.

Fig. 6. Newborn case 2.

(Fig. 5). No other abnormality of the brain was demonstrated.

Newborn occipital meningoencephalocele was shown in Figure 6.

Case 3 Case of porencephalic cyst.

Transabdominal ultrasonographic examination demonstrated cystic cavities within the brain. There is gross distortion of intracranial anatomy and a conspicuous shift of midline echo (Fig. 7). MRI confirmed the ultrasonic findings and added the information of a large CSF-filled cavity in the unilateral hemisphere extension across the frontal region of the contralateral side and connection to the contralateral lateral ventricle. Hypotrophy of

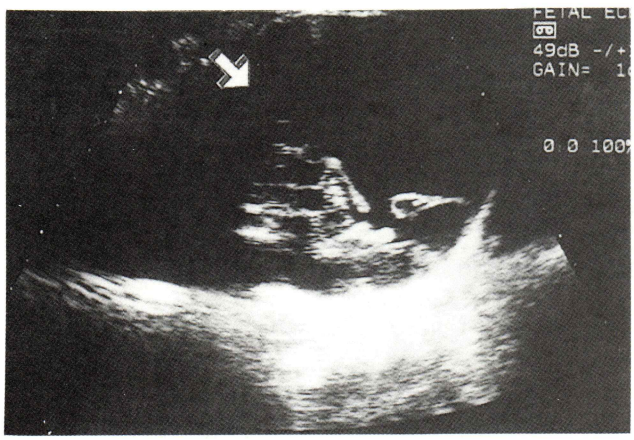

Fig. 7. Ultrasound image of porencephalic cyst.

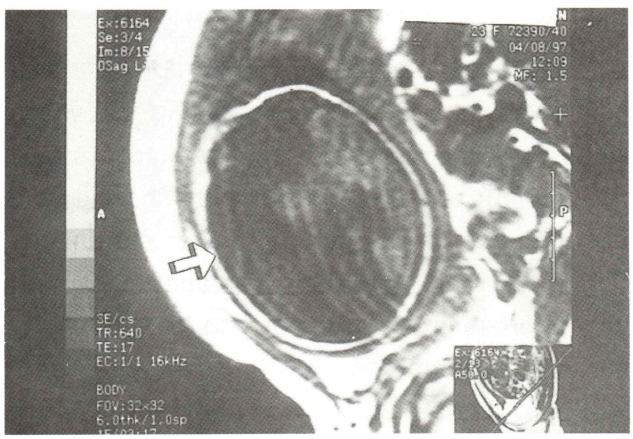

Fig. 8. MRI image.

the contralateral cerebral cortex was observed (Fig. 8). The thalamus was normal.

Case 4 Case of omphalocele

Ultrasound and prenatal MRI findings perfectly defined the abdominal defects with herniation of the liver and bowel loops protruding through anterior abdominal wall (Fig. 9).

Sagittal T_1 - weighted images of the fetus detected herniation of liver and bowel loops protuding through anterior abdominal wall (Fig. 10) .

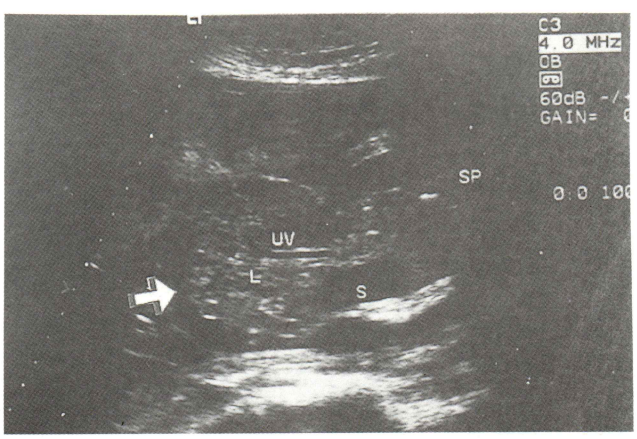

Fig. 9. Ultrasound image of omphalocele.

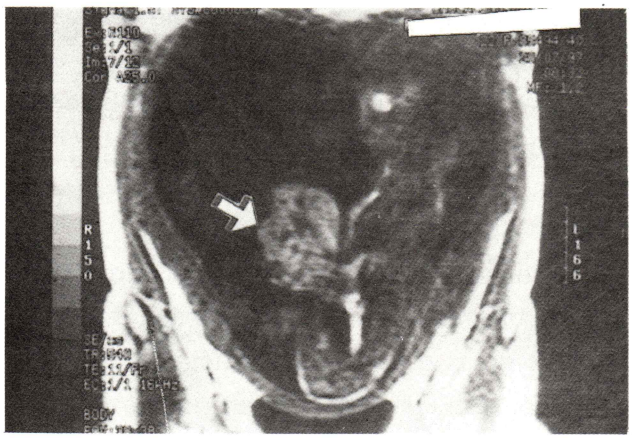

Fig. 10. MRI image of omphalocele.

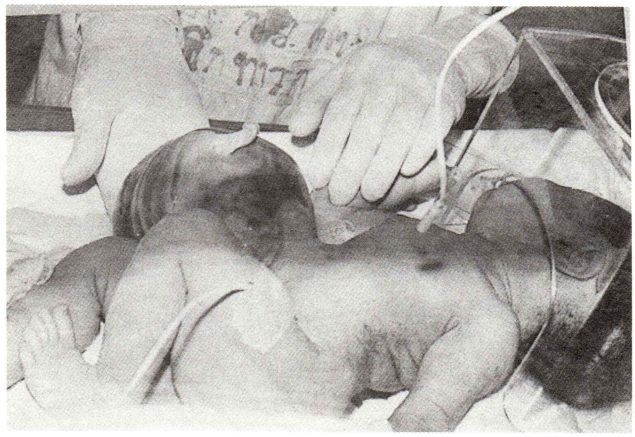

Fig. 11. Newborn case 4

Newborn omphalocele was shown in Figure 11.

Case 5 Case of phocomelia

Transabdominal ultrasonography showed both short upper and lower limbs (Fig. 12) which were also detected by MRI T_1 weighted images (SE 560/10) of the 36 weeks fetus showed very shortening of the upper and lower extremities (Fig. 13). Plain film of the abdomen confirmed very shortening of the upper and lower extremities. Only femoral and humeral part were seen. The baby had a preterm delivery of healthy infant whose postnatal newborn confirmed the prenatal results.

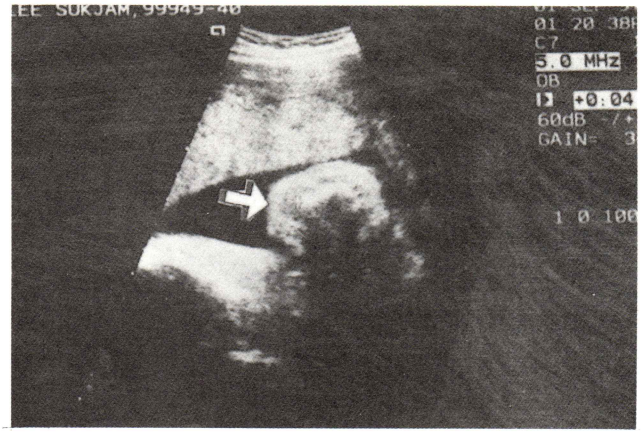

Fig.12. Ultrasound image of phocomelia.

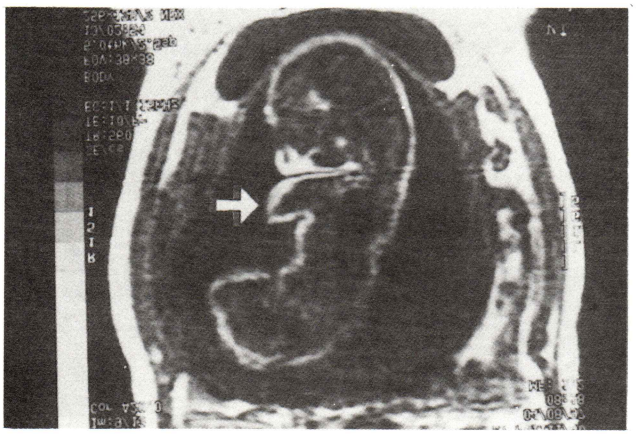

Fig. 13. MRI image of phocomelia.

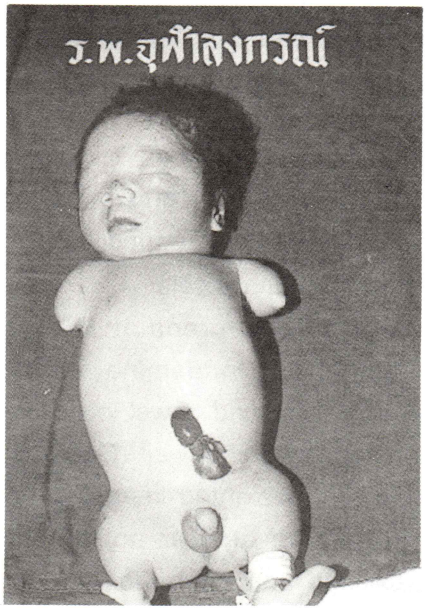

Fig. 14. Newborn case 5.

Newborn phocomelia was shown in Figure 14.

Discussion

The safety of MRI is now well documented.[1,2] Many studies have shown that neither magnetic fields,[1-4] regardless of their strength, nor radiofrequency waves pose a risk for the fetus. MRI has been proposed as a method of imaging the abnormal fetus such as anomalies of the brain, abdominal masses, chest masses, neck masses, heart anomalies and spine anomalies.[8] In addition to fetal anomalies, MRI demonstrated abnormality of placenta, umbilical cord, fetal position, number of fetus and amount of amniotic fluid.[13-15] Prenatal diagnosis of fetal abnormalities by MRI has been reported and most of them were fetal cerebral abnormalities.[16-20]

In our report ; we had 3 cases of abnormality of the brain, microcephaly with encephalocele, occipital encephalocele and porencephaly, other two cases were omphalocele and phocomelia. MRI revealed more information in case of microcephaly with encephalocele and occipital encephalocele. In case of microcephaly with encephalocele, MRI depicted more information about cranial defect at the occipital region but MRI could not demonstrate the encephalocele. MRI gave more information than ultrasound in case of occipital meningoencephalocele. MRI demonstrated herniation of brain and cerebrospinal fluid through the bony defect at the occipital bone.

Conclusion

We believe that ultrasound analysis remains the first choice of screening method for imaging the fetus in utero, but in selected cases, MRI can help to establish a correct diagnosis. MRI is a valid second-step diagnostic tool in pregnancy for further assessment of sonographically detected malformation. However, it should be used wisely and be limited to cases in which ultrasound findings do not fully satisfy are not completely ratistactory..

References

1. Wolff S, Crokks LE, Brown P. Tests for DNA and chromosomal damage induced by Nuclear magnetic resonance imaging. Radiology 1980 ; 136 : 707-10.
2. Wolft S, James TL, Young GB, Margulis AR, Bodycote J, Afzal V. Magnetic resonance imaging : absence of in vitro cytogenetic damage. Radiology 1985 ; 155 : 163-5.
3. Kido DK, Morris TW, Erickson JL, Plewes DB, Simon JH. Physiologic changes during high field strength MR imaging, Am J Nuclear Radiograph 1987 ; 8 : 263-6.
4. Shellock FG, Crues JV. Temperature changes caused by MR imaging of the brain with a head coil. Am J Nuclear Radiograph 1988 ; 9 : 287-91.
5. Smith FW, Adam AM, Phillips WDP. NMR imaging in pregnancy. Lancet 1983 ; 1 : 61-2.
6. Johnson I I, Symonds E, Kean A, Worthington F, Diplain B, Hawkes R, et al. Imaging the pregnant human uterus with nuclear magnetic resonance. Am J Obstet Gynecol 1984 ; 148 : 1136-9.
7. McCarthy SM, Stark DD, Filly RA, Callen PW, Hricak H, Higgins CB. Obstetrical magnetic resonance imaging : maternal anatomy. Radiology 1985 ; 154 : 421-5.
8. McCarthy SM, Filly RA, Stark DD, Callen PW, Golbus MS, Hricak H. Magnetic resonance imaging of the fetal anomalies in utero : early experience. Am J Radiol 1985 ; 145 : 677-82.
9. Weinreb JC, Lowe TW, Santos-Ramos R, Cunningham FG, Parkey R. Magnetic resonance imaging in obstetric diagnosis. Radiology 1985 ; 154 : 157-61.
10. Seeds JW, Corke BC, Spielman FJ. Prevention of fetal movements during invasive precedures with pancuronium bromide. Am J Obstet Gynecol 1986 ; 155 : 818-9.
11. Moise KJ, Carpenter RJ, Deter RL, Kirshon B, Diaz SF. The use of fetal neuromuscular blockade during intrauterine procedures. Am J Obstet Gynecol 1987 ; 157 : 874-9.
12. Pielet BW, Socol ML, MacGregor SN, Dooley SL,

Minogue J. Fetal heart changes after fetal intravascular treatment with pancuronium bromide. Am J Obstet Gynecol 1988 ; 159 : 640-3.
13. Smith FW, Kent C, Abramovich DR, Sutherland HW. Nuclear magnetic resonance imaging a new look at the fetus. Br J Obstet Gynaecol 1985 ; 92 : 1024-33.
14. Weinreb JC, Lowe T, Cohen JPM, Kutler M. Human fetal anatomy MR imaging. Radiology 1985 ; 157 : 715-20.
15. Shellock FG. Biological effects and safety aspects of magnetic resonance imaging. Magn Reson Q 1989 ; 5 : 243-61.
16. D'Ercole C, Girard N, Boubli L, Potier A, Chagnon C, Raybaud C, et al. Prenatal diagnosis of fetal cerebral abnormalities by ultrasonography and magnetic resonance imaging. Eur J Obstet Gynecol Reprod Biol. 1993 ; 50 : 177-84.
17. Revel MP, Pons JC, Lelaidier C. Magnetic resonance imaging of the fetus : a study of 20 cases performed without curarization. Prenat Diagn 1993 ; 13 : 775-99.
18. Benson RC, Coletti PM, Platt LD, Ralls LD, Ralls PCS. MR imaging of fetal anomalies. Am J Roent growth 1991 ; 156 : 1205-7.
19. Lituania M, Passamonti U, Cordone MS, Magnauo GM, Toma P. Schizencephaly : prenatal diagnosis by computed sonography and magnetic resonance imaging. Prenat Diagn 1989 ; 9 : 649-55.
20. Tomo P, Lucigrai G, Rivegnani M, Casiate M, Magnano G, Lituania M. Hydrocephalus Porencephaly : prenatal diagnosis by ultrasonography and MR imaging. J Comput Assist Tomog 1990 ; 14 : 843-5.