Journal of Clinical Obstetrics, Gynecology & Infertility

Research Article
Published: 27 May, 2017

Three-Dimensional Tomographic Ultrasound Imaging (3D TUI) versus Magnetic Resonance Imaging (MRI) for Prenatal Diagnosis of Congenital Arachnoid Cyst

Akmal El-Mazny, Wafaa Ramadan and Mohamed Ali*

Department of Obstetrics and Gynecology, Faculty of Medicine, Cairo University, Cairo, Egypt

Abstract

Objective: To compare 3D tomographic ultrasound imaging (TUI) versus magnetic resonance imaging (MRI) for prenatal diagnosis of congenital arachnoid cyst.

Methods: In a comparative observational cross-sectional study, at university teaching hospitals, 30 pregnant women with suspected fetal arachnoid cyst by 2D ultrasound were subjected to 3D TUI and prenatal MRI for detailed assessment of the intracranial cyst and associated anomalies. Prenatal 3D TUI and MRI findings were compared with postnatal MRI findings.

Results: From 30 suspected arachnoid cysts, 21 (70.0%) were diagnosed at 3D TUI, 22 (73.3%) at prenatal MRI, and 23 (76.7%) were confirmed at postnatal MRI. For associated anomalies, 6 (20.0%) were observed at 3D TUI, 8 (26.7%) at prenatal MRI, and 9 (30.0%) were confirmed at postnatal MRI. The overall accuracy of 3D TUI was comparable to prenatal MRI for diagnosis of arachnoid cysts (P=1.000) and associated anomalies (P=0.612).

Conclusion: Three-dimensional TUI is reliable, relatively inexpensive, not time-consuming, and causes minimal discomfort to the patient. Thus, 3D TUI can be used for prenatal diagnosis of congenital arachnoid cyst before resorting to MRI.

Keywords: 3D ultrasound; Arachnoid cyst; Magnetic resonance imaging; Tomographic ultrasound imaging

Correspondence:
Akmal El-Mazny, Department of Obstetrics and Gynecology, Faculty of Medicine, Cairo University, Cairo, Egypt, Tel: 002 01001454576; E-mail: dr_akmalelmazny@yahoo.com

Received Date: *28 Mar 2017*
Accepted Date: *20 May 2017*
Published Date: *27 May 2017*

Citation:
El-Mazny A, Ramadan W, Ali M. Three-Dimensional Tomographic Ultrasound Imaging (3D TUI) versus Magnetic Resonance Imaging (MRI) for Prenatal Diagnosis of Congenital Arachnoid Cyst. J Clin Obstet Gynecol Infertil. 2017; 1(2): 1009.

Introduction

Cystic malformations of the arachnoid layer had first been reported about 180 years ago. Arachnoid cysts represent approximately 1% of all intracranial space-occupying lesions [1]. Cystic fluid retentions within the arachnoid layer, which may develop secondary to intracranial hemorrhage or meningitis, have to be differentiated from true primary arachnoid cyst. In addition, they have to be distinguished from other cystic lesions which involve the outer part of the cerebral cortex and the meninges, like glioependymal cysts or cystic lesions of infectious or neoplastic origin [2,3].

Ultrasound scan is the primary modality for fetal evaluation. The normal and abnormal appearance of the brain on ultrasonography is based on the ability to obtain specific images of the cerebrum, cerebellum, and spine. Applications of 3D ultrasonography continue to evolve as this technology becomes increasingly available in clinical practice [4].

Potential benefits of 3D ultrasound include the ability to determine the severity, location and extent of central nervous system (CNS) abnormalities; the possibility of reconstructing and visualizing the corpus callosum in the sagittal plane from volume data sets; the ability to visualize the 3 horns of the ventricular system in a single plane (3 horn view); and tomographic ultrasound imaging (TUI) where parallel images in a 3D volume are displayed in a multi slice of different thickness [5-7].

Prenatal magnetic resonance imaging (MRI) helps to confirm the diagnosis of arachnoid cyst and to exclude other possible CNS anomalies, especially additional findings of corpus callosum agenesis/abnormalities and cortical gyral abnormalities [8,9].

The objective of this study was to compare 3D TUI versus MRI for prenatal diagnosis of congenital arachnoid cyst.

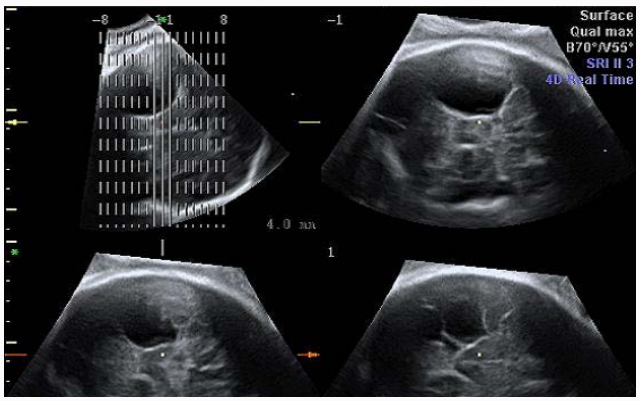

Figure 1: Arachnoid cyst by 3D tomographic ultrasound imaging (TUI).

Methods

This comparative observational cross-sectional study was conducted at the Department of Obstetrics and Gynecology, Faculty of Medicine, Cairo University. The Research Ethics Committee approved the study protocol, and informed consent was obtained from all participants.

The study population was recruited from pregnant women attending the Antenatal Care Clinic. The women were subjected to history taking, obstetric examination, and routine anomaly scan. Patients who had contraindications for MRI examination were excluded from the study. Thirty pregnant women with suspected fetal arachnoid cyst by 2D ultrasound were subjected to 3D ultrasound (Voluson 730; Kretz, Zipf, Austria) for detailed examination of the skull and CNS including cavum septum, thalamus, lateral ventricles, choroid plexus, cerebellum, cisterna magna, and midline echo; face including lips, palate, eyes, nose; spine; heart and great vessels; stomach, abdomen, and umbilical cord insertion; kidney and bladder; and extremities.

The ultrasound was then switched to the analysis of 3D volume using TUI (Figure 1) for detailed CNS assessment in multi-parallel cutting sections. Up to eight parallel planes of section can be simultaneously visualized on the same screen. The number and position of the slices can be adjusted with specific software controls. Hue, brightness and contrast controls can also be adjusted to optimize image quality. It is easily possible to change slice width, to rotate the images, to magnify images, and to rotate images to any direction. This function is extremely useful for detailed CNS assessment as regard the site and size of the intracranial cyst, and the associated CNS anomalies specially agenesis of the corpus callosum (ACC) and associated ventricular dilatation. Ventriculomegaly was defined if the size of the atrium of the lateral ventricle exceeds 10 mm.

Prenatal MRI was performed using a Philips Achiva 1.5 tesla super conducting magnet with a phased-array torso surface coil. Images obtained according to fetal position in the axial, coronal and sagittal planes with the following parameters: 7/3/3(TR/TE/NEX), flip angle 90 degree FOV 18 cm to 39 cm, matrix (284 × 272), slice thickness/gap of 4/1 mm. An average of seven (5-12) sequences was obtained for every examination, with mean time of 7 min to 15 min. Detailed CNS assessment was conducted including the site and size of the intracranial cyst, and the associated CNS anomalies specially ACC and associated ventricular dilatation. Ventriculomegaly was defined if the size of the atrium of the lateral ventricle exceeds 10 mm. Repetition of some sequences was required, because the images were either degraded by fetal motion during acquisition, or because fetal motion between sequences resulted in images that are not in the true anatomic planes. Scanning time/slice was less than 1 s/image.

All cases were followed-up by postnatal MRI and physical examination. Prenatal 3D TUI and MRI findings were compared with postnatal MRI findings; and the accuracy of 3D TUI and MRI in the prenatal diagnosis of congenital arachnoid cyst was calculated.

Statistical analysis

Data were represented as mean ± SD, or number (%). Accuracy was calculated using sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and overall accuracy. Fisher's exact test was used to compare categorical data. A P value <0.05 was considered significant. Statistical analysis was performed using the Statistical Package for the Social Sciences, version 16 (SPSS, Inc., Chicago, Illinois).

Results

Thirty women with suspected fetal arachnoid cyst by 2D ultrasound were included in the study. Their age ranged from 21 to 33 years (mean 26.5 ± 2.4 SD), parity ranged from 1 to 5 (mean 2.1 ± 0.4 SD), and gestational age ranged from 19 to 37 weeks (mean 28.1 ± 3.2 SD). Five cases (16.7%) reported positive consanguinity, 2 cases (6.7%) had history of previous anomalies, and none had history of teratogenic drugs intake.

Of the 30 suspected arachnoid cysts, 21 (70.0%) were diagnosed at 3D TUI, 22 (73.3%) at prenatal MRI, and 23 (76.7%) were confirmed at postnatal MRI. Associated anomalies were observed in 6 women (20.0%) at 3D TUI; ACC in 4 (13.3%), ACC and shizencephaly in 1 (3.3%), and ventriculomegally in 1 (3.3%). At prenatal MRI, associated anomalies were observed in 8 women (26.7%); ACC in 5 (16.7%), ACC and shizencephaly in 2 (6.6%), and ventriculomegally in 1 (3.3%). At postnatal MRI, associated anomalies were confirmed in 9 women (30.0%); ACC in 6 (20.0%), ACC and shizencephaly in 2 (6.6%), and ventriculomegally in 1 (3.3%) (Table 1).

The sensitivity, specificity, PPV, NPV, and overall accuracy for diagnosis of arachnoid cysts were 91.3%, 100%, 100%, 77.8%, and 93.3% respectively for 3D TUI; and 95.7%, 100%, 100%, 87.5%, and

Table 1: Arachnoid cyst and associated anomalies detected at 3D tomographic ultrasound imaging (TUI), prenatal and postnatal MRI.

	3D TUI (n=30)	Prenatal MRI (n=30)	Postnatal MRI (n=30)
Arachnoid cyst	21 (70.0%)	22 (73.3%)	23 (76.7%)
Associated anomalies	6 (20.0%)	8 (26.7%)	9 (30.0%)
ACC	4 (13.3%)	5 (16.7%)	6 (20.0%)
ACC and shizencephaly	1 (3.3%)	2 (6.6%)	2 (6.6%)
Ventriculomegally	1 (3.3%)	1 (3.3%)	1 (3.3%)

ACC: Agenesis of Corpus Callosum.

Table 2: Accuracy of 3D tomographic ultrasound imaging (TUI) and prenatal MRI versus postnatal MRI in diagnosis of arachnoid cyst and associated anomalies.

	Arachnoid cyst		Associated anomalies	
	3D TUI	Prenatal MRI	3D TUI	Prenatal MRI
Sensitivity	21/23 (91.3%)	22/23 (95.7%)	6/9 (66.7%)	8/9 (88.9%)
Specificity	7/7 (100%)	7/7 (100%)	21/21 (100%)	21/21 (100%)
Positive predictive value	21/21 (100%)	22/22 (100%)	6/6 (100%)	8/8 (100%)
Negative predictive value	7/9 (77.8%)	7/8 (87.5%)	21/24 (87.5%)	21/22 (95.5%)
Overall accuracy	28/30 (93.3%)[a]	29/30 (96.7%)	27/30 (90.0%)[b]	29/30 (96.7%)

[a]Non-significant difference versus prenatal MRI (P=1.000); [b]Non-significant difference versus prenatal MRI (P=0.612).

96.7% respectively for prenatal MRI. For associated anomalies, the sensitivity, specificity, PPV, NPV, and overall accuracy were 66.7%, 100%, 100%, 87.5%, and 90.0% respectively for 3D TUI; and 88.9%, 100%, 100%, 95.5%, and 96.7% respectively for prenatal MRI. The overall accuracy of 3DTUI was comparable to prenatal MRI for diagnosis of arachnoid cysts (P=1.000) and associated anomalies (P=0.612) (Table 2).

Discussion

The detection of fetal anomalies was one of the earliest uses and remains a pivotal application of prenatal ultrasound. Prenatal recognition of birth defects is generally regarded as being advantageous and desirable because care of handicapped and disable persons is a serious healthcare burden on communities. The presence or absence of fetal congenital brain anomalies is very important in making the decision of termination or continuation of the pregnancy; hence it should be discovered as early as possible.

Arachnoid cysts are fluid-filled cavities lined completely or partially by the arachnoid membrane arachnoid cysts appear on ultrasound examination as fluid-filled structures inside the intracranial cavity. The differential diagnosis from other cystic lesions may be impossible. Prognosis, survival and quality of life depend on the type of lesion. In particular, arachnoid cysts may be left in place, if asymptomatic, or be surgically removed or shunted if there are seizures on epilepsy. With regard to the relationship between location and prognosis, temporal cysts have the best prognosis, while subtentorial cysts in the posterior fossa are associated with the worst outcome [10].

There are 3 important points when evaluating an arachnoid cyst and establishing follow-up and the prognostic outcome: (1) the presence of other anomalies, especially midline brain developments, such as ACC; (2) the size of the ventricular system, by measuring the atrium, and associated obstructive hydrocephalus; and (3) whether the size of the cyst changes with advancing gestational age [11].

Applications of 3D ultrasonography continue to evolve as this technology becomes increasingly available in clinical practice [12]. Tomographic ultrasound imaging of the brain structure is quite helpful to understand intracranial detailed brain structure [13]. It demonstrates multi-parallel cutting sections and is quite similar imaging technology to magnetic resonance imaging. The superior point of 3D TUI to MRI is that it is easily possible to change slice width, to rotate the images, to magnify images, and to rotate images to any directions. This function is extremely useful for detailed CNS assessment and also for neurosurgical consultation [14].

However, maternal obesity, oligohydramnios, or poor fetal position may cause inability to obtain adequate ultrasound images. Magnetic resonance imaging is less affected by these factors, and is very important in the detection of associated brain malformative disorders together with what appears to be a simple arachnoid or intraventricular cyst on ultrasonography. For example, schizencephaly or semilobar holoprosencephaly sometimes may be under diagnosed on the basis of ultrasonographic findings alone [15].

To the best of our knowledge and review of literature, this is the first study to compare 3D TUI versus MRI for prenatal diagnosis of congenital arachnoid cyst. Our results showed that of the 30 suspected arachnoid cysts, 21 (70.0%) were diagnosed at 3D TUI, 22 (73.3%) at prenatal MRI, and 23 (76.7%) were confirmed at postnatal MRI. For associated anomalies, 6 (20.0%) were observed at 3D TUI, 8 (26.7%) at prenatal MRI, and 9 (30.0%) were confirmed at postnatal MRI. The overall accuracy of 3D TUI was comparable to prenatal MRI for diagnosis of arachnoid cysts (P=1.000) and associated anomalies (P=0.612).

Girard [16] showed that fetal MRI is a useful modality in detection of fetal CNS anomalies as well as complementary modality to 2D/4D US in diagnosing fetal abnormalities in which ultrasound findings are inconclusive. Bennett et al. [17] also found that MRI allows direct imaging of the corpus callosum, so it is very helpful in ACC which is difficult to diagnose sonographically, especially in the second trimester.

Pierre-Kahn and Sonigo [18] suggested that the combination of ultrasonography and MRI enables a more accurate diagnosis and assessment of the prognosis. The differentiation between arachnoid cysts and malformative brain cysts may sometimes be difficult using ultrasonography, especially if the cyst is large and causes a significant distortion of the brain. However, this differentiation is important because the prognosis for intracranial arachnoid cysts may be good, whereas the prognosis for malformative brain cysts may be associated with developmental delay, seizures, and hydrocephalus. Prenatal MRI can demonstrate the location of the cyst, whether intra- or extra-ventricular, supra- or infra-tentorial, and adjacent to cisterns or intraparenchymal.

In conclusion, 3D TUI is comparable to prenatal MRI for diagnosis of arachnoid cysts and associated anomalies. In addition, 3D TUI is relatively inexpensive, not time-consuming, and causes minimal discomfort to the patient. Thus, 3D TUI can be used for prenatal diagnosis of congenital arachnoid cyst before resorting to MRI. However, due to our relatively small sample size, further multi-centric studies in larger series are recommended.

References

1. Pascual-Castroviejo I, Roche MC, Martínez Bermejo A, Arcas J, García Blázquez M. Primary intracranial arachnoidal cysts: a study of 67 childhood cases. Childs Nerv Syst. 1991;7:257-63.

2. Bannister CM, Russell SA, Rimmer S, Mowle DH. Fetal arachnoid cysts:

their site, progress, prognosis and differential diagnosis. Eur J Pediatr Surg. 1999;9(1):27-8.

3. Shukla-Dave A, Gupta RK, Roy R, Husain N, Paul L, Venkatesh SK, et al. Prospective evaluation of in vivo proton MR spectroscopy in differentiation of similar appearing intracranial cystic lesions. Magn Reson Imaging. 2001;19(1):103-10.
4. Timor-Tritsch IE, Platt LD. Three-dimensional ultrasound experience in obstetrics. Curr Opin Obstet Gynecol. 2002;14(6):569-75.
5. Pilu G, Ghi T, Carletti A, Segata M, Perolo A, Rizzo N. Three-dimensional ultrasound examination of the fetal central nervous system. Ultrasound Obstet Gynecol. 2007;30(2):233-45.
6. Chen CP. Prenatal diagnosis of arachnoid cysts. Taiwan J Obstet Gynecol. 2007;46(3):187-98.
7. Simon EM, Goldstein RB, Coakley FV, Filly RA, Broderick KC, Musci TJ, et al. Fast MR imaging of fetal CNS anomalies in utero. AJNR Am J Neuroradiol. 2000;21(9):1688-98.
8. Benacerraf BR, Shipp TD, Bromley B, Levine D. What does magnetic resonance imaging add to the prenatal sonographic diagnosis of ventriculomegaly. J Ultrasound Med. 2007;26(11):1513-22.
9. Pradilla G, Jallo G. Arachnoid cysts: case series and review of the literature. Neurosurg Focus. 2007;22(2):E7.
10. Ersahin Y, Kesikci H, Ruksen M, Aydin C, Mutluer S. Endoscopic treatment of suprasellar arachnoid cysts. Childs Nerv Syst. 2008;24(9):1013-20.
11. Fujimura J, Shima Y, Arai H, Ogawa R, Fukunaga Y. Management of a suprasellar arachnoid cyst identified using prenatal sonography. J Clin Ultrasound. 2006;34(2):92-4.
12. Mittal P, Gonçalves LF, Kusanovic JP, Espinoza J, Lee W, Nien JK, et al. Objective evaluation of sylvian fissure development by multiplanar 3-dimensional ultrasonography. Ultrasound Med. 2007;26(3):347-53.
13. Pooh RK, Kurjak A. 3D and 4D sonography and magnetic resonance in the assessment of normal and abnormal CNS development: alternative or complementary. J Perinat Med. 2011;39(1):3-13.
14. Pooh RK, Pooh K. Transvaginal 3D and doppler ultrasonography of the fetal brain. Semin Perinatol. 2001;25(1):38-43.
15. Pierre-Kahn A, Carpentier A, Parisot D, Cinalli G, Zerah M, Renier D, et al. Treatment of intracranial cysts in children: peritoneal derivation or endoscopic fenestration? Neurochirurgie. 2002;48(4):327-38.
16. Girard NJ. Magnetic resonance imaging of fetal developmental anomalies. Top Magn Reson Imaging. 2011;22(1):11-23.
17. Bennett GL, Bromley B, Benacerraf BR. Agenesis of the corpus callosum: prenatal detection usually is not possible before 22 weeks of gestation. Radiology. 1996;199(2):447-50.
18. Pierre-Kahn A, Sonigo P. Malformative intracranial cysts: diagnosis and outcome. Childs Nerv Syst. 2003;19(7-8):477-83.