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Role Of 3D and 4D Dimensional Ultrasonography in Detection of Fetal Brain Anomalies in Second Trimester of Pregnancy

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ABSTRACT

Background: The detection of foetal anomalies is critical in detecting fetal/maternal problems that may occur during and after pregnancy. As a result, foetal imaging is crucial for obstetricians. Several studies have assessed the efficacy of 2D and 4D ultrasound in diagnosis, and the use of 4D ultrasound in routine practise has begun to be investigated.
Aim of The Work: To determine the extended imaging of 3D/4D ultrasonography in prenatal assessment of anatomical structure of the brain and early diagnosis of the brain congenital anomalies.
Patients and Methods: This was a prospective descriptive study will be conducted on 50 pregnant women with suspected Fetal Brain Anomalies (FBA); to determine the extended imaging of 3D/4D ultrasonography in prenatal assessment of anatomical structure of the brain and early diagnosis of the brain congenital anomalies.
Results: Regarding diagnostic accuracy of 2D vs 4D U/S; A comparison study of 2D and 4D U/S assessments revealed a highly significant increase in specificity and negative predictive value in the 4D U/S assessment (p 0.01 respectively). A comparison of 2D and 4D U/S assessments revealed a non-significant difference in disease detection rate. , sensitivity and positive predictive value ($p > 0.05$). This study shows a fair agreement between 2D and 4D U/S assessments of brain anomalies (kappa =0.380).
Conclusion: There were no significant difference between 2D and 3/4D ultrasound efficacy in detecting different brain anomalies; but 3/4D is more accurate, sensitive and specific, and tend to detect brain anomalies earlier in time than 2D U/S.

Keywords: *3D and 4D dimensional US; Fetal brain anomalies; Second trimester of pregnancy.*

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INTRODUCTION

Congenital defects cause 20-25 percent of perinatal deaths. Because CNS anomalies have a significant association with spontaneous abortion, many genetic and other disorders can now be diagnosed early in pregnancy.[1]

Prenatal diagnosis employs a variety of noninvasive and invasive techniques to assess the health, condition, or abnormality of an unborn foetus. Fetal visualisation techniques include: Noninvasive techniques include ultrasound, foetal echocardiography, and magnetic resonance imaging (MRI). (B) Embryoscopy and Fetoscopy are invasive techniques. Brain malformations are the second most common type of congenital anomaly, following congenital heart disease.[2]

Ultrasound (US) detection of prenatal brain anatomic anomalies is critical in deciding whether to terminate a pregnancy. It is a non-invasive technique that patients find more acceptable. Several studies have shown that the US detects brain anomalies with an accuracy of 92 percent to 99.7 percent. [2]

3D/4D ultrasonography will be used in addition to 2D ultrasonography as an imaging modality. Thus, the current paradigm entails performing 3D/4D ultrasonography as part of a target scan after establishing an initial diagnostic impression with 2D ultrasonography.[3]

Three-dimensional (3D) ultrasonography will be used more frequently to examine the human foetus. Examiners can use this technology to transition from a 3D mental reconstruction of two-dimensional (2D) images to actual 3D/4D visualisation of anatomical structures.[4]

Other potential benefits of 3D/4D ultrasonography in fetal neurosonography include: (1) The ability to assess the seriousness, location, and scope of central nervous system abnormalities. (2) Reconstructing and visualising the corpus callosum in the sagittal plane using volume data sets. (3) The ability to see

the three ventricular horns in a single plane (3-horn view). (4) The ability to interactively review volume data after the patient has left the examination room. (5) The availability of a variety of rendering methods for visualising different aspects of the same structure. (6) The ability to rotate the volume dataset and examine anatomical structures from various angles. (7) The ability to send data over networks for consultation in tertiary care centres, as well as the ability to use offline software programmes as an interactive educational tool. [5]

The primary goal of a foetal ultrasound anomaly scan using 4D ultrasonography is to provide accurate information that will aid in the delivery of optimal antenatal care with the best possible outcomes for both mother and foetus.[6]

The aim of this study was to determine the extended imaging of 3D/4D ultrasonography in prenatal assessment of anatomical structure of the brain and early diagnosis of the brain congenital anomalies.

PATIENTS AND METHODS

Between August 2021 and April 2022, 50 pregnant women with suspected foetal brain anomalies were enrolled in this prospective descriptive study. Patients were referred to Al-Azhar University Hospitals' Department of Diagnostic and Interventional Radiology in Cairo. In addition, approval from the Ethics Committee and informed written consent were obtained. All patient data was kept private and confidential. All data provision was monitored and used solely for scientific purposes.

Inclusion criteria: Fetal gestational age ranged from 18-24 weeks (gestational age was calculated according to the date of the last menstrual period), and maternal age ranges from 18-40 years.

Exclusion criteria: Premature pregnancy (images in earlier pregnancy was difficult and Babies who are born earlier in the pregnancy do not have the same amount of subcutaneous fat). This means the baby appeared less "filled out" and more skeletal or bony on the 3D/4D images, and Oligo-hydramnios (good 3D/4D imaging in oligohydramnios pregnant women requires a cooperative baby and adequate amniotic fluid in front of the structure being imaged). Some babies press against the uterine or placental wall, while others put their arms or hands in front of their faces. Obtaining 3D/4D images became difficult, if not impossible, as a result.

All patients were subjected to:

Full personal, family, maternal and medical history was taken with special emphasis on (presence of previous family history of congenital anomalies, drug intake or infection during pregnancy, positive consanguinity, maternal diabetes and Rh incompatibility).
Full 2D Ultrasound examination was done then 3D and 4D ultrasound was performed in all second trimester cases by Toshiba Aplio 500 at the Department of Diagnostic and Interventional Radiology.
The 3D reconstruction process involves the generation of a 3D image from a digitized set of 2D images.
Two methods have been used for 3D reconstruction: a 3D surface model and a voxel based volume model.
The image analyses was done off-line in 3D, while in 4D the volume was taken on real time.
Surface mode was used for assessment of the superficial structure of the fetal cranial bone and facial features.

Multi-planar image analysis was used for the assessment of the intracranial morphological development

The following parameters were assessed in each fetus:

Calculation of gestational age, fetal number, position, viability and biophysical profile.

Liquor: Amount, turbidity, presence or absence of amniotic septum (Amount of amniotic fluid was calculated using four quadrants amniotic fluid index).

Placenta: Chorionicity, position, thickness, grading, and presence of abruption or retro-placental hematoma.

Brain data: measurements of biparietal diameter, size of the lateral ventricular atria, sizes of the third and fourth ventricles, size of the posterior fossa (posterior fossa area and parameter) including the cerebellum; along with clivo-tentorial distance.

Statistical analysis:

MedCalc ver. 15.8 was used for data entry, processing, and statistical analysis (MedCalc, Ostend, Belgium). We used significance tests (Wilcoxon's, McNemar's, and Kappa statistics analysis). Data were presented, and appropriate analysis was performed based on the type of data obtained (parametric and non-parametric) for each variable. For parametric numerical data, mean, standard deviation (SD), and range are used, while median and interquartile range (IQR) are used for non-parametric numerical data. Frequency and percentage of non-numerical data To determine the statistical significance of a non-parametric variable difference between two (paired) study group means, Wilcoxon's test was used. McNemar's test was used to investigate the relationship between two (paired) qualitative variables. P-values less than 0.05 (5%) were considered statistically significant. Kappa statistics were used to calculate the degree of agreement between two investigational methods. Kappas greater than 0.75 are excellent, 0.40 to 0.75 are fair to good, and less than 0.40 are poor(Fair agreement = 0.20 to 0.40; Moderate agreement = 0.40 to 0.60; Good agreement = 0.60 to 0.80; Very good agreement = 0.80 to 1.00.)

RESULTS

Variables	Frequency (%)
Maternal age (years)	34.98 ± 4.33 ^
Gestational age (weeks)	22 (20 - 23) ^^
Family history of congenital anomalies	13 (26%)
Infection during pregnancy	17 (34%)
Drug intake	4 (8%)
Consanguinity	25 (50%)
Maternal Diabetes	7 (14%)
Rh incompatibility	33 (66%)

^ Mean ± SD, ^^ Median (IQR): inter-quartile range.

Table 1: Basic clinical data among 50 FBA pregnant women:

The mean maternal age of all patients was (34.98 ± 4.33) years; while the median gestational age (GA) was 22 weeks. Regarding basic clinical data, (26%) of patients had positive family history of congenital anomalies; (34%) of patients had infection during pregnancy; (8%) of patients had history of drug intake; and (50%) of patients had positive consanguinity; while (14%) of patients had maternal diabetes; and (66%) of patients had Rh incompatibility (Table 1).

Variables	2D U/S	4D U/S
Diagnosis of brain anomaly (disease detection rate)	46 (92%)	49 (98%)
TP (true positive)	46	49
TN (true negative)	1	1
FP (false positive)	0	0
FN (false negative)	3	0
Sensitivity (TPR) (true positive rate)	93.8%	100%
Specificity (TNR) (true negative rate)	100%	100%
Positive predictive value (PPV)	100%	100%
Negative predictive value (NPV)	25%	100%

Table 2: Diagnostic accuracy of brain anomalies among 50 FBA pregnant women:

The 2D U/S had (93.8%) sensitivity and (100%) specificity; with positive predictive value of (100%) and a negative predictive value of (25%); compared to (100%) in all parameters in 4D U/S (Table 2).

Variable		2D U/S assessment	4D U/S assessment	Wilcoxon's test
				p value
Calculated GA (weeks)		22 (20 – 24)	22 (20 – 23)	= 0.320 ǂ
Variable		2D U/S assessment	4D U/S assessment	McNemar's test
				P value
Fetal number	Single fetus	49 (98%)	49(98%)	= 1.00 ǂǂ
	Twins	1 (2%)	1 (2%)	
Position (presentation)	Breech	7 (14%)	7 (14%)	= 1.00 ǂǂ
	Cephalic	23 (46%)	23 (46%)	
	Oblique	8 (16%)	8 (16%)	
	Vertex	12 (24%)	12 (24%)	
Viability		50 (100%)	50 (100%)	= 1.00 ǂǂ

ǂ Wilcoxon's test, ǂǂ McNemar's test.

Table 3: Comparison between 2D and 4D U/S as regards serial general radiological assessments:

Comparative study between 2D and 4D U/S assessments revealed; non-significant difference in calculated GA, fetal number, position and viability assessments (p > 0.05) (Table 3).

Variable		2D U/S assessment	4D U/S assessment	Wilcoxon's test
				p value
QuadrAnteriors amniotic fluid index		11 (9 – 12)	11 (9 – 12)	= 0.843 ǂ
Variable		2D U/S assessment	4D U/S assessment	McNemar's test
				P value
Amount	Adequate	36 (72%)	36 (72%)	= 1.00 ǂǂ
	Poly-hydramnios	14 (28%)	14 (28%)	
Turbidity	Clear	50 (100%)	50 (100%)	= 1.00 ǂǂ
	Turbid	0 (0%)	0 (0%)	
Amniotic septum		0 (0%)	0 (0%)	= 1.00 ǂǂ

ǂ Wilcoxon's test, ǂǂ McNemar's test.

Table 4: Comparison between 2D and 4D U/S as regards serial liquor assessments:

Comparative study between 2D and 4D U/S assessments revealed; non-significant difference in QuadrAnteriors amniotic fluid index; liquor amount, turbidity; and amniotic septum assessments (p > 0.05) (Table 4).

Variable		2D U/S assessment	4D U/S assessment	Wilcoxon's test p value
Thickness (mm)		22 (20 – 23)	22 (20 – 23)	= 1.00 ǂ
Variable		2D U/S assessment	4D U/S assessment	McNemar's test P value
Grade	1	26 (52%)	30 (60%)	= 0.289 ǂǂ
	2	24 (48%)	20 (40%)	
Position	Anterior	25 (50%)	25 (50%)	= 1.00 ǂǂ
	Posterior	14 (28%)	14 (28%)	
	Antero-posterior	11 (22%)	11 (22%)	
Abruption		0 (0%)	0 (0%)	= 1.00 ǂǂ
Retro-placental hematoma		6 (12%)	6 (12%)	= 1.00 ǂǂ

ǂ Wilcoxon's test, ǂǂ McNemar's test.

Table 5: Comparison between 2D and 4D U/S as regards serial placental assessments:

Comparative study between 2D and 4D U/S assessments revealed; non-significant difference in placental thickness, grade, position, abruption and retro-placental hematoma assessments (p > 0.05) (Table 5).

Variable	2D U/S assessment	4D U/S assessment	Wilcoxon's test p value
Biparietal diameter (cm)	5.4 (4.7 - 6)	5.6 (4.9 - 6.1)	= 0.687 ǂ
Lateral Ventricular size (mm)	11 (7 – 14)	12 (9 – 14)	= 0.015* ǂ
3rd Ventricular size (mm)	2.6 (2.6 – 3.6)	2.6 (2.6 – 3.6)	= 0.125 ǂ
4th Ventricular size (mm)	4 (2.8 – 6)	4 (2.7 – 7)	= 0.812 ǂ
PFA (posterior fossa area) (cm)	4.33 (3.16 – 4.93)	4.33 (2.6 – 4.93)	= 0.875 ǂ
PFP (posterior fossa parameter) (cm)	1.7 (1.6 – 1.8)	1.7 (1.7 – 1.8)	= 0.375 ǂ
CTD (clivo-tentorial distance) (cm)	2.06 (1.75 - 2.33)	2.06 (1.7 - 2.33)	= 0.875 ǂ

ǂ Wilcoxon's test.

Table 6: Comparison between 2D and 4D U/S as regards serial brain assessments:

Comparative study between 2D and 4D U/S assessments revealed; significant increase in lateral ventricular size; in 4D U/S assessment; with significant difference (p = 0.015). Comparative study between 2D and 4D U/S assessments revealed; non-significant difference in biparietal diameter, 3rd, 4th ventricular size, PFA, PFP and CTD assessments (p > 0.05) (Table 6).

Variable		2D U/S assessment	4D U/S assessment	Wilcoxon's test p value
Time of diagnosis (weeks)		21 (18 – 23)	20 (18 – 21)	= 0.0004** ǂ
Variable		2D U/S assessment	4D U/S assessment	McNemar's test P value
Diagnosis of brain anomaly (disease detection rate)		46 (92%)	49 (98%)	= 0.250 ǂǂ
Type of brain anomaly	Anencephaly	4 (8%)	4 (8%)	= 1.00 ǂǂ
	Choroid plexus cyst	5 (10%)	6 (12%)	
	Corpus callosum agenesis	3 (6%)	3 (6%)	
	Dandy walker malformation	2 (4%)	2 (4%)	
	Encephalocele	5 (10%)	5 (10%)	
	Exencephaly	2 (4%)	2 (4%)	
	Holoprosencephaly	6 (12%)	6 (12%)	
	Hydrocephalus	5 (10%)	5 (10%)	
	Meningocele	4 (8%)	4 (8%)	
	Obstructive hydrocephalus	2 (4%)	2 (4%)	
	Vein of galen anomaly	2 (4%)	3 (6%)	
	Ventriculomegaly	6 (12%)	7 (14%)	

ǂ Wilcoxon's test, ǂǂ McNemar's test.

Table 7: Comparison between 2D and 4D U/S as regards serial diagnostic assessments:

Comparative study between 2D and 4D U/S assessments revealed; highly significant decrease in time of diagnosis; in 4D U/S assessment; with highly significant difference (p = 0.0004). Comparative study between 2D and 4D U/S assessments revealed; non-significant difference in disease detection rate and types of anomaly assessments (p > 0.05) (Table 7).

Variable	2D U/S assessment	4D U/S assessment	McNemar's test P value
Diagnosis of brain anomaly (disease detection rate)	46 (92%)	49 (98%)	= 0.250 ǂ
Sensitivity (TPR) (true positive rate)	93.8%	100%	= 0.225 ǂ
Specificity (TNR) (true negative rate)	25%	100%	< 0.0001** ǂ
Positive predictive value (PPV)	98.4%	100%	= 0.822 ǂ
Negative predictive value (NPV)	7.6%	100%	< 0.0001** ǂ

ǂ McNemar's test.

Table 8: Comparison between 2D and 4D U/S as regards diagnostic accuracy assessments:

A comparison study of 2D and 4D U/S assessments revealed a highly significant increase in specificity and negative predictive value in the 4D U/S assessment (p 0.01 respectively). A study comparing 2D and 4D U/S assessments discovered a non-significant difference in disease detection rate. , sensitivity and positive predictive value ($p > 0.05$) (Table 8).

		4D		Total	Agreement	
		-ve	+ve		Kappa	p value
2D	Negative	1	0	1 (2%)	0.380	= 0.250
	Positive	3	46	49 (98%)		
	Total	4 (8%)	46 (92%)	50 (100%)		

Table 9: An agreement between 2D and 4D U/S:

Table (9) shows a fair agreement between 2D and 4D U/S assessments of brain anomalies (kappa =0.380).

DISCUSSION

Our study found that the mean maternal age of all patients was (34.98 ± 4.33) years; while the median gestational age (GA) was 22 weeks.

Regarding basic clinical data, (26%) of patients had positive family history of congenital anomalies; (34%) of patients had infection during pregnancy; (8%) of patients had history of drug intake; and (50%) of patients had positive consanguinity; while (14%) of patients had maternal diabetes; and (66%) of patients had Rh incompatibility.

We also found that, the median value of calculated GA in 2D and 3D/4D U/S assessments was 22 weeks. Regarding general radiological data, (98%) of patients had single viable fetuses, and one patient had viable twins. Regarding position (presentation), (14%) of patients had breech presentation; (46%) of patients had cephalic presentation; (16%) of patients had oblique presentation; (24%) of patients had vertex presentation in 2D and 4D U/S assessments.

We also found that, the median value of QuadrAnteriors amniotic fluid index in 2D and 3D/4D U/S assessments was 11. Regarding liquor data, all (100%) of patients had clear liquor; while no patient had an amniotic septum. Regarding amount of liqour, (72%) of patients had adequate liquor; while (28%) of patients had poly-hydramnios in 2D and 4D U/S assessments.

We also found that, the median value of placental thickness in 2D and 3D/4D U/S assessments was 22 mm. Regarding placental grade, (52%) of patients had grade 1; (48%) of patients had grade 2; and (12%) of the patient have ranged size retro placental hematoma. while nobody had placental abruption. Regarding placental position, (50%) of patients had anterior placenta; (28%) of patients had posterior placenta; while (22%) of patients had antero-posterior placenta in 2D and 4D U/S assessments.

We found that, the median value of diagnosis time in 2D U/S assessment was at 21 week; while in 4D U/S assessment was at 20 week. These results came in agreement with Pooh and Kurjak[3].

Regarding diagnosis of brain anomalies, 2D U/S had (92%); while 4D U/S had (98%) disease detection rate. These results came in agreement with Pooh and Kurjak[3] according to whom 3D and 4D ultrasounds are useful in the early detection and assessment of foetal abnormalities Indeed, even in the first trimester of pregnancy, this diagnostic tool has shifted embryology from postmortem studies to in vivo studies. With the current trend of shifting prenatal diagnosis to the earliest possible gestation, it isn't long before it becomes the first minianomaly scan to diagnose severe structural abnormalities, providing parents with reassurance of the foetal well-being. .[3]

Regarding type of brain anomaly, (8%) of patients had anencephaly; (10%) of patients had choroid plexus cyst; (6%) of patients had corpus callosum agenesis; (4%) of patients had Dandy walker malformation; (10%) of patients had encephalocele; (4%) of patients had exencephaly; (12%) of patients had holoprosencephaly; (10%) of patients had hydrocephalus; (8%) of patients had meningocele; (4%) of patients had obstructive hydrocephalus; (4%) of patients had vein of galen anomaly; (12%) of patients had ventriculomegaly, in 2D U/S assessment.

Regarding type of brain anomaly, (8%) of patients had anencephaly; (12%) of patients had choroid plexus cyst; (6%) of patients had corpus callosum agenesis; (4%) of patients had Dandy walker malformation; (10%) of patients had encephalocele; (4%) of patients had exencephaly; (12%) of patients had holoprosencephaly; (10%) of patients had hydrocephalus; (8%) of patients had meningocele; (4%) of patients had obstructive hydrocephalus; (6%) of patients had vein of galen anomaly; (14%) of patients had ventriculomegaly, in 4D U/S assessment

We found that, 2D U/S had (93.8%) sensitivity and (100%) specificity; with a positive predictive value of (100%) and a negative predictive value of (25%); compared to (100%) in all 4D U/S parameters. These findings agreed with Tonni and his colleagues7, who stated that there were no statistical differences in prenatal diagnosis between 2D and 3D ultrasound. Nonetheless, 2D/3D ultrasound had a sensitivity of 98 percent and 91 percent in diagnosing corpus callosum and other brain anomalies, respectively. According to a retrospective research, hydrocephalus was the most common congenital CNS abnormality, followed by myelomeningocele. In contrast to Moore & Persuade, anencephaly, corpus callosum agenesis, and encephalocele were shown to be more common in succession.

Myelomeningocele, anencephaly, and encephalocele were found in that order among neural tube abnormalities. Several writers have reported the similar trend.[8]

Hydrocephalus and corpus callosum agenesis are linked according to Dávila-Gutiérrez. Other writers, on the other hand, record cases of hydrocephalus and myelomeningocele coexistence, whereas Levey et al. report hydrocephalus and holoprosencephaly coexistence.[9]

Comparative study between 2D and 3D/4D U/S assessments revealed; non-significant difference in QuadrAnteriors amniotic fluid index; liquor amount, turbidity; and amniotic septum assessments ($p > 0.05$). Comparative study between 2D and 4D U/S assessments also revealed; non-significant difference in placental thickness, grade, position, abruption and retro-placental hematoma assessments ($p > 0.05$).

The previous findings agreed with the findings of Roy-Lacroix et al.10, who came to the conclusion that the use of 3D imaging as a primary screening tool is limited and that it is best used as a secondary test. Overall, there is a strong correlation between 2D and 3D foetal biometry measurements.

Comparative study between 2D and 3D/4D U/S assessments revealed; significant increase in lateral ventricular size; in 4D U/S assessment; with significant difference ($p = 0.015$). These results came in agreement with Merz and Pashaj[11].

Comparative study between 2D and 3D/4D U/S assessments revealed; non-significant difference in biparietal diameter, 3rd, 4th ventricular size, PFA, PFP and CTD assessments ($p > 0.05$). These results came in agreement with Merz and Pashaj[11].

Comparative study between 2D and 3D/4D U/S assessments revealed; highly significant decrease in time of diagnosis; in 4D U/S assessment; with highly significant difference ($p = 0.0004$). These results came in agreement with Pooh and Kurjak[3].

A comparison of 2D and 3D/4D U/S assessments revealed no significant differences in disease detection rate or types of anomaly assessments ($p > 0.05$). These findings agreed with Hata et al.12, who stated that characteristic findings such as the absence of the skull and other brain anomalies detected by 2D and conventional 3D ultrasound can correctly suggest the diagnosis. Concerning diagnostic accuracy of 2D vs 4D U/S assessments, a comparative study between 2D and 4D U/S assessments revealed a highly significant increase in specificity and negative predictive value in 4D U/S assessments (p 0.01 respectively).

A comparison of 2D and 3D/4D U/S assessments revealed no statistically significant differences in disease detection rate, sensitivity, or positive predictive value ($p > 0.05$). These findings agreed with those of Roy-Lacroix and colleagues10, who discovered that the overall diagnostic accuracy of 3D ultrasound in the routine mid-trimester scan is not superior for all foetal structures In the mid-trimester, 3D imaging cannot yet replace traditional 2D ultrasound as the primary tool for foetal structural diagnosis. When 2D imaging is insufficient, 3D scanning provides additional information about foetal anatomy. When 2D scans are insufficient, 3D imaging proves to be clinically useful. At 20 and 21 weeks of gestation, foetal biometry evaluation using information from 3D reconstructed images is comparable to traditional 2D imaging. Aside from diagnostic capabilities, 3D imaging may offer additional benefits that could help it maintain its position in foetal imaging, such as faster volume acquisition and shorter scanning times. [10]

We calculated the predictive value of each U/S modality; regarding detection of brain anomalies; using ROC curve analysis and Kappa statistics. By using ROC-curve analysis, 2D and 4D U/S showed non-significant difference in predictive values in discrimination of patients with brain anomalies from patients without ($p > 0.05$). This study shows a fair agreement between 2D and 4D U/S assessments of brain anomalies (kappa =0.380). These results came in agreement with Salman and his colleagues[13].

CONCLUSION

To conclude, there were no significant difference between 2D and 3D/4D ultrasound efficacy in detecting different brain anomalies; but 3D/4D is more accurate, sensitive and specific, and tend to detect brain anomalies earlier in time than 2D U/S.Two-dimensional ultrasonography remains the gold standard in foetal anomaly assessment, and four-dimensional ultrasonography is therefore not a screening technique, but rather an adjunct to two-dimensional ultrasonography for foetuses with known or suspected malformations.

Conflict of interest : none

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