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Full Length Research Paper

Ultrasound in the Detection of Congenital Neurological Anomalies: A retrospective Evaluation of the Two-dimensional versus three/Four-Dimensional Ultrasound

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ABSTRACT

Background: *The early detection of congenital malformation is crucial for fetal medicine and advanced fetal surgery. Ultrasound is the gold standard screening tool. The introduction of three and four-dimensional capabilities added to the value of the two-dimensional ultrasound. However, its cost and added diagnostic values make it questionable. Thus, the current work was designed to investigate the role of 3D/4D ultrasound compared to 2D ultrasound for diagnosis of neurological fetal congenital malformations.* ***Methodology: It*** *is a retrospective review of the files of 600 hundred pregnant females, selected from different secondary and tertiary care centers, on the duration between 2015 and 2019. All records had the data of 2D and 3D/4D ultrasound examination besides the patient demographics and clinical data up to pregnancy termination or delivery. The diagnosis had been confirmed by pathological study for terminated pregnancies, post-natal clinical, and imaging studies.* ***Results:*** *The neurological abnormalities were recognized and confirmed for 50 women (8.3%). The women's age ranged between 20 and 40 years. The 3D/4D ultrasound revealed an equal diagnosis to that detected by the 2D ultrasound among 33 out of 50 (66.0%). However, it was advantageous among 17 cases (34.0%) (mainly for spina bifida and encephalocele). The commonest potential factors associated with congenital neurological malformations were drug intake (mainly non-steroidal inflammatory drugs) (34.0%), followed by diabetes mellitus (20.0%) and the least was past history of Rh- incompatibility (8.0%).* ***Conclusion:*** *3D/4D ultrasound provided an added value to 2D ultrasound, especially for specific anomalies (spina bifida and encephalocele). However, it could not be considered as an alternative to 2D. otherwise, both could be considered complementary.*

Introduction

Ultrasound of pregnancy had witnessed continuous advancement. Two-dimensional (2D) ultrasound was the gold standard for screening in pregnancy for many years. This was continuously replaced by the new introduced three-dimensional and four-dimensional ultrasound. The three-dimensional ultrasound able to produce three-dimensional images with diagnosis of cases like cleft lip, which was difficult to be diagnosed by two-dimensional ultrasound due to production of a flat-look images. The four-dimensional (4D) ultrasound added the continuous update of images (it becomes a moving image, as a video) [(1,2)].

Fetal congenital anomalies are a challenging obstetric condition, which may require termination of pregnancy or warrant early intervention. The condition was reported for about 2-3% of all pregnancies, and not associated with any previous history like the positive past or family history. However, other factors may increase the risk (e.g., advanced maternal age, exposure to teratogenic agents early in pregnancy, smoking or radiation exposure [(3-8)]. The intrauterine diagnosis of congenital anomalies (by ultrasound) permits an early intervention with available treatment options [(9)]. Three-Dimensional ultrasound has replaced the 2D as the gold standard in the intrauterine diagnosis of fetal congenital malformations. It enables a detailed inspection of the fetal structures with improved accuracy of the determination of fetal malformation. The dynamics of fetal structures become clear with 4D ultrasound. Thus, permits inspection of small anatomical structures. The advanced technology included in 3 and 4Ds permits identification of the physiological pattern of the fetal motor development [(10,11)]. However, the high cost associated with advanced ultrasound machine represented a barrier against its wide use, especially in low resources countries. Additionally, and from the economic point of view, if the advanced technology does not provide a valuable addition to compensate for its cost. It is wise to postpone its introduction. However, the train of technology can not be stopped. Here, we suggested that, three/four-dimensional ultrasound will provide a greater and significant improvement in the diagnosis of the intrauterine fetal anomalies, over the 2D

ultrasound. Thus, we carried this retrospective study to evaluate the value of 3/4D ultrasound in diagnosis of neurological congenital malformations.

Patients and methods

This was a retrospective study that evaluated ultrasound results and final diagnosis of neurological abnormalities among a sample of Egyptian women. Files were obtained from Damietta General Hospital (Ministry of Health, Damietta, Egypt), Al-Azhar University Hospital (New Damietta, Egypt), and other private radiology centers, whenever the administrative consent was obtained. The study included patients screened between (January 2015 to January 2019). Data were handled through January to June 2019.

Complete files were recognized for 600 women, who were submitted to ultrasound (both 2D and 3D/4D). The neurological abnormalities were recognized and confirmed for 50 women (8.3%). Those women and their fetuses were evaluated and their data included in the current work. The women's age ranged between 20 and 40 years. Examinations were performed between 15 and 35 ages of gestations during the routine antenatal care visits.

For ultrasound examination, a transabdominal transducer (3-5 MHz), with convex array volume was used for 2DUS and 3D images were constructed by computer software. The routine 2D ultrasound was the initial investigation. The fetus assessment included brain, face, thorax, heart, abdominal wall, viscera, spine and limbs (a complete scan). Once 2D ultrasound had been completed, professional and differential diagnoses were recorded on the basis of examination results. Then, 3D/4D examinations were performed and data were matched with the 2D findings. Fetal movements were monitored in time by 4D ultrasound and recorded. The volume sets were rotated and the images were built in the standard anatomical orientation, and displayed as concurrent topographic images in the three planes (transverse, sagittal and coronal). Different image filters were used to discriminate between the soft and bony structures. The diagnosis obtained by 3D/4D images were compared to the 2D images and analyzed to determine whether the same, additional or conflicting diagnoses were reached. The accuracy of diagnosis that was confirmed by the pathology of terminated pregnancies, post-natal examination, or surgical intervention, was considered the primary outcome of the current work.

Results

In the present work, 50 fetal neurological malformations (8.3%) were detected and confirmed. The 3D/4D ultrasound revealed an equal diagnosis to that detected by the 2D ultrasound among 33 out of 50 (66.0%). However, it was advantageous among 17 cases (34.0%) (mainly spina bifida and encephalocele). Other conditions, where both techniques provide the same diagnosis were presented in table (1).

We searched for potential risk factors associated with congenital neurological malformations are presented in table (2). The commonest was drug intake (mainly non-steroidal inflammatory drugs) (34.0%), followed by diabetes mellitus (20.0%) and the least was past history of Rh- incompatibility (8.0%). Figures 1 and 2 presents some anomalies.

Table (1): Value of 3/4DUS compared to 2D US in all types of examined anomalies.

Anomaly	**Total confirmed anomalies (50)**	**The same diagnosis**	**Other advantageous diagnosis**
Spina Bifida	15	0	15
Agenesis of the corpus callosum.	8	8	0
Porencephalic cyst.	7	7	0
Hydranencephaly.	6	6	0
Anencephaly.	5	5	0
Holoprosencephaly	5	5	0
Encephalocele.	2	0	2
Intraventricular hemorrhage (IVH).	2	2	0
Total	**50**	33(66.0%)	17 (43.0%)

Table (2): Potential associated Factors in females with fetal neurological anomalies

Anomaly	**Statistics**
Drug intake	17 (34.0%%)
Diabetes mellitus	10 (20.0%)
Advanced maternal age	8 (16.0%)
Past history of recurrent abortion	6 (12.0%)
Toxocariasis	5 (10.0%)
Past history of Rh incompatibility	4 (8.0%)

Fig (1): 2D ultrasound showed fusion of lateral ventricles (red arrow) (An axial view).

Fig (2): Three-dimensional ultrasound image showing cystic hygroma posterior to the head and neck (Blue arrow)

Discussion

The highly development computes (with increased capacity and speed) permits the introduction of new technologies to obtain valuable information of the available technologies. Three-dimensional ultrasound is a good example of this fact, as pictures of the two-dimensional ultrasound were rendered by software packages to have a three-dimensional image with superiority in inspection of fetal morphology. It permits vision of the minute structures. The central nervous system greatly benefits from new introduced ultrasound modalities [(12-14)]. However, the wide use of 3D/4D system is reduced by the high cost, with anther burden on the patient and healthcare system. Additionally, the results of 3D/4D is affected by the learning curve of the examiner, which could not be provided for all sonographers' due lack of equipment in many healthcare centers [(15-18)].

The current work aimed to evaluate the value of 3D/4D over the readily available 2D fetal ultrasound in diagnosis of neurological congenital malformations. 3D/4D were advantageous than 2D in detection of correct diagnosis in 34 % of cases. In addition, it confirmed the same diagnosis of 66.0% of the detected fetal anomalies. The idea is not novel in literature. However, it is of significant importance in our environment due to the constraints of 3D/4D ultrasound devices, due to cost constraints.

As in the current work, Mueller et al. [(19)] compared 2D to the 3D/4D ultrasound for diagnosis of the intrauterine central nervous system anomalies of 11 fetuses. One spina bifida was detected by 3D/4D, which was missed by the 2D ultrasound. Another change of primary diagnosis (encephalocele) to cervical meningomyelocele was achieved by the 3D/4D ultrasound. Subsequently, Wang et al. [(20)] confirmed the superiority of 3D/4D ultrasound over than 2D ultrasound in imaging of the intracranial midline and corpus callosum structures and any malformations. 3D/4D ultrasound were able to visualize these structures among 78.1% compared to 3.1% visualized by 2D examination. After that, Scharf et al. [(21)] and Hughes et al. [(22)] advocated the 3D/4D for demonstration of neural tube defects and spinal anomalies. More recently, Liu et al. (23) reported that 3D ultrasound early detects the fetal acrania and offer a novel visual image after reconstruction.

Mohammed et al. (24) reported that, that 3D ultrasonography is effective in the assessment of fetal CNS anomalies, as it detected anomalies for 90.0% as 2D ultrasound. The percentage of agreement was higher than the current work. This was explained by increased awareness among the treating obstetricians and recent advance in ultrasound equipments. They also found that, the commonest malformations were holoprosencephaly and anencephaly with significant agreement between 2D ultrasound from one side and 3D/4D from the other side. In addition, Xu HX, et al. (25) reported that, 3D/4D was superior than 2D ultrasound in the diagnosis of small neurological congenital malformations (e.g., choroid plexus cysts) and spina bifida. These results are in accordance with the current work. Furthermore, Mohamed and Sioudi et al. (26) reported that the diagnosis of a small spina bifida was missed on routine 2-D ultrasound, but it was discovered by 3D imaging.

Three-dimensional ultrasound could be performed without 2D and the fact that 2D ultrasound localizes the sites for 3D rendering to the sites of suspected malformations. Thus, 3D ultrasound could not be considered a sole screening tool for detection of neurological congenital malformations. It is better to be described as an adjunct tool.

However, the retrospective nature of the current work is a limiting step of the current study, which prevents generalization of the current results. Future prospective controlled studies on a large-scale are highly recommended.

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