ROLE OF 3D ULTRASONOGRAPHY IN ASSESSMENT OF FETAL SKELETAL ANOMALIES

Essay

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دور الموجات فوق الصوتية ثلاثية الأبعاد فى تشخيص العيوب الخلقية بالهيكل العظمى للجنين

رسالة

توطئة للحصول على درجة الماجستير
في الأشعة التشخيصية

مقدمة من

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SUMMARY AND CONCLUSION

The majority of fetal anomalies can be diagnosed in the late first/early second trimester anomaly scanning of pregnancy. However, the gestational ages at which the different skeletal dysplasias are seen vary; therefore, the diagnosis of an abnormality should not be excluded if it is not visualized during a single in utero examination. Often, serial examinations are necessary.

Prenatal sonographic evaluation of short-limbed dwarfism is initiated when a significantly shortened femur is found or by referral of a patient with a family history of skeletal dysplasia. If a short femur is demonstrated (length less than the 95% confidence limit), all the long bones are measured and evaluated for bowing, fractures, and mineralization. The bone dysplasia is categorized according to whether it is mesomelic, rhizomelic, or micromelic and whether bowing or fractures are present. The fetal spine, head, thorax, hands, and feet are carefully evaluated to differentiate the type of bone dysplasia and to determine whether it is lethal or not. The differentiation between the lethal and the nonlethal variety is very important in terms of antenatal care and the prediction of fetal outcome.

Thus, any apparently trivial finding of prenatal sonography suggesting musculoskeletal anomaly should be overlooked because it may be a part of wider chromosomal abnormality. So a detailed search for associated abnormalities should always ensue.

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Ibrahim Hamdy Mohamed Hamza

بسم الله الرحمن الرحيم

﴿ وَأَنزَلَ اللهُ عَلَيْكَ الْكِتَابَ وَالْحِكْمَةَ وَعَلَّمَكَ مَا لَمْ
تَكُنْ تَعْلَمُ وَكَانَ فَضْلُ اللهِ عَلَيْكَ عَظِيمًا ﴾

صدق الله العظيم سورة النساء آية (١١٣)

INTRODUCTION

Development of human embryo is a complex and evolutive process that requires accurate evaluation to detect any fetal malformation that may result in lethal or morbid outcome of pregnancy. Early and accurate antenatal diagnosis of fetal musculoskeletal malformations and differentiation between a lethal and a non-lethal variety has important implications for the management of a pregnancy and prediction of fetal outcome ***(Lee et al., 2002).***

Real-time three-dimensional ultrasound is tridimensional and intuitionistic, which produces more sufficient information for diagnosis of fetal surface malformations and is superior to two-dimensional ultrasound and a reliable technique in prenatal diagnosis ***(Chen et al., 2010).***

The 3D/4D ultrasound does not only enable the physician to precisely demonstrate isolated defects to the parents, but the technology can also provide more convincing evidence of a normal fetus than 2D sonograms in cases with increased recurrence risk ***(Merz et al., 2009)*****.**

When skeletal dysplasia is suspected antenatally, the use of 3D ultrasound in the examination of the fetal general appearance and bony structures provides additional information and facilitates antenatal diagnosis and management of the condition ***(Wong et al., 2008).***

The 3D ultrasound proves not only a useful tool in appreciating the severity of a fetal defect, but also provides more convincing evidence of a normal fetus than conventional two-dimensional sonograms in cases with increased risk of a recurrent surface malformation ***(Merz & Welter, 2005)***.

Three Dimensional Ultrasonography has become the new standard in prenatal diagnosis. This technique enables detailed examination of the fetal anatomy and higher quality depiction of congenital anomalies ***(Kurjak et al., 2002).***

Three-dimensional ultrasound can provide an intuitive and life like fetal surface structure of images which enriches the diagnostic information and enhances diagnostic confidence. It is complementarily of the two-dimensional ultrasound and the two in combination can increase the detection rate of the surface malformations ***(Zhang et al., 2010).***

The 3D imaging had advantages over the 2D imaging when it came to evaluation of facial dysmorphism, relative proportion of the appendicular skeletal elements and the hands and feet. Most importantly, the patient and referring physician appreciated the 3D images of the abnormal findings more readily which aided in counseling and management of the pregnancy ***(Krakow et al., 2003).***

AIM OF THE WORK

To prove significance in using three-dimensional (3D) ultrasonography compared to using two-dimensional (2D) ultrasonography in detecting fetal skeletal abnormalities.

PHYSICS OF THREE DIMENSIONAL ULTRASOUND

Development of 3D Ultrasound:

Szilard developed a mechanical three-dimensional (3D) display system to see a fetus three-dimensionally in 1974 ***(Szilard, 1974).*** Brinkley and colleagues developed a 3D position sensor for a probe. They acquired many tomographic images of a stillbirth-baby under water, traced its outline manually and showed its wire-framed 3D image in 1982. ***(Brinkely et al., 1982).***

A modern 3D ultrasound system was first developed by Baba and colleagues in 1986 and a live fetus in utero was depicted three dimensionally. The system was comprised of an ultrasound scanner, position sensor and a computer. An imaging technology named surface rendering was used for 3D image construction. ***(Baba and Satoh, 1986).***

A 3D probe and an ultrasound scanner, that displayed three orthogonal planes on a screen, were developed and became commercially available In the early1990's, clinical applications of the 3-orthogonal-plane display in obstetrics were reported ***(Kuo et al., 1992).*** Sohn reported translucent display by using volume rendering in 1991. ***(Sohn et al., 1991).*** Since then, the number of reports on a 3D image of the fetus increased rapidly because a 3D ultrasound scanner, that could construct and display 3D image as well as 3 orthogonal planes, and became commercially available. ***(Baba, 2004).***

Technical Aspects of 3D Ultrasound:

The three-dimensional data are usually acquired as a large number of consecutive tomographic images through movements of an ultrasound transducer array (conventional 2D ultrasound probe) and the 3D data are obtained automatically (Figure 1 & 2) ***(Smith et al.,1992).***

The 3D probe has a built-in transducer array (2D ultrasound probe) which tilts in the 3D probe, and 3D data are obtained automatically. Each tomographic image should be acquired with its positional information for the following process, construction of a 3D data set. Accurate positional information can be obtained through an electromagnetic position sensor or an electric gyro attached to the probe. ***(Smith et al.,1992).***

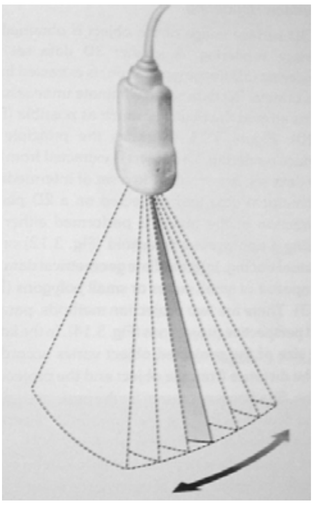

Figure (1): 3D Scanning by a 3D probe ***(Quoted from Baba et al.,2001).***

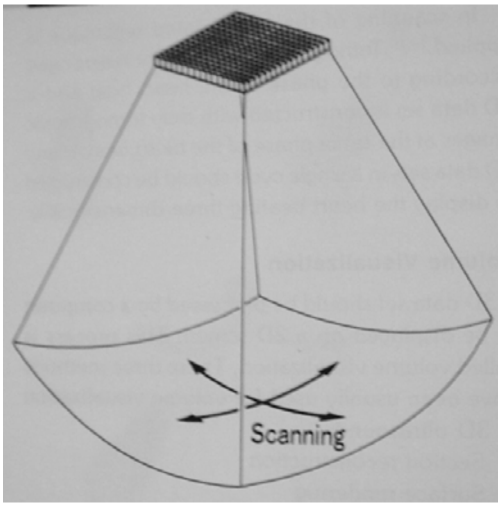

Figure (2): 2D array probe. Transducers are arranged two dimensionally and 3D scanning is performed electrically ***(Quoted from Baba et al.,1997)***