The role of three dimensional ultrasound examination in the evaluation of fetal skeleton during second trimester of pregnancy.

Thesis

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List of abbreviations:

2D………..Two dimensional ultrasound
3D………..Three dimensional ultrasound
4D….Real time three dimensional ultrasound
US………….Ultrasound
HC…………Head circumference
AC………Abdominal circumferences
FL……………..Femur length
HL……………Humerus length
BPD…………Biparietal diameter
mm………………Millimeter
3DXI....Three-Dimensional extended imaging
MSV………..Multi-slice view mode
OBV………….Oblique View mode
TVS………..Transvaginal ultrasound
TAS………Transabdominal ultrasound
MSD………..Mean sac diameter
OFD………Occipitofrontal diameter
AFI……….. Amniotic fluid index

BPP………….Biophysical profile
NST………….Cardiac Non-Stress Test
FBM…………Fetal breathing movements
FM…………...Gross fetal body movements
FT……………Fetal tone
AFV………….Amniotic fluid volume

List of Figures:

INTRODUCTION AND AIM OF THE WORK

Introduction:-

Today, every hospital and clinic has some form of ultrasound instrumentation to provide the clinician with an inside look at the soft tissue structures within the body. The two dimensional information is now able to be recreated into a three-dimensional format to provide a surface rendering of the area in question (**Hagen, 2001).**

It has been almost four decades since the first ultrasonic devices for imaging the fetus were developed. Conventional B-mode (two dimensional) ultrasound examination, which has been routinely used for the evaluation of fetal growth and development for more than two decades, has proved to be a powerful tool in modem obstetrics. Its two major failings, have been operator dependency and the inability to archive and review a complete examination. Its utility for dating pregnancies, assessing fetal growth and in detecting congenital malformations prenatally is well established **(Reece and Chan, 1997).**

Although very accurate, two dimensional (2D) ultrasonography is, due to physical, anatomical and topographical reasons, still limited by the rather restricted number of planes in which the object of interest can be depicted. Using 3D ultrasonography it is possible to depict an unlimited number of different planes in which the object of interest can be displayed **(Kos et al, 2002).**

These last years, the use of 3D and more recently 4D (life 3D-US) ultrasound has extended greatly and provides a clearer image of the fetus. It is used as a complementary tool to the 2D ultrasound examination of the fetus. It provides (in selected indications) additional information, especially when searching for dysmorphologic syndromes **(Avni et al, 2006).**

The major advantage of 3D, or “volume” ultrasound, that it could render US far less operator-dependent, markedly decrease scanning times, and standardize the entire process of performing an examination **(Benacerraf et al, 2006).**

Accurate prenatal diagnosis of skeletal dysplasia allows families to make appropriate decisions for obstetric management and delivery. The specific diagnosis of a skeletal dysplasia in utero requires familiarity with a complex algorithm of ultrasonographic (US) features. Although it is often difficult to determine the specific type of skeletal dysplasia present and whether it is lethal, this information may be extremely valuable in planning obstetric care **(Kareen et al, 2000).**

- The aim of the work is To demonstrate the role of three dimensional ultrasound in adding new dimension in the evaluation of fetal skeleton during second trimester of pregnancy.

Table of contents:

Dedication

This work is dedicated ***to my family mother , father , sister and brother*** *in appreciation of their support and loving encouragement.*

Discussion

At the present time high-resolution 2D scanning remains the cornerstone of prenatal diagnosis. The advantage of 3D over 2D imaging, apart from the apparent improvement in parental–fetal bonding and the increased facility to study fetal behavior. Nevertheless, new applications for 3D scanning are currently being explored in many centers as a result of the rapid improvement in equipment **(Campbell et al, 2005)**.

Acceptance of 3D ultrasound has been growing with technical improvements of 3D equipment during the past few years. These improvements include better image resolution, faster volume acquisition and rendering speed, interactive display and optimized user interface, and integration of color Doppler technique and harmonic imaging. Furthermore, the currently available technology enables real time (4D) visualization of the fetal surface **(Merz and Welter, 2005).**

Preliminary work suggests a role for three-dimensional sonography in more reliably assessing the fetal skeleton **(Sutton et al, 2003)**.

Chaoui R and Heling K (2006) reported the use of 3D ultrasound in the fetal skeleton examination, that the maximum-rendering mode highlights the maximal echo information of a volume dataset and is an ideal tool for the 3D reconstruction of bony structures. Cranial bones, the ribs, and other curvilinear bones, which cannot be properly visualized in a single 2D plane, are better assessed in a maximum-mode projection. This technique has been used to identify spine and limb abnormalities, and has recently been employed in the assessment of nasal bones, cranial bones, and their corresponding sutures.

In this work, **two groups** were evaluated, the **first group** was used to demonstrate the role of three dimensional ultrasound in adding new dimension in the evaluation of fetal skeleton during second trimester of pregnancy.

Gestational age:

In our study, visualization of skeletal anatomic structures observed to be increased with increasing the gestational age.

Platt LD (2000) stated that not all patients will have beautiful images made of their fetuses. Gestational age is very important; the best 3D US images are obtained from 10 to 12 weeks using an endovaginal transducer and from 24 to 30 weeks using a transabdominal transducer.

Amniotic fluid:

In this small study, the effect of the amniotic fluid on the surface rendering appearance was observed as all cases had satisfactory amniotic fluid which allowed appropriate 3D surface rendering.

Garjian et al, study (2000) stated that for satisfactory surface rendered images, the structure of interest must be surrounded by with amniotic fluid.

Baba el al, study (1999) also agreed on that surface-rendered images of the fetus with oligohydramnios and the fetus with thin skin or thin subcutaneous tissue were difficult to obtain with real-time-processible 3D US (4 D).

The face:

Cleft lip and palate are common cranio-facial malformations. A more accurate assessment of the extent of the cleft into the anterior alveolar ridge or the posterior palate can be achieved using multiplanar imaging. Surface rendering images are more easily understood by the parents and therefore more helpful in explaining to the family and to the surgeon **(Avni et al, 2006)**.

In this small study, three-dimensional US allowed clearer surface images of the fetal face than 2D US. Both multiplanar and surface rendering images are helpful for the evaluation of the fetal face.

Pretorius et al. in (1995) reported that the use of 3D sonography increased their ability to identify normal lips on sonograms from 76% with 2D technique to 92% with 3D technique and that 3D sonography showed the greatest diagnostic advantage in the subgroup of fetuses younger than 24 weeks gestational age and increased the confirmation of normal findings on sonograms in this subgroup from 68% to 93%. Fetuses of 24 weeks gestational age or older were adequately imaged using both 2D and 3D sonography.

Lee et al, (2000) study concluded that the diagnostic clues provided by the interactive review of multiplanar images and 3D surface reconstruction may allow better characterization of facial clefts. They should improve the ability to detect cleft palate defects, which have been otherwise very difficult to analyze by conventional 2D imaging alone. Surface rendering of the face may allow increased diagnostic confidence for normal and abnormal lips.

On the contrary **Ghi et al**, 2002 study concluded that the accuracy of conventional 2D ultrasound was very high, and was not increased by the use of 3D ultrasound. Three-dimensional ultrasound may facilitate the understanding of the lesion by the parents and facilitate communication with the plastic surgeons.

A recent development using the “3D reverse face view” has been shown to ensure a more accurate diagnosis of clefts of the posterior palate. By rotating the face by 180°, it is approached from the posterior plate to the anterior plate and this rendered the anatomical delineation easier **(Campbell et al, 2005)**.

Leung et al, study (2005) described Three-Dimensional extended imaging (3DXI) which is a new post-processing package. It includes the Multi-Slice View (MSV) and Oblique View (OBV) modes. They found that 3DXI was another tool which could allow the assessment of the integrity of the alveolus and secondary palate. Unlike the rendering mode, the size of cleft alveolus/palate can be measured in MSV mode.

The vault:

Recognition of craniosynostosis may be important in prenatal screening of families with a history of a syndrome associated with craniosynostosis. Therefore, correct prenatal diagnosis is important **(Dikkeboom et al, 2004)**.

In this study, three dimensional US enabled visualization of cranial sutures and fontanels that have not been assessable by 2D US, by using rendered images and adequate rotation. Gestational age clearly influenced the ability to visualize the cranial sutures and fontanels. 3D ultrasound identified fewer sutures and fontanels with advanced gestational age.

Dikkeboom et al, study (2004) concluded that 3D ultrasound can be a reliable technique for visualizing the fetal cranial sutures and fontanels. With the recording of a sagittal and a transverse scan most of the sutures and fontanels can be made visible during the second half of pregnancy. The addition of a sagittal scan visualizing the back of the head of the fetus could improve visualization of the sagittal suture and posterior fontanel. Visualization may also be affected by the size of the sutures which become smaller later in fetal development.

Chaoui et al, preliminary study (2005) described patterns of abnormal development of the metopic suture in association with fetal malformations during the second and third trimesters of pregnancy.

Faro et al, (2005) study provided 3D ultrasound images that illustrate the process of ossification of the frontal bones and the subsequent development of the metopic suture during prenatal life.

In the case with encephalocele, a midline occipital bony defect with a membranelike swelling herniating through it and little brain tissue within it was more definite by 3D ultrasound more than 2D ultrasound. The ability to view and manipulate the three orthogonal planes simultaneously using 3D ultrasound, allowed a more precise demonstration of the anatomy and demonstration of the skull defect.

Demonstration of the occipital skull defect and continuity between the encephalocele contents and the intracranial structures aided diagnosis of encephalocele as the differential diagnosis following 2-D scan was cervical meningomyelocele.

After the final diagnosis elected pregnancy termination was done for this case.

Mueller et al, 1996 study stated that the ability to rotate the images of a scan frame-by-frame provided projections of the fetus either not possible using conventional 2-D imaging techniques or difficult to obtain because of fetal position.