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Prenatal assessment of fetal subcutaneous fatty area using 3D ultrasound techniques; Tomographic Ultrasound Imaging: Technique standardization

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Objective

For adequate in-utero development to occur, a lot of factors that affect human fetal growth need to act synergistically, thereby enabling newborns to reach their genetic growth potential and to attain what is considered to be "normal" weight and body composition (balance of lean mass and fatty mass). Alterations in growth and body composition in the fetus increase perinatal morbidity and mortality as well as the pathological processes that continue well beyond the neonatal period. Some authors have even found a direct relationship between these alterations and the presentation of certain degenerative chronic illnesses in adulthood, such as hypertension, diabetes, metabolic syndrome and cardiovascular disease, among others (1). In 1997, Bernstein described a prenatal 2D ultrasound technique to measure subcutaneous fatty tissue in the arm and thigh, by manually selecting the axial planes of the bone, in order to assess fetal body composition and to demonstrate differences between accumulated fatty and lean tissue during the second half of gestation. However, this manual selection of the planes can cause biases and lack of reproducibility in the measurement technique (2). The aim of this study was to evaluate the subcutaneous fatty tissue using of 3D ultrasound volume acquisition along with an offline analysis using Tomographic Ultrasound Imaging (TUI), in order to evaluate the technique's reproducibility. Three ultrasound experts (maternal and fetal medicine specialist) participated in this process.

Methods

This study was performed from January 2017 to April 2017 at the fetal growth clinic of the Maternal and Fetal Medicine Department through its Research Unit, at the National Institute of Perinatology. A total of 15 pregnant patients between 32. 0-36. 6 weeks of gestation participated. Gestational age was determined based on day of last menstruation and was corroborated with early USG (before 14 weeks of gestation). Before inclusion in the study, the patients were invited to take place and were explained the risks and benefits. Signed informed consent was also obtained. The ultrasound assessment was performed using a Voluson E8 (General Electric Healthcare ®) equipment with a volumetric transducer (4-8 MHz). The 3D volumes were obtained with a sweep angle of 30º and an acquisition time of 10 seconds. The arm and thigh closest to the mother's abdominal wall were selected and the transducer was placed as close as possible to the extremity without applying pressure, while there was no movement of the fetus or mother. The volumes acquired were evaluated in an offline analysis using the General Electric ViewPoint 4D and the tool Tomographic Ultrasound Imaging (TUI). The volume was programmed with thirteen tomographic axial planes of the femur and the humerus, with the shaft centered to obtain six right and six left planes, dividing the bone into equal distances. Lean and fatty tissue in the extremities were evaluated based on sagittal planes of the arm and thigh, with predetermined settings for 3D evaluation in the second and third trimester. Contrast and zoom were used, so that the structure would fill 70 to 80% of the screen. The focus was adjusted at the zone of interest, which was located at the center, and the gain was adjusted to optimize the image. Soft tissue borders were enhanced by use of a color filter (sepia) with additional gamma curve adjustments for brightness and contrast. Fatty subcutaneous area tissue was obtained by taking the total area obtained in this image and subtracting the center area corresponding to lean mass, which consists of bone and muscle. The offline analyses were conducted by three ultrasound experts (maternal fetal medicine specialists), to obtain the inter-observer agreement. The agreement was evaluated according to the scale proposed by Landis and Koch. The statistical analysis was performed using the SPSS program, version 22 (IBM® SPSS® Statistics), using Intraclass Correlation Coefficient (ICC).

Results

Fifteen patients were evaluated, the mean maternal age was 31. 2 years and the mean gestational age at the time of the study was 34. 1 weeks of gestation. Thirteen axial planes were evaluated to determine the area corresponding to fatty tissue in femur and humerus. The ICC´s for inter-observer agreement in the humerus were: plane 1 (0. 90), plane 2 (0. 95), plane 3 (0. 94), plane 4 (0. 94), plane 5 (0. 90), plane 6 (0. 95), plane 7 (0. 90), plane 8 (0. 96), plane 9 (0. 98), plane 10 (0. 90), plane 11 (0. 91), plane 12 (0. 76), plane 13 (0. 77). The ICC´s for inter-observer agreement in the femur were: plane 1 (0. 92), plane 2 (0. 80), plane 3 (0. 94), plane 4 (0. 91), plane 5 (0. 94), plane 6 (0. 93), plane 7 (0. 91), plane 8 (0. 91), plane 9 (0. 91), plane 10 (0. 85), plane 11 (0. 88), plane 12 (0. 84), plane 13 (0. 90).

Conclusion

The thirteen evaluated axial planes shown an intraclass correlation coefficient higher than 0. 80, which according to the scale of Landis and Koch scale, is considered to be an almost perfect agreement. In clinical practice it is complicated to use 13 axial planes, so for medical application we are proposing to use three axial planes for the evaluation of fatty tissue in humerus and femur: the union of the proximal third with the two distal thirds, the middle of the bone, and the union of the distal third with the proximal thirds, these three axial planes have an ICC greater than 0. 90, so it is considered that the use of TUI in the evaluation of fatty tissue is a very reproducible tool and superior to the 2D measurement proposal. Following this same research line, we are proposing the following three steps: the evaluation of differences between the area of fatty tissue in different populations (between healthy fetuses vs fetuses with pathology), the evaluation of the correlation between the measurement of the subcutaneous fatty mass area and the percentage of fat at birth, measured by plethysmography by air displacement (Pea Pod), and the elaboration of a formula to estimate the percentage of prenatal fat, using the measurements of fatty tissue subcutaneous in humerus and femur. References: 1 Mongelli M, Gardosi J. Fetal growth. Curr Opin Obstet Gynecol. 2000, Apr;12(2): 111-5. Review. 2 Bernstein IM, Goran MI, Amini SB, Catalano PM. Differential growth of fetal tissues during the second half of pregnancy. Am J Obstet Gynecol. 1997 Jan;176(1 Pt 1): 28-32.