Intra- and inter-observer reproducibility study of gestational age estimation using three common foetal biometric parameters: Experienced versus inexperienced sonographer

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ARTICLE INFO

ABSTRACT

Aim: To assess reproducibility of estimating gestational age (GA) of foetus using femur length (FL), biparietal diameter (BPD) and abdominal circumference (AC) within experienced and inexperienced sonographers and between the two.
Patients and methods: Two sets of GA estimates each were obtained for FL, BPD and AC by the two observers in 20 normal singleton foetuses. The first estimates for the three biometric parameters were made by the experienced sonographer. Subsequently, the inexperienced sonographer, blind to the estimates of the first observer obtained his own estimates for the same biometric parameters. After a time interval of ten minutes the process was repeated for the second set of GA estimates. All the gestational age estimates were made following standard protocol. Statistical analysis was performed by Pearson's and intraclass correlations, coefficient of variation and Bland—Altman plots. Statistical inferences were drawn at $p < 0.05$.
Results: The Pearson's and intraclass correlations of between GA estimates within and between both observers from measurement of FL, BPD and AC were very high and statistically significant ($p < 0.05$). Coefficient of variation for duplicate measurements for GA estimates within observers and between observers were quite negligible. Between observers, the first and second GA estimates from FL measurements showed the least variation. Estimates from BPD and AC measurements showed greater degree of variation between the observers.
Conclusion: Reproducibility of GA estimation using FL, BPD and AC within experienced and inexperienced sonographers and between the two was excellent. Therefore, a fresh Nigerian radiography graduate with adequate exposure in obstetric ultrasound can correctly determine the gestational age of foetus in routine obstetric ultrasound without supervision.

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Introduction

Ultrasound has become an integral part of obstetric care in Nigeria. It is a non-invasive method of assessing the foetus and other contents of the uterus. Prenatal ultrasound examination is a very important procedure to the obstetrician. Many clinical decisions depend upon accurate and reproducible measurements of foetal biometry.[1] The best practice of obstetrics presently requires an assessment of gestational age by accurate measurement of foetal biometric parameters. Ultrasound foetal biometry is the measurement of different body parts of the foetus as part of prenatal ultrasound examination. It is the commonest method for establishing gestational age,[2] and provides the most reliable and important information about foetal growth and wellbeing.[3]

Prenatal ultrasound is usually performed by a qualified sonographer or a sonologist. In some cases, where the sonographer and sonologist are available and work together, the sonographer performs the examination and the sonologist interprets the images and issues a report. Some Nigerian obstetricians also perform

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prenatal ultrasound examination having acquired satisfactory competence during their residency training. Obstetrics and gynaecological ultrasound is part of the training in obstetrics and gynaecology of both the National Postgraduate Medical College of Nigeria and West African College of Surgeons. In Nigeria, sonographers are usually radiographers who have acquired competence in medical ultrasonography during their training either at undergraduate or postgraduate level. There is no separate training for sonographers in Nigeria. There are six universities in Nigeria which run the Bachelor of Science programme in radiography and all of them have medical ultrasonography as a course in their curricula. This is in fulfilment of the Radiographers Registration Board of Nigeria (RRBN) minimum professional benchmark and National Universities Commission (NUC) minimum academic benchmark for training of radiographers in Nigeria. During the five-year full time programme, students are exposed to clinical ultrasound in third, fourth and fifth years. During this period they spend fifty percent of their time on clinical postings and are expected to acquire competence in all imaging modalities including ultrasound.

Ultrasound is exceptionally reliable in the field of obstetrics for estimation of gestational age by accurate measurement of foetal biometry, which can be carried out by two or more observers. The protocol for obstetric ultrasound is usually standardized and followed strictly to make ultrasound foetal study reproducible. This will enable observation made by one sonographer to be re-evaluated by another sonographer. The importance of ascertaining the reliability of sonographic measurement is to further improve the accuracy of gestational age estimation during pregnancy, taking into consideration that many clinical decisions are dependent on it.[1]

Reproducibility study of a diagnostic procedure evaluates whether two observers find the same result in the same patient (inter-observer reproducibility) or whether a single observer (intra-observer reproducibility) finds the same result in the same patient on two separate moments in time.[4] Statistically, relationship and agreement between pairs of measurements is evaluated by Pearson's correlation coefficient,[5] intraclass correlation coefficient[6] and coefficient of variation. Additional method of assessing agreement is by graphical evaluation proposed by Bland and Altman.[7] There have been some studies on reproducibility of foetal biometric measurements.[1,8,9]

Shortage of manpower to serve a highly populated country like Nigeria has created an avenue for fresh graduate radiographers to undertake clinical ultrasound duties with minimal supervision. This could result in misdiagnosis as these young radiographers have not undergone tutelage under experienced sonographers. The aim of this study was therefore, to assess reproducibility of estimating gestational age by measurement of three common foetal biometric parameters between an experienced sonographer and an inexperienced sonographer (a graduating radiography student). The foetal biometric parameters for which reproducibility for estimation of gestational age was evaluated were femur length (FL), biparietal diameter (BPD) and abdominal circumference (AC). We evaluated reproducibility of BPD because it continues to be a common biometric parameter measured in Nigeria, although it has been replaced by head circumference (HC) in some countries. The accuracy of gestational age estimation from BPD is dependent on head shape whilst HC is independent of head shape[10] and is unaffected by head compression.[11] This enables the HC to be a better parameter for gestational age estimation.[11]

Patients and methods

This was a prospective study that assessed intra-observer and inter-observer variations in estimating gestational age of foetus in the second half of pregnancy by three common biometric parameters namely; FL, BPD and AC. The research design and protocol was approved by the Research Ethics Committee of Waves Medical Diagnostic and Research Centre, Nnewi, Anambra State, Nigeria. Twenty consenting non-obese women (body mass index $\leq$ 30 kg/m^2) with normal singleton pregnancies of between 23 and 39 weeks GA (dated by last menstrual period) were selected for this study. This is in view that a similar study by Valentine and Bergeline[12] evaluated the same number of women. The women were patients who presented for routine prenatal ultrasound examination. They underwent trans-abdominal ultrasound evaluation by one experienced sonographer and an inexperienced sonographer. The experienced sonographer has practised obstetric sonography for twelve years by the time the study commenced. He has a Bachelor of Science (B Sc.) degree in medical radiography and a Master of Science degree (M Sc.) in medical imaging. The inexperienced sonographer was a graduating student of radiography who was exposed to obstetric sonography as part of the normal clinical posting for a period of two and half years. Prior to the commencement of the study he demonstrated good theoretical knowledge of measurement of foetal biometric parameters and carried out some measurements under the guidance of the experienced sonographer.

A consenting patient who met the inclusion criterion was examined separately by the two sonographers using a **Siemens Sonoline Versa Pro** ultrasound machine (manufactured in January, 1997 by **Siemens Medical Systems, AG**) with 3.5 MHz curvilinear transducer. Two sets of gestational age estimates each were obtained for FL, BPD and AC by the two sonographers. The first estimates for the three biometric parameters were made by the experienced sonographer. Subsequently, the inexperienced sonographer (graduating student), blind to the estimates of the experienced sonographer obtained his own estimates for the same biometric parameters for the first set of estimates. After an interval of ten minutes the process was repeated for the second set of gestational age estimates. This was to reduce intra-observer bias.

Measurement for each of the three biometric parameters for estimation of gestational age was made following the standard protocol described by Chudleigh and Pearce.[13] The FL was measured from the greater trochanter of the femur to the lateral condyle of the femur as illustrated in Fig. 1. Care was taken to ensure that only the femoral diaphysis was included and that the hypoechogenic cartilaginous structures at either end of the femur were excluded. The BPD was measured from an axial image through

Figure 1. Sonogram illustrating measurement of femur length (FL).