



## SCHOLAR TWINNING ARTICLE

# Gestational Age Estimation Based on Fetal Pelvimetry on Fetal Ultrasound in Iraqi Women

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### Abstract

Ultrasound is an integral part of obstetric practice, and assessment of gestational age (GA) is a central element of obstetric ultrasonography. Sonographic estimation of GA is derived from calculations based on fetal measurements. Numerous equations for GA calculation from fetal biometry have been adopted in routine practice. This study reports a new method of estimating GA in the second and third trimester using interischial distance (IID), the distance between the two ischial primary ossification centers, on fetal ultrasound. Four hundred women with uncomplicated normal singleton pregnancies from 16 weeks to term were examined. Standard fetal obstetric ultrasound was done measuring biparietal diameter (BPD) and femur length (FL) for each fetus. The IID, in millimeters, was correlated with the GA in weeks based upon the BPD and FL individually, and the BPD and FL together. Statistical analysis showed strong correlation between the IID and GA calculated from the FL with correlation coefficient ( $r = 0.989$ ,  $P < 0.001$ ). Strong linear correlation was also found between the IID and GA based upon BPD and BPD+FL. Further statistical analysis using regression equations also showed that the IID was slightly wider in female fetuses, but this difference was not statistically significant. Resulting from this analysis, we have arrived at an easy-to-use equation:  $GA \text{ Weeks} = (IID \text{ mm} + 8) \pm 1 \text{ week}$ . We feel this method can be especially applicable in the developing world, where midwives may not have access to software for fetal biometry in their basic handheld ultrasound machines. Even more sophisticated machines may not come with loaded software for obstetrics analysis. There are several limitations to this study, discussed below. We recommend further studies correlating the IID with other biometric parameters.

### Introduction

ACCURATE determination of fetal gestational age (GA) is fundamental to obstetric care and is important in a variety of situations. Precise GA estimation allows for timely delivery or abortion, maternal counseling, fetal management after delivery, accurate interpretation of biochemical and serum tests, and timely scheduling of invasive diagnostic tests such as chorionic villous sampling or amniocentesis. Appropriate timing of these tests is crucial for patient safety and positive outcomes of any procedures performed (1). Uncertain gestational age has been associated with higher perinatal mortality rates, an increase in low birth weight, and spontaneous preterm delivery (1,2).

Virtually every measurable structure in the fetal body has been used to calculate gestational age; most commonly used are crown-rump length (CRL), biparietal diameter (BPD), femoral length (FL), head circumference (HC), abdominal circumference (AC) and certain soft tissues. Fetal growth of these measurements is linear in the first half of pregnancy, and generally non-linear in the second half. In addition, there are racial and geographic variations in growth patterns. Hence, statistical graphs and computed software are routinely employed to calculate fetal maturity.

In the developing world, ultrasound machines, when available, are generally basic and may not come loaded with fetal biometric statistical software. Primarily, cranial landmarks, long bones and abdominal girth

have been used to establish ultrasound GA estimation. Fetal radiography for secondary ossification centers around the knee and hip joints have also been used for biometry (3). In this report we describe the use of the distance between the primary ossification centers of the fetal ischium and compare our results with the commonly used Hadlock charts for fetal biometry. We report an easy-to-use formula, derived from fetal interischial distance (IID), to calculate gestational age on ultrasound scanning, without the aid of complex graphs and statistical software.

**Patients and methods**

Four hundred pregnant females were examined between November 2013 and June 2014 in the Department of Radiology of the Al-Zahra Teaching Hospital in Al Najaf, Iraq using General Electric Logic-200 ultrasound machines with standard transducers. Fetal ischial primary ossification centers (IPOC) were visualized and IID measured in each case. Subjects were between 19 and 38 years of age. Inclusion criteria were: single pregnancy with GA from 16 weeks to term. GA was determined by conventional methods: accurate dates of the last menstrual period (LMP), BPD, and FL. Fetal gender was recorded to assess any gender variation in the IID. Exclusion criteria were: any condition that might affect normal fetal growth, uncertain dates, chronic maternal illness, multiple pregnancies, and suspected growth retardation. Each patient had standard obstetric ultrasound study estimating GA and fetal survey. IPOCs were located by scanning the fetus in the coronal plane down the fetal spine until pelvic outlet. The bilateral IPOCs were identified as symmetrical echogenicities in ischial bones caudal to the levels of the hip joints (Fig. 1). Ischial primary ossification centers (IPOC) were visualized and IID was measured placing the calipers at the center of the caudal ends of the IPOCs. Three measurements were taken in each case and an average recorded (Fig. 2).

To assess the accuracy and reliability of the IID in estimating GA in clinical practice, we plotted the IID GA, both in male and female fetuses, against Hadlock standard reference charts for GA estimation based on BPD (Fig. 3,4), FL (Fig. 5,6), and FL + BPD together (Fig. 7,8) (2).

**Results**

Four hundred pregnant women met the inclusion criteria. Eighteen women were at 16 weeks of gestation, and the rest had more advanced gestation. IPOCs were visualized and IID measured in all cases. Of the 400 fetuses, there were 216 (54%) male fetuses, 184 (46%) were females, a ratio of 1.17.

At 16 weeks the IPOC appeared as thin linear echogenicities. As IPOC grew with the IID, the IPOC assumes thick oval shape and diverged posteriorly along with the ischial bones (Fig. 1). At 16 weeks the IID measured 8mm and grew to 32 mm at full term, with a linear growth rate of 1 mm per week, both in male and females fetuses (Fig. 2). The IID was slightly wider in females than males; however, this difference was not statistically significant.

*Statistical analysis*

In testing the IID as an independent predictor for fetal dating, as stated above, we plotted the IID against the GA based on FL and BPD separately and together from Hadlock reference charts (2).

The correlation coefficient for IID versus BPD in male fetuses was  $r=0.989$ ,  $P<0.001$  (Fig. 3). In female fetuses the correlation coefficient was  $r=0.962$ ,  $P<0.001$  (Fig. 4).

GA based on IID vs. FL (n=400): For IID versus FL, in male fetuses, the correlation coefficient was  $r=0.988$ ,  $P<0.001$  (Fig. 5). In female fetuses the correlation coefficient was

**Figure 1a. Inter-ischial distance.**

8 mm at 16 weeks.

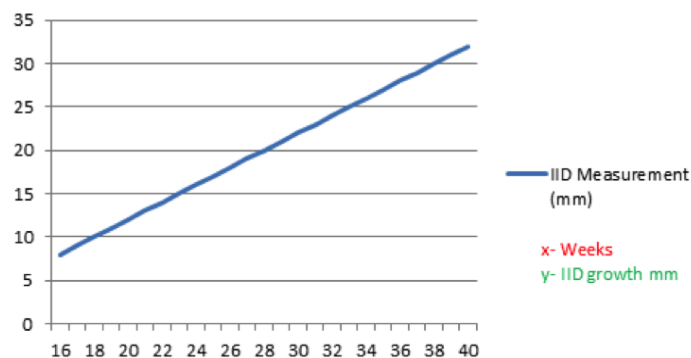


**Figure 1b. Inter-ischial distance.**

26 mm at 34 Weeks.



**Figure 2. Linear growth of IID measurements.**



$r=0.934$ ,  $P<0.001$  (Fig. 6).

In male fetuses, for IID versus combination of BPD + FL,  $r=0.995$ ,  $P<0.001$  (Fig. 7). In female fetuses, for IID versus combination of BPD + FL,  $r=0.991$ ,  $P<0.001$  (Fig. 8).

These results confirm a strong correlation between IID and standard and well-established fetal biometric parameters.

Figure 3. Correlation between IID with GA based on BPD (Hadlock) in male fetuses.

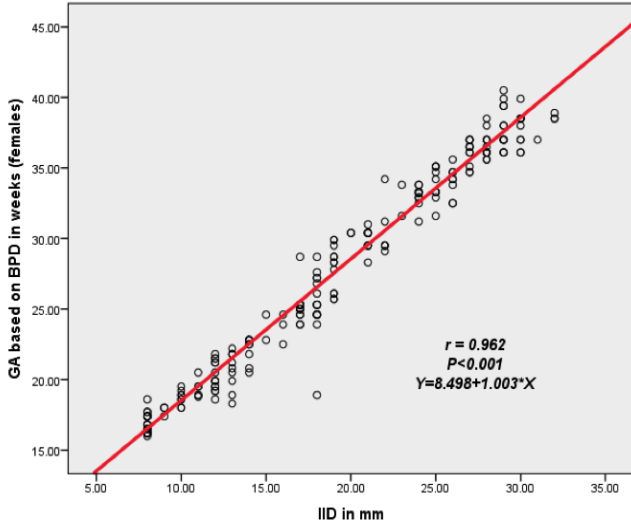


Figure 4. Correlation between IID with GA based on BPD (Hadlock) in female fetuses.

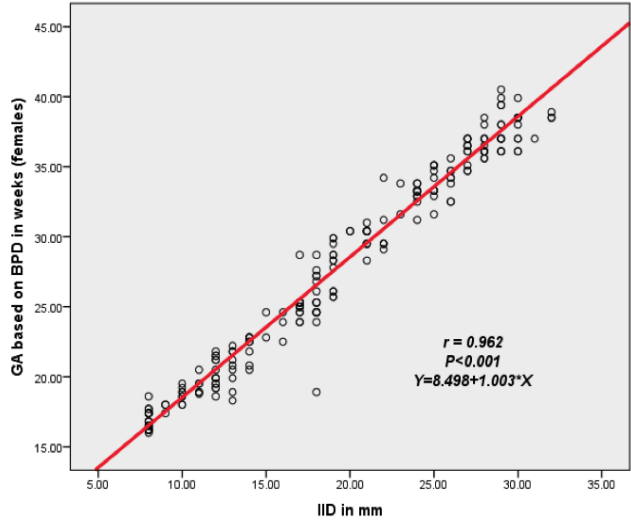


Figure 5. Correlation between IID with GA based on FL (Hadlock) in male fetuses.

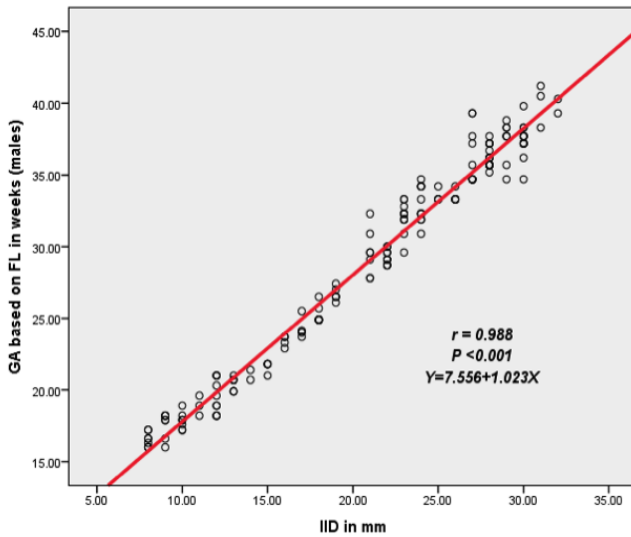


Figure 6. Correlation between IID with GA based on FL (Hadlock) in female fetuses.

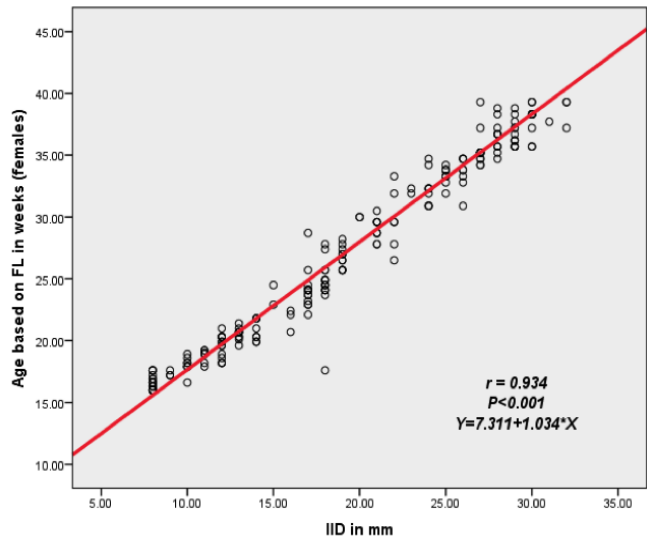


Figure 7. Correlation between IID (mm) with GA based on BPD + FL in male fetuses.

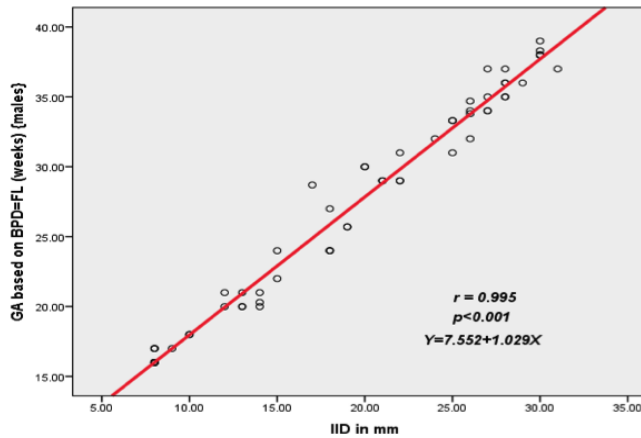
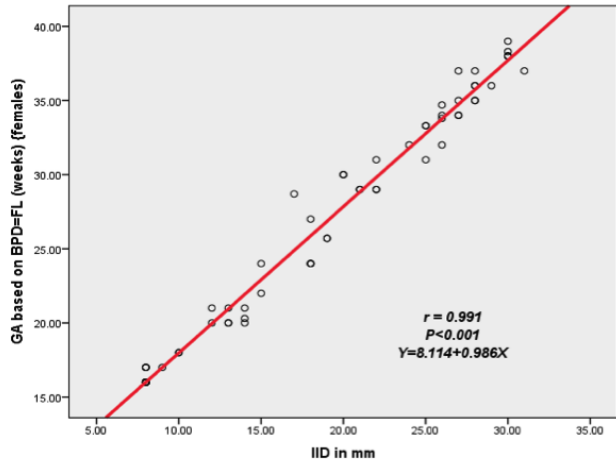


Figure 8. Correlation between IID (mm) with GA based on BPD + FL in female fetuses.



Based on the above analyses the formula  $GA\text{ weeks}=(IID\text{ mm} + 8) \pm 1$  seems to be concordant with the standard fetal biometry after 16 weeks GA.

## Discussion

Ultrasound machines in the clinical settings are preloaded with fetal biometric software from leading researchers (2). These consist of graphs of fetal measurements, BPD, FL and several other parameters versus the gestational age. The Hadlock chart is one such work that is universally accepted and routinely used (2). Fetal GA is calculated with the click of a button after populating biometric fields with the ultrasound fetal measurements. Radiographically, distal femoral and proximal tibial secondary ossification centers have also been described for fetal biometry (3), but these are only applicable around term. To our knowledge, primary ossification center has not been reported for ultrasound fetal biometry.

Hadlock et al. demonstrated the variability to be  $\pm 1$  week between 14 to 20 weeks of gestation in a population of 1,771 patients (2). Similar results have been reported by Persson and Weldner (4, 5). One of these studies has reported FL to be the most accurate of all the individual biometric parameters in predicting GA (6). As the growth rate of BPD and FL increases with fetal age, the above quoted and other studies in ultrasound literature have demonstrated decreasing accuracy in GA calculation from 20 weeks to term. Near term, the variability between the estimated and actual fetal GA can range up to 4 weeks,  $\pm 2-4$  weeks.

Ischial primary ossification center (IPOC) appears at the sixteenth week of gestation (7). From 16 weeks to term, IPOC can always be visualized with ease. In all 18 fetuses scanned at 16 weeks in this study, bilateral IPOCs were visualized as thin linear echogenicities (Fig. 1).

Plotting IID against the universally accepted biometric parameters by Hadlock, using BPD and FL alone and in combination in males and females (Fig. 3-8), confirmed a strong statistical correlation between IID and the established parameters. The P value was  $< 0.05$  with all comparisons. Our data demonstrate that the IID grew at a constant rate of 1 mm per week from 16 weeks to term, unlike the BPD and FL, which exhibit accelerated growth in the third trimester causing inaccuracies. Based on IID, gestational age estimation had an accuracy of  $\pm 1$  week in the second and third trimesters. This observation seems to make IID more accurate than any standard parameter in the second and third trimesters of pregnancy with traditional fetal biometry (8). Obtaining IID as a single biometric measurement has advantages: it provides for reduction in scanning time with reduced fetal exposure to 'harmless' ultrasound waves (7), it allows for more careful scanning of the fetal pelvis which may depict congenital or chromosomal abnormalities, and most importantly, it is an accurate and rapid equation for GA calculation in weeks ( $\text{weeks}=(IID\text{mm}+8) \pm 1$  week), obviating the need for reference charts or software updates (6, 9). This can be particularly important in developing countries where sophisticated ultrasound equipment and software may not be available, and where midwives using handheld ultrasound machines would find it easy to use the above formula.

Published studies have shown that male fetuses have significantly larger BPD compared with female, and these differences increased with advancing gestation (10). However, in practice, one set of biometry charts are used both for the males and female fetuses. We found that IID was larger in female fetuses compared with male, and the difference grew in the third trimester, but the difference was not statistically significant. For practical purposes the rate of IID growth was constant from 16 weeks to term, at 1 mm per week in both male and female fetuses.

In conclusion, we describe IID's role as a new fetal bio-

metric measurement for GA estimation. We demonstrate that IID may be used with confidence for GA estimation in place of the BPD and FL. In an attempt to reduce the complexity of regression equations and obviate the need for computer software, we have arrived at the following equation:  $GA\text{ weeks}=(IID\text{ mm} + 8) \pm 1$  weeks. We feel this formula can be used in clinical practice. It is particularly applicable for use in the developing world. There are limitations to this study, namely that the sample size is small, at only 400 cases. The data are not applicable in the first trimester of pregnancy, and this is a single study from one medical center. Further studies are needed to assess the role or value of IID in fetal growth, growth rate, fetal growth retardation and possible screening for certain congenital anomalies.

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