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Comparison between Femur Length Measurements by ultrasound and Last Menstrual Period for Gestational Age Assessment: Influencing Factors in the Third Trimester

Samer Fadhel Alwazni [1*], Maysaa Jasim Mohammed [2], Muna Sami Rahman Abu-Ragheef [3]
[1] College of Medicine, Wasit University, Al-Kut, Wasit, Iraq
[2] Al-Batool Teaching Hospital for Obstetrics, Gynecology and Pediatrics, Al-Kut, Wasit, Iraq
[3] Al-Zahraa Teaching Hospital, Iraq
*Corresponding: salwazni@uowasit.edu.iq

مقارنة بين قياسات طول عظم الفخذ بالموجات فوق الصوتية وتاريخ آخر دورة شهرية لتقييم عمر الحمل: العوامل المؤثرة في الثلث الثالث من الحمل

سامر فاضل الوزني [1*] , ميساء جاسم محمد [2] , منى سامي الرحمن أبو رغيف [3]
[1] كلية الطب، جامعة واسط، الكوت، واسط، العراق
[2] مستشفى البتول التعليمي لأمراض النساء والولادة والأطفال، الكوت، واسط، العراق
[3] مستشفى الزهراء التعليمي، العراق

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Abstract:

Background: Measurement of the femur length (FL) is one of the basic measurements used in obstetrics to determine gestational age (GA), especially during the second and third trimesters of pregnancy, by ultrasonography. However, its accuracy is influenced by a number of clinical and technical factors such as gestational age, fetal lie, position of the placenta and maternal age. These modulating factors should be well understood to enhance the reliability of fetal biometry and to help detect fetal growth abnormalities like intrauterine growth restriction (IUGR) early. **Methods** The study was conducted in third trimester pregnant women who attended private obstetric clinics, in Wasit and Baghdad governorates in Iraq, during a period of September 2023 – September 2024. The length of the femur was measured by ultrasound machine Philips HD11 (3.5 MHz convex probe) in accordance with the standard obstetric biometry protocol. LMP derived gestational age discrepancies were divided into 6 categories: A = no discrepancy; B = 1-7 days discrepancy; C = 8-14 days discrepancy; D = 15-21 days discrepancy; E = 22-28 days discrepancy; F = 29-35 days discrepancy. **Results**: Most of the cases (46.67%) belonged to Group B (1-7 days). The most common fetal lie was longitudinal cephalic (84%), which correlated with the most consistent FL measurements. Anterior placental position was the most common (50.67%) and showed the widest distribution of discrepancy categories. The highest consistency in measurement was found in women aged 21-30 years. **Conclusions**: The fetal lie, placental position, gestational age and maternal age are significant factors affecting the accuracy of FL measurement in the third trimester. These variables must be documented systematically during obstetric ultrasound and other biometric variables are recommended for use in improving accuracy in the estimation of GA.

Keywords: Femoral Length; Gestational Age; Ultrasonography; Fetal Biometry; Third Trimester; Last Menstrual Period; Iraq.

الملخص

الخلفية :يُعد قياس طول عظمة الفخذ (FL) أحد القياسات الأساسية المستخدمة في طب التوليد لتحديد العمر الحملي(GA) ، لا سيما خلال الثلثين الثاني والثالث من الحمل، وذلك عن طريق التصوير بالموجات فوق الصوتية. ومع ذلك، تتأثر دقة هذا القياس بعدد من العوامل السريرية والتقنية مثل العمر الحملي، ووضعية الجنين، وموقع المشيمة، وعمر الأم. وينبغي فهم هذه العوامل المعدلة فهماً جيداً لتعزيز موثوقية القياسات الحيوية للجنين والمساعدة في الكشف المبكر عن تشوهات نمو الجنين مثل تقييد النمو داخل الرحم (IUGR).**الطرق :**أُجريت هذه الدراسة على نساء حوامل في الثلث الثالث من الحمل ممن راجعن عيادات التوليد الخاصة في محافظتي واسط وبغداد في العراق، خلال الفترة من سبتمبر 2023 إلى سبتمبر 2024. تم قياس طول عظمة الفخذ باستخدام جهاز الموجات فوق الصوتية Philips HD11 (مجس محدب بتردد 3.5 ميجاهرتز) وفقاً لبروتوكول القياسات الحيوية التوليدية القياسي. تم تقسيم تباينات العمر الحملي المشتقة من آخر دورة شهرية (LMP) إلى 6 فئات: الفئة = A لا يوجد تباين؛ الفئة = B تباين من 1-7 أيام؛ الفئة C = تباين من 8-14 يوماً؛ الفئة = D تباين من 15-21 يوماً؛ الفئة = E تباين من 22-28 يوماً؛ الفئة F =تباين من 29-35 يوماً .**النتائج :**انتمت معظم الحالات (46.67%) إلى الفئة B (1-7 أيام). وكانت وضعية الجنين الأكثر شيوعاً هي الوضعية الطولية الرأسية (84%)، والتي ارتبطت بقياسات طول عظمة الفخذ الأكثر اتساقاً. كان توضع المشيمة الأمامي هو الأكثر شيوعاً (50.67%) وأظهر أوسع توزيع لفئات التباين. وقد وُجد أعلى مستوى من الاتساق في القياس لدى النساء اللاتي تتراوح أعمارهن بين 21-30 عاماً .**الاستنتاجات :**تُعد وضعية الجنين، وموقع المشيمة، والعمر الحملي، وعمر الأم عوامل مؤثرة بشكل كبير على دقة قياس طول عظمة الفخذ في الثلث الثالث من الحمل. يجب توثيق هذه المتغيرات بشكل منهجي أثناء الفحص بالموجات فوق الصوتية التوليدية، كما يوصى باستخدام متغيرات قياس حيوي أخرى لتحسين دقة تقدير العمر الحملي.

الكلمات المفتاحية: طول عظمة الفخذ؛ العمر الحملي؛ التصوير بالموجات فوق الصوتية؛ القياسات الحيوية للجنين؛ الثلث الثالث من الحمل؛ آخر دورة شهرية؛ العراق*TDI*.

1. Introduction

Determination of gestational age (GA) is one of the most basic duties of obstetricians. It helps inform clinicians when to deliver, when to suspect growth issues and how to manage high-risk pregnancies. Estimation of GA has traditionally been based on the last menstrual period (LMP), but this is only an approximation, due to the variability between women in the timing of ovulation and fertilization, which generally takes place about two weeks after LMP. It has been found that the LMP based dating method may be a month or two off in a substantial number of cases, especially when periods are irregular [1, 2].

Since its introduction into use, ultrasonography has revolutionized obstetrics. The ultrasound imaging modality is safe, non-invasive, repeatable and not teratogenic, unlike ionising radiation-based imaging techniques such as X-ray, which are contraindicated in routine prenatal imaging [3]. Modern systems, such as Philips HD11, rely on high frequency sound waves that are sent and received by a convex transducer, and they are able to create anatomical images of the developing fetus in real time. Three-dimensional (3D) and four-dimensional (4D) ultrasound imaging has also helped to further refine anatomical assessments, decreasing measurement variability in important biometric parameters [4].

Of the biometric parameters that can be used to estimate GA, the FL is especially appreciated in the 2nd and 3rd trimesters. The measurement is taken linearly from the base to the tip of the femur's shaft (diaphysis) avoiding the cartilaginous growth plate (epiphyseal cartilage) and with the transducer parallel to the femur shaft. With standardized acquisition protocols, FL is highly reproducible both within and between observers and has good correlation with fetal age [5, 6]. In practice the regression formulae developed by Hadlock are used extensively for this purpose in routine obstetrics.

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Although useful, FL measurement faces a few confounding factors. Inaccurate visualization of the full femoral shaft may be caused by fetal mobility and/or suboptimal positioning. The quality of the acoustic window and the resolution of the images are adversely affected by maternal body habitus, especially obesity. The position of the placenta, particularly anterior, may cause an ultrasound beam to be attenuated and create acoustic shadowing artefacts. Measurement variability is also due to operator experience and to the calibration status of the ultrasound equipment [6, 7]. In addition, pathological conditions like IUGR, achondroplasia and skeletal dysplasias have a direct impact on femoral bone growth and should be ruled out prior to using FL for GA dating.

Relatively little data is specifically available on the factors affecting FL measurement variability among Iraqis. Most of the existing FL normative charts have been developed from Western or East Asian women populations and their applicability to Iraqi women is not certain, as they may have different body habitus, nutritional status, and ethnicities. It was therefore designed that in the present study the degree of discordance between the two GA estimation methods would be quantified in a third trimester cohort of Iraqi population and the clinical variables that have the most significant contribution in this discordance would be identified, which are: gestational age, fetal lie, placental position and maternal age.

2. Study Objectives

- To measure the level of agreement among LMP and FL derived estimates of GA during the 3rd trimester of pregnancy.
- To assess the effect of the fetal lie (cephalic, breech or transverse position) on the variability of ultrasound FL measurements.
- To assess the effect of the position of the placenta (anterior, posterior, fundal or placenta previa) on the accuracy of FL measurement.
- To compare the discrepancy of FL measurement with the maternal age.
- To give evidence-based suggestions for optimizing FL based GA estimation in obstetric practice in Iraq.

3. Materials and Methods

3.1 Study Design and Setting

The study was of a prospective cross sectional observational type that was conducted from September 2023 to September 2024. The study was conducted in the private obstetric and gynaecology clinics in Al-Kut city (Wasit governorate) and Baghdad, Iraq among pregnant women. The study was approved by the Research Ethics Committee of the College of Medicine, Wasit University and a written informed consent was obtained from all study participants before enrollment.

3.2 Study Population and Sampling

Using convenience sampling, 75 pregnant women in the third trimester (28 wks + gestation) were recruited. Inclusion criteria included singleton pregnancy, reliable LMP dates and consent to participate. Women were excluded if they had: (1) confirmed or suspected diabetes mellitus (pre-gestational and gestational) that can influence fetal bone growth velocity; (2) fetal congenital musculoskeletal anomalies especially achondroplasia and other skeletal dysplasias known to cause pathologically shortened femur length; or (3) multiple gestation.

3.3 Ultrasound Examination Protocol

The ultrasound examinations were carried out by experienced obstetric sonographers using a Philips HD11 ultrasound system with a 3.5 MHz convex-array. Femoral length was determined by the method of Hadlock, imaging the femur as a plane perpendicular to the long axis of the bone, the whole length of the echogenic diaphysis was shown in a linear horizontal orientation and electronic callipers were placed at the proximal and distal extreme of the echogenic diaphysis avoiding any epiphyseal cartilage or acoustic shadow artefact. Each fetus was measured three times and the average was then calculated.

The following data were obtained at the time of each scan: fetal lie (longitudinal cephalic, longitudinal breech, transverse with left head, or transverse with right head); placental position (anterior, posterior, fundal, or previa); and estimated GA based on FL measurement using the Hadlock formula.

3.4 Gestational Age Calculation

LMP-based GA was determined by the standard obstetric conversions: 1 month = 4 weeks and 2 days; 2 months = 9 weeks and 3 months = 13 weeks. The difference (LMP-FL) was expressed as a number of days and divided into 6 groups: Group A (0 day, no disagreement); Group B (disagreement between 0 and 7 days); Group C (disagreement between 8 and 14 days); Group D (disagreement between 15 and 21 days); Group E (disagreement between 22 and 28 days); Group F (disagreement between 29 and 35 days).

3.5 Statistical Analysis

The collected data was entered and analyzed in MS Excel 2019. All categorical variables were computed using descriptive statistics such as frequencies (n) and proportions (%). Each clinical variable (fetal lie, placental position, maternal age group) was cross-tabulated with the distribution of FL–LMP discrepancy to determine patterns of association. Given the small number of subjects and the exploratory nature of this study, formal inferential statistical tests were not conducted; however, the magnitude of the association between the discrepancy categories was evaluated by comparing the distribution of the categories by subgroups.

4. Results

4.1 Illustrative Ultrasound Images

Figure 1 shows representative ultrasound images for the standardised technique used for FL measurement during the study period in the Dr. Samer Al-Wazni Clinic. Both images (A & B) were acquired with the Philips HD11 system using the Hadlock method at the following gestations: Image A 31w 3d (FL = 6.05 cm) and Image B 29w 2d (FL = 5.58 cm).

Figure 1. Representative ultrasound images demonstrating femoral length (FL) measurement technique. (A) GA 31w3d, FL = 6.05 cm; (B) GA 29w2d, FL = 5.58 cm. Measurements obtained using the Hadlock method on a Philips HD11 system.

4.2 Effect of Gestational Age on FL–LMP Discrepancy

Of the 75 cases, there was no complete consensus between the two sources of GA (LMP versus FL): A = 0 (0.00%). The largest group (n=35, 46.67%) was Group B (1–7 days), which represents the clinically acceptable range of concordance. Group C (±8–14 days) accounted for 36.00% (n=27), while groups D, E, and F combined (discrepancy >14 days) represented only

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17.34% of cases (n=13). The progressive decrease in frequency with discrepancy range suggests that generally the FL-based GA is consistent to LMP-based GA in the third trimester, but there is a small number of cases with greater discrepancies that may warrant clinical investigation (Table 1 and Figure 2).

Table 1. Distribution of discrepancy between LMP-derived and FL-derived gestational age (n=75).

A	No difference	0	0.00
B	±1–7 days	35	46.67
C	±8–14 days	27	36.00
D	±15–21 days	6	8.00
E	±22–28 days	5	6.67
F	±29–35 days	2	2.67
Total		75	100.00

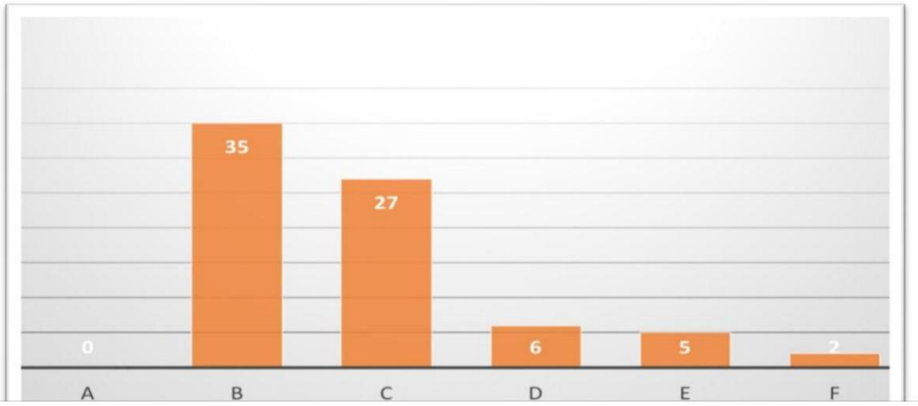

Figure 2. Bar chart showing the distribution of FL–LMP gestational age discrepancy categories (Groups A–F) across the study population (n=75).

4.3 Effect of Fetal Lie on FL Measurement Variability

The fetal lie had a significant effect on measurement consistency (Table 2, Figure 3). Longitudinal cephalic presentation was the most common (n=63, 84.00%) of the subgroup, with the highest number of measurements in Group B (n=32, 42.67%), suggesting that cephalic lie has the best measurability and highest concordance. Longitudinal breech presentation was 12.00% (n=9) and the distribution of the breech presentation was more variable with Groups B (2 cases) C (4 cases), E (2 cases) and F (1 case). In both orientations, transverse (left head (n=1, 1.33%) and right head (n=2, 2.67%)) were rare but exhibited only group C discrepancies indicating moderate measurement difficulty in these orientations. Within the cephalic group, 50.79% (32/63) of measurements fell in Group B, compared with 22.22% (2/9) in the breech group, which reinforces the clinical benefit of cephalic presentation for reliable FL acquisition.

Table 2. Effect of fetal lie on FL–LMP gestational age discrepancy distribution.

A	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
B	32 (42.67%)	2 (2.67%)	0 (0.00%)	1 (1.33%)
C	21 (28.00%)	4 (5.33%)	1 (1.33%)	1 (1.33%)

D	5 (6.67%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
E	4 (5.33%)	2 (2.67%)	0 (0.00%)	0 (0.00%)
F	1 (1.33%)	1 (1.33%)	0 (0.00%)	0 (0.00%)
Total	63 (84.00%)	9 (12.00%)	1 (1.33%)	2 (2.67%)

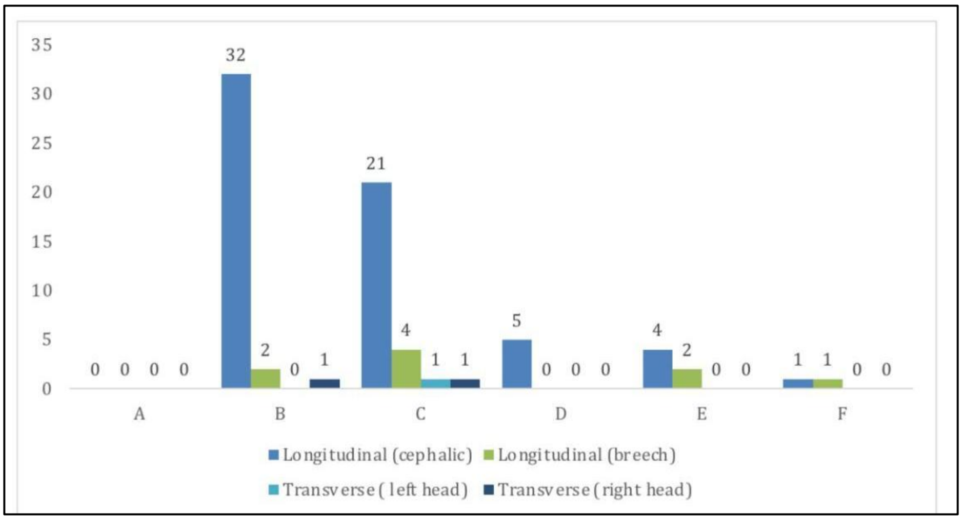

Figure 3. Grouped bar chart illustrating the distribution of FL–LMP discrepancy categories according to fetal lie (longitudinal cephalic, longitudinal breech, transverse left head, transverse right head).

4.4 Effect of Placental Position on FL Measurement Variability

Anterior placental position was the most common finding (n=38, 50.67%), followed by posterior (n=29, 38.67%), fundal (n=7, 9.33%), and placenta previa (n=1, 1.33%) (Table 3, Figure 4). In the anterior group, cases were spread over all discrepancy class grades B to E, the widest gap of variability. However, the distribution was more symmetrical in the posterior cases with Group B (n=12, 41.38%) and Group C (n=12, 41.38%) and less in the higher discrepancy groups. Fundal placentas were predominantly in Groups B (n=4, 57.14%) and C (n=2, 28.57%). Group E (±22-28 days) had one placenta previa case which is representative of the difficult imaging problems caused by this condition.

Table 3. Effect of placental position on FL–LMP gestational age discrepancy distribution.

A	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
B	12 (16.00%)	18 (24.00%)	4 (5.33%)	0 (0.00%)
C	12 (16.00%)	13 (17.33%)	2 (2.67%)	0 (0.00%)
D	3 (4.00%)	2 (2.67%)	0 (0.00%)	0 (0.00%)
E	1 (1.33%)	5 (6.67%)	0 (0.00%)	1 (1.33%)
F	1 (1.33%)	0 (0.00%)	1 (1.33%)	0 (0.00%)
Total	29 (38.67%)	38 (50.67%)	7 (9.33%)	1 (1.33%)

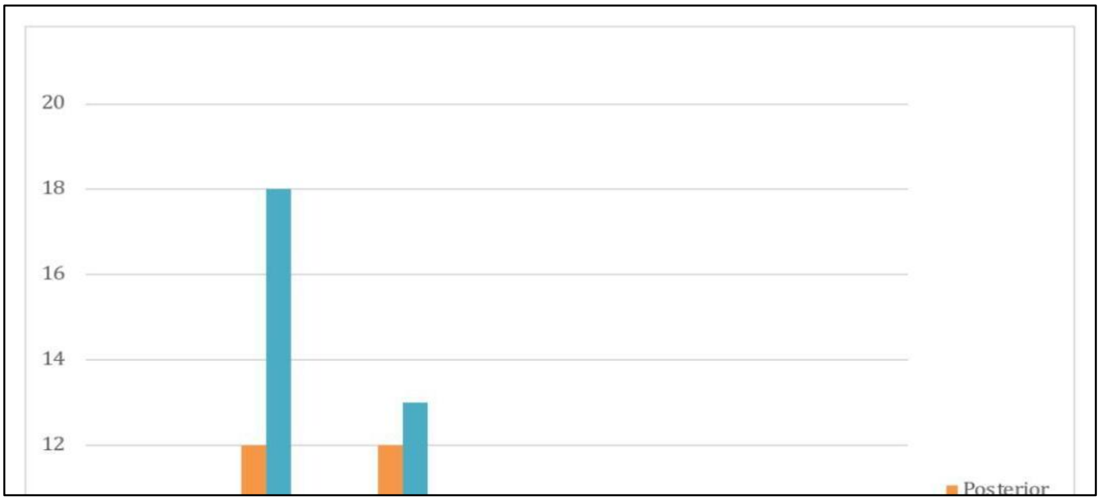

Figure 4. Grouped bar chart showing the distribution of FL–LMP discrepancy categories according to placental position (posterior, anterior, fundal, previa).

4.5 Effect of Maternal Age on FL Measurement Variability

The 21-30 age group was the largest (n = 49, 65.33%) and had the most favourable measurement profile consisting of 24 cases (32.00%) in Group B and 14 cases (18.67%) in Group C (Table 4, Figure 5). The 31–40 year group (n=15, 20.00%) showed a proportionally higher burden in Group C (n=9, 12.00%), and none in Groups D or F, but 0 in Group A. For the adolescent group (11- 20 years; n = 7, 9.33%), all cases were evenly spread between Groups B and C with no significant difference between them. The oldest group (41–50 years, n=4, 5.33%) had cases in Groups C (n=2) and E (n=2), indicating that the extreme maternal age may be linked to high measurement variations, which may mean higher prevalence of comorbidities.

Table 4. Effect of maternal age on FL–LMP gestational age discrepancy distribution.

A	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
B	4 (5.33%)	24 (32.00%)	6 (8.00%)	0 (0.00%)
C	3 (4.00%)	14 (18.67%)	9 (12.00%)	2 (2.67%)
D	0 (0.00%)	6 (8.00%)	0 (0.00%)	0 (0.00%)
E	0 (0.00%)	3 (4.00%)	0 (0.00%)	2 (2.67%)
F	0 (0.00%)	2 (2.67%)	0 (0.00%)	0 (0.00%)
Total	7 (9.33%)	49 (65.33%)	15 (20.00%)	4 (5.33%)

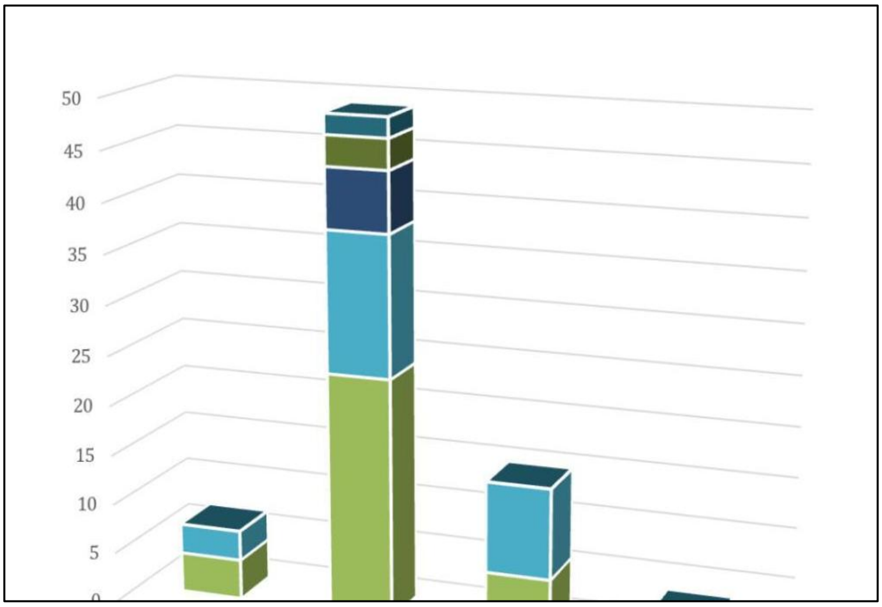

Figure 5. Stacked bar chart showing the distribution of FL–LMP discrepancy categories across maternal age groups (11–20, 21–30, 31–40, 41–50 years).

5. Discussion

This is a prospective study that gives empirical data on the size and causes of FL–LMP discordance in a third-trimester population of Iraqis. Each of the four clinical factors investigated (gestational age at the time of measurement, fetal lie, placental position and maternal age) showed a significant effect on the level of agreement between the two methods of GA estimation with clinical relevance.

5.1 Overall Pattern of FL–LMP Discordance

That nearly half of cases (46.67%) had an FL–LMP discrepancy within ±7 days indicates that FL-based biometry used in the third trimester is generally valid for the purpose of GA confirmation. This is in line with previous dating norms that suggest that the accuracy of ultrasound dating decreases as gestation progresses, that is, first trimester crown-rump length (CRL) dating is accurate to within ±5–7 days, second trimester biometric dating is accurate to within ±2 weeks, and third trimester dating is accurate to within ±3 weeks [1, 2]. The complete absence of Group A cases (exact agreement) within our cohort is not surprising, as it has to be taken into account that all LMP calculations and all FL-to-GA conversion formulae have a degree of inherent rounding.

It is notable that 17.34% of the cases had discrepancies greater than 14 days (Groups D–F). These larger discrepancies may be attributable to: (1) the incorrect recall of LMP; (2) irregular periods and late ovulation; (3) early growth restriction affecting FL; or (4) constitutional variation in femoral growth not captured by the population-generic Hadlock formulae. In clinical practice, such discrepancies should not be based on any one biometric parameter alone but rather a thorough reassessment of the LMP based on multiple biometric parameters (BPD, HC, AC, FL) and clinical review of the accuracy of the LMP. If there are significant differences among Groups C through F, it may reflect a problem with the fetus or a problem in calculating the GA, such as IUGR, that can occur when using late first trimester measurements for GA [8].

5.2 Impact of Fetal Lie

Physiologically, the association between the highest proportion of low-discrepancy measurements (Group B) and longitudinal cephalic presentation is to be expected. In cephalic presentation the lower extremities of the fetus are generally in the fundal region, and the probe can be used to measure FL with minimal angulation. This position allows for the alignment of the transducer with the long axis of the femur, and therefore minimises the chances of

foreshortening artefacts, which are one of the most significant causes of FL underestimation [9].
The breech and transverse lies pose major problems. The breech position is usually one in which the legs are extended at the knees or flexed at the hips and extended at the knees, or "frank breech," thus it is hard to visualize the whole femoral diaphysis in a single plane of the probe when the fetus is in this position. The transverse lie adds to the difficulty as sonographer will have to take parasagittal or oblique cuts to gain access to the femur, making partial visualisation and error during measurement more likely. Garcia et al. [10] noted that the FL measurement was large, and that this measurement variability was caused by being in the transverse fetal position, which is due to the difficulty with optimizing the probe-to-femur alignment during FL measurement. The overall results support the clinical advice to try repeat scanning or manoeuvre (such as changing maternal position) to establish the fetal lie prior to FL measurement if it is not cephalic.

5.3 Impact of Placental Position

The largest percentage of cases (50.67%) and the broadest distribution of cases within the range of discrepancies were found with the anterior placenta. Mechanistically, it is thought that an anterior placenta develops between the uterine wall and fetal body, which introduces an extra acoustic interface that can attenuate the ultrasound beam, lower image resolution, and cause acoustic shadowing and blockage of parts of the femoral diaphysis. Lee et al. [11] showed that the anterior placentas cause a decrease in the accuracy of third-trimester fetal biometry measurements, which was greater for FL than for BPD or HC because the femur is located more peripherally than the BPD or HC, making them more difficult to access.
This is not contradicted by the further finding that 18 anterior placenta cases (47.37%) were still found to be in Group B (acceptable discrepancy) as this is simply to say that an anterior placenta, in itself, does not always make accurate FL measurement impossible, particularly if the fetus is in a favourable position and the operator has experience. Nevertheless, it indicates that the likelihood of larger discrepancies increases with anterior placentas, which should be noted in the ultrasound report. The posterior placenta cohort was shown to have a more symmetric distribution in Group B–C, with more precise biometric parameters observed, as found by Smith et al. [12], who noted that posterior placenta tend to provide more accurate acoustic measurements from the acoustic path through the posterior uterus.

5.4 Impact of Maternal Age

The 21–30-year group was the most represented (65.33% of all cases, the majority in Groups B–C), which may reflect a combination of interacting factors: optimal uterine and fetal vascular physiology, lower rates of metabolic comorbidities (gestational diabetes, hypertension), and physiologically predictable patterns of fetal growth. Younger women tend to have more predictable fetal growth curves and, consequently, a closer correlation between biometric and LMP-based GA estimates, as confirmed by Wang et al. [13].
The greater range observed in the 31–40 and 41–50-year age groups fits with the well-researched epidemiology of advanced maternal age (AMA) obstetrics. AMA is independently linked to an elevated incidence of gestational diabetes mellitus, chronic hypertension, and a dysfunction of the placenta, which may affect the normal FL growth curve and contribute to FL–LMP discordance [13]. In particular, Martinez et al. [14] noted a significantly greater variability of fetal biometric measurements in mothers > 35 years, which may be due to either fetal overgrowth (macrosomia associated with gestational diabetes) and/or fetal growth restriction (in hypertension or placenta-insufficient pregnancies), that both affect the normal correlation between chronological GA and biometric size. Conclusions for the small number of adolescent mothers (n=7) in our series are limited but their relatively positive discrepancy profile is similar to uncomplicated physiological pregnancies.

5.5 Clinical Implications

Some practical implications of the findings of this study are discussed in the Iraqi clinical context of obstetric ultrasonography. Documentation of fetal lie and placental position at the time of FL measurement should be routine because both factors have independent effects on the reliability of the FL measurement. Second, where non-cephalic lie or anterior placentation occurs, consider using additional biometric measurements (HC, AC, BPD) to estimate an additional GA with FL, to decrease over dependence on one parameter that may be less accurate. Third, increased attention should be paid to FL–LMP discordance in AMA patients, and serial biometry should be used to identify the appearance of growth anomalies early on. Fourth, the fact that there is no exact agreement (Group A) across all cases means that any difference between FL and LMP GA is not necessarily a measure of error, but rather physiologically expected, and should not be interpreted as a measurement error.

5.6 Limitations

It is important to recognize there are a number of caveats. Sample size (n = 75) is relatively small, and reduces the statistical power of subgroup analyses. The study is single centre, which may cause selection bias. It is not possible to definitively attribute any observed associations because there are no formal inferential statistical tests. No data on maternal BMI, parity, neonatal birth weight or operator experience was documented and may therefore be important confounding factors. In addition, only GA based on LMP was used as the reference standard; the use of the most accurate dating modality, the crown-rump length (CRL) measured at an early gestation age, was not available for comparison in most patients.

6. Conclusions

The results of this study corroborate the clinical validity of femoral length measurement in the third trimester, showing a good agreement for the majority of measurements and a discrepancy of ≤7 days in 46.67% of cases. Concordance is however systematically influenced by fetal lie, placental position and maternal age which should be systematically recorded and taken into account when interpreting FL-based GA estimates.

The best conditions for getting the FL measurement are for the baby's head to be in longitudinal cephalic presentation. The factors associated with increased FL-LMP discordance – anterior placentation and non-cephalic fetal lie – should be taken as a cue to use multi-parameter biometric assessment. Advanced maternal age was correlated with the least consistent FL measurements and should be treated with the greatest caution, whereas the 21–30-year age group showed the most consistent measurements.

Larger multicenter cohorts from various parts of Iraq, with good standardisation of the sonographer technique, extensive recording of covariates (BMI, parity, operator experience) and formal statistical modelling (multivariate regression, Bland-Altman analysis) of the FL population-specific normal values and more refined guidelines for third trimester FL interpretation in Iraq.

7. Recommendations

The documentation of fetal lie and placental position at the time of FL measurement should be standardised in all the obstetric ultrasound reports in Iraq.

For fetal lies other than cephalic, or anterior placentation, FL should be combined with other biometric parameters (HC, AC, BPD) to obtain a "composite" estimated GA and avoid single parameter dependence.

Patients should have serial third trimester biometry conducted at closer intervals in patients after 35 years of age to help identify FL–LMP discordance and growth disorders early.

Future studies should explore the value of fetal maturity markers as additional or alternative GA dating methods in the third trimester (e.g., epiphyseal ossification of the femur, clarity of the fetal lens).

There is need for larger, multi-centre prospective studies in various governorates in Iraq to create locally validated FL normative charts that may more closely reflect the ethnic and nutritional profile of the people of Iraq.
Recommendations include investment in ongoing training for obstetric sonographers in the aim of standardising the technique of measurement of FL, and minimising inter-operator variation.

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