DOI: https://doi.org/10.54393/pbmj.v5i1.252

PAKISTAN BIOMEDICAL JOURNAL

https://www.pakistanbmj.com/journal/index.php/pbmj/index

Volume 5, Issue 1 (January 2022)

Systematic Review

Estimation of Gestational Age From Fetal Foot Length Measurement- A Systematic Review

Naheed Rubab[1*], M Nawaz Anjum[1], Mussarat Ahmed[2] and Mehreen Fatima[1]

[1]Faculty of Allied Health Sciences, The University of Lahore, Lahore, Pakistan
[2]Life Care Hospital Lahore, Lahore, Pakistan

ARTICLE INFO

Key Words:
Coefficient of determination, correlation coefficient, gestational age, standard deviation, ultrasonography.

How to Cite:
Rubab, N., Anjum, M. N., Ahmed, M. ., & Fatima, M. ..... (2022). Estimation of Gestational Age From Fetal Foot Length Measurement: Estimation of Gestational Age From Fetal Foot Length Measurement. Pakistan BioMedical Journal, 5(1), 262–266. https://doi.org/10.54393/pbmj.v5i1.252

Corresponding Author:
Naheed Rubab,
Faculty of Allied Health Sciences, The University of Lahore
aslamareeba786@gmail.com

ABSTRACT

The estimation of GA (gestational age) is vital part of obstetrical ultrasound examination for managing the pregnancy as well as monitoring the growth of the fetus. FFL measurement is a precise method for the calculation of the GA of the fetus when other methods do not give accurate measurement. **Objectives:** The main objective of our review is to assess the role of ultrasonographic measurement of foot of the fetus in the calculation of GA and secondary objective is to measure the FL to FFL ratio in the normal fetuses. **Methodology:** Review was conducted with the help of different search engines and websites. Only those studies were included that reported on the determination of the GA from the FFL measurements on antenatal ultrasonography and on at least one statistic assessing the accuracy of gestational age estimation. The duplicate, non-English and incomplete studies were excluded. After initial screening of 120 studies only 20 studies were eligible for inclusion. All data extracted from them was analyzed using SPSS version 24. **Results**: After fulfilling eligibility criteria, we were left with 20 studies between years 1987 to 2019. Majority of the studies were conducted in Asia (60%) with study population greater than 50 participants (95%).All of our studies measured FFL for estimation of GA in singleton (80%) and normal (90%) pregnancies. Studies varied in their use of GA reference method, (5%) studies used LMP alone, (10%) studies relied on EDS, (10%) studies used either EDS or LMP as a comparison method, (45%) studies used both EDS and LMP and (30%) studies did not report their reference method. Ten studies reported R with mean value of 0.90002 and SD of 0.073997, 13 studies reported R^2 with mean value of 0.85192 and SD of 0.156988. Six studies (38%) measured FL to FFL ratio with mean value of 0.96. Fifteen studies reported regression coefficient with mean value of 1.39057 and SD of 1.15890. **Conclusion:** After reviewing literature of all the studies it was concluded that FFL is a precise method for the calculation of GA of the fetus. FFL is equally reliable when used with other ultrasonographic parameters as well as when used alone. FFL is also reliable for predicting the estimated FW in the last trimester of pregnancy. FL/FFL is useful in the detection of fetal skeletal dysplasia.

INTRODUCTION

Gestational age is calculated as the number of weeks beginning from the first day of the last menses to the present day [1]. Pregnancy (gestation) is the physiologic procedure of development of the baby in the womb of mother [2]. Estimation of GA and growth pattern of the baby is very important in obstetrical examination and it has always gained the interest of the researchers [3]. This data is very important for programming the antenatal obstetrical care, for planning the necessary antenatal tests, for monitoring the growth of the baby, and for reducing the rate of premature and postmature deliveries and associated morbidity [4]. When ultrasound is not available we have to depend on the history and abdominal examination of pregnant women for the calculation of GA and delivery date [5]. The history consists of proper knowledge of last date of menses as well as the presence of other signs of pregnancy [6]. There are some limitations in the use of LMP method. It can give inaccurate GA

DOI: https://doi.org/10.54393/pbmj.v5i1.252

estimation when a woman has irregular menses, when she has lactational amenorrhea and when she is having bleeding at the time of conception [7,8]. Different stages of development of follicles can be seen in a single menstrual cycle, leading to unpredictable timing of ovulation [9]. With the use of ultrasound calculation of GA is totally changed. Estimation of GA is highly accurate if ultrasound is done precisely [10]. Ultrasonography is said to be gold standard for GA estimation however it is more accurate if done in the first trimester [11]. Ultrasonography in advance pregnancy should include assessment of presenting part, AFI, FCA, localization of placenta, measurement of biometric parameters and detection of fetal congenital anomalies. The uterus and ovaries should be examined [12]. Routine sonographic biometric parameters used in the calculation of GA are BPD, HC, AC and FL [13]. We use a combination of different parameters from thirteen weeks to term [2]. However there has been some limitation in the use of these parameters in cases of anencephaly hydrocephaly, and achondroplasia. In the above-mentioned conditions, we have to adopt another method for the calculation of duration of pregnancy [14]. The fetal foot length (FFL) will be important in the calculation of GA of the fetus because it is easy to visualize the fetal foot and to measure it. In the 2nd and 3rd trimester GA calculations by ultrasonography will improve if FFL measurement is added to the routinely used parameters [2]. FFL is valuable when other biometric parameters cannot accurately calculate GA [15,16]. Calculation of the weight of fetus is important for monitoring growth of the fetus. In the regression model, we use the combination of routine biometric parameters for estimation of fetal weight [17]. These studies have reported that there was a significant correlation between foot length and fetal weight [18,19]. The FFL measurement is useful in the clinical assessment of premature babies [20]. Calculationthe of FL to FFL ratio has demonstrated that this ratio is normally greater than or equal to 0.92 throughout the pregnancy. The FL to FFL ratio can be used to rule out difference between the fetuses having skeletal dysplasia from those having growth retardation [21].

METHODS

Search Strategy: This systematic review was conducted on the studies which had already been published and cited. The search was conducted by the help of different search engines and websites. Only those studies were included in this review which focused on the determination of the G. age from the FFL measurements on antenatal ultrasonography.

Inclusion Criteria: After screening the abstracts following studies were included in the review.

1- The studies which reported on determination of G.A from foot length measurement of the fetus.
2- The studies in which FFL measurements were taken on antenatal ultrasound examination.
3- The studies done in the first, second and third trimester.
4- The studies in which femur length to foot length ratio wascalculated.
5- The studies which reported on at least one statistic assessing the accuracy of gestational age estimate
6- The studies conducted in the year from1987 to 2019.

Study characteristics, data synthesis and analysis procedure: Out of 120 studies only 20 met our inclusion criteria. All selected studies reported on determination of G. age from fetal foot length measurements on ultrasonography. 6 studies measured femur to fetal foot length ratio, 1 study measured gestational age from fetal tibial length and 1 from presence of fetal heel ossification center. Nineteen studies reported on healthy fetuses except one study which also included IUGR fetuses. After fulfilling the inclusion criteria the articles were arranged according to the year of publication from 1987to 2019.Two tables were constructed with various qualitative and quantitative variables from the data set. The data analysis was performed with the help of (SPSS 24, IBM, Armonk, NY, United State of America) Statistical Package for the Social Sciences version 24.

RESULTS

We reviewed all the selected studies to gather, synthesize and analyze the data for our study. Ten out of 20 reported coefficient of determination (R2), 7/20 reported correlation coefficient (R) and 3/20 studies reported both. The mean value of R was 0.90002 with standard deviation of 0.07399.The mean R2 was 0.85192 with standard deviation of 0.156088(Fig 1 and 2).The minimum p value was 0.00, maximum value was 0.001 and the range was 0.001.The mean P value is 0.000447. Fifteen selected studies reported linear regression equation and regression coefficient Minimum value of regression coefficient was 0.245, maximum value was 3.360 and the range was 3.114. The mean regression coefficient was 1.39057 with standard deviation was 1.158961(Fig 3).

DOI: https://doi.org/10.54393/pbmj.v5i1.252

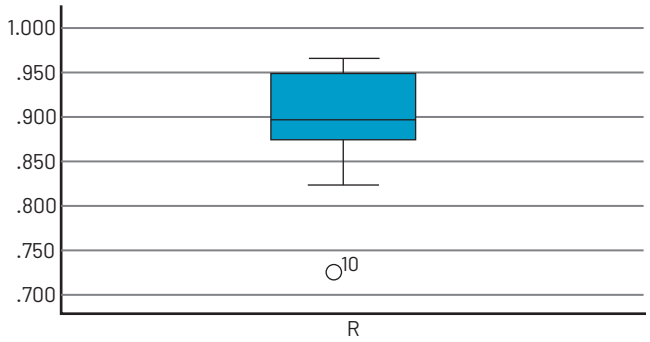

Figure 1: Boxplot of values of R

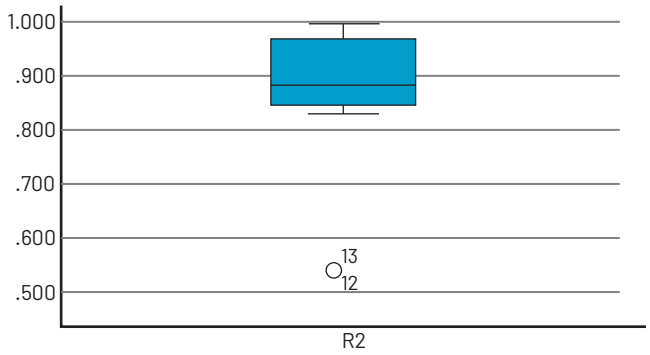

Figure 2: Boxplot showing values of R2

Twelve studies were conducted in Asia (60%), 4/20 were conducted in North America (20%) and 3/20 were conducted in Africa (15%). Study location of one study was not available (5%). One out of 20 studies (5%) compared gestational age measured by FFL with the LMP, 2/20 (10%) studies used EDS , 2/20 (10%) studies used either EDS or LMP , 9/20 (45%) studies used both EDS and LMP and 6/20 (30%) studies did not report their reference method. The majority 19/20(95%) of studies included sample size greater than 50 participant, only one study (5%) had sample size less than 50. The minimum sample size was 47 was 1018. Most of studies (19/20) reported on normal pregnancy (95%). Only one study reported on both normal and suspected IUGR fetuses. The minimum gestational weeks of pregnancy in our studies were 10 and maximum were 43.Six out of twenty studies measured FL/FFL ratio (30%) and 14/20 studies did not measure FL to FFL ratio (70%). The average FL to FFL was found to be 0.96. Out of twenty studies sixteen included singleton pregnancies (80), one study included both singleton and twin pregnancies.

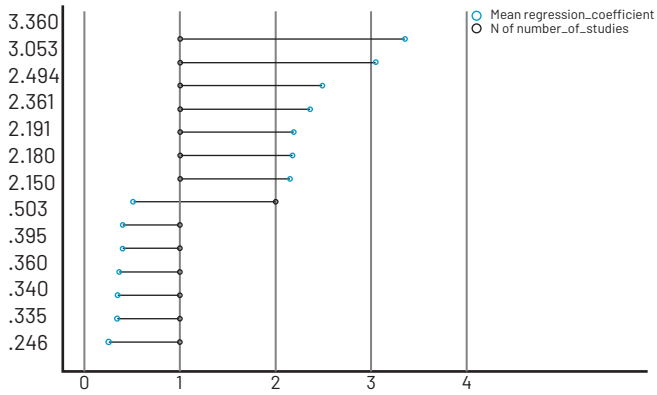

Figure 3: Forest plot of regression coefficient.

DISCUSSION

published literature regarding the use of ultrasonography was extensive. However, the existing literature regarding the role of ultrasound in the calculation of G. age was limited. Most of our selected studies demonstrated strong and positive linear correlation between the G. age and foot length measurement of the fetus especially in the second and third trimester of pregnancy. As reported in the result section the mean of R was 0.90002 with standard deviation of 0.073.The mean of R2was 0.8519 with standard deviation of 0.156088.The mean of P was 0.000447. The mean regression coefficient was 1.39057 with standard deviation of 1.158961. Two of our studies by Bushra Abdel Malik and Mohamed Ebraheem, analyzed that there was no significant correlation of FFL with maternal socioeconomic status, parity, fetal gender and maternal height and occupation. Ebraheem et al also demonstrated that FFL is reliable parameter for predicting the estimated fetal weight in the last trimester. The regression models of FFL in combination with FL improved the accuracy of predicting EFW and GA with R value of 0.92 and R2 value of 0.87. As reported in the result section above our 6 selected studies measured FL to FFL ratio with a mean value of 0.96. Hong Soo Wong measured FL to FFL ratio in early pregnancy [22] while Drusty K measured the same ratio in late pregnancy [23]. However in both studies the value was 0.9. The strength of our study is its variegation as it was conducted with varying study population, at different weeks of gestation and in different parts of the world. However, most of the studies were conducted in the normal and singleton pregnancies. A limited number of studies were available regarding the use of FFL measurement in the estimation of G.age of the fetus on antenatal ultrasonography, on various search engines and web sites.

DOI: https://doi.org/10.54393/pbmj.v5i1.252

CONCLUSION

After reviewing literature of all of our selected studies it was concluded that FFL is precise method for calculation of GA of the fetus. FFL measurement is equally reliable when used with other ultrasonographic parameters as well as when used alone. It is a useful alternate parameter in the estimation of fetal G. age when other parameters fail to provide accurate measurement. FFL is reliable for predicting the fetal weight in the last trimester of pregnancy. FL to FFL ratio less than 0.92 is diagnostic of fetal skeletal dysplasia.

REFERENCES

[1] Cleveland Clinic. Fetal Development: Stages of Growth. Reviewed April 16, 2020. https://my.clevelandclinic.org/health/articles/7247-fetal-development-stages-of-growth

[2] Abdel Malik B,Ibrahim M., Youssef M. and Jastaniah, S. Use of Foot Measurements as Sonographic Parameter for Estimation of Fetal Age. Open Journal of Medical Imaging 2017; 7, 248-262 DOI: 10.4236/ojmi.2017.74023.

[3] Hemraj S, Acharya DK, Abraham SM, Vinayaka U, Ravichandra G. Fetal Foot Length and Its Sonographic Correlation with Gestational Age. Donald School J Ultrasound Obstet Gynecol 2017; 11(2):141-145.DOI: 10.5005/jp-journals-10009-1515

[4] Karl S, Li Wai Suen CS, Unger HW, Ome-Kaius M, Mola G, White L, et al., Preterm or not—an evaluation of estimates of gestational age in a cohort of women from Rural Papua New Guinea. PloS one. 2015;10(5):e0124286 doi.org/10.1371/journal.pone.0124286. .

[5] Butt K, Lim K. Determination of gestational age by ultrasound. Journal of obstetrics and gynaecology Canada: JOGC. Journal d'obstetrique et gynecologie du Canada: JOGC. 2014; 36(2):171-83 doi: 10.1016/S1701-2163(15)30664-2.

[6] Rudder, Meghan. Use of Ultrasound to Determine Gestational Age in Low and Middle Income Countries: A Systematic Review of the Literature, Doctoral dissertation, Harvard Medical School, 2016.

[7] Committee opinion no 611: method for estimating due date. Obstetrics and gynecology 2014; 124(4): 863-6 doi: 10.1097/01.AOG.0000454932.15177.be..

[8] Pereira AP, Dias MA, Bastos MH, da Gama SG, Leal Mdo C. Determining gestational age for public health care users in Brazil: comparison of methods and algorithm creation. BMC research notes.2013;6:60 doi: 10.1186/1756-0500-6-60.

[9] Brink HV, Chizen D, Hale G, Baerwald A. Age-related changes in major ovarian follicular wave dynamics during the human menstrual cycle.Menopause (New York, NY). 2013; 20(12):1243-54 doi: 10.1097/GME.0b013e31828cfb62..

[10] Reddy UM, Abuhamad AZ, Levine D. Fetal imaging: Executive summary of a Joint Eunice Kennedy Shriver National Institute of Child Health and Human Development, Society for Maternal-Fetal Medicine, American Institute of Ultrasound in Medicine, American College of Obstetricians and Gynecologists, American College of Radiology, Society for Pediatric Radiology, and Society of Radiologists in Ultrasound Fetal Imaging Workshop. American journal of obstetrics and gynecology 2014; 210(5):387-97 doi: 10.7863/ultra.33.5.745..

[11] Shiyam Sunder Tikmani, MSc1, Sana Roujani, MSc1, Syed Iqbal Azam, MSc1, Haleema Yasmin, FCPS2, Khadija Bano, FCPS2, Saleem Jessani, MSc1, Sayyeda Reza, MSc1, Elizabeth M. McClure, PhD3, Robert L. Goldenberg, MD4, Sarah Saleem, FCPS The Aga Khan University, Karachi, Pakistan, Jinnah Postgraduate Medical Center, Karachi, Sindh, Pakistan Research Triangle Institute International, Durham, NC, USA, Columbia University, New York, NY, USA DOI: 10.1177/2333794X20974206

[12] Medicine AIoUi (2013) Aium Practice Guideline for the Performance of Obstetric Ultrasound Examinations. Journal of Ultrasound in Medicine: Official Journal of the American Institute of Ultrasound in Medicine, 32, 1083.

[13] Akram Muhammad et al.Estimation of Gestational Age from Fetal Kidney Length in the Second and Third Trimester of Pregnancy by Ultrasonography. Saudi J Med Pharm Sci,March 2019: 5(3): 222-229 DOI:10.21276/sjmps.2019.5.3.10.

[14] Sharma, Vaibhav & Saxena, Ruchi & Gaur, Priyanka.. Fetal foot length for assessment of gestational age: a cross sectional study. Int J Reprod, Contrac, Obstet and Gynecol 2021; 10: 3153 DOI: http://dx.doi.org/10.18203/2320-1770.ijrcog20212972.

[15] Gupta S and Rajni. Ultrasonographic estimation of fetal gestational age using foot length as a parameter.Int J Sci Res 2019; 8:81-83.

[16] Pandey V D, Singh V, Nigam G L, Yasmeen, Yadav Y, Fetal tibial and foot length for prediction of gestational age: An ultrasonographic study. Santosh Univ J Health Sci 2018; 4(1):25-30 DOI: 10.18231/2455-1732.2018.0007

[17] Ebraheem M, Malik BA, Ali QM, Gameraddin M, Gareeballah A. Accuracy of fetal foot length measurement in estimation of gestational age and fetal weight in the third trimester of pregnancy. J

DOI: https://doi.org/10.54393/pbmj.v5i1.252

Health Res Rev 2018; 5:142-6 DOI: 10.4103/jhrr.jhrr_23_18

[18] Salge AK, Rocha ÉL, Gaíva MA, Castral TC, Guimarães JV, Xavier RM, et al. Foot length measurements of newborns of high and low risks pregnancies. Rev Esc Enferm USP 2017; 51:e03200 doi.org/10.1590/S1980-220X2016016703200.

[19] Gavhane S, Kale A, Golawankar A, Sangle A. Correlation of foot length and gestational maturity in neonates. Int J Contemp Peediatr 2016; 3:705-8 doi.org/10.18203/2349-3291.ijcp20162212.

[20] Lutterodt MC, Rosendahl M, Yding Andersen C, Skouby SO, Byskov AG. Age determination enhanced by embryonic foot bud and foot plate measurements in relation to Carnegie stages, and the influence of maternal cigarette smoking. Hum Reprod 2009; 24:1825-33 doi: 10.1093/humrep/dep176..

[21] Mital M,Gupta p. Fetal gestational age estimation by fetal foot length measurement and fetal femur to foot length ratio in Indian population – a prospective study. J Evol Med Dent Sci.2014; 3(10):2620-25 DOI:10.14260/jemds/2014/2183.

[22] Wong H S.A revisit of the fetal foot length and fetal measurements in early pregnancy sonography. International Journal of Women's Health.2017; 9:199-204 doi: 10.2147/IJWH.S122586.

[23] Drusty K. Majmudar, Chirayu V. Vaidya, Vaishali J. Sanghrajka.Accuracy of foetal foot length and femur/foot length ratio in USG estimation of gestational age. International Journal of Contemporary Medicine Surgery and Radiology.2019; 4(2):B112-B113. doi.org/10.21276/ijcmsr.2019.4.2.25.