Post-Natal Gestational Age Assessment Using Sonographic Measurement of Femoral Length

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Abstract

Introduction: An accurate Gestational Age (GA) is a better predictor of neonatal outcome than birth weight. GA assessment has many diagnostic and therapeutic importance. The methods available for GA estimations are LMP, new Ballard score and each methods has its own drawback which makes them either over estimate or under estimate GA. Antenatal 2nd trimester ultrasound measured femoral length gives more accurate GA estimation. Using similar principles we hypothesized that biometry of long bones with sonography imaging is feasible after birth and may be used to assess GA. The objectives of this study were to assess Post-natal gestational age using sonographic measurement of femoral length and then compare values with antenatal standards and further comparison of validity of each value with gestational age assessment by new Ballard score and the GA by LMP. **Material and Methods**: Ninety neonates from 32 weeks to 40 weeks of GA according to accurate LMP were subjected ultrasonographic measurement of femoral length. **Results**: GA calculated using accurate LMP as standard and compared with GA calculated from New Ballard score over estimated the GA. Post natal femoral length measured using sonographic method showed increase in femoral length with increasing GA similar to antenatal femoral standard and showed no statistical difference (*p*-value 0.375). **Conclusions**: post natal femoral length measured by ultrasonographicaly is a safe, feasible, objective and fastest method of GA estimation.

Key words: Gestational age, Neonatal ultrasosnography, Femoral length, New Ballard score.

Introduction

Gestational age (GA) has emerged as the single most important predictor of mortality and morbidity in neonatal literature[1,2,3]. GA assessment is important for following reasons

1. To decide the method of feeding a newborn(tube/spoon/breast feeding)
2. To decide level of care for a newborn (level 1/2/3)
3. Therapeutic hypothermia is used only after 36 weeks GA. Contraindicated below 36 weeks of GA.

4. Prophylactic surfactant is considered in less than 32 weeks of GA.
5. These days late preterm 34(0/7) to 36(6/7) are gaining importance because of complication associated with them.

These are the few examples out of so many reasons to know accurate GA[5]. An accurate GA is a better predictor of neonatal outcome than birth weight[4]. The methods available for GA estimations antenatally are based on last menstrual age (LMP), antenatal ultrasound and postnatally new Ballard score.

Problems with the accuracy of gestational age computed by LMP on birth certificates have been documented[6,7,8,9,10]. Inaccuracy of LMP-based gestational age can be caused by biologically associated errors in menstrual cycles and by human error in recall or data entry[11,12]. Inherent in estimating gestational age with LMP is the assumption that all women have a regular 28-day menstrual cycle and ovulate 14 days after the first day of their LMP. However, because timing of ovulation varies, even with accurate recall and data entry of the LMP, estimates of gestational age based on LMP can be inaccurate. For example, one study found that 10% of women had cycles <25 days long, 12% were between 31 and 35 days, and 3% were 36 days or longer, while 5% were too irregular to say[13].

Early trimester ultrasound has been established clinically as the gold standard[14] but only 52% will have three antenatal visits and most of the women seek medical care 1st time at the time of delivery in which case GA estimation by any method is not possible[15].

After birth, clinical methods are used to assess GA. These use the difference in physical and neurological maturation at different GA. The Dubowitz scoring system is an excellent estimate of GA in newborn infant older than 34 weeks but is unsuitable, by the nature of its design, for the low birth weight neonates[16,17,18]. The Ballard score system, using principles similar to those of Dubowitz, is less complex and less time consuming and has been validated for use in premature newborns[16,18,19]. Further modification to Ballard score has made it suitable for use in extremely premature neonates[20]. Clinical methods, however, remain subjective and can result in a substantial error in the assessment of GA, especially of low birth weight babies and babies with perinatal asphyxia with hypoxic ischemic encephalopathy.

Assessment of gestational age in the second trimester by real-time ultrasound measurement of the femur length, adds a new parameter for estimating fetal age by ultrasound which would appear to be as accurate as that of biparietal diameter[21]. Using similar principles we hypothesized that biometry of long bones with sonography imaging is feasible after birth and may be used to assess GA. The calculated validity in predicting menstrual age from fetal femoral length is ±9.5 days between 12 and 23 weeks of GA ±22days between 23 to 40 weeks of GA. We have devised a method of measuring femoral length (FL) postnatally with ultrasonography. This may permit estimation of GA using tables of fetal FL measurements.

Material and Methods

Study conducted in neonatal intensive care unit, Silchar Medical College, Silchar, Assam, India. Ninety neonates from 32 weeks to 40 weeks of gestational age (GA), 10 from each GA, born to mother with regular menstrual period and accurate recall of LMP were included in the study. Neonates with; IUGR, Any life threatening congenital conditions, Cardio respiratory instability, GA less the 32weeks and more than 40 weeks, Age more the 1week old, Microcephaly or macrocephaly, Congenital Bony deformities and Neonates with facial dysmorphism were excluded from study. The protocol was approved from ethical committee of Silchar Medical College, Silchar and consent of respective parents taken before enrolling neonates in the study.GA (number of completed weeks) was calculated for each neonates from accurate LMP. The modified new-Ballard scoring system was used to reconfirm GA in all newborn infants.

The femur was imaged sonographyically by trained radiologist with 4 MHz curvilinear transducer aligned longitudinally along the thigh. Sterile gloves containing 300ml distil water facilitated imaging. FL was measured by electronic calipers after clear visualization of the ends of the femoral shaft (two ends of diaphysis were taken, ephiphyses not included) as shown in Fig 1.

Fig 1: Showing method of sonographic measurement of femoral length.

Statistical analysis was performed using the GA calculated from LMP as the "gold standard". Student *t*-test was used to analyze residuals.

Results

All the newborn had weight, length and head circumference appropriate for GA as calculated from LMP. Birth weights were compared with standard reference to exclude IUGR neonates as shown in Table 1.

Table 1. Average birth weight of neonates in each GA

GA (LMP)* in weeks	Birth wt*** in Kg
32	1.72±0.5
33	1.95±0.6
34	2.13±0.4
35	2.32±1.2
36	2.42±0.9
37	2.68±1.3
38	2.87±0.8
39	3.03±1.6
40	3.14±1.0

*** Birth weight are between 50th and 10th percentile as per AAP intrauterine growth chart.

Gestational age estimated by new-Ballard score over estimated GA in comparison with GA calculated from LMP as shown in Table 2. And the difference is significant as p value is <0.05.

Femoral length measured was compared with fetal standard femoral length. A progressive increase in FL measurement was noted with increasing GA, similar to that seen in fetal FL measurements. Comparison between the measured neonatal FL and the predicted FL revealed no statistical significance (*p*=>0.05) as shown in Table 3.

Discussion

Rapid advances in neonatal intensive care have demanded critical analyses of neonatal mortality and morbidity[16]. GA is recognized as an important predictor of neonatal mortality and morbidity[22,23]. Antenatal GA assessment relies heavily on accurate menstrual history with regular cycle. These are often unavailable in pregnancies, and studies have shown that GA assessment by LMP is unreliable in 25 to 59% of pregnancies. This is especially true in pregnancy complicated by premature labor, post maturity, as poor antenatal care and teenage mother are common

Table 2: Comparison of GA calculated from accurate LMP* and New Ballard score.

GA(LMP)* in weeks	GA by Ballard score (wk)	*p*-value
32	33.4±0.8	
33	34.2±1.2	
34	36.3±0.6	
35	38.1±1.4	
36	37.0±1.2	0.0007
37	38.2±1.0	
38	38.0±0.8	
39	41.2±1.2	
40	41.8±1.0	

Table 3: Comparison of average measured neonatal femoral length with fetal standard FL in each GA

GA(LMP)*in weeks	Femoral Length(mm)		*p*-value
	Neonatal	Foetal***	
32	60.7±2.3	61.2	
33	64.9±1.8	63.1	
34	65.6±3.2	64.9	
35	67.3±1.4	66.6	
36	69.4±2.6	68.2	*p*-value = 0.375
37	70.2±1.9	69.7	
38	71.0±3.1	71.1	
39	73.2±1.7	72.4	
40	74.4±1.5	73.6	

*** Predicted fetal value from Rumack USG: text book of radiology.

association[24]. Sonographic assessment of GA is extremely useful for pregnancies less the 18 weeks of GA but the variability of data increases as pregnancy progresses[25], furthermore, this narrow window of time limits its application.

Postnatal assessment of GA (New Ballard score and Debowitz score) uses clinical development criteria at various stages of gestation and correlates stages of physical and neurological development to GA[3,26]. All scoring systems involve subjectivity and clinical acumen. The physiologic criteria can often be affected by generalized edema that commonly occurs in sick premature newborn and neurologic criteria can be altered by perinatal asphyxia, any condition leading to CNS depression[25]. The Ballard maturational scoring system has been useful in GA of extremely premature newborns. However it tends to overestimate GA as much as 2 to 3 weeks[16,18]. Further clinical methods are time consuming, require experience, and necessitate the handling of sick newborns. These methods can't be used for paralyzed infants and generally done by junior staff in the NICU, further decreasing their accuracy.

Considering all these above facts we framed a cross sectional study in which we selected 90 healthy neonates from 32 to 40 weeks of GA, 10 from each GA. Mackanjee et al[27] did similar study by taking preterm neonates from 23 to 33 weeks of GA. Table 1 explains average weight of neonates in each GA. This was compared with AAP intrauterine growth charts to rule out IUGR neonates from study.

As seen from table 2 that, in most of the cases New Ballard over estimated the GA. Similar finding was seen in Mackanjee et al[27]. In Table 3 we have calculated average FL of neonates from each GA, and it was seen that with increasing GA femoral length also increases. Similar finding of, increasing FL with increasing GA was seen in study conducted by Mackanjee et al. We compared our result with fetal standard femoral length taken from Rumack USG: text book of radiology. Many other studies on antenatal femoral length also showed increasing FL with increasing GA.

The lack of "gold standard" for GA estimation makes evaluation difficult. We have used pregnancies with accurate menstrual history as true GA. And it was compared by GA calculated by new Ballard score. Results showed that sonographic FL measurements can be used to estimate GA in newborns who do not have any risk factor that might result in IUGR. Sonographic measurements of FL compare with antenatal values and have advantage of objectivity and can be used in premature, neurologically depressed, sedated and paralyzed infants. The method is also rapid, a single estimation taking less than 3 minutes of contact with the baby. The objectivity and reproducibility of sonographic FL measurements are evident in the high inter-observer and intra-observer reliability data.

Conclusion

We conclude that GA estimation by FL measurements is a rapid, objective method of GA assessment in newborns without IUGR. It gives accurate GA in comparison to New Ballard score. We believe that this method of GA assessment may enable GA to be more objective perinatal attribute, and it may improve neonatal diagnosis, treatment modality, outcome and the design of clinical trials in neonatology.

Limitation of Study

Study has limitation to calculate GA in IUGR neonates as it may show false low GA as IUGR causes shortening of long bones. There is need to be more and large population studies to prove usefulness of femoral length measurement by ultrasonography in estimation of postnatal GA and to validate the values. There is a need to do comparative study of accuracy of estimation of postnatal GA in IUGR neonates by New Ballard score and femoral length measurement by ultrasonography.

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