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Original Research Article

Correlation of Gestational Age Assessed by Last Menstrual Period, Antenatal Ultrasonography and New Ballard Score

Maitri Chauhan[1], Yashvi Dattani[2], Sandeep Tilwani[3], Vinisha Makhijani[4], Shivani Barad[2], Rekha Thaddanee[2*]

[1]Department of Paediatrics, Government Medical College, Bhavnagar, Gujarat, India
[2]Department of Pediatrics Gujarat Adani Institute of Medical Sciences, Bhuj, Gujarat, India
[3]Department of Neonatology, Gujarat Adani Institute of Medical Sciences, Bhuj, Gujarat, India
[4]Department of Pediatrics, Pandit Dindayal Upadhyay Medical College, Rajkot, Gujarat, India
* Correspondence: Dr Rekha Thaddanee (rekhathaddanee@gmail.com)

ABSTRACT

Background: Determining gestational age (GA) significantly influences the prognosis of newborns. Of the various methods available for gestational age assessment, gestational age assessment by first trimester ultrasonography (USG) as the most reliable method gestational and by LMP (last menstrual period), is next best surrogate. In remote areas and rural settings in Low- and Middle-Income Countries, the reliability of LMP based GA assessment is questionable due to low literacy rates and less awareness among women and USG is not cost effective. In such a scenario, GA assessment by clinical methods like New Ballard Score (NBS) seems an attractive alternative. Hence this study was conducted to compare the reliability of GA assessments by LMP and NBS as compared to 1st trimester ultrasonography in our institute.

Materials & Methods: This was a prospective study carried out at neonatal intensive care unit of a tertiary care teaching hospital of western Gujarat, India, from August 2022 to July 2023. A total of 200 neonates with mother having first trimester scan and who recalls LMP were recruited for the study. Gestational age according to first trimester scan was calculated and compared with gestational age according to LMP and NBS.

Results: Gestational age by UGS with NBS show significant correlation (p value <0.001) Gestational age by LMP with NBS show significant correlation (p value <0.001) Significant correlation was also observed between gestational age accessed by LMP, first trimester USG and NBS (p value <0.001) Gestational age by UGS with NBS which gave a higher correlation (r = 0.886), Correlation among all three gestational age by LMP, USG and NBS which came out to be lower than previous (r =0.545) and at last Correlation amongst gestational age according to LMP and NBS came out to be lowest (r =0.540). Hence, gestational age by USG comes out to be most similar with gestational age by NBS.

Conclusion: In low resource settings and in public sector hospitals, GA assessment by NBS is a more reliable option than LMP, and it closely correlates with GA assessed by USG.

Keywords: Gestational Age, Last Menstrual Period (LMP), New Ballard Score (NBS), Ultrasonography (USG)

INTRODUCTION

Determining gestational age is crucial for predicting newborn outcomes, particularly in reducing neonatal mortality associated with preterm birth, a leading cause of global neonatal mortality.[1] Early identification of preterm newborns within 48 hours of birth allows for timely interventions to prevent mortality and morbidity.[2]

The American College of Obstetricians and Gynecologists recommends first-trimester ultrasound as the most reliable method for assessing gestational age.[3] However, access to antenatal ultrasound is limited in developing countries like India, especially in rural and tribal regions.

In low- and middle-income countries, Last Menstrual Period (LMP)-based gestational age assessment may be unreliable due to low literacy rates, limited awareness among women, and irregular menstrual cycles.[4] A 2017 meta-analysis suggested LMP as a surrogate method, but its applicability in these settings is questionable.[5]

This study aims to compare the reliability of gestational age assessments by LMP and New Ballard Score (NBS) with first-trimester ultrasound, exploring alternative methods for gestational age assessment in resource-limited areas. Accurate gestational age assessment is essential for identifying preterm births, providing timely interventions, reducing neonatal mortality and morbidity.

MATERIALS AND METHODS

This prospective, cross-sectional, comparative study was conducted in the Neonatal Intensive Care Unit (NICU) of a tertiary care teaching hospital in Western Gujarat, India, from August 2022 to July 2023. A total of 200 neonates were enrolled, provided their mothers had undergone a first-trimester ultrasound scan and could accurately recall their last menstrual period (LMP). Institutional Ethics Committee (IEC) approval was obtained prior to the study. Written informed consent was also taken from the parents before enrolling their newborns.

Gestational age (GA) was estimated based on the first-trimester ultrasound and LMP by the principal investigator. To prevent bias, these details were not recorded in the newborns' case sheets and were maintained separately. GA assessment using the New Ballard Score (NBS) was performed by other investigator who had been trained in NBS assessment through proper training and instructional videos.

All collected data were entered into Microsoft Excel Sheet and analyzed using SPSS version 24. Agreement between GA estimated by first-trimester ultrasound, LMP, and NBS was assessed using Bland-Altman analysis. Pearson's correlation coefficient was calculated to evaluate the correlation between first-trimester ultrasound and both LMP and NBS. A p-value < 0.05 was considered statistically significant. Inter-rater reliability was assessed using the intraclass correlation coefficient (ICC) on a subset of 50 newborns.

RESULTS

In our study, 200 neonates were enrolled. The demographic details of neonates are shown in Table-1. The distribution by gender showed a slight predominance of males (52.5%) over females (47.5%). Regarding maturity, 70% of the neonates were preterm, 28% were term, and 2% were post-term. Birth weight distribution revealed 51% with low birth weight (LBW), 32% with very low birth weight (VLBW), 2% with extremely low birth weight (ELBW), and 15% with normal weight (Table-1).

The mean gestational age estimated by different methods was as follows: 34.3 weeks (SD = 3.02) by ultrasound (USG), 33.1 weeks (SD = 3.17) by last menstrual period (LMP), and 34.2 weeks (SD = 4.52) by New Ballard Score (NBS) (Table-2).

The correlation analysis showed a strong positive correlation ($r = 0.886$, $p < 0.001$) between gestational age estimated by first-trimester ultrasound (USG) and New Ballard Score (NBS). Moderate positive correlations were found between gestational age estimated by NBS and last menstrual period (LMP) ($r = 0.545$, $p < 0.001$), as well as between gestational age estimated by USG, NBS, and LMP ($r = 0.540$, $p < 0.001$). These findings highlight the importance of accurate gestational age estimation using multiple methods (Table-3, Figures 1 & 2).

Table-1: Distribution of neonates according to demographic parameters

Parameters	Number (%)
Gender	
Male	105 (52.5%)
Female	95 (47.5%)
Maturity	
Term	56 (28%)
Preterm	140 (70%)
Post-Term	4 (2%)
Birth Weight	
ELBW	4 (2%)
VLBW	64 (32%)
LBW	102 (51%)
Normal Weight	30 (15%)
Birth sizes for gestational age	
Appropriate for gestational age (AGA)	132 (66%)
Large for gestational age (LGA)	11 (5.5%)
Small for gestational age (SGA)	57 (28.5%)

Table-2: Gestational age (GA) by New Ballard Score (NBS) with first-trimester ultrasound (USG) and last menstrual period (LMP)

Gestational age (GA) calculation method	Mean GA (in weeks)	Standard Deviation (SD)
NBS	34.2	4.52
USG	34.3	3.02
LMP	33.1	3.17

The analysis of individual NBS components showed significant correlations with the total NBS score. The strongest correlation was observed with the Eye/Ear

component (r = 0.786, p < 0.001), while the weakest correlation was seen with the Plantar Surface component (r = 0.421, p < 0.001). These findings provide insights into the performance of individual NBS components and can help in refining the scoring system (Table-4).

Table-3: Correlation of Gestational age (GA) by New Ballard Score (NBS) with first-trimester ultrasound (USG) and last menstrual period (LMP)

Category	r value	p value
GA USG-NBS	0.886	< 0.001
GA NBS-LMP	0.545	< 0.001
GA USG-NBS-LMP	0.540	< 0.001

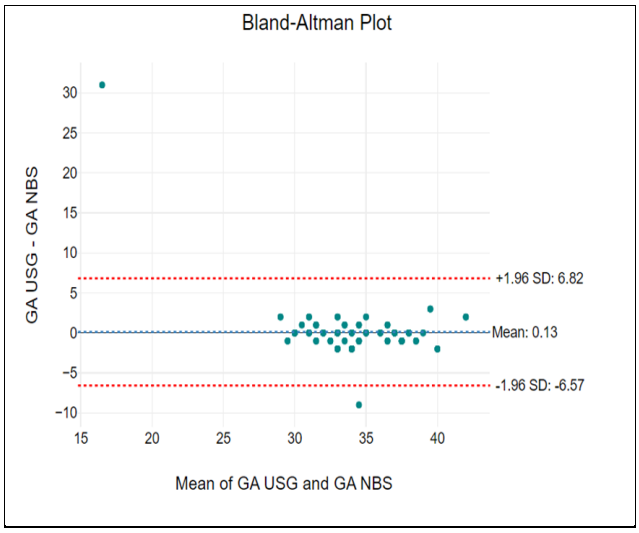

Figure-1: Bland Altman Plots Correlation of Gestational age (GA) by New Ballard Score (NBS) with first-trimester ultrasound (USG)

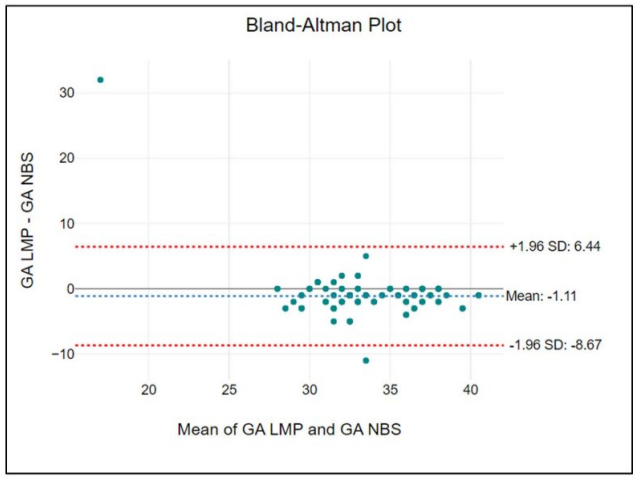

Figure-2: Bland Altman Plots Correlation of Gestational age (GA) by New Ballard Score (NBS) with last menstrual period (LMP)

Table-4: Correlation of Total New Ballard Score (NBS) with each NBS component score

Category	r value	p value
Total NBS - Posture	0.662	< .001
Total NBS - Square window	0.489	< .001
Total NBS - Arm recoil	0.678	< .001
Total NBS - Popliteal angle	0.614	< .001
Total NBS - Scarf sign	0.586	< .001
Total NBS - Heel to ear	0.424	< .001
Total NBS - Skin	0.630	< .001
Total NBS - Lanugo	0.598	< .001
Total NBS - Plantar surface	0.421	< .001
Total NBS - Breast	0.569	< .001
Total NBS - Eye/ear	0.786	< .001
Total NBS - Genitals	0.693	< .001

DISCUSSION

Gestational age (GA) assessment is a critical component of neonatal care, guiding clinical decision-making and predicting outcomes such as prematurity and growth restriction. In our study, we aimed to compare GA estimation by three commonly used methods—last menstrual period (LMP), ultrasonography (USG), and the New Ballard Score (NBS)—with a focus on their relative reliability and agreement.

In our study, the mean GA by USG was 34.3 weeks (SD 3.02), which was slightly higher than the mean by NBS (34.2 weeks, SD 4.52) and significantly higher than the LMP-based mean GA (33.1 weeks, SD 3.17). This finding is important as it suggests that LMP may tend to underestimate GA compared to other methods.

Our findings are supported by a similar study by Jyotsana B et al., in which GA by LMP was slightly higher (mean 36.5 weeks, SD 3.6), USG estimated GA at 36.0 weeks (SD 3.8), and NBS at 36.1 weeks (SD 4.1).[6] This small discrepancy between our values and theirs could be attributed to differences in study populations, such as gestational age distribution, maternal health profiles etc.

We observed that NBS correlated more closely with USG than with LMP, a finding that contrasts with the results of Jyotsana B et al., who reported a stronger correlation of NBS with LMP. This variance may suggest that in our clinical setting, LMP is less reliable—possibly due to factors such as inaccurate maternal recall, illiteracy, or irregular menstrual cycles, which are common limitations in public health setups and low-resource environments. In contrast, USG and NBS, being more objective and clinically based, are less affected by such recall bias.

Our findings resonate with Ravish Singhal et al., who reported a very high correlation (r = 0.96) between USG and LMP, and moderate correlation of NBS with USG (r = 0.86) and LMP (r = 0.88).[7] Our study reflects a slightly different trend, favoring a stronger correlation of NBS with USG rather than LMP—supporting the use of clinical examination tools like NBS in circumstances where reliable maternal history is unavailable. Krithika S et al: Found a highly significant correlation between NBS and LMP in preterm infants, supporting the use of NBS when other methods are unavailable.[8]

Gagandeep V et al: Mean GA by LMP, USG, and NBS were closely matched in their study, with high correlation values (0.95), particularly between NBS and USG, similar to our study.[9] Another study by Sultana R et al: Also reported strong correlations between GA by USG and NBS.[10] Andrea Pietravalle et al: In low-resource settings, a combination of NBS and birth weight (BW) was the least biased method compared to local USG standards, though accuracy for all alternative methods was limited.[11] Rosenberg RE et al, compared validity of three methods (last menstrual period [LPM], Ballard and Dubowitz scores) for assessment of gestational age for premature infants in a low-resource setting, using antenatal ultrasound as the gold standard.[12]

We also compared each NBS component score with total score and most correlation was seen with Eye ear component and least seen with Plantar surface component, so from our study we can say that gestational age assessed by New Ballard Score is significantly correlated to that assessed by USG and also if we cannot measure all the components of NBS eye/ear component of NBS score is highly correlated with total NBS score, so we can just measure that. Bland-Altman analysis in our study revealed wide limits of agreement between GA assessed by LMP and other methods, highlighting the poor accuracy and high variability of LMP-based estimations. This statistical evidence strengthens the conclusion that LMP should be interpreted cautiously, particularly in contexts where prenatal care is inconsistent, or documentation is absent. Conversely, the narrower agreement between USG and NBS underscores their comparative reliability.

Our findings align with literature emphasizing the limitations of LMP and the practical utility of both USG (especially in early pregnancy) and NBS (at birth) for GA determination. As recommended by ACOG (American College of Obstetricians and Gynecologists) early USG remains the gold standard.[3] Considering the constraints of resource-limited settings, where early USG might not always be feasible, our findings highlight NBS as a valuable and relatively accurate tool for estimating gestational age. It offers a clinical, cost-effective alternative with strong correlation to USG estimates. Caution should be exercised with LMP-based GA, particularly in populations with low antenatal follow-up or inaccurate menstrual history.

CONCLUSION

Ultrasonography remains the most accurate antenatal method to determine gestational age; the New Ballard Score provides a reliable postnatal alternative and shows better correlation with USG than LMP in our setting. Given its clinical ease of use and reliability, NBS should be promoted as a primary GA assessment tool in low-resource settings, especially in the absence of prenatal records or early USG.

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