

# Assessment of Gestational Age by Modified Ballard Score and Its Correlation with Assessment based on Ultrasound and Date of Last Menstrual Period

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## ABSTRACT

**Background:** In developing countries, significant number of deliveries, including preterm ones, is conducted at home by birth attendants and the neonate's first contact with pediatrician happens only after a few days of life. The present work aimed to study the validity of New Ballard Score (NBS) on day 7 of life for estimation of gestational age (GA) in preterm neonates. Objective of our study was to assess GA using Modified Ballard Score (MBS) on days 1, 3, and 7 of life among preterm neonates and find its correlation with GA assessed antenatally using USG report and last menstrual period (LMP).

**Materials and methods:** It was a prospective observational study, GA was estimated by principal investigator based on NBS on days 1, 3, and 7. The principal investigator was blinded to calculate GA based on USG and LMP. The parents of the neonate were explained about the study and informed consent was obtained. Intraclass correlation (ICC) statistic was performed to detect correlation between the GA measured antenatally and MBS measured GA.

**Results:** Correlation between GA assessed ultrasonographically and that assessed postnatally by MBS on days 1, 3, and 7 of life was found to be significant (r-value: 0.832, 0.837, 0.831;  $p < 0.01$ ).

**Conclusion:** In situation where newborn encounters physician after first few days of life and does not have an exact assessment of GA through an established LMP and ultrasonography (USG) MBS can be utilized even on day 3 or 7 of life.

**Keywords:** Gestational age, Modified Ballard Score, Perinatal care.

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## INTRODUCTION

Assessment of GA of the neonate is an important part of neonatal examination. Antenatally GA is calculated by LMP using Nägele's rule<sup>1</sup> and antenatal USG examination. In a neonate, GA is best assessed by utilizing the MBS or NBS.<sup>2</sup> Modified Ballard Score is most accurate when assessment is done between 12 and 20 hours of life.<sup>3</sup> There are times when an accurate GA by obstetrical history or early USG report is not available. In developing countries, sizeable number of deliveries are still conducted at home and the neonate's first contact with a pediatrician happens only after a few days of life. Some studies have shown that MBS can be used up to 7th day of life or beyond, however, the evidence is weak.<sup>4,5</sup> The present work aimed to study the validity of MBS on day 7 of life for estimation of GA in preterm neonates. Objective of our study was to estimate GA using MBS on days 1, 3, and 7 of life among preterm neonates and assess its correlation with GA assessed antenatally using USG report and LMP.<sup>6-9</sup>

## MATERIALS AND METHODS

It was a prospective observational study conducted at a tertiary care center in north India. Sample size was calculated to be approximately 120. All preterm neonates (<37 weeks of gestation age) born at our hospital during the period of study, from January 2018 to May 2019 were included except those meeting exclusion criteria. Exclusion criteria included factors which may confound the neurological evaluation, these included seriously ill neonates who were unable to maintain their vital parameters without

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**Conflict of interest:** None

support, neonates born with gross congenital anomalies, babies who had sustained birth injuries like Erb's paralysis and shoulder dystocia, developmental dysplasia of hip, neurological disorders, and babies born to mothers who did not have an USG report from antenatal period were also excluded as comparison based on LMP dates and USG assessment was required. Demographic profile of study population has been shown in Table 1. The parents of the neonate were explained the nature of the study and informed

consent was taken. Ethical clearance was taken from hospital ethical committee.

**Study Measurements**

Postnatal GA assessment using MBS was done before completing 24 hours after birth, then on day 3, and then on day 7 of life. The babies were examined in a warm room. Total physical score based on MBS chart and total neurological score based on MBS chart were recorded. And GA was assessed based on the scores. The MBS was recorded by a pediatrics postgraduate resident (MA) and was trained for MBS scoring under supervision of the main guide (VN). Investigator recording MBS was blinded to USG findings and date of LMP.

**Statistical Analysis**

Statistical analysis was done by Karl Pearson’s coefficient of correlation. Both mean and standard deviations were calculated and compared with the main value. Analysis was computed by using Statistical Package for the Social Sciences.

**RESULTS**

Present study included 120 preterm neonates with 73 males and 47 females among them. Out of total 120 preterm neonates, 8.3% were between 29 and 31 weeks, 35% were between 32 and 34 weeks, and 56.7% were between 35 and 37 weeks. Mean GA according to LMP was 34.4 weeks and as per the sonographic estimation it was 34.61 weeks while mean GA as per MBS on days 1, 3, and 7 of life was 34.92 weeks, 35.17 weeks, and 35.53 weeks, respectively. The MBS slightly overestimated the GA as compared to LMP, however, the difference was less than a week (Table 2).

**Table 1:** Demographic profile of study population

<i>Total study population 120 (%)</i>	
Female	47 (39.2%)
Male	73 (60.8%)
<i>Period of gestation</i>	
29–31 weeks	10 (8.3%)
32–34 weeks	42 (35.0%)
35–37 weeks	68 (56.7%)

**Table 2:** Correlation of MBS with period of gestation based on LMP

<i>Period of gestation</i>	<i>Mean</i>	<i>Standard deviation</i>	<i>Mean difference (days)</i>	<i>Mean difference (%)</i>
LMP	34.40	1.85		
MBS day 1	34.92	2.05	<b>-3.62</b>	<b>1.5%</b>
MBS day 3	35.17	1.93	<b>-5.37</b>	<b>2.2%</b>
MBS day 7	35.53	1.81	<b>-6.94</b>	<b>3.2%</b>

Bold value signify the average difference which is very low

**Table 3:** Correlation of MBS with period of gestation based on USG

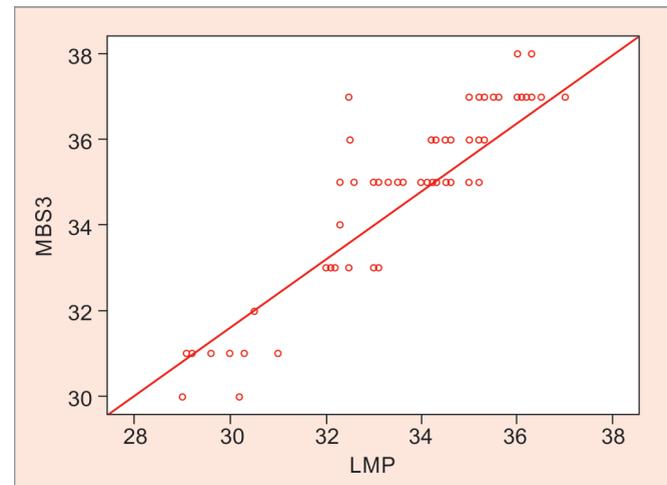
<i>Period of gestation</i>	<i>Mean</i>	<i>Standard deviation</i>	<i>Mean difference (days)</i>	<i>Mean difference (%)</i>
USG	34.61	1.96		
MBS day 1	34.92	2.05	<b>-2.15</b>	<b>0.9%</b>
MBS day 3	35.17	1.93	<b>-3.90</b>	<b>1.6%</b>
MBS day 7	35.53	1.81	<b>-6.46</b>	<b>2.6%</b>

Bold value signify the average difference which is very low

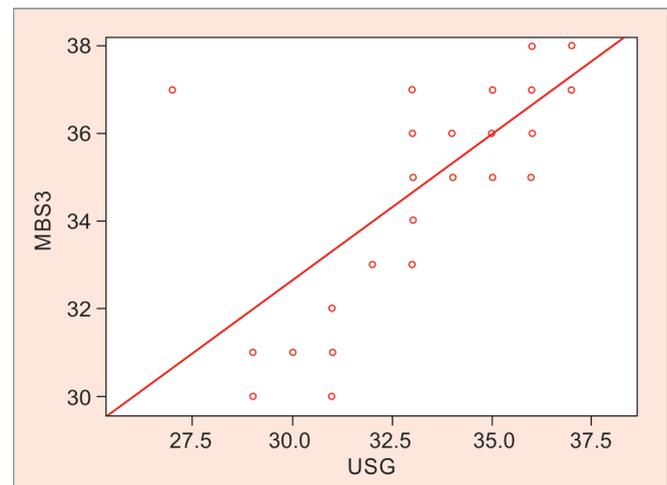
Similarly, it was also overestimated when compared to USG method but the difference was less than 1 week (Table 3). A significant correlation was observed between GA assessed antenatally using LMP and that assessed postnatally by MBS on days 1, 3, and 7 of life (r-value: 0.961, 0.951, 0.944;  $p < 0.01$ ). A significant correlation was also observed between GA assessed by USG and by MBS on days 1, 3, and 7 of life (r-value: 0.832, 0.837, 0.831;  $p < 0.01$ ) (Figs 1 and 2).

**DISCUSSION**

The Ballard system of estimating GA of a neonate depends upon six physical and six neurologic criteria.<sup>3</sup> The scores of each feature are added to calculate a maturity rating that correlates with GA and is accurate within 2 weeks. This simplified assessment can be accomplished in about 3.5 minutes, therefore, easier to perform on sick infants.<sup>3</sup> The Ballard system was modified as NBS or MBS to improve assessment of infants as preterm as 20 weeks.<sup>4</sup> This method expands the description of physical and neurologic features and was tested in infants from 20 to 44 weeks gestation. In the initial report, GA was slightly greater when estimated by MBS than by LMP and USG (0.15 and 0.32 weeks for the total population and infants less than 26 weeks, respectively). Correlation was similar when the examination was done up to 96 hours of age



**Fig. 1:** Correlation of gestation age estimation by LMP and MBS on day 7



**Fig. 2:** Correlation of gestation age estimation by USG and MBS on day 7

in infants of at least 26 weeks gestation, but is best if done prior to 12 hours in infants below 26 weeks.<sup>6-8</sup> Very few studies have been done till now to assess the validity of MBS for 7th day of life or beyond.<sup>9-11</sup> In the present study MBS slightly overestimated the GA as compared to LMP and USG, however, the difference was less than a week. In a similar study, Gabriel et al.<sup>6</sup> observed that agreement between MBS and USG/LMP was good (ICC = 0.6–0.8). They also observed that MBS slightly overestimated GA compared to USG/LMP (mean difference = 1.2–2.9) but differences of more than 2 weeks in GA were infrequent. Sultana et al.<sup>7</sup> in a similar study observed positive relationship between period of amenorrhea, antenatal assessed GA, and MBS. A significant correlation was observed between GA assessed antenatally using LMP and that assessed postnatally by MBS on day 7 of life (r-value: 0.944;  $p < 0.01$ ). A similar significant correlation was also observed with ultrasonographic assessment (r-value: 0.831;  $p < 0.01$ ). Sasidharan et al.<sup>8</sup> studied the validity and reliability of MBS for GA assessment on postnatal age of 1, 5, and 7 days. On day 7, MBS overestimated and underestimated GA in 26.7% and 19.8% cases, respectively; all discrepancies were less than or equal to 2 weeks. Singhal et al. studied MBS among small for gestational age (SGA) neonates and concluded that physical parameters of MBS overestimate GA among SGA babies.<sup>9</sup> Zahan et al.<sup>10</sup> found that this tendency to overestimate the GA by MBS increased from day 1 to day 5 to day 7. But the GA calculated from LMP and USG did not differ more than 2 weeks from GA by MBS. Arshpreet et al. assessed role of MBS on 10th day of life and found it to match GA according to mother's LMP or first-trimester USG report in 24 weeks.<sup>10,11</sup>

## CONCLUSION

Present study showed that assessment of GA in a newborn can be accurately done by using the MBS up to 7th day of life. Though slight overestimation of the GA was observed with increasing days, the difference was less than a week. Our study has importance in situation where newborn encounters physician after first few days of life and does not have an exact assessment of GA through an

established LMP and USG. However, further multicenter large-scale studies are needed to confirm this finding.

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