Accuracy of Gestational Age Estimation in Newborns using New Ballard Score – An Observational Study.

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ABSTRACT:

Background:

The New Ballard Score is widely employed for estimating gestational age postnatally. This scoring system is a swift and dependable method for assessing gestational age. It evaluates physical and neuromuscular maturity through specified criteria at regular intervals. By scoring these criteria, the system extrapolates a total score to determine the infant's gestational age. The aim of this study is to assess the consistency between two observers in estimating gestational age using the New Ballard Score.

Materials and methods:

Our study included approximately 200 participants selected based on specific criteria using purposive sampling at our tertiary care hospital. All neonates born during the study period were eligible, except those requiring immediate resuscitation and life support (such as ventilation and inotropes) or those affected by perinatal asphyxia. Each newborn delivered in the hospital was assessed by two separate investigators. Information including history, last menstrual period, EDD by ultrasound, and other pertinent details were documented in the case records without disclosure to the investigators. Both investigators independently estimated the gestational age using the New Ballard Score. Subsequently, all data were recorded and analyzed for comparison.

Results:

The two investigators demonstrated substantial agreement, as indicated by an ICC ranging from 0.8523 to 0.9467. Additionally, Kappa Statistics revealed perfect agreement (kappa value = 0.952) between the two independent observers in assessing the gestational age of newborns using the New Ballard Score.

Conclusion:

The strong agreement between the two investigators in estimating gestational age using the New Ballard score, as indicated by the interclass correlation coefficient, confirms the accuracy of this method for estimating gestational age.

Introduction:

Accurately determining the gestational age at birth is crucial for predicting illnesses, selecting appropriate newborn care levels, assessing the anthropometric measurements, and anticipating the neurodevelopmental outcomes. Ultrasonography and the first day of the last menstrual cycle are the methods used to estimate the gestational age. When there is a difference of more than 14 days between these two methods, ultrasound results should take precedence[1]. However, precise gestational age determination is essential for the effective management planning and anticipating the potential newborn issues.

The New Ballard Score is widely utilized for the postnatal gestational age assessment. It efficiently assesses gestational age based on physical and neuromuscular maturity criteria at regular intervals[2]. By scoring various criteria across six neurological and six physical categories, this method extrapolates a total score that corresponds to gestational age estimates ranging from 26 to 44 weeks. Specifically designed for extremely preterm infants, including those born at 20 weeks or earlier, the New Ballard Score incorporates intrauterine maturation-related changes. Physical criteria evaluate anatomical changes, while neurological criteria predominantly assess muscle tone, which tends to be lower in infants under 37 weeks due to physiological hypotonia. Variations in fetal maturation rates among healthy fetuses or fetal developmental anomalies can influence gestational age assessment accuracy. Even slight differences in gestational age significantly impact the outcome for extremely preterm infants, potentially influencing decisions about intensive care. The Ballard

Results:

score ranges from -10 (corresponding to 20 weeks gestation) to 50 (corresponding to 44 weeks gestation). Studies show a strong correlation (0.97) between Ballard score assessment and prenatal ultrasound, underscoring its reliability in predicting the gestational age[3]. This study aims to assess the agreement between two different observers in estimating gestational age using the New Ballard Score.
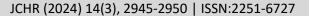
Materials and methods:

This study is an observational study which was conducted among all the neonates born in Vinayaka Mission's Kirupananda Variyar Medical College and Hospital Salem. The study subjects were the inpatients of labour room, NICU and post-natal ward. About 200 study participants were included in our study as per the inclusion and exclusion criteria following the purposive sampling technique. All the neonates during the study period were chosen for the study. We included all the neonates born in the hospital and excluded the sick neonates who needed immediate resuscitation and life support (ventilation and inotropes); neonates who suffered from perinatal asphyxia and those neonates whose parents refused to give consent to participate in the study.

All the neonates during the study period delivered in the hospital were examined by 2 different investigators. A detailed history, last menstrual period, EDD by USG and other relevant details were recorded in the case sheet. These details were not provided to the investigators. Both the investigators estimated the gestational age of newborn by New Ballard Score. All the data were recorded and compared.

Table 1: Baseline characteristics of the newborn (N-200)

Characteristics	Frequency	%
Gender		
Male	120	60
Female	80	40
Birth		

Vaginal birth	148	74
Caesarean section	52	26
Gestational period		
post term	4	2
term	170	85
preterm	26	13
Birth weight		
> 2500 gms	173	86.5
1500-2500 gms	18	9
1000-1500 gms	8	4
< 1000 gms	1	0.5

The table-1 depicts the distribution of baseline characteristics of the neonates. From the table it is evident that majority 60% were male and 40% were female babies. And about 74% were born through normal vaginal delivery and the remaining 26% were born through caesarean section. With regarding to the gestational period, 85% were term, about 13% were preterm and 2% were post-term babies. Majority of the neonates (86.5%) were born with birth weight of >2500 gm. The table-2 shows the complications in the neonates.

70.5% of the neonates did not have any complication. Only a small number of neonates had complications such as respiratory distress syndrome(6.5%); sepsis (2%); neonatal seizures(0.5%); metabolic abnormality (4%); NICU observation (8.5%); Transient tachypnea of newborn (5.5%); Respiratory distress syndrome and sepsis (0.5%); Respiratory Distress Syndrome and Metabolic abnormality(1%); Respiratory Distress Syndrome, Metabolic abnormality and Convulsions (0.5%); Sepsis and convulsions (0.5%).
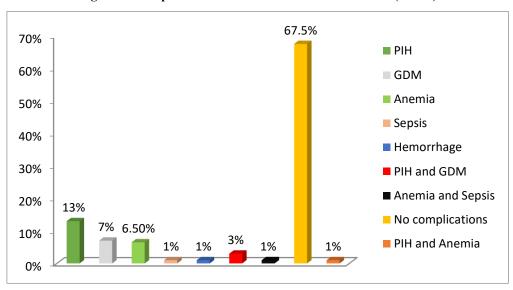
Table-2: Complication in New Born

Complication in Newborn		
Respiratory Distress Syndrome	13	6.5
Sepsis	4	2
Convulsions	1	0.5
Metabolic abnormality	8	4
NICU observation	17	8.5
TTN	11	5.5
Respiratory Distress Syndrome and Sepsis	1	0.5
Respiratory Distress Syndrome and Metabolic abnormality	2	1
Respiratory Distress Syndrome, Metabolic abnormality and Convulsions	1	0.5
Sepsis and Convulsions	1	0.5
No complications	141	70.5
Total	200	100

Figure 1: Complications in the mothers of the neonates (N-200)

The Figure-1, illustrates the complications in the mothers of the neonates. It shows that majority of the mothers did not have any complications. Only a small percentage of the mothers had some complications as shown in figure.

Table-3: Intraclass correlation coefficient

Group	Intraclass correlation	95%CI	P
Two investigators	0.943	0.8523 - 0.9467	0.0082

Since the data were numerical, the statistical analysis of the amount of agreement between the two investigators was done using the intraclass correlation coefficient (ICC) as shown in table-3. According to this study, there was a fair level of agreement between the two investigators (ICC: 0.943; 95% CI: 0.8523 - 0.9467 and p0.008). Since the New Ballard score uses a number of factors that adds up to one score, the results were expressed using the arithmetic mean.

Agreement between the two independent observers for assessing the gestational age of the newborn using New Ballard score was tested using Kappa statistics and there was a perfect agreement between the two observers with a kappa value of 0.952.

Discussion:

Before the initiation of the study, both the investigators were given a refreshing instructions regarding the assessment of neonates. The study found that there was a very strong agreement between the two investigators with an ICC between 0.8523 - 0.9467. Interobserver agreement between two examiners was described by Maria et al [4] as being very good if the ICC value was more than 0.8.

The new Ballard Score approach has benefits and drawbacks of its own. For instance, the New Ballard Score method's accuracy outperformed USG's (ICC = 0.6-0.8). The New Ballard Score was quicker to evaluate (2 minutes and 48 seconds) than the Dubowitz Score Method (4 minutes and 28 seconds), but it was less accurate than the Dubowitz Score Method (Dubowitz score ICC: 0.94 vs. Ballard score ICC=0.93)[5]. In health care facilities with a shortage of personnel, Verhoeff et al[6] recommendation was that a nurse complete the usual physical criterion test for the New Ballard Score. Mcgready et al [7], who indicated that paramedics can reliably complete the evaluation of neurological criteria of the New Ballard Score, backed this proposal.

Similarly, in the study done by Wibowo et al [8] where the study done between the paediatrician and a trained paramedic. From their study they found that Paediatricians and certified paramedics had a very

significant correlation agreement, according to intraclass correlation (r=0.925 and p0.05). The Ballard score examination results that were conducted between 48 and 96 hours of age were nearly identical to the gold standard (r=0.993 and p0.05). In conclusion, paediatricians and skilled paramedics had a fair level of agreement when determining the infant gestational age using NBS.

From our study it is evident that the NBS is better in estimation of gestational age, similar results also seen in the study done by Singhal et al[9] which concluded that In SGA neonates, the physical NBS parameters overstate gestation. In SGA infants, changing scores of the skin and plantar creases improves estimations of gestational age.

The data were gathered by a paediatric resident in order to eliminate bias; as a result, the two examiners were unaware of the research participants and examination outcomes. Variability of observers, subjects, and instruments had an impact on measurement accuracy. Standardisation of measurement, assessment, and repeated measurement were carried out to improve the study's measurement accuracy. Observing the confidence interval is one way to determine the accuracy of a measurement of a numeric variable; the smaller the interval, the more accurate the measurement[10].

Subject bias, examiner bias, and instrumental bias were three types of measurement bias that this study made an effort to minimise. Valid sampling, which involved sequential sampling, was used to reduce subject bias since it covered all eligible subjects up until the required minimum of subjects. Blinded examination, meanwhile, managed examiner prejudice. The outcomes of each subject's examination were unknown to the two examiners. The standardisation of test time and location prevented institutional bias. Evaluation of the New Ballard Score assessment's repeatability was conducted using intraclass correlation. The limitation of this study is that, all the neonates were recruited from a single centre.

Conclusion

This study clearly demonstrates strong agreement between two investigators in estimating the gestational age using the New Ballard score, as indicated by the interclass correlation coefficient. Therefore, the New Ballard score provides accurate estimation of gestational age.

References:

[1] Taipale P, Hiilesmaa V. Predicting delivery date by ultrasound and last menstrual period in early gestation. Obstetrics & Gynecology. 2001 Feb 1;97(2):189-94.

[2] Ballard JL, Khoury JC, Wedig K, et al. New Ballard Score,expanded to include extremely premature infants. J Pediatr 1991;119:417–23.

[3] Wibowo HS. Agreement between pediatrician and trained paramedic in the assessment of gestational age among newborns using New Ballard Scored. Journal of the Medical Sciences (Berkala Ilmu Kedokteran). 2011;43(02).

[4] Gabriel M, CR PA, de la Cruz Bértolo J. Assessment of the new Ballard score to estimate gestational age. InAnales de Pediatria (Barcelona, Spain: 2003) 2006 Feb 1 (Vol. 64, No. 2, pp. 140-145).

[5] Sunjoh F, Njamnshi AK, Tietche F, Kago I. Assessment of gestational age in the Cameroonian newborn infant: a comparison of four scoring methods. Journal of Tropical Pediatrics. 2004 Oct 1;50(5):285-91.

[6] Verhoeff FH, Milligan P, Brabin BJ, Mlanga S, Nakoma V. Gestational age assessment by nurses in a developing country using the Ballard method, external criteria only. Annals of tropical paediatrics. 1997 Dec 1;17(4):333-42.

[7] McGready R, Simpson J, Panyavudhikrai S, Loo S, Mercuri E, Haataja L, Kolatat T, Nosten F, Dubowitz L. Neonatal neurological testing in resource-poor settings. Annals of tropical paediatrics. 2000 Dec 1;20(4):323-36.

[8] Wibowo HS. Agreement between pediatrician and trained paramedic in the assessment of gestational age among newborns using New Ballard Scored. Journal of the Medical Sciences (Berkala Ilmu Kedokteran). 2011;43(02).

[9] Singhal R, Jain S, Chawla D, Guglani V. Accuracy of New Ballard Score in small-for-gestational age

neonates. Journal of Tropical Pediatrics. 2017 Dec 1;63(6):489-94.

[10] Sastroasmoro S. Pengukuran dalam penelitian. Dalam: Sastroasmoro S, Ismael S editor. Dasar-dasar metodologi klinis. 2nd Ed. Jakarta: Sagungseto. 2002:49-67.

[11] Ballard JL, Khoury JC, Wedig KL, Wang L, Eilers-Walsman BL, Lipp R. New Ballard Score, expanded to include extremely premature infants. The Journal of pediatrics. 1991 Sep 1;119(3):417-23.

[12] Lee AC, Panchal P, Folger L, Whelan H, Whelan R, Rosner B, Blencowe H, Lawn JE. Diagnostic accuracy of neonatal assessment for gestational age determination: a systematic review. Pediatrics. 2017 Dec 1;140(6).

[13] Sasidharan K, Dutta S, Narang A. Validity of New Ballard Score until 7th day of postnatal life in moderately preterm neonates. Archives of Disease in Childhood-Fetal and Neonatal Edition. 2009 Jan 1;94(1):F39-44.

[14] Erman E, Retayasa W, Soetjiningsih S. Clinical gestational age assessment in newborns using the new Ballard score. Paediatrica Indonesiana. 2006;46(3):97-101.

[15] Ambey R, Gogia P, Kumar A. Comparison of gestational age assessment by new Ballard score and Parkin score in neonates. Int J Contemp Pediatr. 2018 Jul;5:1231-5.

[16] Arshpreet D. Validity of modified ballard score after 7 days of life. Int J Med Res Health Sci. 2017 Jan 1;6(7):79-83.