International Journal of Contemporary Pediatrics
Mehta VR et al. Int J Contemp Pediatr. 2022 Jan;9(1):32-38
http://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20214849

Original Research Article

A study of postnatal assessment of gestational age of neonates by new Ballards and Parkins score

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Received: 26 November 2021
Revised: 11 December 2021
Accepted: 13 December 2021

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ABSTRACT

Background: The aim, of the study was to find the correlation between new Ballard score and Parkin's score and whether they correlate with obstetric gestational age estimated by LMP and/or 1st-trimester USG.
Methods: A cross-sectional clinical study for 6 months duration was carried out at tertiary care NICU and postnatal ward of a teaching hospital. Any intramural neonate admitted in NICU and neonates examined after randomized selection in postnatal ward within the first 24 hours of life were included in the study after written informed consent. Their demographic profile was documented using preset Performa and gestational age was assessed using both New Ballard score and Parkins score.
Results: Total 387 new-borns were screened with mean age of 12.86±11 hours. Out of which 209 (54.0%) were males and 178 (46.0%) were females. The 259 (66.0%) new-borns were normal vaginal delivered and 128 (33.0%) new-borns were delivered by caesarean section. In the study it was found that the obstetric gestational age strongly correlates to gestational age by new Ballard score ($r=0.880$, $p<0.001$), and to gestational age by Parkins score ($r=0.880$, $p<0.001$). The gestational age by new Ballard score also strongly correlates to gestational age by Parkins score ($r=0.937$, $p<0.001$). Scatter diagram shows that there is strong positive linear correlation between gestational age assessed by LMP and NBS. While that gestational age accessed by Parkins having weak positive relationship compared to NBS.
Conclusions: New Ballard score predicts new-born gestational age better in preterm and term new-borns, but Parkin's Score, being simpler assessment method, takes very less time and has the advantage of no subjective neurological criteria and lesser interpersonal variation.

Keywords: Gestational age, New Ballard score, Parkin's score

INTRODUCTION

The knowledge of gestational age is important for obstetricians and, neonatologists and it is routinely estimated both prenatally and postnatally. The development of some neonatal problems during and immediately after birth is known to be dependent, largely, on gestational age rather than birth weight. The determination of gestational age is therefore important in planning appropriate treatment for the fetus or infant and may modify details of their care.

Generally, the gestational age of new-borns is estimated by LMP and/or USG. Postnatal assessment of gestational age is mostly done by NEW BALLARD score, which comprises physical and neurological characters of the newborn.[1] Neurological characters of NEW BALLARD score have interpersonal observational bias so many

paediatricians use only physical characteristics to determine the Gestational age. PARKIN'S score estimates the Gestational age of new-borns taking into account only four physical characteristics i.e., Skin texture, Skin colour, Ear firmness and Breast size and seems to have a more practical usage, being easier.

Hence, this study was undertaken to find the correlation between new Ballard score and Parkins score and whether they correlate with obstetric gestational age estimated by LMP and/or 1st-trimester USG and thereby their practical use in NICU.

Methods of post-natal estimation of gestational age

Assessment of physical and neurological maturity

Interest in ways of assessing the gestational age in new-born infants using physical and neurological characteristics has spanned over 30 years.[2,3] This interest was stimulated by the growing awareness that gestational age was as important as birth weight in determining the hazards faced by the baby during and immediately after birth.[4] There were also reports showing that clinical problems encountered by infants who were small-for-dates differed from those truly premature.[2] It also became clear that other neonatal problems such as patent ductus arteriosus, intraventricular hemorrhage and retinopathy of prematurity are also influenced by gestation rather than birth weight. It, therefore, became a matter of practical importance to know whether a particular baby of low birth weight was truly premature or mature and small for-dates or both premature and small-for-dates, a distinction that depended on accurate knowledge of gestational age.[2] The problems sometimes encountered in gestational age assessment using ultrasonic measurements and LMP dates, as previously highlighted, led to the development of simple bedside techniques for assessment of the maturity of the newborn which are less technologically oriented, painless and inexpensive.[4]

Several methods of assessing gestational age using physical and neurological criteria at the bedside have been proposed. These methods use either a series of physical/external criteria,[3 5 6] neurological criteria,[2 7]or a combination of both criteria.[3,5-10] Generally, external features reflect maturational skin changes while neurological features reflect the maturation of the central nervous system.[10] Clinical methods of assessing gestational age using neurological criteria have been popular since the 1960s.[2,7]This approach is based on the relationship between late prenatal cerebral maturation and certain continuous criteria that develop steadily during the late gestation period.[7,11] These criteria include muscle tone as manifested by changes in posture, popliteal angle, and scarf sign, as well as the development of certain reflexes, such as the Moro, and crossed extension reflexes.[7,11]

Some of these methods are described here

Farr physical characteristics[12]

Farr was the first amongst his era to develop an objective gestational age estimation formulation using only physical characteristics of the new-born.

It took into account individual 11 physical characteristics at birth and the scoring was then formulated by a correction factor and the gestational age of the new-born was derived.

Amiel Tison neurological characteristics[7,13-15]

Amiel-Tison described the neurological evaluation of the maturity of the new-born using some of these criteria. Appreciation of muscle tone was a fundamental feature in this examination and included a study of ‘passive tone’ [resting posture or attitude] and ‘active tone’

Cerebral maturation during the last three months of fetal life brings about constant modification in muscle tone and certain reflexes. In contrast, 'active tone' is studied with the infant in an active situation, the physician noting, for instance, the righting reaction of the trunk when the infant is placed vertically.

'Passive tone' is appreciated by the physician applying certain movements to the infant who remains passive at rest, while, for instance, the amplitude of passive movements of a single joint is measured. This is responsible for the progressive development of the predominantly flexor posture of the newborn infant at term. Muscle tone is completely flaccid at 28 weeks, increases first in distal segments, to proceed in a caudo-cephalic direction. Flexor hypertonicity is generalized at term. The measurement of different limb-angles gives an objective measurement of passive tone; all these angles diminish as the muscle tone increases.

'Active tone' is studied with the infant in an active situation. This is evaluated through the righting reactions, investigated segment by segment. At first, only the righting of the lower extremities exists, and this is seen when the infant is held upright. Later the infant is able to sustain the weight of his body and righting of the trunk occurs. Finally, the righting of the head becomes possible. Active tone is responsible for the quality of the primary reactions (or reflexes). At 28 weeks these reflexes are present but weak and difficult to elicit several times in succession. With increasing age, they become progressively stronger. This method requires a lot of experience in the assessment of muscle tone.[2]

Dubowitz score[8]

Dubowitz combined the physical characteristics of Farr, Mitchell and neurological examination criteria of Amiel Tison and developed a scale for estimation of gestational age in new-borns. The Dubowitz method was used widely before the development of the new Ballard score.

The revised Dubowitz scoring system incorporates 34 physical and neurologic assessments.[16] These are divided into 6 categories (tone, tone patterns, reflexes, movements, abnormal signs, and behaviours), and each are assigned scores based on instructions sheet with illustrations. Higher scores indicate greater maturity. The scores are added, and total score is plotted on a graph to estimate gestational age. Physical features allow differentiation of gestational ages in infants greater than 34 weeks. Neurologic criteria are important between 26 and 34 weeks, when physical differences less apparent.

However, the Dubowitz system has two important disadvantages. One disadvantage is its overestimation of gestational age in preterm infants. As an example, in a study of 110 preterm infants with a mean gestational age of 28.3 weeks calculated from the last menstrual period (LMP) and best obstetric estimate, the Dubowitz examination overestimated the gestational age by 2.8 weeks.[17] Another problem with this method is the large number of criteria that require evaluation, rendering it difficult to perform on sick or extremely preterm infants and requiring 15 to 20 minutes for completion. The Ballard system has replaced the Dubowitz method as the standard assessment because it is easier to use.

Parkins score[5]

Parkins observed that neurological assessment in Dubowitz and Amiel Tison scoring was difficult and physical characteristics were enough in gestational age estimation in neonates.

Skin texture: 0: Very thin with gelatinous feel 1: Thin and smooth 2: Smooth and of median thickness, irritation rash or peeling may be seen 3: Slight thickening and stiff feeling with superficial cracking and peeling especially on hands and feet 4: Thick and parchment like with superficial or deep cracking
Breast size: 0: No breast tissue palpable 1: Breast tissue palpable on either one or both sides, with neither one being >0.5 cm in diameter 2: Breast tissue palpable on both sides, with either one being >0.5-1 cm in diameter 3: Breast tissue palpable on both sides, either One being 1-2 cm in diameter
Skin colour: 0: Dark red 1: Uniformly pink 2: Pale pink, though may vary at different parts of body, some parts may be very pale 3: Pale, nowhere really pink except for ears, lips, palms and soles
Ear firmness: 0: Pinna is soft and is easily foldable into bizarre shapes and doesn't recoil spontaneously 1: Pinna is soft at the edges, easily foldable but returns to original shapes slowly spontaneously 2: Cartilage can be felt at the edges of the pinna, pinna springs back spontaneously on folding 3: Pinna firm with definite cartilage in periphery, springs back immediately on being folded

Figure 1: Parkin's scoring.

Table 1: Parkins score and gestational age.

Parkins score	Gestational age (Weeks)
1	27
2	30
3	33
4	34.5
5	36
6	37
7	38.5
8	39.5
9	40
10	41
11	41.5
12	42

Although we have array of methods for determining gestational age in neonates and many of them do employ both physical and neurological criteria for deriving gestational age, physical characteristics along sufficed in predicting maturity. Inter personal variation decreases substantially and while predicting gestational age using only physical characteristics (Figure 1 and Table 1). It has advantages over other methods that it is simpler and easier method, it has no subjective neurological criteria so lesser interpersonal variation and lesser false over prediction of maturity due to abnormal uterine environment.

There are certain drawbacks of this method. It is not useful before 27 weeks of gestation. Timeframe for each score is nonconstant, it is not useful after 42 weeks. Skin colour was difficult to assess in African children especially after 48 HOL. Only 4 criteria are used. So wrongly determining 1 criterion will have a significant bearing on final maturity.

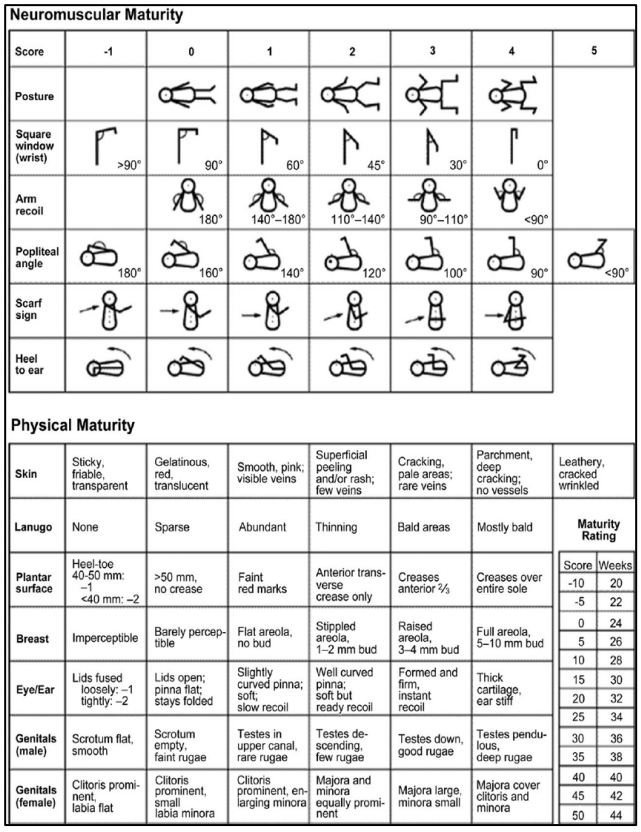
Ballards score and new Ballards score[9]

The Ballard system shortened the Dubowitz method to depend upon six physical and six neurologic criteria. The examination is most reliable when it is performed between 30 and 42 hours of age. Similar to the Dubowitz method, the scores of each feature are added to calculate a maturity rating that correlates with gestational age and is accurate within two weeks. This simplified assessment can be accomplished more quickly than can the Dubowitz method and is, therefore, easier to perform on sick infants.

In 1991, Ballard introduced negative scoring in physical characteristics and made the minimum scoring of the scale to -10. This helped to determine the gestational age of extremely premature new-borns up to the gestational age of 20 weeks. Ballard scoring is finally calculated by the following formula: (Total score+120)/5 (Figure 2).

It is trainable scoring, no resources required, reliable with no racial confounding factors. Neurological criteria

overestimate maturity, here; interpersonal variations are widely prevalent, Ballards score depends on the intrauterine environment. It is difficult assess in very sick neonates as this infant have poor neurological status to assess (i.e., posture, tone).



Neuromuscular Maturity

Score	-1	0	1	2	3	4	5
Posture							
Square window (wrist)	>90°	90°	60°	45°	30°	0°	
Arm recoil		180°	140°–180°	110°–140°	90°–110°	<90°	
Popliteal angle	180°	160°	140°	120°	100°	90°	<90°
Scarf sign							
Heel to ear							

Physical Maturity

Skin	Sticky, friable, transparent	Gelatinous, red, translucent	Smooth, pink; visible veins	Superficial peeling and/or rash; few veins	Cracking, pale areas; rare veins	Parchment, deep cracking; no vessels	Leathery, cracked wrinkled
Lanugo	None	Sparse	Abundant	Thinning	Bald areas	Mostly bald	
Plantar surface	Heel-toe 40-50 mm: –1 <40 mm: –2	>50 mm, no crease	Faint red marks	Anterior transverse crease only	Creases anterior ⅔	Creases over entire sole	
Breast	Imperceptible	Barely perceptible	Flat areola, no bud	Stippled areola, 1–2 mm bud	Raised areola, 3–4 mm bud	Full areola, 5–10 mm bud	
Eye/Ear	Lids fused loosely: –1 tightly: –2	Lids open; pinna flat; stays folded	Slightly curved pinna; soft; slow recoil	Well curved pinna; soft but ready recoil	Formed and firm, instant recoil	Thick cartilage, ear stiff	
Genitals (male)	Scrotum flat, smooth	Scrotum empty, faint rugae	Testes in upper canal, rare rugae	Testes descending, few rugae	Testes down, good rugae	Testes pendulous, deep rugae	
Genitals (female)	Clitoris prominent, labia flat	Clitoris prominent, small labia minora	Clitoris prominent, enlarging minora	Majora and minora equally prominent	Majora large, minora small	Majora cover clitoris and minora	

Maturity Rating

Score	Weeks
-10	20
-5	22
0	24
5	26
10	28
15	30
20	32
25	34
30	36
35	38
40	40
45	42
50	44

Figure 2: New Ballard scoring system.

METHODS

This is a cross-sectional observational clinical study, which was conducted for a period of 6 months (1/1/2019 to 31/6/2019) in a tertiary care NICU at and postnatal ward of LG general hospital, Ahmedabad.

Any intramural neonate admitted in NICU and neonates examined after random selection in postnatal ward within the first 24 hours of life were included in the study after written informed consent. Among these new-borns whose mothers could not recall their Last menstrual period were excluded. Sick new-borns and those with gross congenital anomalies were also excluded. Here sick new-borns are defined as neonates suffering from birth asphyxia and consequent hypoxic-ischemic encephalopathy and admitted with oxygen requirement, on CPAP or ventilator and those who are vitally not stable.

Neonates in whom mother's last menstrual period was known and their demographic profile was documented using preset Performa and gestational age was assessed using both new Ballard score and Parkins score. Both scores were plotted by the same examiner. The examiner was blinded to the menstrual gestational age and the gestational age extrapolated from the first-trimester sonogram. After gestational age from all three methods was calculated, they were computed using standard statistical software SPSS and correlation between them was looked for. They were categorized as preterm, full-term and post-term by obstetric age by LMP. The maximum limit for agreement between any two methods to be statistically insignificant (and hence both scores corresponding to one another) was pre-fixed at two weeks. Mean of both PKS and NBS were found taking LMP as gold standard as 1st-trimester USG of was not readily available in our setting. Mean difference and standard deviation of both the methods were found. Correlation between the two methods was found using a Bland Altman plot. The level of significance of this study was prefixed at 0.05 (5%). This study was presented and approved by the institutional review Board's ethical committee.

RESULTS

Total 387 new-borns were screened with mean age of 12.86±11 hours. Out of which 209 (54.0%) were males and 178 (46.0%) were females. The 259 (66.0%) new-borns were normal vaginal delivered and 128 (33.0%) new-borns were delivered by c-section. In present study new Ballard score corresponds with LMP more accurately (84.0%) than Parkins score (65.4%)

This bland Altman plot was plotted based on mean of gestational age obtained from LMP and ew Ballard score on X axes and difference between gestational age obtained from LMP and new Ballard score on Y axes, the mean of differences was found to be 0.71, and standard deviation was 1.66. It can be observed that most of values fall in between 95% confidence limits. So, it is found that there is similarity and most of values were found within the limits of agreement. And difference between two values increases as mean of gestational age increases more than 35 weeks (Figure 3).

This bland Altman plot was plotted based on mean of gestational age obtained from LMP and Parkins score on X axes and difference between gestational age obtained from LMP and Parkins score on Y axes, the mean of differences was found to be 1.62, and standard deviation was 1.65. It can be observed that most of values fall in between 95% confidence limits. So, it is found that there is similarity and most of values were found within limits of agreement. And it can be noticed that difference of values is more when mean is less than 30 weeks (Figure 4).

The obstetric gestational age was strongly correlated to gestational age by New Ballard score ($r=0.880$, $p<0.001$), and to gestational age by Parkins score ($r=0.880$, $p<0.001$). The gestational age by new Ballard score was also strongly correlated to gestational age by Parkins score ($r=0.937$, $p<0.001$).

Table 2: Demographic profile of newborns.

Variables		Total, (n=387)		NBS corresponding to obs. GA		PKS corresponding to obs. GA		NBS corresponding to PKS	
		N	%	N	%	N	%	N	%
Birth weight (kg)	<1.5	47	12.0	47	100	29	61.7	38	80.9
	1.5-2.5	171	44.2	142	83	116	67.8	147	86
	2.5-4	167	43.2	134	80.2	107	64.1	149	89.2
	>4	2	0.6	2	100	1	50	2	100
Gender	Male	209	100	179	85.6	136	65.1	187	89.5
	Female	178	100	146	82	115	64.6	149	83.7
SGA/ AGA/ LGA	SGA	139	100	121	87.1	107	77	121	87.1
	AGA	244	100	201	82.4	145	59.4	211	86.5
	LGA	4	100	3	75	1	25	4	100
Gestational age (Weeks)	<32	28	7.3	28	100	13	46.4	19	67.9
	32-37	97	25	77	79.4	56	57.7	85	87.6
	37-42	250	64.6	218	87.2	177	70.8	222	88.8
	>42	12	3.1	2	16.7	7	58.3	10	83.3
Total		387	100	325	84	253	65.4	336	86.8

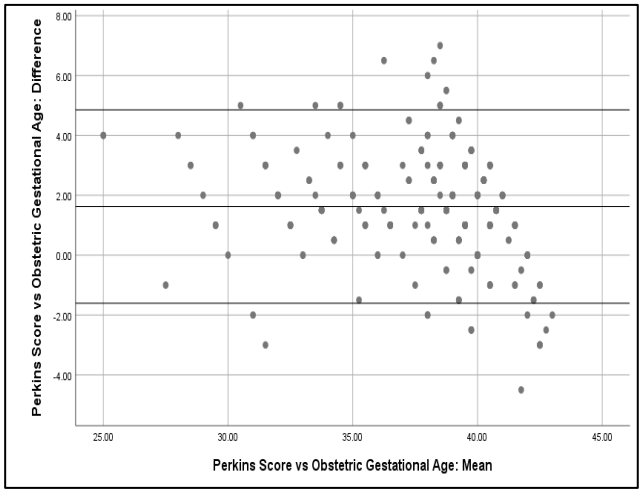


Figure 3: Parkins score versus obstetric gestational age.

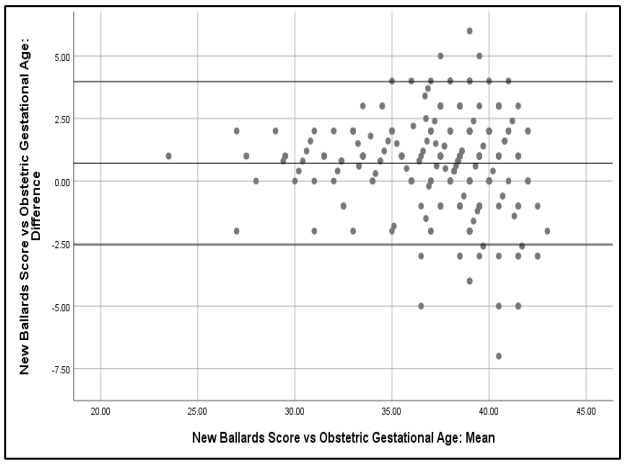


Figure 4: New Ballard's score versus obstetric gestational age.

DISCUSSION

In present study, NBS corresponds with obstetric GA more accurately (84%) then by PKS (65.4%). A study done by Sakharkar et al and Anne et al also documented that new Ballard score is more accurate than Parkins score in gestational age assessment, though they have taken 1st trimester USG (CRL) for comparison, not LMP.[18,19]

A study by Weinstein et al taking 1st trimester USG as gold standard has proven that LMP is better predictor of GA than NBS. And there was high correlation of gestational age by NBS with that of USG.[20] In some studies GA by LMP was taken as reference and they showed similar results. Studies by Ravi et al., Bela et al. had the same results where Parkin score gestational age correlated well with LMP-GA but was less accurate than NBS.[21,22]

The new Ballard score overestimates obstetric GA by about 5.01 days (range -49 to +42 days), and the Parkins Score overestimates it by 11.46 days (range-32 to +49 days). So, it is very apparent by our study that NBS is more accurate in assessment of gestational age than Parkins. Parkins score gives an average of 11 days (1.5 week) variation which is comparable with observations made in the following studies. Studies done by Sreekumar et al and Wariyar et al variation between last menstrual period and Parkins's method is 1.5 weeks to 2 weeks. Even Parkin et al observed that Parkins score overestimates gestational age by 15 days.[3,4,23]

Although in present study sick new-borns were excluded, PKS seems to be easier to perform on sick new-borns than NBS, as there is minimal handling of baby while performing PKS as compared to NBS. And in sick neonates' neuromuscular tone can be deranged (hypoxic

ischemic encephalopathy) which alters NBS score. Study by Sreekumar et al has also shown that PKS is easier to perform and less time consuming in sick neonates.[23] In present study mean time taken by NBS was 5 min 16 sec, and time taken by PKS was 1 min 35 sec.

Limitations

this study was held in a general hospital where higher number of patients gets admitted with limited education and literacy. These include mothers not knowing their last menstrual period date. And we had to exclude their new-borns from our study which makes the sample size smaller. As neuro-muscular maturity rating is component of new Ballard's score, new-borns with altered tone and posture (i.e., hypoxic ischemic encephalopathy) could not be assessed and we had to exclude them from current study.

CONCLUSION

Preventing childhood mortality is essential for enhancing health security. Preterm birth is a major contributor to childhood mortality worldwide and identification of premature new-born is necessary for proper allocation of care and prevention of mortality. While prenatal ultrasound is the most accurate method for determining gestational age if performed early in pregnancy, it is frequently not available. LMP, new Ballard and Parkins score are widely available methods that have been shown to be quite accurate under ideal conditions. NBS predicts new-born gestational age better in preterm and term new-borns, but PKS, which is a far simpler assessment method, takes very less time and has the advantage of no subjective neurological criteria and lesser interpersonal variation. Also, PKS is easier to perform in sick neonates as compared to NBS. So PKS can be taught easily to a peripheral health worker who is working at grass root level in developing countries like India.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Mehta VR, Parmar HR, Khandwala AB, Kakkad KM, Vekaria VV, Bhatt JV. A study of postnatal assessment of gestational age of neonates by new Ballards and Parkins score. Int J Contemp Pediatr 2022;9:32-8.