



## NEW BALLARD SCORE VERSUS FIRST TRIMESTER ULTRASOUND FOR GESTATIONAL AGE: A PROSPECTIVE, OBSERVATIONAL, HOSPITAL BASED, COMPARATIVE STUDY.

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### ABSTRACT

**INTRODUCTION** Gestational- age assessment is important to both the obstetrician and pediatrician and must be made with a reasonable degree of precision.. India has a very high neonatal mortality rate due to preterm birth. Accurate estimation of gestational age by clinical methods like NBS is indispensable in a country like India where preterm birth rate is very high and first trimester USG records are rarely available particularly in rural set up and also LMP recall method of GA estimation is unreliable.

Aims to compare NBS with first trimester USG for GA estimation

**MATERIALS AND METHODS** This study was a hospital based prospective, observational, comparative study conducted at Batra Hospital and Medical Research Centre, New Delhi , a tertiary care hospital in Delhi. A total of 94 neonates were taken up for the study. Hemodynamically unstable neonates, those neonates who presented after 7 days of PMA, those born less than 28 weeks GA, neonates with congenital malformations were excluded from the study. NBS scoring was done for all inborn neonates within 24 hours of birth and for out born neonates immediately as they presented till seven days PMA presentation ,after which neonate was excluded from study. NBS scoring was calculated and GA thus determined was compared with GA estimated from first trimester USG .

**RESULTS** Our study divided the 94 neonates into various groups depending on sex, age at NBS scoring, mode of delivery, presenting part, mother received ante natal corticosteroid are not etc.

There was strong agreement between NBS and USG based GA (ICC=0.93, 95%CI=0.90-0.95). NBS underestimated the gestational age only by 0.73 week with a narrow confidence interval being 0.49-0.96.

**CONCLUSION** This study showed that there is a strong agreement between NBS and first trimester USG in estimation of gestational age, ICC=0.93. Thus in resource poor countries where first trimester USG records are not available and LMP recall cannot be relied upon, NBS assessment of gestational age is a valid and accurate method with most accurate gestational age being obtained when the NBS is performed within first 24 hours of birth.

**KEYWORDS :** New Ballard Score, Preterm, First trimester USG

### INTRODUCTION

Gestational- age assessment is important to both the obstetrician and pediatrician and must be made with a reasonable degree of precision. Neonates are classified into three categories based on gestational (postmenstrual) age<sup>1</sup>.

Preterm: less than 37 completed weeks; with sub groups, moderate to late preterm: 32 to <37 weeks, very preterm: 28 to <32weeks and extremely preterm: <28 weeks.<sup>1</sup>

Term: 37 to 41 weeks 6 days and Post term: 42 weeks are more.<sup>1</sup> Neonates can be further classified on the basis of birth weight and gestational age into: SGA (small for gestational age), LGA (large for gestational age) &AGA (appropriate for gestational age).<sup>1</sup>

On the basis of weight alone neonates are classified as: Normal birth weight from 2500 to 4000g, low birth weight ; less than 2500g , further sub-classified as; very low birth weight: less than 1500g , extremely low birth weight : less than 1000g.<sup>1,2</sup> Prematurity and IUGR are associated with increased neonatal morbidity and mortality.

The incidence of preterm births in developing countries continues to rise and is due in part to multiple gestation pregnancies and female infertility treatments<sup>2</sup>. VLBW infants weigh <1,500 g and are predominantly premature .Perinatal care has improved the rate of survival of VLBW infants.<sup>2,3</sup>

The etiology of preterm birth is multifactorial and involves a complex interaction between fetal, placental, uterine, and maternal factors.<sup>1,2,3</sup>

Problems of preterm birth are related to difficulty in extra uterine adaptation due to immaturity of organ system. IUGR is associated with medical conditions that interfere with the circulation and efficiency of the placenta, with the development or growth of the fetus, or with the general health and nutrition of the mother. Many factors are common to both prematurely born and LBW infants with IUGR.<sup>2,3</sup>

Problems of neonates with SGA or with intrauterine growth retardation include intrauterine foetal demise, perinatal asphyxia, hypoglycaemia, polycythemia- hyper viscosity, reduced oxygen consumption, hypothermia, and dysmorphology<sup>1,3</sup>

Post-term infants are those born after 42 completed weeks of gestation, as calculated from the mother's last menstrual period, regardless of weight at birth. Common complications of post maturity include perinatal depression, meconium aspiration, persistent pulmonary hypertension, hypoglycemia, hypocalcaemia, and polycythemia.<sup>3</sup>

Infants with birth weight > the 90<sup>th</sup> percentile for gestational age are called large for gestational age (LGA). LGA infants, regardless of their gestational age, have a higher incidence of birth injuries, such as cervical and brachial plexus injuries, phrenic nerve damage with paralysis of the diaphragm, fractured clavicles, cephalohematomas, subdural hematomas, and ecchymosis of the head and face. LGA infants are also at increased risk for hypoglycaemia and polycythemia.<sup>3</sup>When premature delivery is inevitable, gestational age is important with regard to prognosis, the management of labor and delivery, and the initial neonatal treatment plan.<sup>3</sup>

The clinical estimate of gestational age is usually made on the basis of the first day of the last menstrual period.<sup>1,3</sup>

During the first trimester, fetal crown-rump length on ultrasonography can be an accurate predictor of gestational age. Crown-rump length estimation of gestational age on first trimester USG is expected to be within 7 days of the true gestational age.<sup>1</sup>

In situations where the validity of the information on the LMP is questionable and the mother has not done USG in the first or second or any period during pregnancy, gestational age can be estimated by observing physical and neurological characteristics of the newborn in its first two days of life.

The NBS includes six Neuromuscular maturity components: Posture, Square Window, Arm recoil, Popliteal angle, Scarf sign, and Heel To Ear. It also includes six physical maturity components: Skin, Lanugo, Planter surface, Breast, Eye/Ear, and Genitalia Male /Female.<sup>1,4</sup>

Since India has a very high neonatal mortality rate due to preterm birth, it is essential to do studies on accurate estimation of gestational age so that a specific initial neonatal treatment plan is formulated. There is a shortage of studies in our scenario that discuss the validity of this New Ballard Score for estimation of gestational age.<sup>2</sup>

Therefore, this study was conducted for secondary analysis aimed at comparing estimates of neonatal gestation age by New Ballard scoring and the antenatal first trimester ultrasound.

**MATERIALS AND METHODS**

This study was a hospital based prospective, observational, comparative study conducted at Department of Paediatrics and Neonatology & Department of Radio diagnosis and Imaging, Batra Hospital and Medical Research Centre, 1, Tughlakabad Institutional Area, M.B. Road, New Delhi-110062.

Study subjects were recruited from Department of Paediatrics & Neonatology, Batra Hospital, a tertiary care Paediatric hospital catering to a population where incidence of complicated deliveries including pre-term/ near term

deliveries is high.

After applying inclusion / exclusion criteria, all subjects' parents were provided with written informed consent forms. Approval of study was obtained from institutional review board. Subsequently, we obtained informed consent after detailed explanation.

The sample size was 94 which will included both inborn and out born babies admitted to our NICU/Observation Nursery. The study was conducted from March 2016 to May 2017. All Stable New-borns of gestational age equal to or more than 28 weeks and PMA equal to or less than 168 hours admitted to our NICU/Observation Nursery were included in the study. Hemodynamically unstable neonates, New-borns with major congenital malformations, Outborns who present after 168 hours of age, Premature neonates < 28 weeks of gestational age (as per USG), Neurologically affected babies, Neonates in whom mother's antenatal first trimester USG records are not available were excluded from the study.

The New Ballard Score was done preferably anytime within 96 hours of birth on preterm babies (≤32 weeks) to achieve good accuracy. For other neonates, examination was performed within 7 days of life at different postnatal ages.

**NBS was performed in two components:**

- 1. Neuromuscular maturity (FIG A) and
- 2. Physical maturity (FIG B).

SIGN	SCORE						SIGN SCORE
	-1	0	1	2	3	4	
Posture							
Square Window							
Arm Recoil							
Popliteal Angle							
Scarf Sign							
Heel To Ear							
TOTAL NEUROMUSCULAR SCORE							

**Fig A. Neuromuscular Maturity Components**

**Physical Maturity**

SIGN	SCORE							SIGN SCORE
	-1	0	1	2	3	4	5	
Skin	Sticky, friable, transparent	gelatinous, red, translucent	smooth pink, visible veins	superficial peeling &/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 40-50mm: -1 <40mm: -2	>50 mm no crease	faint red marks	anterior transverse crease only	creases ant. 2/3	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	sl. curved pinna; soft; slow recoil	well-curved pinna; soft but ready recoil	formed &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	prominent clitoris &small labia minora	prominent clitoris &enlarging minora	majora &minora equally prominent	majora large, minora small	majora cover clitoris &minora		
TOTAL PHYSICAL MATURITY SCORE								

**Fig B. Physical Maturity Components Maturity Rating Table**

TOTAL SCORE (NEUROMUSCULAR + PHYSICAL)	GA IN 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

**STATISTICAL ANALYSIS AND RESULTS**

The present study was conducted in the Department of Pediatrics & Neonatology and Department of Radio diagnosis & Imaging, Batra Hospital and Medical Research Centre, New Delhi with the objective to compare New Ballard Score with first trimester ultrasound for gestational age estimation. A total of 94 cases were included in the study.

**Table-1: Distribution of cases according to presentation**

Presentation	No. (n=94)	%
Breech	10	10.6
Brow	2	2.1
Chin	1	1.1
Face	4	4.3
Shoulder	7	7.4
Vertex	70	74.5

**Table-2: Distribution of cases according to mode of delivery**

Mode of delivery	No. (n=94)	%
LSCS	38	40.4
NVD	45	47.9
NVD+Instrumentation	11	11.7

**Table-3: Distribution of cases according to gender of baby**

Gender	No. (n=94)	%
Male	61	64.9
Female	33	35.1

**Table-4: Distribution of cases according to Apgar score**

Apgar score	Mean±SD	Min.-Max
1 Minute	7.24±0.71	5-8
5 Minute	7.71±0.69	6-9

**Table-5: Distribution of cases according to antenatal corticosteroids received by mother or not**

Prenatal corticosteroids	No. (n=94)	%
Received	63	67.0
Did not receive	31	33.0

**Table-6: Distribution of cases according to AGA/LGA/SGA**

	No. (n=94)	%
AGA	76	80.9
LGA	11	11.7
SGA	7	7.4

**Table-7: Distribution of cases according to time of examination**

Time in hours	No. (n=94)	%
<24	43	45.7
24-96	31	33.0
>96	20	21.3
Mean±SD, Median (Range)	58.36±60.19, 32 (3-168)	

**Table-8: Distribution of cases according to GA LMP known or not known**

Time in hours	No. (n=94)	%
Known	62	66.0
Not known	32	34.0

**Table-9: Comparison of gestational age by NBS and USG according to presentation**

Presentation	Gestational age (Mean±SD)	
	NBS	USG
Breech	33.50±2.12	34.20±2.20
Brow	35.00±1.41	35.00±1.41
Chin	36.00±0.0	34.00±0.00
Face	32.50±2.51	31.75±2.21
Shoulder	33.71±1.89	32.43±1.90
Vertex	32.93±2.42	32.06±2.58

**Table-10: Comparison of gestational age by NBS and USG according to mode of delivery**

Mode of delivery	Gestational age (Mean±SD)	
	NBS	USG
LSCS	32.18±2.60	31.71±2.53
NVD	33.36±1.72	32.33±2.01
NVD+Instrumentation	35.27±2.34	34.91±1.97

**Table-11: Comparison of gestational age by NBS and USG according to gender of baby**

Gender of baby	Gestational age (Mean±SD)	
	NBS	USG
Male	33.11±2.49	32.34±2.66
Female	33.09±2.06	32.42±2.52
p-value <sup>1</sup>	0.96	0.88

<sup>1</sup>Unpaired t-test

Table-11 shows the comparison of gestational age by NBS and USG according to gender of baby. There was no significant (p>0.05) difference in the gestational age measured by NBS and USG between male and female babies.

**Table-12: Comparison of gestational age by NBS and USG according to known about GA LMP**

GA LMP	Gestational age (Mean±SD)	
	NBS	USG
Known	33.24±2.36	32.37±2.61
Not known	32.84±2.31	32.41±2.42
p-value <sup>1</sup>	0.43	0.95

<sup>1</sup>Unpaired t-test

Table-12 shows the comparison of gestational age by NBS and USG according to known about GA LMP. There was no significant (p>0.05) difference in the gestational age measured by NBS and USG between known and unknown about LMP.

**Table-13: Comparison of gestational age by NBS and USG according to AGA/LGA/SGA**

AGA/LGA/SGA	Gestational age (Mean±SD)	
	NBS	USG
AGA	32.86±2.40	32.18±2.61
LGA	34.09±1.97	33.36±2.57
SGA	34.29±1.49	32.86±1.35
p-value <sup>1</sup>	0.10	0.31

<sup>1</sup>ANOVA test

Table-13 shows the comparison of gestational age by NBS and USG according to AGA/LGA/SGA. There was no significant (p>0.05) difference in the gestational age measured by NBS and USG according to AGA/LGA/SGA.

**Table-14: Comparison of gestational age by NBS and USG according to time of examination**

Time in hours	Gestational age (Mean±SD)	
	NBS	USG
<24	33.42±2.41	33.35±2.41
24-96	32.77±2.33	31.90±2.32
>96	32.95±2.21	31.00±2.42

Table-14 shows the comparison of gestational age by NBS and USG according to time of examination. NBS overestimated gestational age compared to USG with mean difference increasing with increasing postnatal age of examination. Mean difference in <24 hour group is 0.07 weeks, 24-96 hour group is 0.87 weeks, >96 hour group is 1.95 weeks

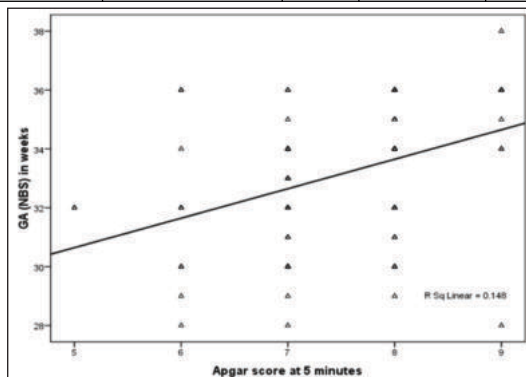
**Table-15: Comparison of gestational age by NBS and USG according to prenatal corticosteroids received by mother or not**

	Gestational age (Mean±SD)	
	NBS	USG
Received	33.54±2.06	32.83±2.47
Not received	32.23±2.65	31.48±2.46

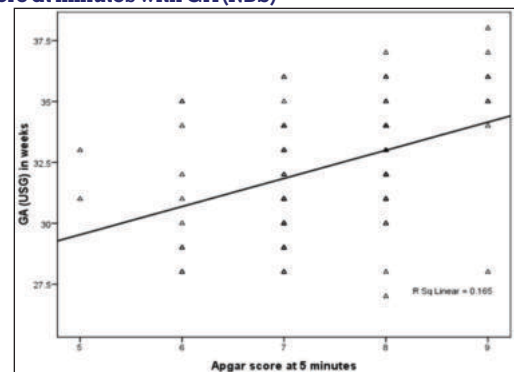
Table-15 shows comparison of gestational age estimated by NBS and first trimester USG according to prenatal corticosteroids received by mother or not. Mean gestational age difference measured by NBS and first trimester USG between neonates whose mothers had received prenatal corticosteroids and those neonates whose mothers had not received prenatal corticosteroids is statistically insignificant.

**Table-16: Correlation of Apgar score with gestational age by NBS and USG**

Apgar score	Gestational age			
	NBS	USG		
	Correlation coefficient	p-value	Correlation coefficient	p-value
1 Minute	0.22	0.02*	0.27	0.005*
5 Minutes	0.37	0.0001*	0.41	0.0001*



**Fig.1: Scatter diagram showing correlation between Apgar score at minutes with GA (NBS)**



**Fig.2: Scatter diagram showing correlation between Apgar score at minutes with GA (USG)**

**Table-17: Comparison of mean gestational age measured by NBS, USG and LMP**

Methods of measurement	Gestational age (Mean±SD)	95%CI
NBS (n=94)	32.60±3.16	30.33-34.87
USG (n=94)	32.50±2.82	30.47-34.53
LMP (n=62)	34.00±2.82	31.98-36.02

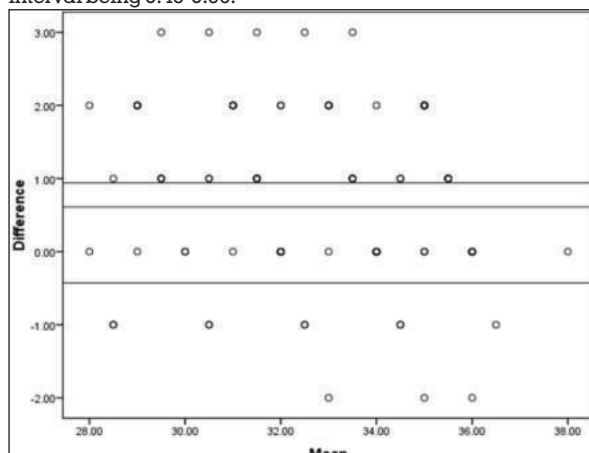
p=0.11 (Between NBS and USG)

Table-17 shows the comparison of mean gestational age measured by NBS, USG and LMP. There was no significant (p=0.11) difference in the gestational age measured by NBS (32.60±3.16, 95%CI=30.33-34.87) and USG (32.50±2.83, 95%CI=30.47-34.53).

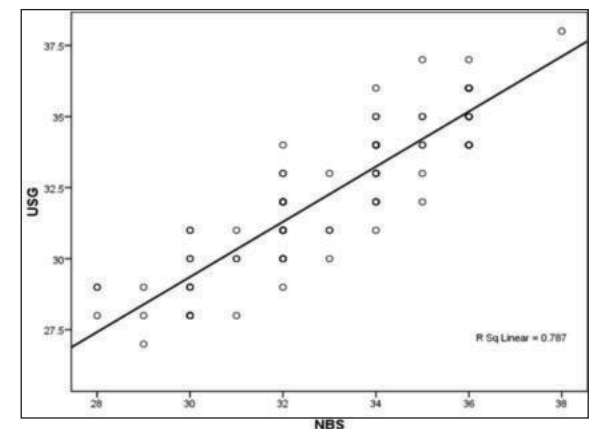
**Table-18: Comparison of agreement between NBS and USG**

Statistics	Value
Intra-class Correlation Coefficient (95%CI)	0.93 (0.90-0.95)
Cronbach's Alpha	0.94
Concordance correlation coefficient	0.88 (0.81-0.92)
Bland-Altman LOA (95% LOA)	0.73±1.83 (0.49-0.96)

Table-18 shows the comparison of agreement between NBS and USG. There was strong agreement between NBS and USG (ICC=0.93, 95%CI=0.90-0.95). NBS underestimated the gestational age only by 0.73 week with a narrow confidence interval being 0.49-0.96.



**Fig. 3: Bland-Altman plots of ultrasound GA estimates with NBS**



**Fig.4: Scatter diagram showing Concordance correlation of USG and NBS**

**Statistical Analysis**

The results are presented in frequencies, percentages and mean±SD. The Unpaired t-test was used to compare 2 means

for continuous variables. One way analysis of variance followed by Tukey's post-hoc tests was used to compare more than 2 means. The Pearson correlation coefficient was calculated. To assess the validity of NBS, the intra-class correlation coefficient (ICC) with Cronbach's Alpha was calculated. The Concordance correlation coefficient with its 95% confidence interval was calculated. Bland-Altman limit of agreement (LOA) was also calculated. The p-value < 0.05 was considered significant. All the analysis was carried out on SPSS 16.0 version (Chicago, Inc., USA).

## DISCUSSION

It is over half a century since interest arose in clinical assessment of GA in the newborn baby. Despite the proliferation and popularity of the different clinical methods for this assessment, the problem is far from solved. Difficulties still exist in the accuracy and implementation of these methods. This justifies the multiplicity of studies on this subject, aimed at modifying or simplifying the methods without losing accuracy

Incidence of babies born preterm in India is 10-12% as compared to 5-7% in the West. Neonatal mortality of these babies is high as they are both physiologically and anatomically immature

The present study was conducted in the Department of Pediatrics and Neonatology and Department of Radio diagnosis and imaging Batra Hospital and Medical Research Centre, New Delhi with the objective to compare New Ballard Score with first trimester USG for gestational age estimation. 94 newborns who presented to our nursery (inborn/out born) were enrolled in this study. Their gestational age varied from 28 weeks to 38 weeks.

Our study showed a strong agreement between NBS and first trimester USG for the estimation of gestational age. Intra-class correlation coefficient (95% CI) was 0.93 (0.90-0.95); cronbach's Alpha was 0.94; concordance correlation coefficient was 0.88(0.81-0.92); Bland Altman LOA (95%LOA) 0.73±1.83 (0.49-0.96).

NBS underestimated the gestational age only by 0.73 weeks in comparison to first trimester USG with a narrow confidence interval being 0.49-0.96.

Mean gestational age measured by NBS is 32.60±3.16 with 95% CI being 30.33-34.87. Mean gestational age measured by first trimester USG is 32.50±2.82 with 95% CI being 30.47-34.53. Mean difference between NBS and first trimester USG was 0.1 ± 0.34 weeks.

There was no significant (p=0.11) difference in the gestational age measured by NBS and first trimester USG.

Thus, our study concludes that there is a strong correlation between NBS and first trimester USG for the estimation of gestational age. These results are consistent with the study of **Ballard J L et al**<sup>[7]</sup>. Their study concluded that Intra-class correlation coefficient between gestational ages estimated by NBS and that by first trimester USG was 0.97. Mean difference between gestational ages estimated by NBS and by first trimester USG was 0.32 ± 1.58 weeks.

**Marin Gabriel MA et al**<sup>[12]</sup> study concluded that agreement between NBS and first trimester USG for estimation of gestational age was good. The Intra -class correlation coefficient range was 0.6-0.8. Differences of more than 2 weeks in GA NBS and GA USG were frequently observed in very premature neonates.

**Amol Dahyalkar et al**<sup>[16]</sup> study found the highest correlation coefficient between NBS based GA and first trimester USG based GA with the value of 0.74. NBS tended to overestimate

USG in estimation of gestational age by 1.3 weeks. P value with comparison between NBS and first trimester USG was > 0.05. Hence the difference in estimation of GA by NBS and first trimester USG was not significant. The results are consistent with our study.

These results are also consistent with the study of **Erman et al**<sup>[11]</sup>, **F. Sunjoh et al**<sup>[15]</sup>, **K Sasidharan et al**<sup>[22]</sup>, **Tiffany M McKee Garrett et al**<sup>[23]</sup>,

Neonates were examined at different postnatal ages, within 24 hours (45.7%), 24-96 hours (33.0%), and more than 96 hours (21.3%). The mean time of examination was 58.36 ± 60.19,

Ranging from 3 to 168 hours.

NBS tended to overestimate gestational age compared to first trimester USG in all the three groups with the mean difference increasing with increasing postnatal age of assessment.

Those neonates in whom the NBS assessment was done within first 24 hours of birth, NBS based GA and first trimester based GA was very close with a mean difference of only 0.07 ± 0 weeks; Mean gestational age ± SD was 33.42 ± 2.41 weeks (NBS) and 33.35 ± 2.41 weeks (USG). Between 24-96 hours the mean difference of GA computed from NBS and first trimester USG increased to 0.87 ± 0.01 weeks; Mean gestational age ± SD was 32.77 ± 2.33 weeks (NBS) and 31.90 ± 2.32 weeks (USG). All those neonates in whom NBS assessment was done after 96 hours of birth, mean difference between NBS estimated GA and first trimester USG estimated GA increased to 1.95 ± 0.21 weeks; Mean gestational ages was 32.95 ± 2.21 weeks (NBS) and 31.00 ± 2.42 weeks (USG).

It follows that with increasing post natal ages NBS estimated GA tends to overestimate first trimester USG estimated GA with the overestimation increasing with increasing PNA and hence NBS loses accuracy and reliability with increasing PNA. These results are consistent with **K Sasidharan et al study**<sup>[22]</sup> who concluded that NBS overestimates GA in comparison to gold standard (first trimester USG) with increasing postnatal age. The intra-class correlations (ICCS) values of the gold standard GA (first trimester USG) and the NBS based GA fell from 0.94 to 0.92 with increasing postnatal age from 1 to 7 days. NBS-based GA on days 5 or 7 did not differ from the gold standard GA by more than 2 weeks in any subject. On day 7, NBS overestimated GA in 26.7% neonates all discrepancies were < Or = 2 weeks.

**Ballard J L et al**<sup>[7]</sup> study also concluded that NBS based GA overestimated first trimester USG based GA with increasing post natal age. Correlation was similar when the examination was performed up to 96 hours of age but best if done prior to 12 hours of age in infants of lower gestational ages.

Male and female newborns were 61 and 33 respectively. There was no significant (p > 0.05) difference in the GA measured by NBS and first trimester USG between male and female babies in our study. In male neonates Mean ± SD gestational age was 33.11 ± 2.49 (NBS) and 32.34 ± 2.61 (USG); mean difference 0.77 weeks. In female neonates Mean ± SD was 33.09 ± 2.06 (NBS) and 32.42 ± 2.50 (USG); mean difference of 0.67 weeks. In other words NBS assessment does not depend on the sex of the neonate. The results are consistent with the studies of **Ballard JL et al**<sup>[6,7]</sup>, **Amol Dahyalkar et al**<sup>[16]</sup> and **Kavita Sree Kumar et al**<sup>[24]</sup>

In our study 91 neonates were preterm and 3 neonates were term. Term and preterm neonates were further divided into subgroups on the basis of weight for gestational age: 80.9% were AGA (between 10<sup>th</sup> to 90<sup>th</sup> percentile), 11.7% were LGA (more than 90<sup>th</sup> percentile), and 7.4% were SGA (less than 10<sup>th</sup> percentile). This study showed no significant (p > 0.05) difference in the GA estimated from NBS and first trimester

USG in neonates of SGA, LGA, AGA. No study in past has shown any significant difference between the NBS based GA and first trimester based GA in newborns of SGA, LGA, AGA. In other words rate and extent of intra uterine growth does not affect the NBS assessment. The results are consistent with studies of **Ballard J L et al.**<sup>[6,7]</sup>, **Erman et al.**<sup>[11]</sup>, **F. Sunjoh et al.**<sup>[15]</sup>, **K Sasidharan et al.**<sup>[22]</sup> and **Tiffany M McKee Garrett et al.**<sup>[23]</sup>

Majority of neonates were born after NVD (47.9%), after LSCS (40.4%), after NVD+Instrumentation (11.7%). There was no statistically significant difference between NBS based GA and first trimester USG based GA in different modes of delivery. Mean difference was 0.47 weeks (LSCS), 1.03 weeks (NVD), 0.36weeks (NVD+INSTRUMENTATION). Studies of **Ballard J L et al.**<sup>[7]</sup>, **Erman et al.**<sup>[11]</sup>, **F. Sunjoh et al.**<sup>[15]</sup>, **Amol Dahyalkar et al.**<sup>[16]</sup>, **K Sasidharan et al.**<sup>[22]</sup>, and **KavitaSree Kumar et al.**<sup>[24]</sup>, also did not find any significant differences in gestational ages estimated from NBS and first trimester USG with regard to different modes of delivery in neonates.

Vertex (74.5%) was the most common presentation of the neonates, followed by Breech (10.6%), shoulder (7.4%), face (4.3%), brow (2.1%), and chin (1.1%).

In breech presentation, NBS GA tended to underestimate first trimester USG based GA with mean difference of  $0.7 \pm 0.08$  weeks. GA NBS ( $33.50 \pm 2.12$ ), first trimester USG ( $34.20 \pm 2.20$ ) [mean  $\pm$  SD].

This was largely due to those neonates examined within 24hours of breech delivery, probably due to the flexor fatigue in these neonates giving low scores to popliteal angle and heel to ear components of NBS. Neonates examined after 24 hours showed almost consistent GA based on NBS with that estimated from first trimester USG. However the sample size of breech deliveries (10.6%) was small in this study.

.In brow presentation mean gestational age measured by NBS was equal to USG. In all other presentations NBS measured mean gestational age was higher compared to USG. Mean differences were brow 0.00 weeks, chin 2.00weeks, face 0.75 weeks, shoulder 1.28 weeks, vertex 0.87 weeks. Only one neonate had chin presentation, so mean difference was 2weeks. Only two neonates had brow presentation so mean difference is 0. In other presentation NBS overestimated GA in comparison to first trimester USG and the difference was statistically not significant. **Ballard J L et al.**<sup>[7]</sup> study did not find any statistically significant differences in the estimation of GA by NBS and first trimester USG with regard to different presentations of fetus except the breech presentation where NBS tended to underestimate GA compared to first trimester USG if the NBS assessment was done within first 24 hours of birth. Same reason as that of the flexor fatigue in lower limbs giving low scores to popliteal angle and heel to ear components of NBS and hence underestimation of GA, were cited as explanation in their study.

In our study GA based on LMP was known in 66.0% and in rest of neonates (34.0%), it was not known. Mean difference in estimated gestational age between NBS and first trimester USG in GA LMP known cases was 0.87 weeks and in GA LMP unknown cases was 0.43.

This study showed that there is no significant ( $p > 0.05$ ) difference in the GA measured by NBS and first trimester USG between the cases with known LMP based GA and not known LMP- GA. In other words knowing LMP based GA does not bias the NBS estimation of GA in neonates. This result is consistent with the study of **Smith LN et al.**<sup>[10]</sup>.

In our study 67.0% of mothers had received prenatal corticosteroids and 33% did not receive. Mean gestational age  $\pm$  SD in received group was  $33.54 \pm 2.06$  weeks(NBS) and

$32.83 \pm 2.47$  weeks(USG), mean difference being 0.71weeks. In not received group mean gestational age  $\pm$  SD was  $32.23 \pm 2.65$  weeks(NBS) and  $31.48 \pm 2.46$ (USG), mean difference being 0.75. The results are statistically insignificant. The results are consistent with the studies of **Ballard J L et al.**<sup>[7]</sup>, **K Sasidharan et al.**<sup>[22]</sup>, who also did find any significant differences in estimation of GA from NBS and first trimester USG between the neonates whose mothers had received prenatal corticosteroids and those whose mothers did not receive prenatal corticosteroids.

These results contrast the study of **Marin Gabriel M A**<sup>[12]</sup> et al who concluded that NBS tended to overestimate GA in comparison to first trimester USG by 1.2-2.9 weeks in those neonates whose mother had received prenatal corticosteroids. This might be because of the presence of other confounding factors in neonates in their study as explained by them. The neonates were more premature and having lower birth weights. However, **Ballard J L et al.**<sup>[6,7]</sup> study did not relate prenatal corticosteroid administration in mother to any significant discrepancies in NBS estimation of gestational age.

In our study, there was significant poor correlation between Apgar score at 1 minute and gestational age measured by NBS ( $r=0.22$ ,  $p=0.02$ ) and USG ( $r=0.27$ ,  $p=0.005$ ). However, Apgar score at 5min was significantly mildly correlated with gestational age measured by NBS ( $r=0.37$ ,  $p=0.0001$ ) and USG ( $r=0.41$ ,  $p=0.0001$ ). This is because of the fact that neonates in our study were stable with 1 min A/S ranging from 5-8 mean  $\pm$  SD  $7.24 \pm 0.71$  and 5 min A/S ranging from 6-9 mean  $\pm$  SD  $7.71 \pm 0.69$ . Neonates with perinatal asphyxia or birth asphyxia were excluded from the study. Similar results were reported by study of **Ballard J L et al.**<sup>[7]</sup>, **K Sasidharan et al.**<sup>[22]</sup>, **KavitaSree Kumar et al.**<sup>[24]</sup> who included only stable neonates for study with no birth or perinatal asphyxia.

In this study, it was found that with increasing PNA, NBS neuromuscular components are more reliable than physical components. In other words as neonates mature, the physical components of NBS lose accuracy. This result was also depicted earlier by **K Sasidharan et al.**<sup>[22]</sup>, **KavitaSree Kumar et al.**<sup>[24]</sup>. However this result contrasts with the study of **F. Sunjoh et al.**<sup>[15]</sup> who concluded that physical components of NBS are more reliable than neuromuscular components with increasing PNA.

**Ballard J L et al.**<sup>[7]</sup> study showed that as neonates mature, both physical and neuromuscular components of NBS change. However physical components lose accuracy rapidly as compared to neuromuscular ones with increasing postnatal age. In other words neuromuscular components of NBS are more reliable than physical ones with increasing postnatal age.

## CONCLUSION

- This study showed that there is a strong agreement between NBS and first trimester USG in estimation of gestational age, ICC=0.93. Thus in resource poor countries and in developing countries where mothers' prenatal first trimester USG records are not available and LMP recall cannot be relied upon, NBS assessment of gestational age is a valid and accurate method with most accurate gestational age being obtained when the NBS is performed within first 24 hours of birth.

In developing countries like India, the deliveries are still conducted by midwives in rural settings. NBS being a simple new born assessment, all midwives can be effectively trained for NBS assessment so that they can identify the premature neonates immediately after birth and decide for the transport of new born to tertiary care hospital with NICU facilities.

Furthermore, an emphasis shall be laid on the categorisation of new born as term or preterm by this simple scoring i.e., NBS and all the neonates categorised as preterm be transported to higher centres with proper temperature regulation.

- NBS estimated GA tended to overestimate first trimester USG based GA with the overestimation increasing with increasing postnatal age. The mean difference increased from 0.07 weeks to 1.95 weeks between the neonates examined within 24 hours of birth and after 96 hours of age, respectively.
- It is thus concluded that NBS be better performed within first 24 hours of birth to achieve highest accuracy in estimation of NBS based GA. NBS loses accuracy with increasing postnatal age because of the variability of physical maturity components.
- Neurological signs are more reliable than physical signs of NBS. As neonates mature, NBS physical signs become less reliable.
- This study showed no significant difference ( $p > 0.05$ ) in the gestational age estimated by NBS and first trimester USG according to babies of SGA, LGA, AGA. Thus it is concluded that rate and extent of intrauterine fetal growth and hence birth weight do not affect estimation of gestational age based on NBS.
- NBS based gestational age is not affected by the prior knowledge of LMP and hence GA-LMP. The score is reliable whether LMP based GA is known or not.
- NBS based estimation of gestational age is sex independent, that is, gestational age estimated does not differ in males and females. A male neonate and a female neonate of same maturity will have same NBS based gestational age, provided other factors are also same in both sexes.
- In breech deliveries, it is better to perform NBS assessment after 24 hours of birth, to let the flexor fatigue subside. NBS performed within 24 hours of breech delivery will give lower gestational age as compared to the true gestational age of the neonate.
- Apgar score and NBS estimation of gestational age have no significant correlation so far as the 5 min Apgar score is  $\geq 7$  and neonate is stable. In others, the variation is due to neonatal flexor tone being affected, as for example by birth asphyxia.
- NBS based gestational age assessment does not vary with mode of delivery and presentation of fetus except for breech presentation where if the assessment is done prior to 24 hours of birth may lead to lower gestational age estimation.

**Conflicts Of Interest :NONE**

#### ACKNOWLEDGEMENT:

The authors want to thank the parents and the guardians who consented for the participation of their neonates in the study

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