Scarf ratio in the evaluation of muscle tone in preterm infants intrarater and interrater reliability

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ABSTRACT

Background and objectives: Early identification of postures and movements possibly associated with a poorer quality of developmental outcome is very desirable. Assessment of gestational age of the infant help to identify the developmental status of the infant . One of the widely used tools in gestational age assessment is the scarf sign . Recently, a new method of measuring scarf sign called scarf ratio was described. This scale being relatively new , the available literature reflects a need for estimating intrarater and interrater reliability of scarf ratio., **Subjects and measurments** : Thirty two preterm infants recruited from neonatal ICU at district maternity hospital who met the inclusion & exclusion criteria were examined to estimate interrater and intrarater reliability of scarf ratio . Intrarater reliability for scarf ratio was estimated with a second assessment following a brief interval. Simultaneously, interrater reliability of scarf ratio was estimated with second therapist, **Conclusions :** Scarf ratio can be used as an efficient individual tool to estimate gestational age in preterm infants. It is also a reliable measure when conducted by two different clinicians who are well versed with the method.

Key words: Preterm infants, Gestational age assessment, scarf sign , scarf ratio.

INTRODUCTION

'Prematurity', as defined by the World Health Organization is a baby born before 37 weeks of gestation counting from the first day of the last menstrual period. In the past four decades specialized neonatal intensive care units and technological advances have contributed to a dramatic decline in neonatal mortality , particularly among low birth weight (< 2,500grams) infants. The combined effect of immature physiological systems, poor muscle tone and lack of resistance against gravity lead to development of abnormal postures in preterm neonates.[1,2] The assessment procedures which demands least handling and are quick to administer helps in the early diagnoses of abnormal postures associated with poor development outcome in the later life.

One means of identifying the neonate who may develop problems early in life is the "gestational age assessment". It is determination of the approximate duration of fetal development and a comparison against standardized norms of neonatal growth versus weeks of gestation, to identify those infants unusually large or small for gestational age. There are several approaches to measure gestational age like one of them being to obtain a careful menstrual history as according to the Naegele's rule where the date of onset of the last menstrual period determines the estimated date of confinement. According to Korones, recall of the date of onset of the last menstrual period is accurate in 75% to 85% of women .Also miscalculation is possible, for reasons other than an inadequate history (e.g. irregular menses, post conceptual bleeding). Although according to

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Lippink , electroencephalogram patterns and motor nerve conduction times correlate well with gestational age, to date there seems to be no rationale for using them as routine screening tools. Gestational age can also be ascertained by ultrasound examination within a range of ± 1 week in early pregnancy (six to eight weeks) , decreasing in certainty to ± 3 weeks from 29 weeks to term as according to Petrucha .

Saint Anne Dargassies described that changes occur during the second half of gestation in the quality of passive and active tone, up to term there is an ascending wave of increased flexor tone in the limbs and of extensor postural reactions in the body axis (spine and lower limbs). Based on her work with Andre-Thomas, Saint-Anne Dargassies developed sequential, stage oriented neurological examination techniques for assessing neuromaturation of premature infants between 28 and 41 weeks of gestation . It was also suggested by Amiel-Tison that observation of the presence of primitive reflexes may also be used to assess gestational age in combination with measure of active and passive muscle tone .[3] According to him the passive tone was assessed by six items i.e. posture , heel to ear maneuver , popliteal angle, dorsi flexion , scarf sign , return to flexion of forearms.

Later Dubowitz LM ; Dubowitz V and Goldberg C developed a "clinical assessment of gestational age", which has 10 neurologic signs and 11 external signs.[4] The totals are added to give a composite score , which is correlated with weeks of gestation. He included the same components to assess the passive tone, as Amiel -Tison, but few new items were also added from the work of Dubowitz [5] Dargassies,[6] Prechtl [7], Parmelee and Michaelis [8] and Brazelton [9]. Dubowitz and associates found a positive correlation between the neurologic portion of the gestational examination when done at 40 weeks gestational age and the neurologic status of the child at the end of the first year of life. As the Dubowitz examination appear to over estimates gestational age by about two weeks for low birth weight infants, later Ballard , Novak and Driver, developed the "newborn maturity rating", a simplified version of the Dubowitz tool. This version was later modified by Ballard in 1988 to assess neonates from 20 weeks to 40 weeks.

The Ballard examination is currently the most commonly used gestational age assessment tool. [10, 11] The passive tone assessment components included scarf sign . "Scarf sign" is widely used to identify shoulder posture in neonatal assessments [3] .A new method of measuring the scarf sign ; called the " Scarf ratio " has been described recently , in which data derived were reported on a continuous scale [12]. Scarf ratio being a relatively new scale, its efficacy in estimating gestational age needs to be studied further . The available literature reflects the need to estimate the interrater and intrarater reliability of scarf ratio .

METHODOLOGY

Thirty two preterm infants were recruited from neonatal intensive care unit at a 260 bed district maternity hospital. The Infants with gestational age of less than 37 weeks post conceptional age, who were free of any congenital and genetic disorders were included in the study whereas those infants who under went surgical procedures or had complications as hydrocephalus, periventricular hemorrhage grade III and above , ventricular dilatation ,retinopathy of prematurity stage III were excluded . A total of 45 infants were examined during the study out of which 13 preterm infants were excluded. Five of the preterm infants had the intravenous line attached to the right forearm. Since, in the study done by Raweewan Lekskulchai and Joan Cole, only right arm was examined to calculate the scarf ratio, the same was done in the present study to maintain consistency.[12] Three preterm infants were excluded as they required surgical intervention and were constantly monitored in the intensive care unit. Two of the preterm were extremely low birth weight infants (ElBW = < 1,500grams) and so were not included in the study sample.

Preterm infants usually have low birth weight as compared to full term born infants. In order to keep uniformity, all the preterm infants included in the study have their birth weights in between the range of 1.5 kg to 2 kg, One of the infant developed hydrocephalous and two of the preterm infants were excluded due to poor

compliance of the infant's parents. Thirty two preterm infants made up the study population

Preterm infants are examined after the informed consent of their parent , to estimate the gestational age using component of passive muscle tone assessment that is scarf ratio [12] . The assessment was performed midway between the feeds to avoid any possible complications. Infants suffering from fever were tested later. Infants on the mechanical ventilator or respirator were also examined once they were free of it . Infants with an intravenous line attached to the right arm also have their measurements delayed until the line is removed. Prior to the assessment, the infant's records were checked for Apgar scores and neuromotor behaviour assessment to rule out those who have serious complications which are likely to affect the further development. Infants with similar scores were included in the study.

To provide the same surface texture for the assessment at each occasion of measurement, a thin wooden board covered by a diaper is used to support the infants in supine . As the head position can alter muscle tone ; eliciting a symmetrical tonic neck reflex , a midline adjustable pillow is used to support the infant's head in the middle so that head turning during the examination is prevented . In addition to the positioning devices, a tape measure with one millimeter increments is required for the measurement of scarf ratio.

Intrarater reliability for the scarf ratio is estimated with a second assessment done after a gap of half an hour by the first rater. Simultaneously, interrater reliability of scarf ratio is estimated with the second rater of similar educational qualification after a gap of five minutes following initial reading by the first rater. Both the raters are blind to the result of one another and are well familiarized with the method to be followed for consistency.

To obtain the right scarf ratio , the method of assessment of the scarf sign as described by Amiel-Tison 1968 is first followed , that is ,the right arm is moved across the trunk until a resistance is **met (fig 1).**[4] At the end of this manoeuver , the

Fig 1: Measurement of scarf sign

distance between the tip of the olecranon process of the right arm and a line specifically identified for this test known as the left acromial line, is measured. The left acromial line is an imaginary construct which consists of a line beginning from the tip of left acromion process and running parallel down the side of the trunk. To determine scarf ratio, the distance between the olecranon process and the infant's left acromial line is compared with biacromial width, that is distance between the tips of infant's right and left acromion process [11].

RESULTS

A total of 32 preterm infants constituted the study population and were examined to estimate gestational age using scarf ratio. The data obtained

Table 1: distribution of scarf ratio at various post conceptional,Ages (pca) ranges in weeks

< 32 weeks	N	6	6	6
	Mean	0.185	0.183	0.185
	Std. Deviation	0.005	0.003	0.006
	Minimum	0.171	0.181	0.171
	Maximum	0.191	0.188	0.191
32 wk – 36 wk	N	14	14	14
	Mean	0.546	0.545	0.546
	Std. deviation	0.026	0.024	0.025
	Minimum	0.490	0.490	0.490
	Maximum	0.580	0.580	0.580
37 wk-39 wk	N	10	10	10
	Mean	0.570	0.570	0.571
	Std. Deviation	0.005	0.008	0.008
	Minimum	0.561	0.560	0.561
	Maximum	0.578	0.585	0.585
>40 weeks	N	2	2	2
	Mean	0.673	0.673	0.671
	Std. Deviation	0.004	0.004	0.002
	Minimum	0.670	0.670	0.670
	Maximum	0.676	0.676	0.673

was classified into four categories that is according to their post conceptional ages. The number of preterm infants varied in each group (table 1). The mean value of scarf ratio was obtained for the first and the second rater both for the first and the second reading respectively for each of the groups .At the same time the minimum and the maximum value of scarf ratio out of the total set of readings was also recorded. The readings of scarf ratio obtained by the first rater (SR1)was compared with the second reading by the first rater after an interv al of thirty minutes (SR 2) to estimate the intrarater reliability of scarf ratio. Wilcoxon's signed rank sum test was used to calculate the reliability in each of the groups. In the group of preterm infants less than 32 weeks , the z value of 1.000 and p = 0.317 was obtained . In the next group of preterm between 32 to 36 week the values obtained were z = 0.944, p= 0.345. Preterm infants between the post

conceptional age of 37 to 39 week had z and p values as 0.000 and 1 respectively. In the last group of infants of more than 40 week PCA, the reliability couldn't be estimated as only two preterm infants constituted the group. The p value obtained for all the three group of preterm infants shows that the difference between the

PCA Range (weeks)	Scarf Ratio Ist Rater (SR1)	Scarf Ratio Ist Rater (After 30 min) (SR2)	Scarf Ratio IInd Rater (SR3)

Table 2: Intrarater Reliability

PCA (Weeks)	Paired		Z	p
	Difference SR1 – SR2 (mean)	Std. Deviation		
< 32 wks	0.003	0.005	1.000	0.317 ns
32 wk- 36wk	0.002	0.005	0.944	0.345 ns
37 wks-39wks	0.000	0.005	0.000	1 ns

readings of the first rater and second reading by the first rater after 30 minutes is not significant which indicate a high intrarater reliability. (Table 2) (fig 2)

Scarf ratio values estimated by the first rater (SR1) and the second rater (SR3) were compared to determine the interrater reliability using Mann-Whitney U test { Z }. In the group of pretern infants <32 wk ; the z value of 0.147000 and p value of 0.883 was obtained . In the next group which included infants between PCA 32 wk to 36 wk the z value of 0 and p value of 1 was noted. Subsequently in the group of preterm between the PCA of 37 wk to 39 wk, the z and p values were 0.114000 and p = 0.909 respectively. And the last group of preterm infants of more than 40 wks PCA had a z value of 0.408000 and p value of 0.683. The p values obtained for all the four groups

Table 3: Interrater Reliability

PCA (weeks)	Scarf Ratio By Raters	N	Mean	Std. Deviation	Z
< 32 wks	SR1 SR3	6 6	0.185 0.185	0.005 0.006	0.147000 p =0.883 ns
32wk-36wk	SR1 SR3	14 14	0.546 0.546	0.026 0.025	0 p=1 ns
37wk-39wk	SR1 SR3	10 10	0.570 0.571	0.005 0.008	0.114000 p =0.909 ns
>40 wks	SR1 SR3	2 2	0.673 0.671	0.004 0.002	0.408000 p =0.683 ns

Fig. 2: Intrarater Reliability

Intrarater Reliabilitry of Scarf ratio is pound to be High

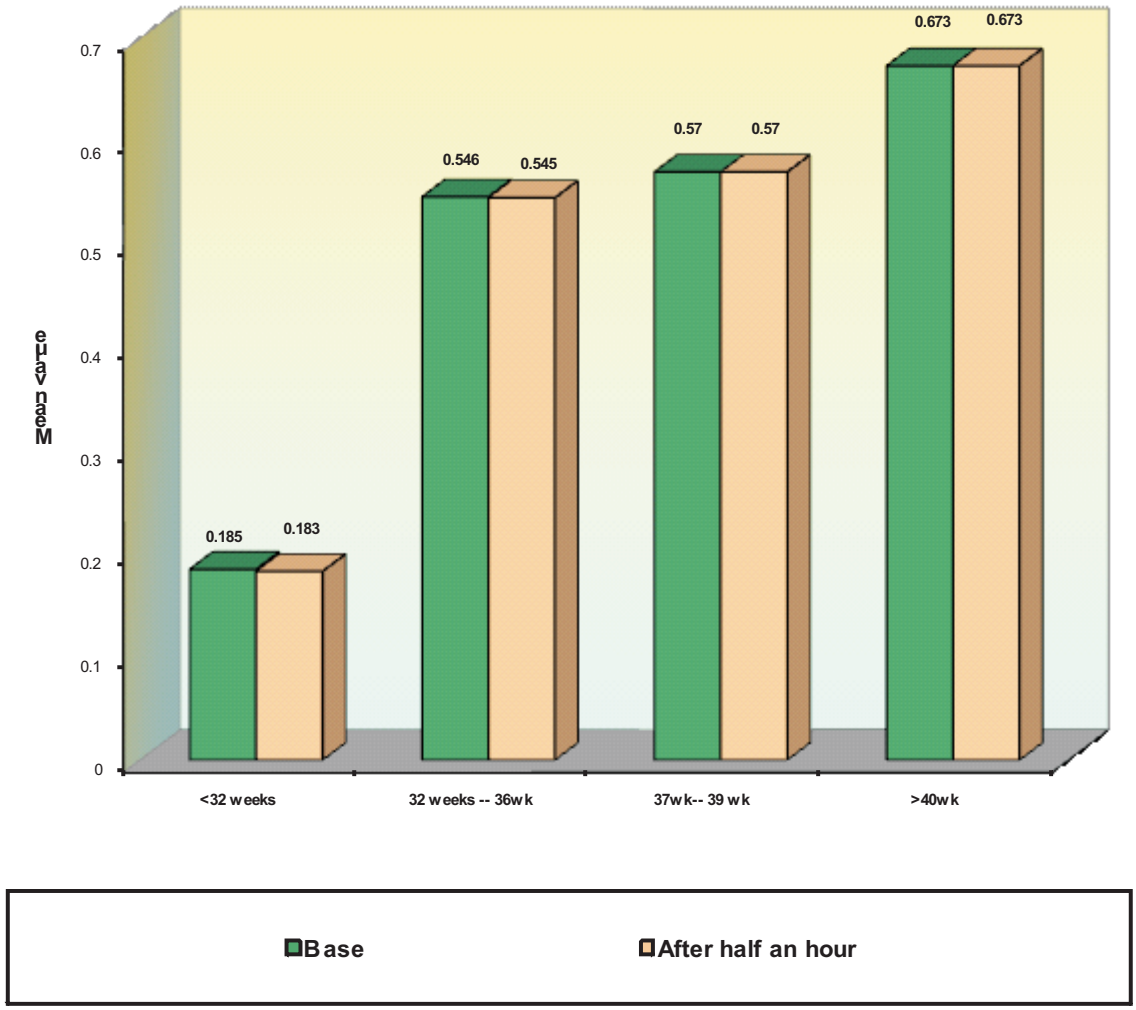
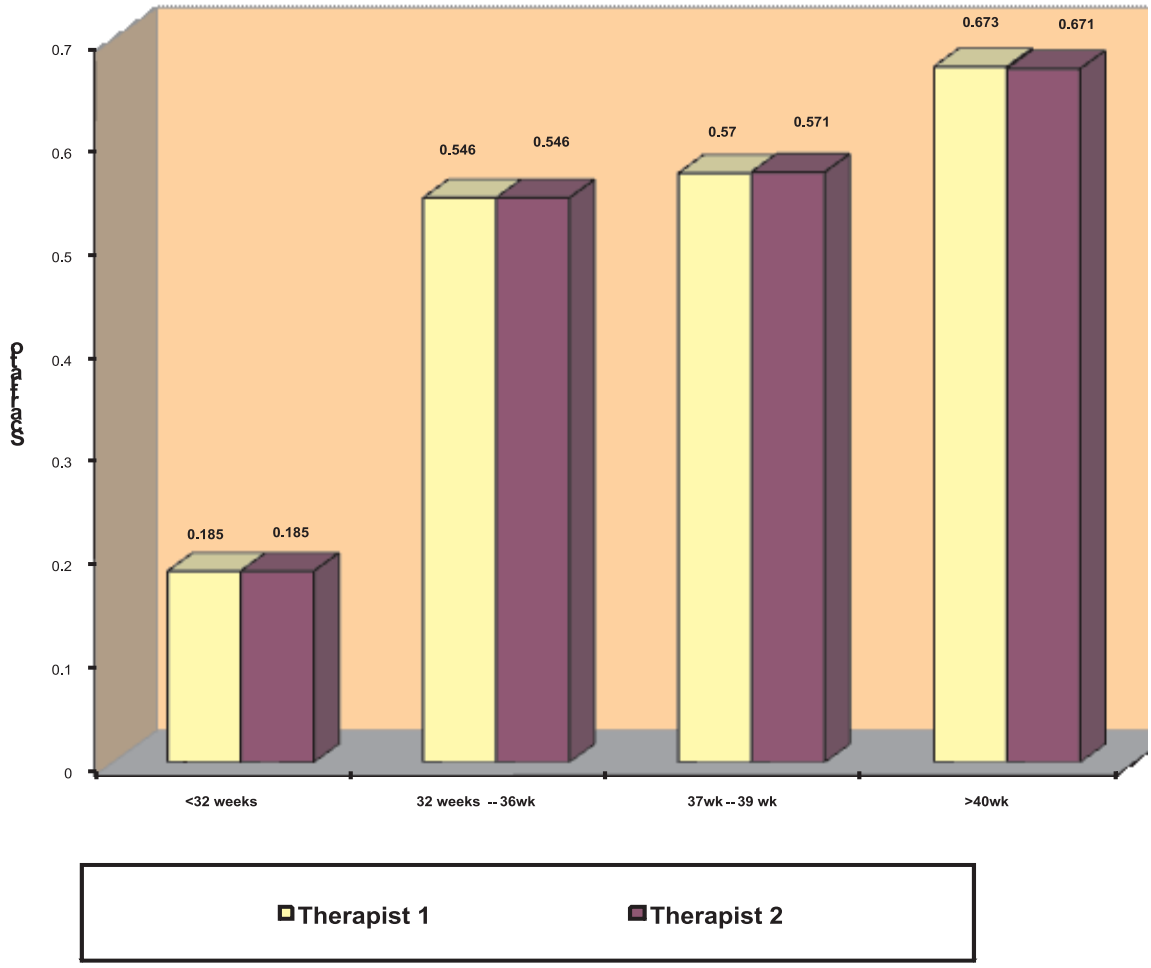


Fig. 3: interrater reliability

Interarater reliability of scarf ratio is high



indicated that there wasn't a significant difference between the readings of the first rater and the second rater indicating a high interrater reliability . (Table 3) (Fig 3)

DISCUSSION

A preterm born infant differ in its needs from the full term born infant even though if he is born without any neurological deficits, and require special care nursery [13]. The extent of the premature infant's adjustment to an environment depends largely on the gestational age and weight of the infant . The neurodevelopmental outcome for infants born prematurely; or for term infants with prenatal or birth complications, depends on the timing of the brain injury as well as on the nature of an insult to the developing brain. Different components of fetal central nervous system are more vulnerable to noxious events or exposures at specific times in maturational process. For e.g. insult occurring in early pregnancy typically results in neural tube defects, dimorphic features, and congenital malformations. The subcortical periventricular region of the fetal brain is more vulnerable to injury during gestational period spanning the late second trimester and early third trimester whereas the basal ganglia and cerebral cortex are more susceptible as the fetus approaches term.

Periodic, sequential examinations over time are the most useful method of determining the developmental outcome of an individual infant.

[3] Also gestational age assessment help to predict possible insult and later developmental outcome. Prenatal brain damage may be roughly separated into events during the first half of gestation versus later events as according to Evrard P et al.[14] .Perfusion failures caused by placental, embolic, and other factors are more common in the second half of gestation and lead to conditions such as ; Hydranencephaly, Destructive microcephalies and Periventricular leukomalacia. Cerebral convolutions first appear in the fetal human brain during the fifth month of gestation and continue to develop into the first postnatal year. During the sixth and seventh months of gestation, the cerebral cortex remains largely underdeveloped with smooth surfaces quite uncharacteristic of the full term brain with its many cerebral cortical convolutions.

The preterm infants included in the present study were in between the PCA of 32 weeks to 39 weeks. The major reasons for the variations between different groups being that extremely premature infants has much lower survival rate and are mostly associated with other anomalies or require surgical interventions. Hence, the number of preterm's who can be included in the study was less for this group and those infants who were above 40 weeks were mostly discharged from the hospital.

Most of the mother's whose preterm infants were included for the present study were of age between the ranges of 25 to 35 years. As various studies indicate that age of the mother can be of significance as far as prematurity is concerned hence the data was recorded to see any variation in scarf ratio with the advancing mother's age , no relevant information could be inferred from the present study and further studies are needed to evaluate the effect of other maternal factors on scarf ratio as multiple births. Although, most of the parents of the preterm infants included for the study belonged to the low economic status , the mothers have been going for regular check ups and had immunization done at appropriate times. Twenty five out of the 32 preterm infants were females ; but no inference could be drawn regarding the sex of the premature infant from this sample size.

Twenty one mothers had normal vaginal delivery, about seven of them had vaginal assisted breech delivery and rest four mothers have undergone caesarian section. Birth trauma especially with assisted or forceps delivery can also lead to various neurological deficits for e.g. brachial plexus injury can alter the readings of scarf ratio, but none of the infants included in the present study had such a problem. No inference could be drawn on the effect of consanguineous and non consanguineous marriage from this sample size but most of them had non consanguineous history.

Information was also obtained about the personal habits of the mother in the past and during the time of pregnancy. As habits like consuming alcohol, smoking and drugs like marijuana and narcotics can lead to premature births. A study of Hadeed AJ and Siegel SR showed that the immediate complications in cocaine using pregnant women include increased incidence of ; Abruptio placentae, Spontaneous abortion, Fetal death, and Premature delivery. Even on neurobehavioral testing, infants demonstrate poor motoric and state control and orientation / interaction ability.[15] There is strong evidence to show that maternal smoking, and possible maternal passive smoking, is harmful to the fetus, and that it can affect the pregnancy and the subsequent development and health of children after they are born. [16]

Excessive drinking during pregnancy causes a condition known as fetal alcohol syndrome, which presents a growth retardation, craniofacial and cardiac defects and mental retardation, and that alcohol has been linked with increased risks of spontaneous abortion, still birth, congenital abnormalities and abnormal neurobehavioral development. Many women planning pregnancy are now aware that it is advisable to eliminate alcohol from their diet prior to conception. Two out of 32 mothers of the present stage had a history of consuming alcohol in the past.

Almost all the preterm infants of the present study were kept in the intensive care unit for the period of five to eight days. Preterm infants who stayed in intensive care unit for a much longer time were not included as the environmental exposure of intensive care unit can also alter the developmental outcomes of these infants. [17] Further studies are needed to see the variation in the value of scarf ratio in infants who are kept in the ICU for longer durations.

The estimation of scarf ratio in 32 preterm infants of the present study revealed that the intrarater and interrater reliability of this tool is quite high. The results of the present study are well consistent with the findings of study done by Raweewan LeksKulchai and Joan Cole. As the PCA increases, the mean value of scarf ratio was found to increases. This suggests that infants at older PCA showed more resistance to the passive movement of the arm which reflects the greater muscle tone of upper trunk and extremities in older infants.

Further study may be undertaken to find the gestational age using scarf ratio in preterms who were excluded in the present study to see if it differs from the results of the present study.

CONCLUSION

The good intrarater and interrater reliability of scarf ratio is of great importance when the data obtained need to be compared between the two different raters and even the readings obtained by the same rater at two different times are comparable. Hence, it may be indicated that scarf ratio is an efficient individual tool to assess gestational age in preterm infants.

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