Volume : 3 | Issue : 5 | May 2014 • ISSN No 2277 - 8160

Research Paper | Pediatrics

A Simple Method For Assessment of Gestational Age in Neonates Using Head Circumference

Dhaval Gandhi — MBBS (Post Graduate Student), Department of Pediatrics, NIMS Medical College and Hospital, Jaipur, Rajasthan, India

Rupesh Masand — MBBS, MD Pediatrics (Associate Professor), Department of Pediatrics, NIMS Medical College and Hospital, Jaipur, Rajasthan, India

Alok Purohit — MBBS, MD Pediatrics (Professor and Head of Department), Department of Pediatrics, NIMS Medical College and Hospital, Jaipur, Rajasthan, India

ABSTRACT

Objective:To construct standard reference intrauterine growth charts of head circumference (HC)for neonates of 28-42 weeks gestational age (GA) and derive regression equation for calculating GA from HC. Design:Cross-sectional study. Setting: Tertiary care hospital. Materials and Methods:Study group included 1000 consecutively live-born singleton neonates of 28-42 weeks gestation. Data were recorded for HC according to GA. Using MS -Excel spread sheet, the mean, standard deviation, 3rd, 5th, 10th, 50th, 90th, 95th and 97th percentiles were calculated and percentile curves drawn. Correlation of HC with GA was performed by applying correlation & regression analysis. Regression equation was derived to predict GA from HC.Results:HC correlated well with GA with r = 0.97. Regression equation obtained was: Y = 1.45X – 9.79 to predict GA (Y) from HC (X). Conclusion: HC can be used as simple tool to identify high risk newborns by primary health workers in rural areas of developing countries.

KEYWORDS : Head Circumference, Gestational age, Correlation, Equation, Newborn, India

Introduction

An estimated 1 million babies die globally every year because of prematurity, of which about 375,000 neonatal deaths due to prematurity and low birthweight occur in India alone [1,2]. Only about half of the newborns are weighed at birth and for a smaller proportion of them, the gestational age (GA) is known [3].

Conventionally, GA is calculated by Naegele's formula and antenatal ultra-sonography (USG), or by using New Ballard Score (NBS) in neonates. In rural settings with low literacy levels, application of Naegele's formula and non-availability of antenatal USG check-up are limiting factors [4,5]. Application of NBS requires the expertise of a pediatrician who may not be available in remote area. Moreover, it cannot be used in asphyxiated neonates

Thus, there arises a need to develop a simple, inexpensive and reliable method to estimate GA in rural set-up by a community health worker (6,7) before referral to a higher centre. These alternative measurements should have a close correlation with GA and have very little intra- and inter-observer variability [8].Only few studies have been conducted to find anthropometric surrogate for estimation of gestational age [9]. Head circumference (HC) is one such parameter that can be measured easily in preterm and sick neonates. Hence we conducted this study to prepare reference charts of HC for neonates from 28 to 42 weeks of gestation and to derive a regression equation for calculating the gestational age using HC

Materials and Methods :

This cross-sectional study was conducted in a rural tertiary care teaching hospital from August 2011 to February 2012. All the study subjects hailed from adjoining rural areas and belonged to lower socio-economic strata of the society. One thousand consecutively selected singleton live-born babies between the GA of 28 to 42 weeks were included after obtaining informed written consent from the parents/guardians. The following were the exclusion criteria- Neonates for whom reliable information about gestational age was not available (mother not aware of the beginning of her last menstrual period; irregular menstrual cycles prior to pregnancy; bleeding during the first two months of pregnancy; gross discrepancy between gestational ages calculated by LMP & Ballard's score by >2 weeks.), those with gross congenital anomalies and with severe birth asphyxia were excluded from the study. Approval for the study was obtained from the Institutional Ethics Committee.

HC measurement of all neonates in the study group was performed thrice within 72 hours of birth and the mean value recorded in a pre-structured proforma. This was measured between the glabella anteriorly and along the most prominent point posteriorly by cross-over technique, using a non-stretchable tape and recorded in centimetres to the nearest 0.1 cms.

GA of the study subjects was calculated from the case sheets of their mother, using Naegele's formula, i.e. addition of 9 months and 7 days to the first day of the last menstrual period (LMP) and by NBS which was regarded as the gold standard for our study. To avoid inter-observer bias, measurement of HC and the assessment of GA by NBS were carried out by only one of the investigators.

The collected data was then tabulated according to GA. Using Microsoft Excel spread sheet the mean, standard deviation, 3rd, 5th, 10th, 50th, 90th, 95th and 97th percentiles were calculated and then their curves drawn. The correlation of HC with GA was analyzed by applying correlation and regression analysis and a regression equation was derived to calculate GA from HC. The equation so derived was then validated on a set of 100 neonates randomly selected from the total population, using a computer-generated random number table.

Results :

Out of 1000 neonates, 560 (56.1%) males and 440 (44%) females constituted the study group. Their distribution with respect to GA is graphically represented in Figure 1. 670 (67%) subjects were term (37-42 wks) and 330 (33%) were preterm babies bearing 28 wks to 36 wks 6 days gestation. The mean, standard deviation and percentiles for head circumference were tabulated with respect to GA as in Table-1. In the present study, an increase in HC was observed with an increase in GA i.e. from 25.2 ± 1.34 cm at 28 weeks to 32.76 ± 1.38 at 37 weeks. The increase was steady initially till 37 weeks after which growth in HC exhibited plateau level till 42 weeks (Ref Figure 2). The value of correlation coefficient (r) of HC with GA was 0.977 and regression equation to calculate gestational age from head circumference was Y= 1.45X – 9.79, where Y is the gestational age (in weeks) and X is the Head Circumference (in cms).

Discussion :

During the past two decades, there has been a sustained reduction in infant and child mortality rate but the reduction in neonatal mortality rate (NMR) is far from satisfactory [10].

Out of the 3.072 million neonatal deaths reported worldwide by the World Health Organization (WHO) in 2010, nearly one-third (875,000) occurred in India [11].The early identification of preterm babies is an important prerequisite of any initiative to reduce mortality. There are

various measurements in newborns to assess growth, namely, birth weight, crown heel length, foot length etc. In many developing countries including India, the equipments required to measure them may not be available or the babies may be sick and minimum handling has been mandated. Assessment of the gestational age by NBS requires expertise owing to its complexity and inter-observer variability. Moreover, it is dependent on the neurological condition of the neonate and is time consuming. In such cases, HC is a parameter which can be easily measured even in sick neonates by health personnel in rural areas. It requires less handling and negates observer bias.

In the present study, the increase in HC was steady till 37 weeks after which growth in HC exhibited plateau level till 42 weeks. The mean values of Head Circumference at various gestational ages as obtained in this study were in consonance with the other studies [Ghosh et al (1971) [12]Premalaxminarayana et al (1974) [13].

This study was performed to find correlation of HC with GA in neonates, so that HC can be used as a surrogate measurement for estimation of GA . We found a good linear correlation between gestational age and head-circumference with r = 0.977. Sasanow et al. [9] observed a significant ($p<0.001$) linear correlation between HC (r=0.95) and the estimated gestational age between 25 and 42 weeks. However, Thawani et al [8] observed a value of r= 0.52 for HC in predicting gestational age.

Experienced health workers showed poor skill development, despite being trained in external Ballard examination to assess gestational age [14]. In contrast, anthropometric measurements collected by health workers have been shown to be more reliable than clinical examination [15,16]. Hence, providing ready mathematical formula for assessment of gestational age can be valid option for skilled and unskilled peripheral health workers [17]. A regression equation was derived to calculate GA (Y) in weeks from HC (X) in cms - Y= 1.45X – 9.79 e.g. for a HC of 30 cms, the gestational age calculated will be 33 weeks, which is very close to the mean value of Head circumference obtained in the present study for this gestational age : 29.5 cms**.**

The study group comprised of babies delivered to mothers belonging to adjoining rural areas. Thus the regression equation derived as above can be unambiguously applied by a peripheral health worker at rural community level. However, this study had its share of limitations. The proportion of study subjects in each gestational week (28-42 weeks) was not evenly divided with the majority bearing term gestation. The measurement of HC can be inaccurate if there is alteration in head size due to moulding during prolonged and obstructed labor.

Conclusion:

The results of our study suggest that HC is a simple, quick and reliable parameter which can be used as an anthropometric surrogate for estimation of gestational age. It can be easily measured by peripheral health care workers & traditional birth attendants and could be used effectively for identifying and referring high risk newborns. However, further studies with larger sample size involving preterm neonates mainly are required to validate our results in community settings.

Acknowledgement:

Source(s) of support in the form of grants, equipment, drugs or all of these: NONE

Declaration on competing interests: competing interests: NONE

Funding: NONE

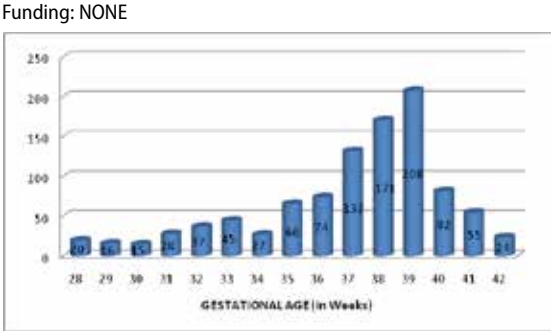

Figure 1- Break-up of the study sample in each gestational age

GA	N	Mean	St-dev	Mean +2SD	Mean -2SD	Percentile						
						3rd	5th	10th	50th	90th	95th	97th
28	20	25.2	1.344	27.88	22.512	22.71	22.79	22.98	25.15	27.03	27.31	27.38
29	16	25.65	1.575	28.8	22.5	22.76	23.75	23.9	25.2	28	28.15	27.53
30	15	26.58	1.406	29.392	23.768	24.43	24.46	24.53	26.5	28.05	28.55	28.81
31	28	28.48	0.967	30.414	26.546	27	27.13	27.26	28.3	29.82	30.14	30.23
32	37	28.5	1.488	31.476	25.524	26.6	26.6	26.7	28.55	30.75	31.5	31.5
33	45	29.29	1.517	32.324	26.256	26.2	26.28	26.6	29.5	31.5	31.5	31.5
34	27	30.32	1.435	33.19	27.45	27.2	27.2	28.34	30.5	31.76	32	32
35	66	30.49	1.401	33.292	27.688	29	29	29.2	30.75	32.1	32.2	32.6
36	74	31.54	1.56	34.66	28.42	28	28	29	32	33	33	34.21
37	132	32.76	1.38	35.52	30	30.5	30.5	31.5	32.6	34.6	35.6	35.8
38	171	33.41	1.314	36.038	30.782	30.62	31.1	32	33.5	35	35.75	36
39	208	33.2	1.451	36.102	30.298	31	31	31.28	33.4	35.06	35.5	36.5
40	82	33.76	1.110	35.98	31.54	32.2	32.5	32.5	33.6	35.47	35.8	36.19
41	55	34.21	1.172	36.554	31.866	31.7	32.67	33	34.1	35.92	36.06	36.27
42	24	34.16	1.009	36.178	32.142	33	33	33.06	34	35.7	36.42	36.5

Table-1 Mean, standard deviation and percentiles for Head circumference (in cms)

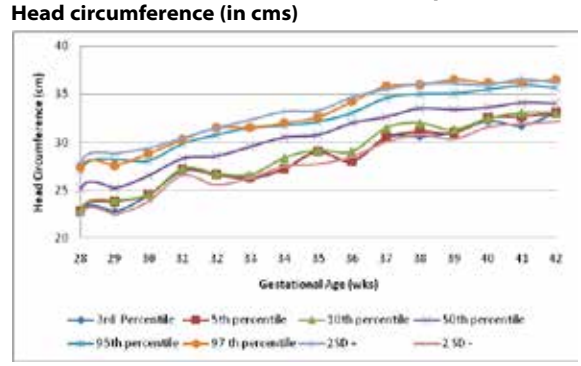

Figure 2 Mean ± 2SD and percentile curves of Head circumference (cms) for gestational age (wks)

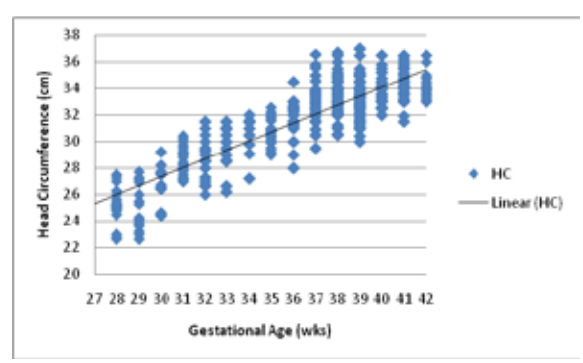

Figure 3 Correlation of head circumference with gestational age

REFERENCES

[1] World Health Organization. Child health profile: India. Geneva: Department of Child and Adolescent Health and Development, World Health Organization, 2007. 7 p | | [2] March of Dimes. Born too soon: the global action report on preterm birth. Howson CP, Kinney MV, Lawn JE, editors. Geneva: World Health Organization, 2012. (http://www.who.int/pmnch/media/ news/2012/introduction.pdf, accessed on 27 March 2010). | | [3] Ann K. Blanc and Tessa Wardlaw- Monitoring low birth weight: an evaluation of international estimates and an updated estimation procedure. Bull World Health Organ. Mar 2005; 83(3): 178–185. | | [4] Savitz DA, Terry JW, Jr., Dole N, Thorp JM, Jr., Siega-RizAM, Herring AH. Comparison of pregnancy dating by last menstrual period, ultrasound scanning, and their combination. Am J Obstet Gynecol 2002;187:1660-6. | | [5] International Institute for Population Sciences (IIPS).National Family Health Survey (NFHS-3), 2005-06: India. Key findings. Mumbai: International Institute for Population Sciences, 2007. 24 p. | | [6] Mullany LC, Darmstadt GL, Coffey P, Khatry SK, LeClerq SC, Tielsch JM. A low cost, colour coded, hand held spring scale accurately categorises birth weight in low resource settings. Arch Dis Child 2006;91:410-13. | | [7] Sreeramareddy CT, Chuni N, Patil R, Singh D, Shakya B. Anthropometric surrogates to identify low birth weight Nepalese newborns: a hospital-based study. BMC Pediatr 2008;8:16. | | [8] Estimation of Gestational Age, Using Neonatal Anthropometry: A Cross-sectional Study in India Rajat Thawani, Pooja Dewan, M.M.A. Faridi, Shilpa Khanna Arora, and Rajeev Kumar | | [9] Sasanow SR, Georgieff MK, Pereira GR. Mid-arm circumference and mid-arm/head circumference ratios: standard curves for anthropometric assessment of neonatal nutritional status. J Pediatr 1986;109:311-5. | | [10] Lawn JE, Cousens S, Zupan J; Lancet Neonatal Survival Steering Team. 4 million neonatal deaths: when?Where? Why? Lancet 2005;365:891-900. | | [11] United Nations Children's Fund. Levels and trendsin child mortality: report 2011. Estimates developedby the UN inter-agency group for child mortality estimation.New York, NY: United Nations Children'sFund, 2011. 19 p. | | [12] Ghosh S, Bhargava SK, Madhavan S, Taskar AD, Bhargava V, Nigam SK. Intrauterine growth of north Indian babies. Pediatrics. 1971;47:826-32 | | [13] Laxminarayan P, Nagaswami S, Balgopal RV. Fetal growth as assessed by anthropometric measurements. Indian Paediatrics 1974, 12:803-10. | | [14] Taylor RAM, Denison FC, Beyai S, Owens S. The external Ballard examination does not accurately assess the gestational age of infants born at home in a rural community of the Gambia. Ann Trop Paediatr 2010;30:197-204. | | [15] Ngirabega JD, Hakizimana C, Wendy L, Munyanshongore C, Donnen P, Dramaix-Wilmet M. [Reliability of anthropometric measurements performed by community nutrition workers in a community-based pediatric growth-monitoring program in rural Rwanda]. Rev Epidemiol Sante Publique 2010;58:409-14. [French]. | | [16] Johnson W, Cameron N, Dickson P, Emsley S, Raynor P, Seymour C et al. The reliability of routine anthropometric data collected by health workers: a crosssectional study. Int J Nurs Stud 2009;46:310-6. | | [17] Venkatachalam J, Kumar D, Gupta M, Aggarwal AK. Knowledge and skills of primary health care workers trained on integrated management of neonatal and childhood illness: follow-up assessment 3 years after the training. Indian J Public Health 2011;55:298-302. |