Original Research Article

A Study On The Relation Of Head Circumference And Chest Circumference With Gestational Age

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Abstract

At birth HC is larger than ChC by about 2.5cm. By 6-12mnths of age, both are equal. After1st year of life, ChC tends to be larger by 2.5cm. By the age of 5 years, it is more or less 5cm greater in size than the HC. In undernourished Indian children, it may not equal to HC even by the end of the 2nd year. All the singleton live born babies born in the hospital were examined within 48 hours of birth. Gestational age was calculated by enquiring into 1st day of mothers last menstrual period and will be subsequently confirmed by New Ballard Score. If any disparity of more than 2 weeks between gestational age by enquiring LMP and by NBS, were excluded from the study. Their gestational ages ranged from 29 to 42 weeks. The *mean* head circumference of the babies analyzed was 33.64 cm, with the *standard deviation* of 1.40 cm. It was found that HC was correlated well with the gestational age. It gave a correlation coefficient "r" value of 0.680 (p<0.0001). The *mean* chest circumference of the babies analyzed was 31.85 cm, with the *standard deviation* of 2.19 cm. It was found that chest circumference was correlated well with the gestational age. It gave a highest correlation coefficient "r" value of 0.763 (p<0.0001).

Keywords: Head circumference, chest circumference, gestational age

Introduction

The average full term baby's head circumference is between 33-38cms, then increases by 2 cm per month for the 1st three months 1 cm per month for next 3 months, and 0.5 cm per month for the next 6 months till the age of 1 year.

The average rate of growth of HC in a healthy premature infant is 0.5cms in the 1st 2 weeks, 0.75cm in the third week and 1cm in the 4th week and thereafter until the 40th week of the development [1].

Microcephaly is the head size of less than 3rd percentile for weight or period of gestation. It may be subdivided into two main groups. Primary (genetic) microcephaly and secondary (non-genetic) microcephaly. A precise diagnosis is important for genetic counseling and for prediction of future pregnancies.

Primary Microcephaly refers to group of condition that usually has no other malformation and follows a mendelian pattern of inheritance or are associated with a specific genetic syndrome.

These infants are usually identified at birth because of small head circumference. The more common etiologies include autosomal dominance microcephaly and a series of chromosomal syndromes [2].

Secondary Microcephaly results from a large number of noxious agents that may affect the fetus in utero or the infant during periods of rapid brain growth particularly in the first two years of life. It is important to obtain the head circumference at the birth as serial head circumference than a single determination.

Macrocephaly is based on HC of more than 97th percentile for gestational age.

At birth HC is larger than ChC by about 2.5cm. By 6-12mnths of age, both are equal. After1st year of life, ChC tends to be larger by 2.5cm. By the age of 5 years, it is more or less 5cm greater in size than the HC. In undernourished Indian children, it may not equal to HC even by the end of the 2nd year [3].

According to WHO study, ChC was defined at the level of the nipples during the end phase of expiration. The measurement was taken to nearest mm and was recorded within 3- 4hrs of birth. In most Indian studies the ChC was obtained at the level of the xiphisternum and below the inferior angle of the scapula during quite respiration [4].

The ChC is measured to the nearest of 0.1cm at the level of the xiphisternum below the inferior angle of the scapula during quite respiration by a flexible non-stretchable fiber glass tape, with the hope that it would fit the chest more snuggly and thus, ensure better accuracy.

Methodology

1283 single live babies born in institute of medical college and research center over a period of one year were included in the study.

Inclusion criteria

All the singleton live born babies born in hospital were included in the study.

Exclusion criteria

1. All twin babies.
2. Intra uterine deaths and still born babies.
3. Babies with gross congenital anomalies.
4. Babies born to mothers with condition likely to influence fetal growth i.e. hypertensive disorders of pregnancy, gestational diabetes mellitus, chronic infections and illnesses are excluded.
5. Babies whose gestational age could not be accurately assessed i.e. >2 weeks difference between obstetrical and clinically assessed gestational age.

Method of collection of data

All the singleton live born babies born in the hospital were examined with in 48 hours of birth. Gestational age was calculated by enquiring into 1st day of mothers last menstrual period and will be subsequently confirmed by New Ballard Score. If any disparity of more than 2 weeks between gestational age by enquiring LMP and by NBS, were excluded from the study. Their gestational ages ranged from 29 to 42 weeks. As there were few babies in less than 30 weeks gestation they were grouped together.

Newborns were subjected to the following anthropometric measurements within 48 hours of

birth by standard techniques.

Head circumference: A flexible non-stretchable fiber glass tape was used. The head circumference in the largest dimension around the head (the occipito-frontal circumference) was obtained with a tape placed snugly above the ears. The tape is placed over the mid forehead and is extended circumferentially to include the most prominent portion of the occiput. The measurement was taken to the nearest 0.1cms.

Chest circumference: The Chest circumference was measured to the nearest of 0.1cm at the level of the xiphisternum, below the inferior angle of the scapula during quite respiration by a flexible non-stretchable fiber glass tape.

Results

The *mean* head circumference of the babies analyzed was 33.64 cm, with the *standard deviation* of 1.40 cm.
It was found that HC was correlated well with the gestational age. It gave a correlation coefficient "r" value of 0.680 ($p < 0.0001$).
In the derived normogram based on head circumference and gestational age it was observed that there is a linear relationship of the head circumference with increasing gestational age.
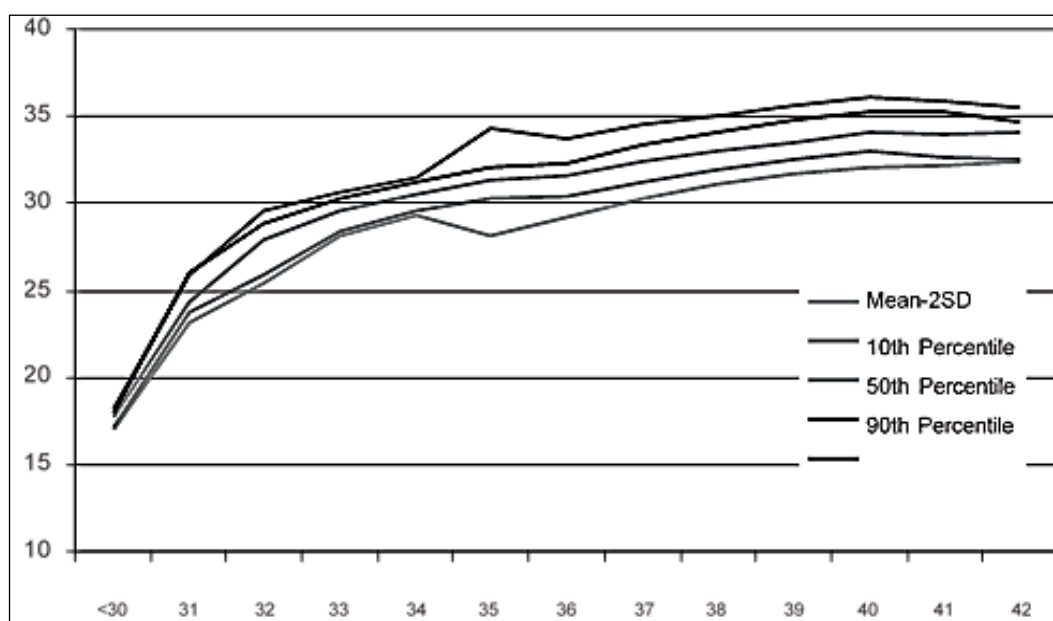
Graph 1: Shows the normogram of head circumference with 10th, 50th, 90th percentiles and mean ± 2SD

Table 1: Head circumference and gestational age

Gestational age (wks)	No. of subjects	Mean	Std. Deviation	Mean-2SD	Percentiles			Mean + SD
					10th	50th	90th	
< "30	6	28.67	0.47	27.73	27.8	28.8	29.2	29.60
31	8	29.15	0.98	27.18	28.2	28.8	31.4	31.12
32	7	29.46	1.21	27.03	27.4	30.2	30.8	31.89
33	12	30.68	0.39	29.91	30.06	30.8	31.28	31.45
34	30	31.12	0.46	30.20	30.24	31.2	31.8	32.04
35	21	31.71	2.21	27.29	30.8	31.8	32.6	36.14
36	46	31.66	0.88	29.90	30.48	31.8	32.4	33.42

| 37 | 124 | 33.04 | 1.03 | 30.97 | 31.8 | 33 | 34.1 | 35.11 |
| 38 | 235 | 33.58 | 0.91 | 31.76 | 32.4 | 33.4 | 34.6 | 35.40 |

39	315	33.98	0.96	32.07	33	33.8	35.2	35.90
40	437	34.36	1.00	32.36	33.2	34.4	35.6	36.35
41	36	33.91	0.88	32.15	32.4	33.8	35.2	35.67
42	7	33.89	0.67	32.54	32.4	34.2	34.2	35.23
Overall	1284	33.64	1.40	30.84	31.8	33.6	35.2	36.45

The head circumference increased with the increasing gestational age upto 40 weeks, after which it started declining.

There is some deviation in the ± 2 standard deviation curves noticed especially between *34-36 weeks* of gestation age groups. The variations are possibly because of small numbers of study group in these gestational ages leading to deviation. In the study there were only 97 babies between 34-36 wks of gestational group constituting only 7.56% of the study group.

The *mean* chest circumference of the babies analyzed was 31.85 cm, with the *standard deviation* of 2.19 cm.

It was found that chest circumference was correlated well with the gestational age. It gave a highest correlation coefficient "r" value of 0.763 (p < 0.0001).

In the derived normogram based on chest circumference and gestational age it was observed that there is a linear relationship of the chest circumference with increasing gestational age.

There is a linear rise of chest circumference with the increasing gestational age, which started declining after 40 weeks gestations.

There is slight depression in the curve noticed at 36 wks of gestation. This is possible because of only 46 babies are there in 36 wk gestational group constituting only 3.56% of the total study group.
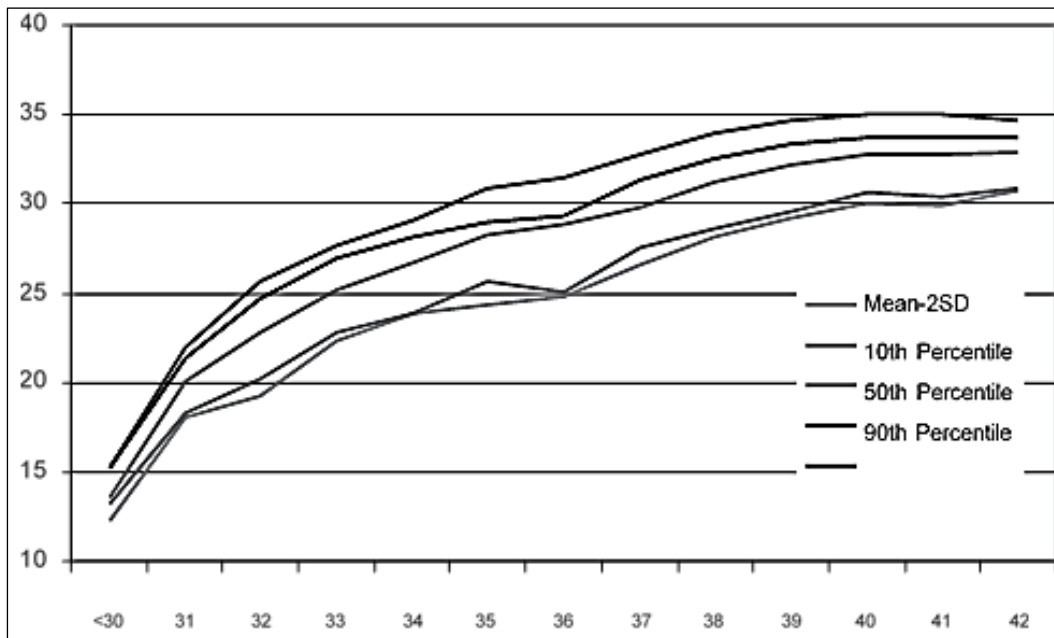
Graph 2: Shows the normogram of chest circumference with 10th, 50th, 90th percentiles and mean ± 2SD

Table 2: Chest Circumference and Gestational age

Gestational age (wks)	No. of subjects	Mean	Std. Deviation	Mean-2SD	Percentiles			Mean + SD
					10th	50th	90th	
<"30	6	22.27	1.22	19.83	21.4	21.9	24.6	24.70
31	8	24.25	1.15	21.95	21.6	24.5	25.6	26.55
32	7	24.06	1.97	20.11	21.4	24.6	26.8	28.00
33	12	26.72	1.18	24.36	24.6	26.8	28.5	29.08

34	30	27.42	1.29	24.84	24.62	27.8	29	30.00
35	21	28.38	1.85	24.68	26.8	29.2	29.56	32.07
36	46	28.50	1.70	25.10	24.74	29.2	29.6	31.90
37	124	30.72	1.47	27.78	29.2	30.4	32.6	33.66
38	235	31.95	1.38	29.19	29.4	32.2	33.4	34.71
39	315	32.50	1.30	29.91	30.2	32.8	33.8	35.10
40	437	32.96	1.20	30.56	31.36	33.2	34	35.37
41	36	32.44	1.27	29.89	30.2	32.8	33.8	34.99
42	7	32.80	0.77	31.25	31.2	33	33.6	34.35
Overall	1284	31.86	2.20	27.46	29.2	32.6	33.8	36.26

Discussion

Birth head circumference-for-age can be measured more reproducibly than birth length although the presence of head moulding (particularly after a difficult or forceps-assisted delivery) may affect the measurement. As with birth length, head circumference as an indicator of brain volume may provide important diagnostic and prognostic information beyond that provided by birth weight alone [5].

A decreased rate of head growth manifested by flat curve or by dropping to a lower percentile may indicate poor brain growth, atrophy or premature cranial synostosis.

At the beginning of the 3rd month the head constitutes approximately half of the CRL. By the beginning of the 5th month the size of the head is about one third of the CHL and at birth it is approximately one fourth of CHL. This is one of the most striking changes taking place during fetal life, with the relative slowdown in growth of the head compared with the rest of the body [6].

Studies done shown that birth weight followed a linear pattern in relation to HC measurement. HC are also useful for assessing the degree of compromise in nutrition of neonates in intrauterine growth retardation by measuring the MAC/HC ratio [7].

The correct measurement of head circumference is important. A non-distensible plastic measuring tape should be utilized. The head circumference in the largest dimension around the head (the occipito-frontal circumference) obtained with a tape placed snugly above the ears. The tape is placed over the mid forehead and is extended circumferentially to include the most prominent portion of the occiput so that the greatest volume of the cranium is measured. The measurement is taken to the nearest 0.1cms.Babies born with congenital malformations, genetic disorders, were excluded to prevent errors in measurement [8].

In the study done by WHO9, they have recommended that in areas where the accurate, early weighing of neonate is not feasible, community health workers should be trained to measure the ChC. Newborns with chest circumference <29 cm should be designated as "highly at risk". And those with circumference>/-29 cm but <30 cm as "at risk". It should be noted, however, that this measures has been validated only in terms of its relationship to birth weight and not to perinatal outcomes [9].

Those babies diagnosed to be at risk through complication associated with LBW could then be either given specialized home care or referred to the nearest health center for appropriate treatment. The tape used to measure ChC should be color coded to overcome the problems of illiteracy. A three-color tape could be used to identify babies at high risk, at risk and those at low risk [10].

They have suggested that where community health workers are likely to be absent at the time of birth, it is important that the mothers are given a color coded tape, to measure and instructed in its use. This tape measure should be part of delivery kit containing for example soap, a razor blade, a bandage and a dressing set each of which would promote a healthy delivery [11].

They have stated that further studies need to be done to know whether the relationship between birth weight and ChC remains the same in situations where community health worker cannot visit the mother until a few days after the birth. In a study done in Bangladesh, a three- colored tape was used; the devise used was a flat, flexible non stretchable tape and suitably colored in red, yellow and green or any other contrasting colors, so that these can be used and understood easily by the illiterate traditional birth attendants. Hence in the absence of weighing machine the measurement of ChC of newborn may indicate the possible birth weight [12].

ChC has many bony landmarks for measurement, which will not vary and will not be affected by acute problems like body water and fat distribution. It also has large cross sectional area with less chance of systemic or random errors in measurement.

Use of the nipple line is not recommended as the position of the nipple may vary. Measurement of the ChC requires undressing, which is discomforting to the neonate. There might be errors in measurement due to the influence of phases of respiration. The measurement of ChC may also have some errors especially in the hands of paramedical workers.

Conclusion

- There is a linear rise of chest circumference with the increasing gestational age, which started declining after 40 weeks gestations.
- The head circumference increased with the increasing gestational age upto 40 weeks, after which it started declining.

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