



Crown-Rump Length estimation of Human Fetuses by external surface area of Right Parietal bone

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Abstract

Background: Despite enormous volume of research devoted to the skeletogenous and to the quantitative studies of the developing and mature skeleton, the growth of skull in respect to its surface area is still never been comprehensively studied. Since classical study of Streeter reported gestational age estimation from crown-rump length (CRL), numerous investigators have studied and reported various measures of fetal growth during pregnancy such as biparietal diameter, diaphyseal length of long bones and even cephalometric growth analysis. Present study was done in dried fetal skull bones by calculation of their external surface area and estimation of linear correlation with crown-rump length and hence determination of gestational age.

Aim: To establish the correlation between the external surface area of right parietal bone and crown-rump length, to predict fetal age from crown-rump length and calculation of growth rate of right parietal bone.

Material and methods: Fifty apparently normal fetuses ranging from 12 cm – 42 cm CR length of both sexes were obtained from the Department of Obstetrics and Gynecology, of our native hospital. After measuring crown-rump length of each fetal skull after removing brain tissue via foramen magnum was then kept for maceration in running tap water. After complete maceration and separation of right parietal skull bone, measurement of external surface area of right parietal skull bone was obtained using wet cotton cloth, marker pen and graph paper.

Results: The regression values were plotted in the graph and these values were found to cluster around the standard straight line and are in hand with the straight line indicating highly significant results.

Conclusion: In the present study, CR length was estimated from external surface area of right parietal bone. A definite correlation was observed between external surface area of right parietal bone and CR length.

Key words

Crown-Rump length, Right parietal bone, External surface area, Normal fetus, Both sexes.

Introduction

Study of correlation between various measurements derived from dried fetal skeletal remnants and crown-rump length assumes great importance in medico-legal practice since the correlation can be used to estimate the age of fetus. Though skull, pelvis and long bones are more reliable for medico-legal application but individual skull bones are yet to be studied in detail. Despite enormous volume of research devoted to the skeletogenous and to the quantitative studies of the developing and mature skeleton, the growth of skull in respect to its surface area is still never been comprehensively studied. Since classical study of Streeter [1] reported gestational age estimation from crown-rump length numerous investigators have studied and reported various measures of fetal growth during pregnancy such as biparietal diameter [2], diaphyseal length of long bones [3] and even cephalometric growth analysis [4]. In the present study, correlation between the external surface area of right parietal skull bone and crown-rump length was established and hence an equation was derived to predict the approximate fetal age from crown-rump length.

Material and methods

Human fetuses for the purpose of the present investigation were collected from Department of Obstetrics and Gynecology in hospitals of Maharashtra state. The fetuses were the Medical Termination of Pregnancy (MTP) as well as the other aborted fetuses. Fresh fetuses which appeared to be normal only were selected for the present investigation. Fetuses delivered

after spontaneous abortion, twin pregnancy, or known maternal diseases were excluded. After proper cleaning of fetuses in running tap water crown-rump length were taken with the help of blunt ended spreading calipers calibrated in mm. Head was separated from trunk with the help of sharp knife applied at the junction of head and neck. Then brain of fetus was removed through foramen magnum completely. Transparent glass jar containing water level at which head was completely immersed were kept in maceration room having open air with proper ventilation with minimum humidity. After the process of maceration and separation of individual skull bones from each other, right parietal bone was identified and cleaned. **(Photo - 1)** They were kept for drying at room temperature for two weeks. For the measurement of external surface area of individual right parietal bone, a new thin cotton cloth was taken. It was completely immersed in lukewarm water and kept overnight as such. Following morning, the cloth dipped in water was slightly squeezed to remove excess of water. This wet cloth was pasted on the external surface of right parietal bone. **(Photo - 2)** Then carefully the outline of bone underneath cloth was marked with the marking pen. Then with the help of sharp cutting scissors the outline was cut along the outer margins of the bone. This cloth was then spread over the graph paper taking care not to form any creases while taking impression. Then an outline was drawn along the margins of spread cotton piece over graph paper. **(Photo - 3)** Area under the graph **(Photo - 4)** was then calculated and thus the individual surface area of right parietal bones was obtained.

Photo – 1: Right parietal bone. (Marked)



Photo – 3: Drawing the margins with cotton cloth pasted over graph paper.

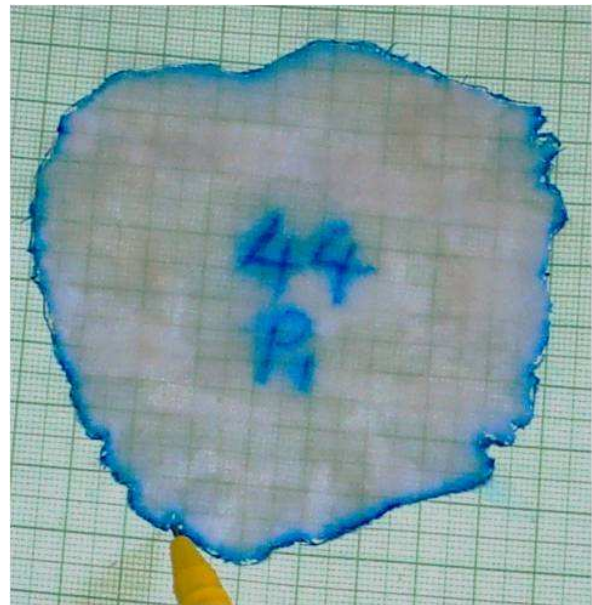


Photo – 2: Right parietal bone with cotton cloth pasted.

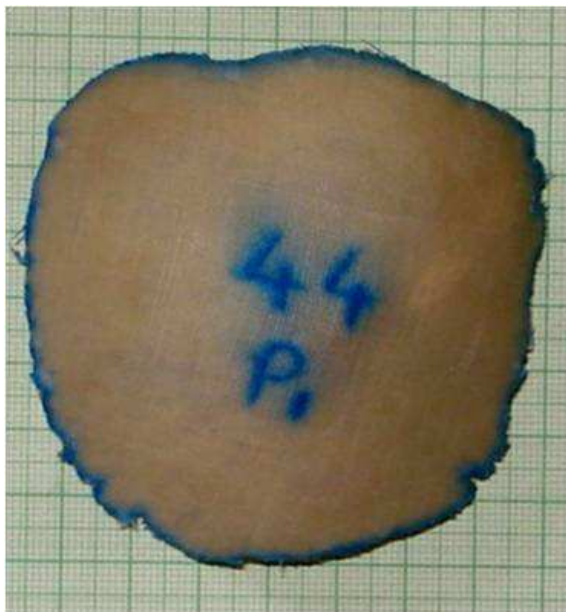
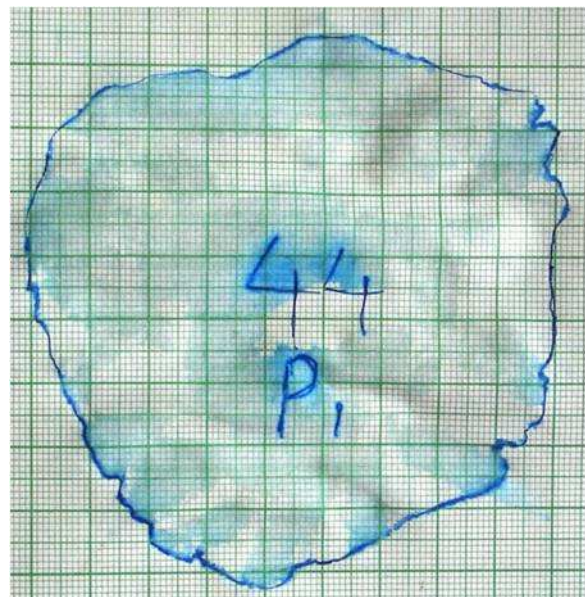


Photo – 4: Graph paper showing surface area of right parietal bone.



Results

Surface area of right parietal bone from minimum to maximum range was 6.03 – 73.88 sq cm with mean surface area 33.27 sq cm as per **Table – 1**.

The correlation coefficient (r) for right parietal bone was calculated as per **Table - 2** and was equal to 0.943. The regression equation of CR length and right parietal i.e. y on x was thus calculated and given by following equation.

$$Y = 11.02 + 0.40 \times X$$

With the help of above regression equation the crown rump length were worked out for surface area of right parietal bone from minimum to maximum range of the sample obtained as per **Graph - 1**. The straight line regression was plotted on graph paper as per **Graph - 2**. The regression values were plotted in the graph and these values were found to cluster around the standard straight line and are in hand with the straight line indicating highly significant results.

Z test was calculated for assessing the significance level. There was highly significant correlation between CR length and surface area of right parietal bones i.e. P value = < 0.0001.

Growth rate

In the present study, at mean crown-rump length of 14.5 cm mean parietal area was 11.32 sq cm. From 14.5-19.5 cm range, 1 cm increase in CR length there was increase of right parietal area by 1.592 sq cm. From 19.5-24.5 cm range, with 1 cm increase in CR length, increase of parietal area was found to be 2.436. From range of 24.5-29.5 cm CR length, 1 cm increase in CR length, increase of parietal area occurred by 2.708. From 29.5-34.5 cm range of CR length, 1 cm increase in CR length, increase of parietal area was found to be 2.116. From range of 34.5-39.5 cm CR length, 1 cm increase in CR length, there was increase of right parietal area by 2.039.

Discussion

A definite correlation was observed between external surface area of right parietal bone and CR length. In present study, CR length was estimated using following regression equation for right parietal bone. In the present study, using 'Z' test, significance level was assessed i.e. 'p' value was calculated which was <0.0001 indicating highly significant correlation.

$$Y = 11.02 + 0.40 \times X$$

Regression coefficient 'r' = 0.943

Kharkar A.R. and Fakhruddin S. (1986) [5] estimated CR length from external surface area of right and left parietal bones. A linear correlation was observed between the external surface area of parietal bone and CR length. In their study 'chi square test' was found to be statistically significant. Kharkar A.R. and Fakhruddin S. (1986) [5] in their study CR length was calculated by following regression equation.

$$X = Y + 13.87 / 2.13$$

Similarly, Kulkarni P.Y. and Zambare B.R. (2006) [6] estimated crown rump length from external surface area of parietal bones. Paired 't' test was found to be statistically significant. In their study, CR length is given by following equation.

$$X = Y + 39.18 / 2.9481$$

Gary S. B., Edelman D.A. and Kerenyi T.D (1975) [2] reported linear co relationship between fetal size (crown-rump length and biparietal diameter) and gestational age in second trimester of pregnancy.

However, a method of staging human fetuses has not yet devised. The most widely used, and most useful, index of growth of the crown-rump length, and an estimate of age can be obtained by relating the length to a standard curve, such as that published by Boyd E. (1941) [7].

Conclusion

The present study was undertaken to establish the correlation between the external surface area of parietal fetal bone and crown-rump length and hence to predict the approximate fetal age from crown-rump length, which is of great Medico-legal significance. The correlation coefficient (r) for right parietal bone was calculated and was equal to 0.943. The regression equation of CR length and right



parietal i.e. y on x was thus calculated and given by following equation.

$$Y = 11.02 + 0.40 \times X$$

P value was <0.0001 for right parietal bone and growth rate of right parietal was 2.1784.

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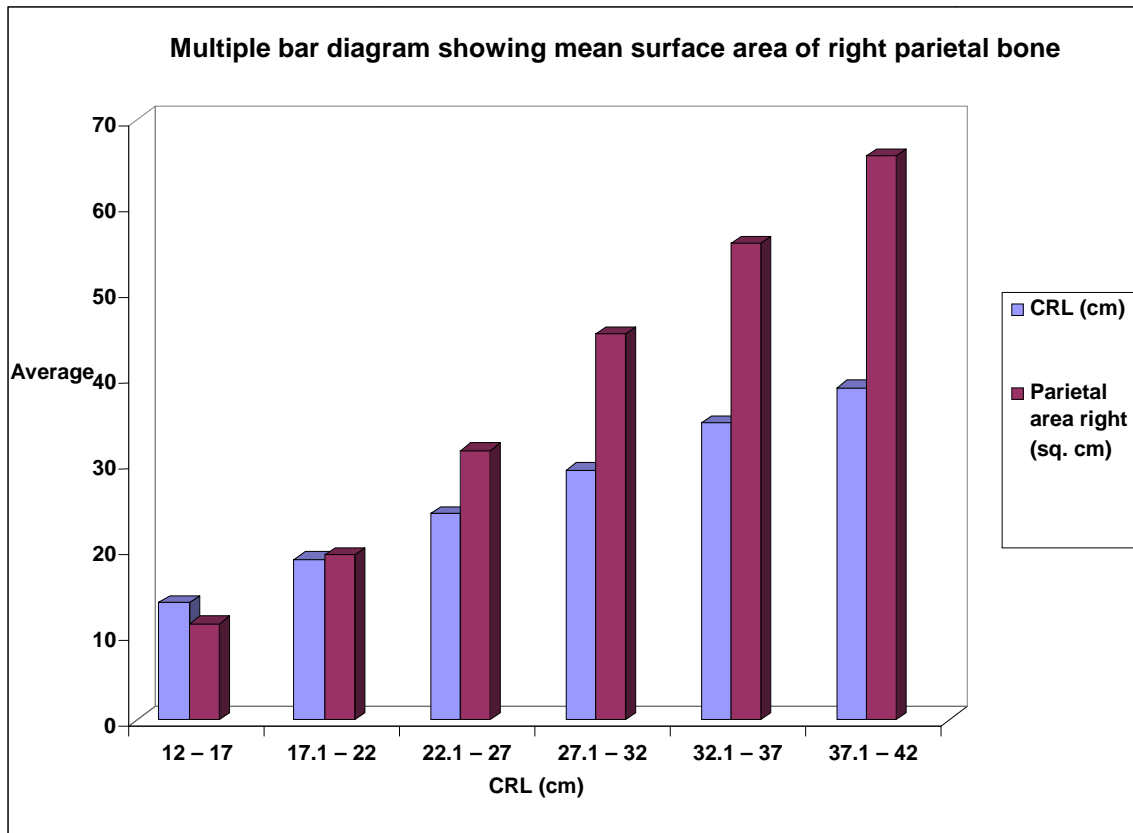
Table - 1: Minimum, maximum and mean surface area of Right Parietal bone.

CRL (cm)	No of cases	Mean CRL (cm)	Mean Right Parietal area (Min. - Max.) sq. cm
12 – 17	9	13.64	11.32 (6.03 – 17.42)
17.1 – 22	10	18.71	19.28 (11.03 – 30.94)
22.1 – 27	12	24.07	31.46 (22.42 – 51.05)
27.1 – 32	9	29.1	45 (37 – 57.74)
32.1 – 37	7	34.64	55.58 (48.51 – 73.76)
37.1 – 42	3	38.77	65.78 (60.5 – 73.88)
Total	50	24.39	33.27 (6.03 – 73.88)

Table - 2: Correlation between CRL and Right Parietal bone (P1).

Correlation between	r	P Value
CRL (cm) and P1 right (cm ²)	0.943	<0.0001

Graph – 1: Mean surface area of right parietal bone.





Graph – 2: Correlation between CRL and P1 right in parietal bone.

