# EVALUATION OF FETAL DEVELOPMENT BY REAL-TIME SONAR CEPHALOMETRY IN INDIAN PREGNANT WOMEN

by

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*Introduction*

Ultrasonic measurement of the fetus during the antenatal period is an important means of assessing fetal maturity, size and growth rate. Cephalometry is the most precise measurement technique available during the antenatal period for measuring week by week growth of the fetal biparietal diameter. Serial measurements are valuable in detecting the growth retarded fetuses. The antenatal detection of these babies would permit their delivery at a preselected time to give the greatest chance of survival and minimum chance of adverse sequalae. Dewhurst *et al* (1972) found that 22.0 per cent of pregnant women did not remember the definite last menstrual period (L.M.P.). The clinical estimate of maturity by bimanual palpation in the first trimester was in error by at least two weeks in 25 per cent of the cases. The range of error in the second and third trimesters was as much as ± 8 weeks (Bearley and Underhill, 1970 and Campbell 1974). An accurate estimation of fetal age is of paramount importance in high-risk obstetric situation. Every centre using sonography for high-risk obstetrics, needs to establish its own standards for biparietal diameter (BPD) at each week of gestation. This is done to eliminate the differences due to patient population, instrument (and its calibrated velocity of sound in human tissue) and operator. Therefore, a study was conducted to determine the accuracy of BPD measurement, to find a correlation between the fetal age and BPD and to establish BPD standards at our centre from 20-40 weeks gestation.

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*Materials and Methods*

*Apparatus*: A real-time equipment with a transducer frequency of 2.5 mHz was used. The calibrated velocity of sound in tissue was 1540 M per Sec. The screen gave a 1:1 display and the BPD measurements were directly read off from the screen with a transparent scale.

*Place of Measurement*: The BPD measurement was taken at right angles to the parietal bones and the maximum diameter perpendicular to the falx cerebri was considered. Fetal movement did not pose a problem in BPD measurement. With real-time equipment, finding the correct plane, after accounting for the

asynclytism and occipital rotation was quite easy and quick.

*Gain*: The gain-setting significantly affects the real-time BPD measurement by altering the apparent skull-table thickness. All measurements were taken at medium gain with skull table widths of 3-4 mm. The cephalic points used to define the BPD were taken from the outer table of the anterior parietal bone to the outer table of the posterior parietal, 0-0 measurement since that has been shown to correlate best with the true neonatal BPD (Campbell 1969).

*Gravidas*

A total of 853 measurements were made on 502 gravidas attending the antenatal clinic from 20-40 weeks gestation. The readings were made from January 1979 through October 1979. All the gravidas included in the study satisfied the following criteria:

1. the last menstrual period (LMP) was known and the previous menstrual cycles were regular.
2. the pregnancy was uncomplicated.
3. the delivery took place within ± 2 weeks of the menstrual EDD.

*Observations*

The mean BPD value at each week of gestation from 20-40 weeks is shown in Table I along with the number of readings at each week of gestation and the 2 x standard deviation (S.D.) value. Fig. 1 shows the fetal head and BPD of 87 mm. Midline is marked by arrow and H = Head. Fig. 2 shows the normal fetal biparietal diameter (Mean BPD and ± 1 S.D.) growth curve during the second and third trimesters. Fig. 3 shows hydrocephalic head with a BPD of 140 mm. HC = hydrocephalic head.

TABLE I

| Gestation (weeks) | No. of Readings | Mean BPD (mm) | 2 S.D. (mm3 |
|---|---|---|---|
| 20 | 36 | 51.2 | 3.0 |
| 21 | 38 | 53.8 | 3.2 |
| 22 | 40 | 55.7 | 3.0 |
| 23 | 35 | 58.0 | 3.4 |
| 24 | 37 | 60.1 | 3.8 |
| 25 | 39 | 63.2 | 3.2 |
| 26 | 38 | 67.4 | 3.6 |
| 27 | 36 | 69.3 | 3.4 |
| 28 | 34 | 71.0 | 3.6 |
| 29 | 35 | 74.3 | 3.6 |
| 30 | 37 | 76.9 | 3.8 |
| 31 | 43 | 79.5 | 4.2 |
| 32 | 44 | 82 | 4.2 |
| 33 | 48 | 83.8 | 3.8 |
| 34 | 44 | 85.0 | 4.6 |
| 35 | 49 | 87.4 | 4.0 |
| 36 | 42 | 89.2 | 4.4 |
| 37 | 47 | 90.1 | 4.6 |
| 38 | 45 | 91.2 | 5.0 |
| 39 | 46 | 91.9 | 5.2 |
| 40 | 40 | 93 | 5.6 |

It is seen from Fig. 2 that the rate of growth is rapid and relatively constant until 30th week but it gradually lessens after the 30th week. The standard deviation is much less in the second trimester and is found to increase in the third and is greatest at term. Therefore, it would be expected that the accuracy of maturity prediction would increase if the measurements were made nearer to term.

The percentile value of BPD at each week of from 20-40 weeks is shown in Table II. It is seen that the confidence bands widen in the third trimester.

The mean growth rate of BPD from 20-30 weeks gestation is 2.6 mm/week and 1.5 mm/week from 30-40 weeks gestation. Linear regression was applied for the relationship between BPD and gestation from 20-30 weeks and it was found to be a good fit. The gestational age could be determined up to ± 7 days with 95 per

TABLE II

| Gestation | BPD Percentiles (Centimeters) | | | | |
|---|---|---|---|---|---|
| | 5 | 25 | 50 | 75 | 95 |
| 20 | 4.7 | 4.8 | 5.0 | 5.2 | 5.4 |
| 21 | 4.9 | 5.0 | 5.3 | 5.5 | 5.7 |
| 22 | 5.5 | 5.6 | 5.7 | 5.8 | 5.9 |
| 23 | 5.8 | 5.9 | 6.1 | 6.2 | 6.3 |
| 24 | 6.0 | 6.2 | 6.4 | 6.6 | 6.8 |
| 25 | 6.4 | 6.5 | 6.7 | 6.8 | 7.0 |
| 26 | 6.6 | 6.7 | 7.0 | 7.2 | 7.4 |
| 27 | 7.0 | 7.1 | 7.3 | 7.4 | 7.6 |
| 28 | 7.2 | 7.3 | 7.5 | 7.7 | 7.8 |
| 29 | 7.6 | 7.7 | 7.8 | 8.0 | 8.1 |
| 30 | 7.8 | 7.9 | 8.1 | 8.3 | 8.3 |
| 31 | 7.4 | 7.6 | 8.0 | 8.3 | 8.5 |
| 32 | 7.9 | 8.0 | 8.2 | 8.6 | 8.9 |
| 33 | 7.1 | 8.1 | 8.3 | 8.6 | 9.0 |
| 34 | 8.0 | 8.2 | 8.6 | 8.9 | 9.1 |
| 35 | 8.1 | 8.4 | 8.7 | 8.9 | 9.1 |
| 36 | 8.5 | 8.7 | 8.9 | 9.3 | 9.4 |
| 37 | 8.5 | 8.7 | 9.0 | 9.3 | 9.5 |
| 38 | 8.7 | 8.9 | 9.1 | 9.3 | 9.6 |
| 39 | 8.7 | 9.0 | 9.1 | 9.3 | 9.5 |
| 40 | 8.7 | 8.9 | 9.2 | 9.4 | 9.8 |

cent confidence from a single BPD reading from 20-30 weeks gestation.

The BPD values at our centre are compared with those of Campbell and Newman (1971) and Sabbagha and Turner (1974) in Table III.

*Discussion*

Real-time imaging has contributed in a large measure to the utility and application of ultrasound in modern obstetrics. The factors that assume great importance in real-time measurement are: good image resolution, correct plane of BPD measurement, gain setting and skull reference points.

1. *Gain Setting*: A medium-gain setting should be obtained to give a skull-table width of 3-4 mm, with high-gain setting the skull-table thickness may be about 1 cm leading to error in BPD measurement.

TABLE III

*Comparison of BPD values with other workers*

| Weeks Gestation | Campbell & Newman (1971) | (mm) Our centre | Sabbagha et al (1974) |
|---|---|---|---|
| 20 | 50.2 | 51.0 | 47 |
| 21 | 53.5 | 53.6 | 50 |
| 22 | 56.7 | 56\|0 | 53 |
| 23 | 61.0 | 58.0 | 56 |
| 24 | 64.3 | 60.2 | 59 |
| 25 | 67.2 | 63.5 | 62 |
| 26 | 69.5 | 67.0 | 66 |
| 27 | 72.9 | 69.0 | 69 |
| 28 | 75.8 | 71.2 | 72 |
| 29 | 78.5 | 74.2 | 75 |
| 30 | 81.3 | 77.0 | 78 |
| 31 | 83.3 | 79.6 | 80 |
| 32 | 85.8 | 81.9 | 83 |
| 33 | 88.6 | 83.6 | 85 |
| 34 | 90.0 | 85.1 | 87 |
| 35 | 92.0 | 87.1 | 88 |
| 36 | 93.2 | 89.0 | 90 |
| 37 | 95.0 | 90.0 | 92 |
| 38 | 96.3 | 91.1 | 93 |
| 39 | 97.4 | 91.6 | 94 |
| 40 | 98.1 | 92.0 | 95 |

2. *Skull Reference Points*: 0-0 measurements have been shown to correlate best with neonatal BPD's and are greater than corresponding 0-1 measurements by 3-4 mm (Hughey and Sabbagha 1979). Thus is seems logical to use 0-0 charts when scanning with real-time equipment.

Linear regression was applied to the relationship between BPD and fetal age of 20-30 weeks and it was found to be a good fit. The regression equation was derived; with this the gestation (y) could be calculated from BPD (x) as follows:

$$y = 0.3825\ x + 0.6327$$

The gestation could be predicated with an accuracy of ± 7 days with 95% confidence between 20-30 weeks gestation. Flamme (1972), Sabbagha and Turner (1974) and Campbell (1969) have also found this relationship. We found in serially followed women that the babies tended to remain in the same percentile group as pregnancy advanced. Early diagnosis of growth retardation is thus possible if a baby fails to maintain its growth rank. This was also shown by Sabbagha *et al* (1976). The mean BPD growth rate was 2.6 mm/week from 20-30 weeks gestation and 1.5 mm/week thereafter.

Comparing our BPD values with those of Campbell and Newman (1971) and Sabbagha and Turner (1974), it is found that the values at our centre were less in the third trimester and at term. This may be explained by the lower birth weight of our babies. One wonders whether this is due to a difference in genetic potential or due to subnormal nutrition.

A measurement should be made in the second trimester in all high risk pregnancies to have an accurate gestational age. Further accuracy may be achieved in predicting gestation by using percentile growth rank and taking the BPD twice once at 20-24 weeks gestation and then 10 weeks later. This would assign every fetus a growth rank which it is expected to maintain. An early diagnosis of intrauterine growth retardation (IUGR) is possible if the fetal BPD deviates from the expected percentile group to which it was assigned in the second trimester.

Our BPD chart helped us to date pregnancies and to diagnose IUGR both of which are of great importance in high risk obstetrics.

*Summary*

Real-time ultrasound biparietal diameter measurements were made on 502 gravidas attending our ante-natal clinic from 20-40 weeks gestation. A total of 853 measurements were made. The mean BPD values and percentile values at each week of gestation were calculated. The measurements were made from the outer aspects of the cephalic outline (0-0). This measurement correlates best with the true neonatal BPD. The mean BPD growth rate was 2.6 mm/week from 20-30 weeks gestation and 1.5 mm/week thereafter. The BPD values at our centre were less than those of other workers in the third trimester and more so near term. This correlates with the lower mean birth rate of our babies. The gestation could be predicted to within ± 7 days by a single BPD reading between 20-30 weeks gestation.

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*See Figs. on Art Paper II*