FETAL HEAD ANTHROPOMETRY: A CROSS-SECTIONAL STUDY FROM KUMAUN REGION

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ABSTRACT

Introduction: Biparietal diameter (BPD) and head circumference (HC) are important for estimating gestational age (GA), monitoring fetal growth and to rule out congenital abnormalities. Western references using HC and BPD can lead to erroneous GA estimation, therefore regional reference is required.

Aim: To measure HC and BPD in fetus at different GA, their relationship with GA and comparison of HC and BPD with expected HC and BPD by "Hadlock's formula".

Material & Methods: CRL, HC and BPD were measured in 72 fetuses. Mean and standard deviation of HC and BPD were calculated for all fetuses and across three trimesters. The correlation of HC and BPD with GA was calculated and p value was derived. Hadlock's HC and BPD were calculated for the gestational age. The observed HC and BPD in the study were compared with the Hadlock's value to find out any difference between them

Results: The mean HC of fetuses was 23.7 ± 8.58 cm. The mean HC in first trimester was 6.3 cm, 15.13 cm in second trimester and 30.8 cm in third trimester. The mean HC of fetuses according to Hadlock's formula was 23.72 ± 8.80 cm. The mean Hadlock's HC in first trimester was 5.6 cm, 14.92 cm in second trimester and 31.12 cm in third trimester. The mean BPD in the studied fetuses was 5.92 ± 2.24 cm. The mean BPD in first trimester was 1.7 cm, 4.8 cm in second trimester and 7.8 cm in third trimester. The mean Hadlock's BPD was 6.33 ± 2.41 cm. The mean Hadlock's BPD in first trimester was 1.6 cm, 4.4 cm in second trimester and 8.3 cm in third trimester.

The mean HC of fetuses were nearly equal to mean Hadlock's formula, while BPD of the study fetuses was less than mean Hadlock's BPD. Both HC and BPD measured at different GA showed increase, with increase in GA and strong positive correlation and statistically significant association.

Conclusion: This study had shown that while HC is nearly equal to Hadlock's reference, BPD was less than Hadlock's for GA, reflecting need of local reference data for accurate fetal age estimation.

Keywords: Head circumference, biparietal diameter, fetus.

INTRODUCTION

Antenatal measurement of multiple fetal parameters is important for assessing fetal wellbeing and monitoring intrauterine growth. Head circumference (HC) and biparietal diameter (BPD) are routinely measured by ultrasound in second and third trimester of pregnancy [1]. BPD and HC are important for estimating gestational age (GA), monitoring fetal growth and to rule out congenital abnormalities. Various ultrasound-based formulas using HC and BPD are available for GA estimation but they are mostly western based data but variations exist based on races, ethnic group and nutritional status, like African babies have higher HC and Indian babies have low HC [2].

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World Health Organization Multicentric Growth Reference Study (MGRS) provides set of reference growth curve chart for fetal development but large studies have shown marked difference in HC among national and ethnic group. Therefore, use of single HC reference is not justified. Statistical data from local population is urgently needed for accurate assessment of GA [3].

Ultrasound-based studies measuring HC and BPD are found from India [4,5], however anthropometric studies are limited, if any from Kumaun region, Uttarakhand. This anthropometric study provides a unique opportunity for measurement of HC, BPD at different GA and their relationship with GA. We also compared measured HC and BPD with "Hadlock's formula" values to observe the difference if any exist among the two.

MATERIAL AND METHODS

This cross-sectional study was done in Department of Anatomy, Government Medical College, Haldwani, Nainital, Uttarakhand. Study involved 72 spontaneously aborted human fetuses from 10 to 42 weeks of gestation. The menstrual GA was taken from the history. Inclusion criteria were spontaneously aborted fetus and known menstrual GA. Exclusion criteria were congenital abnormality involving head, face and neck; unsure menstrual GA, intrauterine growth retardation and poor nutritional status.

All measurements were taken with help of a flexible, non-stretchable metal ruler. The measurements were recorded in centimeters (cm), with values rounded off to first decimal place. HC was taken as widest possible circumference of head from broadest part of forehead above eyebrow, above the ear to most prominent part in posterior head above occiput [6]. BPD was measured from greatest transverse diameter of the head, which extends from one parietal boss to the other.

Three group were divided among fetuses according to GA in to first, second and third trimester. First group comprises of GA up to 12 weeks, second trimester with fetuses from 13 weeks to 26 weeks of GA and last trimester above 26 weeks. Mean and standard deviation of CRL, HC and BPD were calculated for all fetuses and across three different trimesters. The Pearson correlation coefficient of CRL, HC and BPD with GA was calculated and p value was derived to see whether CRL, HC and BPD had statistically significant association with GA. Hadlock's HC and BPD were calculated for the gestational age and the observed HC and BPD in the study were compared with the Hadlock's value [7] to find out if any difference between them exist. Graph was plotted for different value of CRL, HC and BPD against GA to show their relations.

OBSERVATIONS AND RESULTS

Out of a total of 72 fetuses, 38 were male fetuses and 34 were female fetuses. There were 3 fetuses in first trimester, 32 in second trimester and 37 in third trimester. The mean CRL of male and female fetuses were 23.62 ± 8.00 cm and 22.68 ± 7.02 cm, respectively.

The mean HC of fetuses was 23.7 ± 8.58 cm (Table 1). The mean HC in first trimester is 6.3 cm, 15.13 cm in second trimester and 30.8 cm in third trimester. The HC measured at different GA showed increase in head circumference with increase in GA (Fig. 1) and strong positive correlation with correlation coefficient of 0.96 and significant statistical association with GA when p value less than 0.01 was considered as significant (Table 1). The mean HC of fetuses according to Hadlock's formula was 23.72 ± 8.80 cm. The mean Hadlock's HC in first trimester is 5.6 cm, 14.92 cm in second trimester and 31.12 cm in third trimester (Table 2). A graph plotted for comparing HC obtained for all fetuses and expected Hadlock's HC for respective GA, shows both HC to be nearly equal (Fig. 2). Across all three trimesters, the measured HC is nearly equal to expected Hadlock's HC (Fig. 3).

The mean BPD in the studied fetuses was 5.92 ± 2.24 cm (Table 1). The mean BPD in first trimester is 1.7 cm, 4.8 cm in second trimester and 7.8 cm in third trimester (Table 2). The expected BPD according to Hadlock's formula was also calculated; the mean Hadlock's BPD was 6.33 ± 2.41 cm. The mean Hadlock's BPD in first trimester is 1.6 cm, 4.4 cm in second trimester and 8.3 cm in third trimester (Table 2). The BPD measured for different GA showed increase in BPD with increase in GA (Fig. 1) and showed strong positive correlation with correlation coefficient of 0.99 and significant statistical

association when p value less than 0.01 considered as significant (Table 1). A graph plotted for comparing BPD obtained for all fetuses and expected Hadlock's BPD for respective GA, shows Hadlock's BPD to be higher than measured BPD (Fig. 4). Across all three trimesters, the measured BPD is less than expected Hadlock's BPD (Fig. 5).

Table 1: Mean and standard deviation of CRL, HC and BPD and their correlation and p value with GA

Parameter (cm)	Mean (cm)	St Dev (cm)	r value	p value
CRL	23.17	8.00	0.989617	Significant
HC	23.7	8.58	0.959974	Significant
BPD	5.92	2.24	0.994524	Significant

Table 2: Mean BPD, mean Hadlock's BPD, mean HC and mean Hadlock's HC in first, second and third Trimester

Trimester	BPD (cm)	Hadlock BPD (cm)	HC (cm)	Hadlock HC (cm)
First	1.73	1.66	6.3	5.66
Second	4.12	4.4	15.13	14.92
Third	7.83	8.3	30.8	31.12

Fig. 1: HC, BPD and CRL on y axis in cm and gestational age in weeks on x axis. CRL, HC and BPD increases with increase in GA

Fig. 2: HC and Hadlock's HC on y axis and gestational age on x axis; both HC and Hadlock's HC are equal

Fig. 3: Mean HC (blue) and Hadlock's HC (orange) in first, second and third trimester

Fig. 4: BPD and Hadlock's BPD on y axis and gestational age on x axis. Hadlock's BPD is higher than study BPD

Fig. 5: Mean BPD (blue) and Hadlock's BPD (orange) in first, second and third trimester

DISCUSSION

HC measurement is a surrogate marker of brain size and brain growth and integral part of Pediatric Neurological Examination [8]. Normal range of HC is important as marked variation in HC was noted among different population. Asian newborns were found to have smaller HC than Caucasian newborn [9]. Head size above and below two standard deviation places head into macrocephaly (large head) and microcephaly (small head). The underlying causes of macrocephaly and microcephaly may be just an anatomical cause but may signify important congenital abnormalities. Periodic antenatal ultrasound scans can detect early abnormal growth of various head parameter, helping in early detection of various congenital abnormalities affecting head [8].

Growth of fetus is different between populations. Indian babies are considered to be smaller than western population [10] but this is not proportionate for all the measurements, as a comparative study between UK and India showed birth weight and abdominal circumference to be much less in comparison to length and subscapular skinfold [11].

Gestational age estimation is based on various models that are western population based like Hadlock's (AC-HC), Woo's (AC-BPD) model, Combs (AC-HC-FL) and Hadlock-3 (AC-HC-FL) models. But directly applying western based models on Indian population can lead to higher errors on Indian population, therefore need of models based on native Indian population is essential; for that fetal head anthropometric measurement are needed [2].

Deloison et al. (2012) studied pregnancies outcomes in which the fetal HC was below the 5th centile in second-trimester scan of 18,377 women. They found that 3.7% of fetuses had HC below the 5th centile. They found that in comparison to fetuses with normal HC, fetuses with progressively less HC for GA have much higher chances of neurological abnormalities and associated with poor pregnancy outcome. A HC less than 5th centile is associated with various neurological disorders. HC with z score below 2.5 was strongly associated with neurological and chromosomal abnormalities [12].

Abnormally large head for gestational age is associated with various obstetrical complications, due to mismatch between large fetal head and maternal pelvis leading to cephalopelvic disproportion (CPD). CPD can leads to obstructed labor, one of the leading causes of obstetrical death in developing countries and are more common in primigravidae. Fetus with large head are associated with difficult delivery leading to increasing likelihood of emergency lower segment cesarean section and assisted delivery. Other complications include shoulder dystocia, prolonged labor and signs of fetal distress. Thus, head parameters become more relevant in predicting mode of delivery and necessary steps to prevent complications [13-15].

The mean BPD in the studied fetuses was 5.92 ± 2.24 cm and mean Hadlock's BPD was 6.33 ± 2.41 cm. The mean BPD in first trimester is 1.7 cm, 4.8 cm in second trimester and 7.8 cm in third trimester and is found to be lower when compared to expected mean Hadlock's BPD which is 1.6 cm in first trimester, 4.4 cm in second trimester and 8.3 cm in third trimester (Table 2, Fig. 5). This study showed linear increase in BPD with increase in GA.

Jaiswal et al. (2015) assessed GA in local population (southern zone) of Rajasthan by measuring fetal BPD with ultrasound in pregnant females in their second and third trimester with known gestational age by last menstrual period. They found that BPD shows linear increase with increasing GA and mean BPD in Indian population is lower than western studies but correlated with Hadlock's series and they suggested that the difference is possibility due to racial, genetic, nutritional and socioeconomic factor [5].

Chan and Yeo (1991) measured BPD by ultrasound in 1442 Chinese fetuses between 17 to 40 weeks of GA and calculated the two standards of error. They compared the results with 2 standard errors of the BPD of the Caucasian fetuses. They found statistical difference between two means and the 2 standard errors and emphasized that nomogram for local regional population is needed [16].

The mean HC and Hadlock's HC for respective GA were 23.7 ± 8.58 cm and 23.72 ± 8.80 cm, respectively. Kinare et al. (2010) in their study from Pune, India measured HC and BPD by ultrasound in 653 singleton pregnancies and they found that HC of fetuses in their study was comparable to that of French reference at 18 and 36 weeks of gestation; BPD in Indian fetuses was smaller than French reference for same GA. The study stressed that Indian fetuses were smaller than French counterpart [17]; however, Warriar and Ashokan (2016) found HC to be less in Indian fetuses as compared to

western population for respective GA. HC may vary across different races and following criteria of western population can result in inaccurate GA estimation and microcephaly [4].

Natale and Rajagopalan (2014) in their study compared growth parameters among economically advantage children across 55 countries and compared it with WHO's Multicentre Growth Reference Study (MGRS). They found marked difference in HC among national and ethnic group and following WHO set of reference growth curve chart can lead to misdiagnosis of many children having microcephaly or macrocephaly. Hence use of single HC reference is not justified [3].

The study reflects that both HC and BPD shows linear increase with increase in GA and HC to be nearly equal to that of Hadlock's HC and BPD to be lower than Hadlock's BPD. Study is limited by number of representative fetuses of different GA, requiring larger studies for findings to be clinically useful.

CONCLUSION

HC and BPD are important marker for estimation of GA and fetal growth monitoring. Western based data are often used but different racial, geographical and ethnical factor and nutritional factors leads to different BPD and HC. This study had shown that while HC is nearly equal to Hadlock's reference, BPD was less than Hadlock's for GA, reflecting need of local reference data for accurate fetal age estimation and growth monitoring.

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