Sonographic Measurement of Fetal Pinna Length in Normal Pregnancies

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ABSTRACT

Background

Many studies have emphasized on fetal pinna measurements and morphologic features to use this structure as an additional marker for fetal chromosomal anomaly.

Objectives

To assess relationship between fetal pinna length and gestation age and develop a nomogram. To assess relationship between fetal pinna length and head circumference and biparietal diameter.

Methods

Fetal pinna measurements from the tip of helix to the end of lobe were obtained prospectively in 850 singleton pregnant women between 15 and 40 weeks' gestation Normal case was defined as normal sonographic findings during examination and normal infant examination at birth or both. Final study population was 787. The relationship between gestational age in weeks to pinna length in millimeters was analyzed by simple linear regression. Correlation of fetal ear length measurements with gestational age, biparietal diameter and head circumference were also obtained.

Results

Linear relationships were found between fetal pinna length and gestational age [Pinna Length (mm)=1.044xGestational age (weeks) -3.857]. A nomogram of normal pinna length was obtained. High correlation was found between pinna length and gestational age (r=0.942; p< 0.001), pinna length and head circumference (r=0.931; p< 0.001). Significant correlation was found between pinna length and biparietal diameter (r=0.934; p=0.004)

Conclusions

The results of this study provide a nomogram for fetal pinna. The study also provides relationship and good correlation between pinna length and other biometric measurements.

KEY WORDS

gestational age, pinna length, sonography

INTRODUCTION

Abnormal fetal pinna lengths are features of many chromosomal anomalies and aneuploid conditions.[1,2,3] Many studies have emphasized on fetal pinna measurements and morphologic features in an attempt to use this structure as an additional marker for fetal chromosomal anomaly.[4-8] But routinely we do not give much attention to this small but important structure during our routine antenatal scan. Fetal pinna length is however a simple measurement which can be obtained in nearly all fetal ultrasonographic examinations from early second trimester till term. Moreover ultrasound is one of the most popular, cheap, non-hazardous and easily available imaging modality in our country. Hence many of the practicing radiologists/ sonologists can make a routine to assess this important structure. This helps to suspect chromosomal anomalies and aneuploid conditions early in gestation.

There are handful numbers of studies in the English literature journals that give prenatal standard for fetal pinna

length.[6,9,10] One of the studies even used 3-D ultrasound to evaluate fetal pinna.[11] But they are focused mostly on Western population. We have taken a step to define a nomogram for fetal pinna length in normal second and third trimester pregnancies in our country. This helps to define normal and abnormal fetal pinnas in our population which we belief is different from Western data as other anthropometric measurements.

METHODS

This is a hospital based cross sectional study. For type I and type II errors of 5% and 20% respectively, total number of subjects (N) was calculated by the formula 32/ES2 , where ES is the smallest effect size worth detecting. Because a correlation of 0.1 is equivalent to the effective size of 0.2, total minimal sample required was 800. After institutiona research committee approval, fetal pinna measurements were obtained prospectively in 850 singleton pregnant women between 15 and 40 weeks' gestation in Dhulikhel Hospital, Kathmandu University Hospital over a 15 month period between May 2010 and July 2011.

The inclusion criteria were normal sonographic findings during examination and normal infant examination at birth or both. The cases with sonographic abnormalities

such as IUGR, structural anomalies, oligohydramnios, polyphydramnios were excluded from the study. The cases where postnatal follow up was not found were also excluded from the study. Hence final study population constituted 787 healthy fetuses (Fig 1).

Ultrasonographic measurements were made by a real-time system with a 3.5-MHz curvilinear transducer (ACUSON X150, Mountain View, CA 94043 USA). Gestational age (GA) was determined by two methods: first by knowing the first day of last menstrual period (GA by date) and second by sonographic measurement of four major parameters viz; Biparietal Diameter (BPD), Head circumference (HC), Abdominal Circumference (AC) and Femur Length (FL) and obtaining the final average GA (GA by measurement). If the two methods match closely within ±14 days, then gestational age by date was considered final GA. But if there is discrepancy of > 14days; GA by measurement was considered final GA. In addition to these measurements, detailed evaluation of fetus was done from head to toe. Fetal pinna length was taken from the tip of helix to the end of lobe either in sagittal view or in coronal view (Fig 2 and 3). Two measurements were taken in each case and one of them was taken into consideration when both the measurements were close. But when there was some difference, third measurement was also taken and one of

Table 1. Normogram of fetal pinna length (in millimeters) according to percentile distribution.

Gestation (weeks)	No. of fetuses	5	10	25	50	75	90	95
15	10	8.18	8.36	9.00	9.20	10.08	11.47	12.24
16	12	8.83	9.54	9.98	10.60	13.03	13.97	14.00
17	12	12.91	13.02	13.43	14.20	14.73	15.25	15.35
18	11	12.55	12.70	13.80	15.00	16.20	16.70	17.05
19	23	14.00	14.00	15.55	16.00	17.25	17.94	18.00
20	60	15.00	15.40	16.00	17.00	18.00	19.60	20.00
21	88	15.80	16.00	17.00	17.90	19.00	20.20	20.90
22	92	16.20	17.00	18.00	19.00	20.00	21.40	22.50
23	63	17.00	17.60	18.40	20.00	21.40	22.60	22.80
24	52	18.50	19.10	19.90	20.90	22.40	23.60	24.00
25	35	18.90	19.10	20.00	21.90	23.00	24.20	24.60
26	39	21.00	21.20	22.40	23.70	25.50	26.80	29.00
27	21	21.60	22.20	23.00	25.00	27.30	28.60	28.60
28	20	24.40	24.90	25.50	26.40	27.10	28.10	28.50
29	18	23.90	24.40	25.00	28.10	29.90	31.60	33.60
30	21	25.00	25.00	27.00	28.00	29.20	31.10	31.30
31	17	26.20	26.30	27.00	28.30	29.90	30.20	31.00
32	29	26.40	27.30	28.00	30.00	31.20	32.20	33.60
33	24	24.70	25.70	28.00	31.40	34.00	34.60	35.00
34	30	27.10	27.70	29.60	32.20	34.30	36.10	37.40
35	33	29.30	30.20	31.10	32.60	34.00	35.80	38.10
36	24	30.00	30.50	31.90	34.00	35.60	36.80	37.40
37	18	29.90	30.40	33.70	35.10	36.40	37.90	38.20
38	13	30.90	31.30	32.20	34.00	37.70	38.20	38.50
39	12	29.60	29.90-D	32.10	34.90	36.40	37.90	38.90
40	10	29.10	29.20	36.20	37.30	37.90	38.20	39.10

the two closely matched measurements was considered.

All the data were initially managed with MS excel programme and the statistical analyses were later performed by SPSS 11.5 software. The relationship between gestational age in weeks to pinna length in millimeters was analyzed by simple linear regression. For a given gestational age, predicted values were obtained for the 5th, 10th, 25th, 50th, 75th, 90th and 95th percentiles to develop a nomogram. Correlation of fetal ear length measurements with GA, HC and BPD were also obtained alongwith BPD/ Pinna Length ratio and HC/ Pinna Length ratios.

Table 2. Summary of relationship of pinna length with GA, BPD and HC

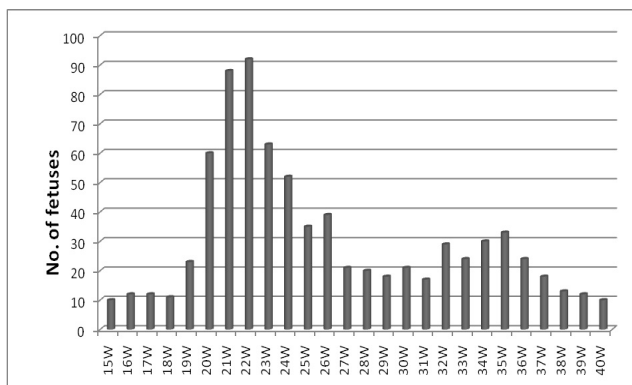| y axis	x axis	Regression Formula	Correlation Coefficient	P value
pinna length	Gestational age	y = 1.044 x -3.857	0.942	<0.001
	BPD	y = 0.392 x -1.210	0.934	0.004
	HC	y = 0.109 x -1.777	0.931	<0.001

Figure 1. Frequency distribution of fetuses at various gestational age in weeks(W).

Figure 2. Fetal pinna length(open arrow) taken from the tip of helix to the end of lobe(cursors) in sagittal view at 20 weeks of gestation.

RESULTS

Linear relationships were found between fetal pinna length and gestational age (Fig 4). Pinna length in mm =1.044xGestational age (weeks) -3.857. A nomogram was obtained with the predicted values at 5th, 10th, 25th, 50th, 75th, 90th and 95th percentiles (Table I). Linear relationship was also found between fetal pinna length and BPD (Fig 5) and Fetal Pinna length and HC (Fig 6). High correlation was found between pinna length and GA (r=0.942; p< 0.001). Similar correlation was also found between pinna length and HC (r=0.931; p< 0.001). Significant correlation was found between pinna length and BPD (r=0.934; p=0.004). Table II summarizes relationship and statistical correlation between pinna length and GA, BPD and HC.

BPD/Pinna length ratio and HC/Pinna length ratio were fairly constant throughout gestation (Fig 7 and 8). BPD/ Pinna Length ratio is approx. between 2.6-2.8 and HC/ Pinna length ratio is approx. between 9.5-10.5.
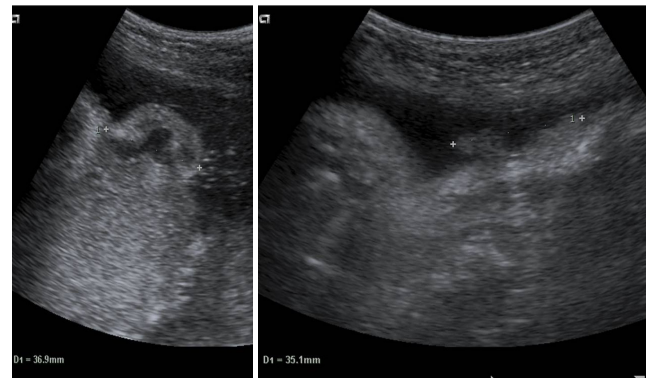

Figure 3. Fetal pinna (cursors) at 40 and 36 weeks of gestation in parasagittal and coronal views respectively.
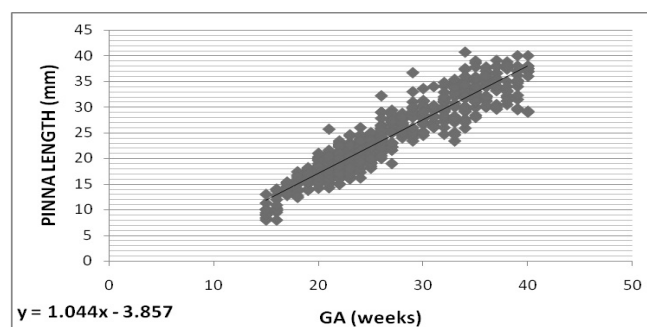

y = 1.044x - 3.857

Figure 4. Relationship between pinna length(PL) with gestational age (GA).

y = 0.392x - 1.210
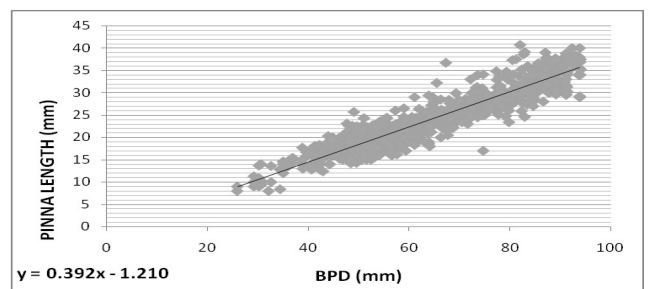
Figure 5. Relationship between pinna length (PL) with BPD.
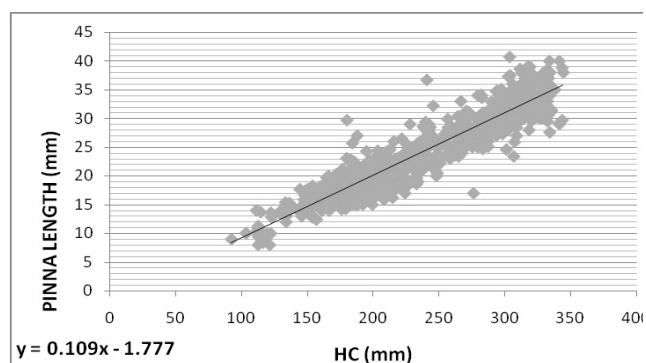
y = 0.109x - 1.777

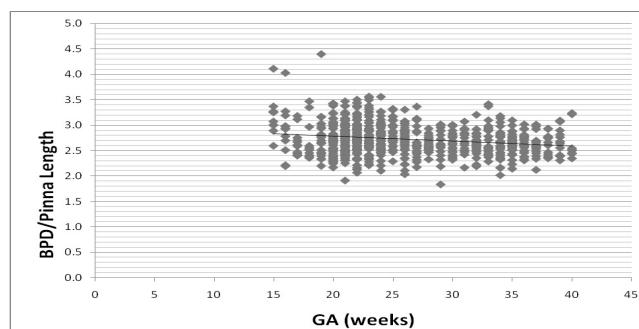**Figure 6.** Relationship between pinna length (PL) with HC.

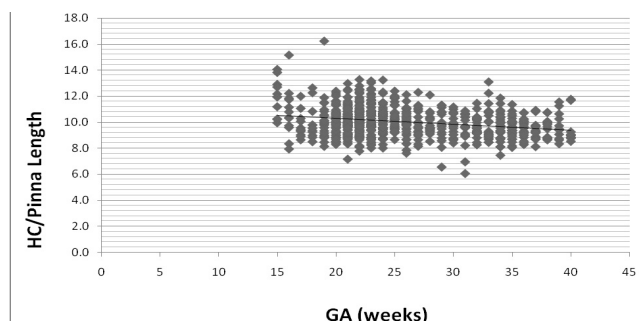**Figure 7.** Scatterdiagram. BPD/pinaa length ratio vs GA(weeks).

Figure 8. Scatterdiagram. HC/pinna length ratio vs GA(weeks).

DISCUSSION

At least three routine antenatal scans are performed regularly in all pregnant ladies visiting our hospital; one at first visit regardless of gestational age, second for anomaly scan between 18-22 weeks and third at the time of delivery. Additional scans are performed only if clinically indicated. One of the main objectives of these routine scans is to detect obvious fetal anomalies. Among these, the detection of fetal chromosomal anomalies and other aneuploid conditions is one of the challenging jobs. Various laboratory parameters are available for the detection of same viz; amniocentesis, chorionic villus sampling, single marker (maternal serum alpha fetoprotein) and multiple-marker biochemical screening tests. Apart from these, genetic sonograms are also being used to detect fetal aneuploidy.[12,13] One of the sonographic parameters frequently used is fetal pinna length.[7,8,14] In our experience, pinna length measurement is relatively simple and straightforward technique which can be obtained in nearly all fetal sonographic examinations.

Abnormally small pinna length is one of the most prominent and consistent features of trisomies and other aneuploidy. In their study, Sivan et al defined small ears as values less than the mean -2 SD.[15] Only one study by Gill et al however does not agree that fetal ear measurements are diagnostically helpful due to wide range of normal variation seen at each gestational age.[14] However many other studies are in favor of the fact that reduced fetal ear length is helpful in identifying fetal chromosomal anomalies.[2,4,5,7] This prompted many investigators to use abnormal pinna length as potential additional parameters in the detection of these anomalies.

There are a number of studies providing ear length measurement for normal fetuses. These studies are mostly based on Western population. Our study is based entirely on Nepalese population. Our data suggest linear relationship between fetal pinna length and gestation age. This is in comparison with a study by Shimizu et al in which regression analysis was done in ultrasonologically obtained fetal ear length in 124 normal cases with r=0.956.[10] In their study, Chitkara et al developed a nomogram by linearly regressing ear length on gestational age and found a high correlation between them (r=0.96; p=.0001).[6] Birnholz et al in a study of 180 normal subjects found ear length increased from about 6mm at 15 weeks to 33mm at term and this was well fit by linear regression (r2-0.96).[9] Lettieri et al also found linear relationship between ear length and gestational age across second trimester.[2] Though all of these studies including our study were cross sectional in nature, they also perhaps indicate linear pattern for length increment for individual cases in the second and third trimester cases. We have formulated a nomogram that is similar to the nomograms of previous studies.[6,16] This shows that fetal pinna growth and size in our population is similar to that of Western population.

Unlike previous studies we did not include karyotyping as one of the criterion to define normal fetus due to lack of availability of such test in our setting.[6,10] Normal fetus is defined on the basis of normal ultrasonographic examination and normal outcome at birth.

Other observations in our study include linear relationship between BPD and pinna length, HC and pinna length. This is in accordance with previous studies by Shimizu et al and Chitkara et al.[6,10] We also observed BPD/pinna length ratio and HC/pinna length ratio which remain relatively constant throughout gestation. This means there is uniform rate of growth of these parameters. Any significant deviations in these ratios could also potentially be used as an additional parameter to detect chromosomal abnormalities. Normal BPD/ pinna length ratio is approx. between 2.6-2.8 in our study. In their study Chitkara et al noted an increased BPD/ ear length ratio of ≥ 4.0 in fetuses with abnormal karyotype.[8]

Abnormally short pinna is not only seen in chromosomal anomalies but also in other structural abnormalities.[17] Hence antenatal evaluation of fetal pinna may be a useful adjunct to detect various other fetal congenital anomalies apart from chromosomal abnormalities and other aneuploidy. We do agree with Birnholz et al and suggest

pinna length be determined ultrasonologically whenever risk or suspicion of a chromosomal disorder is present or when a fetal anomaly is detected.[9]

We have developed a nomogram to detect deviations from normal pinna length. This will help radiologists/ sonologists/ obstetricians to detect abnormal pinna and suspect underlying fetal abnormalities. We have also formulated BPD/Pinna Length and HC/ Pinna Length ratios which can also be additional markers to detect abnormality.

CONCLUSION

The results of this study provide a nomogram for fetal pinna length at various gestational ages. The study also provides relationship and good correlation between pinna length and GA, BPD and HC. Large scale study is recommended in both antenatally and postnatally detected fetal anomalies in our part of world regarding the utility of these observations possibly in adjunct with karyotyping.

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