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Original Article

Radiology Section

Antenatal Ultrasound Fetal Pinna Measurement and Evolving Nomogram in South Indian Population in Normal Pregnancies

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ABSTRACT

Introduction: The abnormality of pinna length and morphology can indicate chromosomal anomaly and can be a marker for chromosomal aneuploidy. There are many studies about sonographic pinna length measurements correlating this with gestational age and fetal biometric measurements. Studies have been done in different population about the ultrasound pinna measurement with deduction of nomogram. To our knowledge this study has not been done on the South Indian population.

Aim: To evolve nomogram for fetal pinna length measurement for South Indian population and to correlate this with gestational age and fetal biometry.

Materials and Methods: Pinna length measurements (from the tip of the helix to the tip of the lobe) are measured prospectively in normal singleton pregnancies between 16-28 weeks. Normal pregnancy is normal sonographic study and/or normal infant examination after birth. The ear length is measured in either oblique sagittal or coronal plane in millimeters and this is correlated with the gestational age and fetal biometry.

Results: There is a linear relationship between the pinna length and the various fetal biometric parameters and the gestational age of the fetus.

Conclusion: Study deduces the nomogram of the fetal pinna length. A linear relationship between the pinna length and the gestational age was established and there is no significant difference of pinna length as compared to the studies done on the other populations.

Keywords: Chromosomal abnormality, Fetal morphology, Ultrasound marker

INTRODUCTION

There are many studies about sonographic pinna length measurements correlating this with gestational age and fetal biometric measurements [1-6]. Studies are there correlating the fetal ear length and morphology to aneuploidy [7,8]. Studies have been done in different parts of the world involving various ethnic population like Turkish, Nepal and Western population involving the fetal pinna length to evolve nomogram [1,5,6]. We intend do this study first to evolve a nomogram for fetal pinna length in the second and early third trimester in the South Indian population and to look for any significant differences between the studies done in different parts of the world.

In antenatal ultrasound many markers are used to screen for fetal chromosomal abnormality in different gestational ages. In 11-13 weeks Nuchal Translucency (NT) scan done for assessment of the Nuchal Translucency and nasal bone for early prediction of fetal aneuploidy [9] other markers used in this period are ductus venoses spectrum, tricuspid regurgitation. Anomaly scan done between 18-22 weeks scan, there are markers to indicate possibility of chromosomal abnormality. The abnormality of pinna length and morphology can indicate chromosomal anomaly and can be a marker for chromosomal aneuploidy [2,10]. Though the ear length can be measured from 11 weeks itself, we have taken gestational age as 15-28 weeks, as in the early gestational age the smaller ears makes the difference in normal and abnormal as tiny and can give both false positive and false negative results [2]. So it is better to measure the fetal ear length after 14 weeks, and fetal morphology can be optimally assessed between 15 to 28 weeks we have chosen this as the gestational period of examination for our study [3]. Some studies have proposed that during 2nd trimester it will be useful to measure ear length for detection of aneuploidy [7].

Ultrasound is cheap, readily available and also the assessment of fetal ear length can be done routinely when the pregnant women comes for the routine anomaly scan which will be convenient to the patient and no need for a separate visit for this assessment. This can further increase the sensitivity of detection of aneuploidy. There are studies using pinna length as marker of aneuploidy, some have taken the morphology assessment for detection, in some they have considered the taking three dimentional measurement and some have studied fetal pinna in 3D ultrasound [10-13]. All this has been done to further enhance the sensitivity and specificity of detection. But considering the patient load in Indian set-up, and practicality of spending time for 3 dimensional measurement, time and cost of 3D imaging we have decided to consider only the pinna length for our study.

MATERIALS AND METHODS

This is a prospective study conducted at Sapthagiri Hospital attached to the Sapthagiri Medical College and Research Centre Bangalore, India. Study was conducted between the period of March 2015 to February 2016 in the Radiology Department of the Hospital.

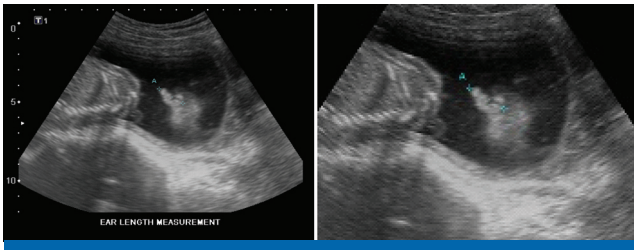
After getting approval from the ethical committee of the hospital for the study we have randomly selected the normal pregnant women coming for the routine ultrasound scan to our department for the antenatal scan in the gestational age group of 15 weeks to 28 weeks gestation.

A convenient sample size of 250 normal singleton pregnancies was selected for the fetal pinna measurement.

In our study we considered only the normal singleton pregnancy for evaluation. Gestational age estimation by the fetal biometry was taken as the gestational age, provided the gestational age estimation by fetal biometry correlated with last menstrual period gestational age. If there is discrepancy of more than one week and cases where we could not get the proper section for measuring the pinna, such cases were excluded. Pregnancies with abnormal findings like IUGR, poly or oligohydramnios, fetal anomalies, history of anomaly or chromosomal abnormalities in previous pregnancies, those with irregular cycles and unreliable menstrual date were also excluded from the study. Finally, out of 250, 18 cases were excluded leaving the final sample size of 232 cases. Informed consent was taken from all the patients who were examined.

Two ultrasound machines, Siemens Acuson 700, Toshiba Nemio were used with convex probe. Obstetric scan done for estimation of gestational age taking the biometric parameters and detailed fetal morphology scan done to rule out possibility of any fetal anomalies

The fetal pinna is measured in para sagittal plane. The largest dimension from the cranial tip of the helix to the caudal tip of the lobe is taken. Two measurements of the ear length were taken and if they were close then one of the measurement was considered and if there was wide difference, third measurement was taken and the average of the two closer values were considered. There are studies where three dimensional ear measurements were evaluated, however, we have considered only the length as taking three measurement was time consuming and practicality to be ascertained [8]. The pinna measurements were tabulated in accordance with the gestational age and the results analyzed using statistical methods [Table/Fig-1].



[Table/Fig-1]: Ultrasound images showing fetal pinna measurement in oblique saggital plane.

STATISTICAL ANALYSIS

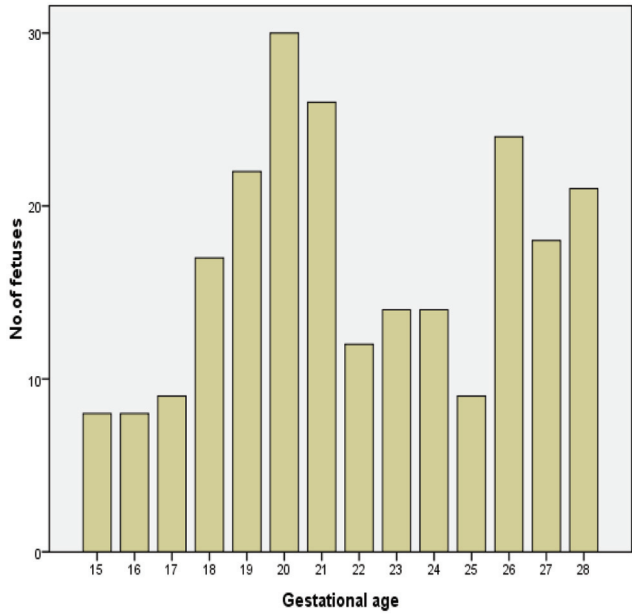
Data analysis was done using Statistical Package for Social Sciences v.16. Pearson's Correlation test was applied to know the relationship of fetal pinna length with the gestational age, BPD and HC.

RESULTS

Total 232 fetuses were examined between gestational ages of 15 to 28 weeks, as most of the fetal morphological assessments are done at this time. Usually the fetal anomaly scan will be completed latest by 28 weeks, and fetal morphology can be assessed better between the 15 to 28 weeks as before 15 weeks the fetal organs will be too small to assess and in later gestational age because of reduced fetal movements, reduced amniotic fluid and the fetal position, the optimal fetal morphology assessment can't be done.

The pinna length varies between minimum of 8.1 mm at 15 weeks of gestation to maximum of 29.5 mm at 28 weeks of gestation with a standard deviation of 4.805. There is a linear relationship between the pinna length and the gestational age, biparietal diameter and the head circumference. With increase in the gestational age, BPD and HC there is increased fetal pinna length. This is having a high correlation coefficient and significant p-value [Table/Fig-2-4].

The scatter diagrams show the linear relationship of the fetal pinna length with the gestational age, biparietal diameter and the head circumference. The correlation coefficient of pinna length with gestational age is 0.925 and p-value <0.001, the correlation coefficient of BPD and HC with the pinna length



[Table/Fig-2]: Frequency distribution, number fetuses to the gestational age in weeks.

Descriptive Statistics					
	Range	Mini-mum	Maxi-mum	Mean	Std. Deviation
Gestational Age (in weeks)	13	15	28	22.05	3.757
Biparial Diameter (in mm)	53.1	27.9	81	52.74	12.457
Head Circumference (in mm)	254.6	25.4	280	194.14	46.280
Pinna Length (in mm)	21.4	8.1	29.5	18.85	4.805

[Table/Fig-3]: Descriptive statistics of the study .

Y-axis	X-axis	Correlation coefficient	Regression Formula	p-Value
Pinna Length	GA	0.925	Y=-7.235+1.183X	0.001
	BPD	0.902	Y=0.478+0.348X	0.001
	HC	0.848	Y=2.311+0.086X	0.001

[Table/Fig-4]: The relation of the pinna length to the gestational age, biparietal diameter and head circumference.

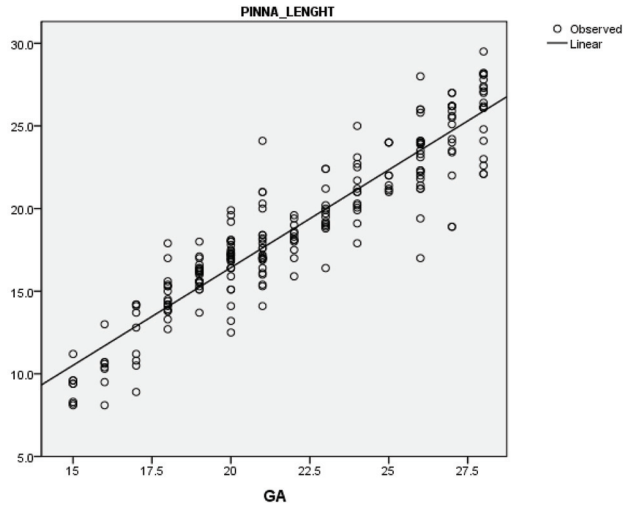
are 0.902 and 0.848 respectively. The p-value <0.001 which shows that there is a significant correlation [Table/Fig-5-8].

The ratio BPD/pinna length and the HC/pinna length is fairly constant throughout the gestation.

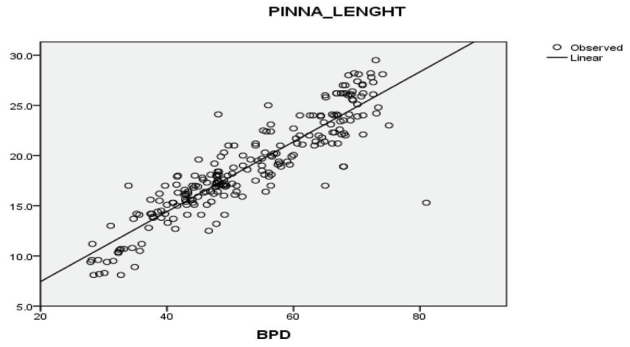
The regression formula for the fetal pinna length was constructed and is represented by:—

Pinna Length – Y= -7.235+ (1.183 X Gestational Age)

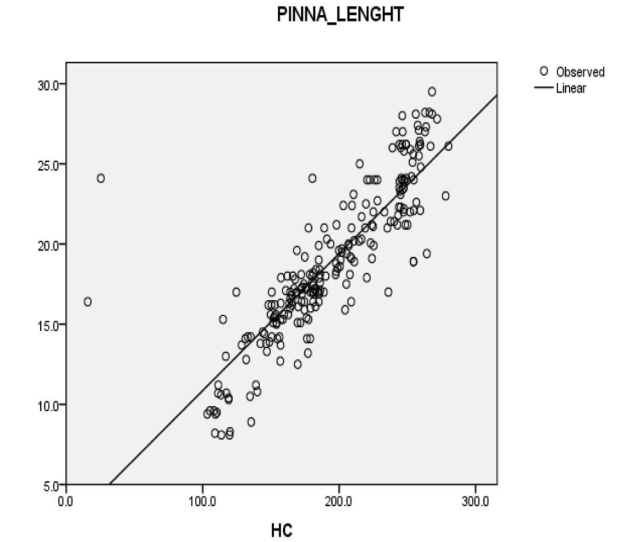
Pinna Length – Y= 0.478 + (0.348 X BPD)



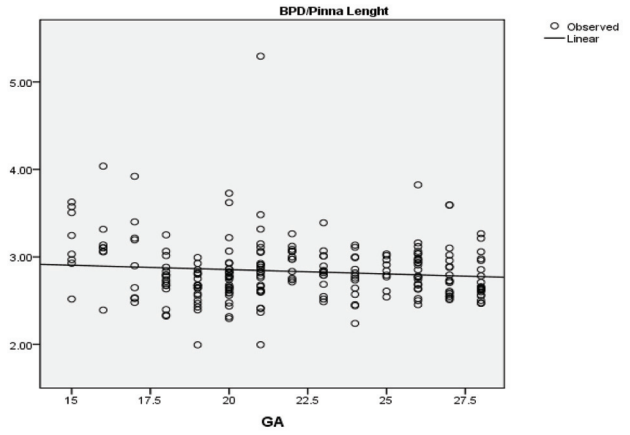
[Table/Fig-5]: The scatter diagrams show the linear relationship of the fetal pinna length with the gestational age.



[Table/Fig-6]: The scatter diagrams show the linear relationship of the pinna length with the BPD.



[Table/Fig-7]: The scatter diagram showing the linear relationship of the pinna length with the head circumference.



[Table/Fig-8]: The scatter diagram showing the relationship of the BPD/pinna length with the head circumference.

Pinna Length – Y= 2.311+ (0.086 X HC)

The nomogram for the fetal pinna length was constructed with varying percentiles starting from the 15th weeks of gestational age upto the 28th weeks of gestation, the duration in which the fetal morphology assessment is mostly done. [Table/Fig-9] depicts the various nomogram with various percentile distributions.

DISCUSSION

Assessment of fetal morphology for detection of any fetal anomaly is routinely done around the 18-22 weeks. In 11-13 weeks NT scan done for assessment of the Nuchal translucency and nasal bone for early prediction of fetal aneuploidy [9]. During NT scan early fetal morphology assessment is done to rule out any anomalies. There are many fetal morphology variations, or ultrasound markers denoting the fetal aneuploidy. The increased Nuchal translucency and nasal bone assessment in the 1st trimester and many soft markers like increased Nuchal fold thickness, intra-cardiac echogenic focus echogenic bowel, pyelectasis etc are the markers assessed in the 2nd trimester for the aneuploidy assessment. With these markers the aneuploidy is suspected and further confirmation is by chorionic villous biopsy and amniocentesis. But both the CVS and the amniocentesis as they are invasive in nature are having complications .So by increasing the various markers for the fetal aneuploidy assessment the indication for the invasive procedures like the CVS and amniocentesis can be reduced. There are many studies proposing the fetal ear length as the marker of the fetal aneuploidy [10]. The ultrasound screening of external ear can be used as one of the indicators of prenatal diagnosis of fetal chromosomal abnormalities. The small ears in case of fetal aneuploidies need not be only due to small fetal size and the ears are disproportionately small for the fetal size. Also there are studies which have evaluated the presence of abnormal ear morphology in fetal aneuploidy [11]. This can be used as criteria for using ear length as a marker for aneuploidy. Ear abnormalities are seen in many syndromes related to chromosomal abnormalities.

For those women who at high risk like elderly primi, women with previous sibling affected by chromosomal abnormalities it is beneficial to add fetal pinna length as marker with other markers for detection of aneuploidy which increases the sensitivity [4].

Study was done by Sacchani et al., to evaluate the fetal ear

Gestational Age (Weeks)	(n) Number of fetuses	Percentile distribution						
		5	10	25	50	75	90	95
15	8	8.1	8.1	8.225	9.4	9.6	11.2	11.2
16	8	8.1	8.1	9.7	10.5	10.7	13	13
17	9	8.9	8.9	10.65	12.8	14.15	14.2	14.2
18	17	12.7	13.18	13.85	14.4	15.35	17.18	17.9
19	22	13.91	15.1	15.575	16.2	16.4	17.07	17.865
20	30	12.885	14.2	16.4	17.15	17.85	19.09	19.735
21	26	14.52	15.37	16.775	17.15	18.4	21	23.015
22	12	15.9	16.23	17.625	18.2	18.9	19.54	19.6
23	14	16.4	17.6	18.975	19.6	20.45	22.4	22.4
24	14	17.9	18.5	20.02	21	22.55	24.05	25
25	9	21	21	21.15	22	24	24	24
26	24	17.6	20.3	21.85	23.4	24.075	26	27.5
27	18	18.9	18.9	23.475	25.55	26.2	27	27
28	21	22.1	22.2	24.45	26.4	27.95	28.2	29.37

[Table/Fig-9]: Table showing nomogram with various percentile distributions.

length at 11-14 weeks in trisoamy 21 fetuses [2]. They have concluded that there is reduced fetal ear length in trisomies, and the shortening of ear length is independent of the other characteristics of the trisomy, like nuchal translucency and the nasal bone. However, the degree of deviation from the normal in trisomies is too small to consider this parameter for screening of trisomies.

In 2002 another study done by Chitkara U et al., to determine the usefulness of short ear in the chromosomal abnormalities in the 2nd and 3rd trimester. They have concluded that the there is increased Biparietal diameter/ear length ration and short ear length in the chromosomal abnormalities. But the short ear length is having higher positive predictive value for screening of chromosomal abnormalities [4]. So in our study we have included the 2nd and 3rd trimester gestation for determining the fetal ear length nomogram.

There is a linear relationship between the pinna length and the gestational age, biparietal diameter and the head circumference. With increase in the gestational age, BPD and HC there is increased fetal pinna length. The same has been observed in the other studies which reinforces our finding [5, 6,10]

Study similar to ours done by Shimizu et al., they have done the study in the gestational period of 18 to 42 weeks and deduced the nomogram for the fetal ear length [1]. They have also concluded that there is linear relationship between the ear length and the gestational age of the fetus. In the study done by Lami Yeo et al., they have prospectively deduced the nomogram of the fetal ear in the gestational age group of 14 to 41 weeks gestation [10]. Also they have evaluated the fetal ear length in 93 aneuploid fetuses. They have concluded that the ear length will be significantly smaller in the aneuploid fetuses, and this smaller ear length is not just due to smaller aneupolid fetuses and the ear length will be disproportionately smaller as compared to the fetal biometric values.

The studies have been done to determine the fetal pinna length nomogram in the Turkish population and in Nepal of Indian sub-continent [5,6]. There are studies done using 3D ultrasound evaluating the fetal pinna length [12,13]. According our knowledge no study has been done in South Indian population to deduce the fetal pinna nomogram. We have compared the nomogram constructed for the Turkish population [5] and the for the population of Nepal [6] with our study and we found there is no significant difference in the nomogram of these.

LIMITATIONS

Although we have obtained the fetal pinna length nomogram we feel study with larger sample size and prospective karyotyping will be more useful. We have evaluated only the length of the pinna in our study, though evaluating the three dimensional measurements in our study could have added more precision.

CONCLUSION

Our study deduces the nomogram of the fetal pinna length. We could find a linear relationship between the pinna length and the gestational age, which suggested that with increased gestational age there is increased pinna length. There is no significant difference of pinna length as compared to the studies done on the other populations.

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