

Ultrasound Evaluation of Foetal Nasal Bone and Maxillary Bone Length in the Second and Third Trimester

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ABSTRACT

Introduction: Genetic diseases are the major causes of perinatal death and childhood disabilities. Foetus with a genetic disease have either major structural malformation or minor abnormalities (known as markers) that are detected during sonographic examination. Antenatal ultrasonography now permits the measurement of numerous parts of the fetal body, and nomograms have been developed that help to distinguish normal from abnormal foetal biometry.

Aim: 1) To define a nomogram for nasal and maxillary bone length in the local population of Salem. 2) To assess the correlation between nasal bone and maxillary bone length with bi-parietal diameter, Head Circumference (HC), Abdominal Circumference (AC) and Femur Length (FL).

Materials and Methods: The present study was a prospective, cross-sectional study conducted in Department of Radiodiagnosis, Vinayaka Missions Medical College, Salem Tamil Nadu, India. Study was conducted for period of one year from September 2012-September 2013. A total of 250 patients with routine antenatal check-up scan were included in the study. Measurement of Bi-Parietal Diameter (BPD), HC, AC, FL, NBL, MBL with 5th, 50th and 95th percentiles of each parameter was

calculated. Pearson's correlation coefficients were calculated to examine the strength of the linear relationship between the nasal and maxillary bone with gestational age, BPD, HC, AC, and FL. For each parameter, regression analysis was used as a dependent variable to calculate the equation of the linear fitted function with each of the independent variables.

Results: The maternal age ranged from 17 years to 37 years. The gestational age by Last Menstrual Period (LMP) ranged from 12 weeks to 40 weeks. The mean nasal bone length increased linearly with gestational age from 2.9 mm at 12 weeks to 13.1 mm at 40 weeks. The mean maxillary bone length increased linearly with gestational age from 8.7 mm at 12 weeks to 15.6 mm at 40 weeks. Significant statistical correlation was found between nasal and maxillary bone length and BPD, HC, AC and FL.

Conclusion: Normative data for ultrasonographic measurements of the foetal nasal and maxillary bone lengths throughout pregnancy are provided for the local population of Salem Tamil Nadu, India. These data potentially allow the prenatal diagnosis of abnormal nasal and maxillary bone length which is a marker for chromosomal defects.

Keywords: Chromosomal defects, Genetic markers, Nasal bone

INTRODUCTION

Chromosomal abnormalities are the leading cause of pregnancy loss [1]. Aneuploid foetus accounts for approximately 6-11% of all the stillbirths and intra-uterine deaths [2]. First-trimester screening for Down's syndrome includes maternal serum biochemistry, measurement of nuchal translucency thickness and evaluation of the foetal nasal bone [3-5]. Facial dysmorphism is one of the most common features seen in many genetic syndromes. A small nose was a common characteristic in patients with trisomy 21 [6]. The presence or absence of the foetal nasal bone on prenatal ultrasound has been shown to be useful in screening for Down syndrome and other aneuploidies [7]. The nasal bone length varies in second trimester fetuses according to race and ethnicity [8]. A short maxillary length is related to choanal atresia, Marfan syndrome and trisomy 21 [9]. Individuals with trisomy 21 show a flat face as a consequence of underdevelopment of the maxilla. Several studies have attempted to establish the normative data of nasal [10-14] and maxillary lengths [15]. However, variations in facial measurements exist among different populations. There is no nomogram established in the local population of Salem. Hence, the present study was done, to define a nomogram for fetal nasal and maxillary bone length between 12 and 40 weeks of gestation. And to assess the correlation between nasal bone and maxillary bone length with bi-parietal diameter, head circumference, abdominal circumference and femur length.

MATERIALS AND METHODS

It was a prospective, cross-sectional study conducted in Department of Radiodiagnosis, Vinayaka Missions Medical College, Salem Tamil Nadu, India. Study was conducted for a period of one year from September 2012-September 2013. A total of 250 patients with routine antenatal check-up scan were included in the present study that fulfilled the inclusion and exclusion criteria. Institutional Ethical Committee Clearance was obtained for the study (IRB number: 2023). The details of each patient were entered in PCPNDT form and informed consent was obtained from every subject. Gestational age was assessed by menstrual history (last menstrual period) and in conjunction with BPD, HC, AC, and FL measured using pre-installed Hadlock obstetrics software in the machines.

Inclusion criteria: Cases with known last menstrual period, gestational age between 12 and 40 weeks and singleton pregnancy were included.

Exclusion criteria: Patients with multiple pregnancies, severe oligohydramnios, pregnancy-related complications such as pre-eclampsia, gestational diabetes, intrauterine growth retardation, those fetuses with suspected anomalies were excluded from the study.

Scanning Protocol

Curvilinear probe of 3.5 MHz of two GE ultrasound machines with similar pre-installed biometry software was used for the study. After completion of the measurement of the BPD, HC, AC and

FL, identification and measurement of the nasal and maxillary bones were done. The plane of the nasal bone was strictly done in the median midsagittal plane of foetal face [Table/Fig-1]. Care was taken to keep the angle of insonation close to 45° to 135°. After the identification of the correct plane, three independent measurements were obtained and averaged to obtain the final measurement. From the midsagittal view, the probe was slightly moved posteriorly to visualise the maxillary bone which is rod-shaped [Table/Fig-2]. Similar to the nasal bone, three measurements of the maxillary bone were taken and averaged to obtain the final measurement. The scan was done by a single observer, to eliminate interobserver variation.



[Table/Fig-1]: Plane of measurement of nasal bone.



[Table/Fig-2]: Plane of measurement of maxillary bone length.

STATISTICAL ANALYSIS

Following data collection, statistical analysis was performed using Stats Direct Statistical software (version 2.7.8). The 5th, 50th and 95th percentiles of each parameter were described for each gestational age. Pearson's correlation coefficients were calculated to examine the strength of the linear relationship between the nasal and maxillary bone with gestational age, BPD, HC, AC, and FL. For each parameter, regression analysis was used as a dependent variable to calculate the equation of the linear fitted function with each of the independent variables.

RESULTS

In 250 cases, the maternal age ranged from 17 years to 37 years (24.20±4.15 years). The gestational age by LMP ranged from 12 weeks to 40 weeks. The mean nasal bone length increased linearly with gestational age from 2.9 mm at 12 weeks to 13.1 mm at 40 weeks. Nomograms for nasal and maxillary bone lengths were tabulated. The mean maxillary bone length increased linearly with gestational age from 8.7 mm at 12 weeks to 15.6 mm at 40 weeks [Table/Fig-3]. Both NBL and MBL increased linearly with increasing gestational age. According to Pearson's correlation, they were found to have significant positive correlation with gestational age, BPD, HC, AC and FL [Table/Fig-4,5].

The ratios of nasal bone length and maxillary bone length with BPD, HC and AC, FL remained virtually constant throughout the gestation [Table/Fig-6,7].

Gestational age (Weeks)	Nasal bone length (Mm)			Maxillary bone length (Mm)		
	5%	50%	95%	5%	50%	95%
12-13	2.5	2.9	3.3	7.7	8.7	9.7
14-15	4.0	4.2	4.4	9.9	10.1	10.3
16-17	4.7	5.5	6.3	10.4	10.6	10.8
18-19	6.1	6.3	6.5	11.0	11.2	11.4
20-21	6.6	6.8	7.0	11.4	11.6	11.8
22-23	7.2	7.4	7.6	11.2	11.4	11.6
24-25	8.2	8.6	9.0	11.9	12.1	12.3
26-27	8.9	9.1	9.3	12.7	13.1	13.5
28-29	9.5	9.7	9.9	13.4	13.8	14.2
30-31	10.2	10.4	10.6	12.8	13.2	13.6
32-33	9.5	10.3	11.1	12.5	13.7	14.9
34-35	10.4	10.8	11.2	14.2	14.6	15.0
36-37	10.9	11.1	11.3	13.4	14.8	16.2
38-39	11.6	12.0	12.4	15.1	15.3	15.5
40	12.9	13.1	13.3	15.4	15.6	15.8

[Table/Fig-3]: Nomogram.

Gestational age	1.158-0.011×Gestational age (r=0.989; p<0.0001)
BPD	0.053+0.124×BPD (r=0.989; p<.0001)
HC	0.035+0.0365×HC (r=0.989; p<.0001)
AC	0.033+0.154×AC (r=0.986; p<.0001)
FL	0.209+0.137×FL (r=0.982; p<.0001)

[Table/Fig-4]: Regression equation for NBL.

Gestational age	1.4742-0.0075×Gestational age (r=0.989; p<.0001)
BPD	0.699+0.088×BPD (r=0.989; p<.0001)
HC	0.688+0.0252×HC (r=0.963; p<.0001)
AC	0.769+0.0234×AC (r=0.966; p<.0001)
FL	y=0.807+0.097×FL (r=0.947; p<.0001)

[Table/Fig-5]: Regression equation for MBL.

GA	NBL						
	Total Number of Cases	50 th % (mm)	SD	NBL/BPD	NBL/HC	NBL/AC	NBL/FL
12-13	10	2.9	0.2	0.13	0.03	0.04	0.19
14-15	14	4.2	0.1	0.14	0.03	0.04	0.22
16-17	17	5.5	0.4	0.14	0.04	0.04	0.21
18-19	15	6.3	0.1	0.14	0.03	0.04	0.21
20-21	17	6.8	0.1	0.13	0.03	0.04	0.19
22-23	33	7.4	0.1	0.12	0.03	0.04	0.19
24-25	28	8.6	0.2	0.13	0.03	0.04	0.18
26-27	19	9.1	0.1	0.13	0.03	0.04	0.18
28-29	15	9.7	0.1	0.13	0.03	0.03	0.17
30-31	10	10.4	0.1	0.13	0.03	0.04	0.17
32-33	18	10.3	0.4	0.12	0.03	0.03	0.16
34-35	22	10.8	0.2	0.12	0.03	0.03	0.16
36-37	20	11.1	0.1	0.12	0.03	0.03	0.16
38-39	7	12.0	0.2	0.13	0.03	0.03	0.16
40	5	13.1	0.1	0.14	0.04	0.03	0.14

[Table/Fig-6]: Ratio for nasal bone length.

DISCUSSION

The second-trimester sonographic screening for Down syndrome is based on morphologic and biometric parameters, like nuchal fold thickening, hyperechoic bowel, pyelectasis, short humerus and femur. The importance of absent nasal bone or shorter nasal bone length for

GA	MBL						
	Total Number of Cases	50 th % (mm)	SD	MBL/BPD	MBL/HC	MBL/AC	MBL/FL
12-13	10	8.7	0.5	0.40	0.11	0.13	0.58
14-15	14	10.1	0.1	0.34	0.09	0.11	0.53
16-17	17	10.6	0.1	0.28	0.07	0.09	0.45
18-19	15	11.2	0.1	0.25	0.06	0.08	0.37
20-21	17	11.6	0.1	0.22	0.06	0.07	0.33
22-23	33	11.4	0.1	0.19	0.05	0.06	0.30
24-25	28	12.1	0.1	0.18	0.05	0.06	0.26
26-27	19	13.1	0.2	0.19	0.05	0.06	0.26
28-29	15	13.8	0.2	0.18	0.05	0.05	0.25
30-31	10	13.2	0.2	0.17	0.03	0.04	0.22
32-33	18	13.7	0.6	0.16	0.04	0.04	0.21
34-35	22	14.6	0.2	0.17	0.04	0.05	0.23
36-37	20	14.8	0.7	0.16	0.04	0.04	0.21
38-39	7	15.3	0.1	0.17	0.04	0.04	0.21
40	5	15.6	0.1	0.17	0.04	0.04	0.21

[Table/Fig-7]: Ratio for maxillary bone length.

gestation age was observed in fetuses with Down syndrome [7,8]. Nomogram is most essential to differentiate normal from abnormal parameter in any population. A few studies have assessed the foetal nasal bone lengths at different gestational age [Table/Fig-8] [10-14]. Sonek JD et al., had studied the normal range of nasal bone length in 11th to 40th week gestations in 3537 patients which ranged from 2.3 mm to 12.1 mm in length [10]. In the present study, the nasal bone was evaluated from 12 to 40 weeks gestation and was 2.9 mm at 12 to 13 weeks and 13.1 mm at 40 weeks. In a previous study by Cicero S et al., the absence or hypoplasia (defined as 2.5 mm) of the foetal nasal bone was the single most sensitive and specific second-trimester marker for Down syndrome, with a detection rate of 61.8% and a false positive rate of only 1.2% [7]. In comparison with the studies done in the Indian population [13,14], the nasal bone measurements in the present study were slightly higher.

	Gestational age included in the study (weeks)	Total number of patients studies	Range of nasal bone length (mm)
This study	12-40	250	2.9-13.1
Sonek JD et al., [10]	11-40	3537	2.3-12.1
Persico N et al., [11]	16-24	135	4.1-7.1
Gamez F et al., [12]	19-22	2035	6.19-6.77
Narayani BH et al., [13]	16-26	2962	3.3-6.65
Kashikar SV et al., [14]	17-22	486	3.7-7.0

[Table/Fig-8]: Comparison with other studies on nasal bone [10-14].

Goldstein I et al., evaluated maxillary bone lengths throughout gestation between 13 to 40 weeks [15]. The maxillary bone length at 50th percentile was 10 mm at 14 weeks. The mean range of maxillary bone length was 9.97 mm to 14.84 at 14-40 gestational weeks. In the present study, the maxillary bone was 10.1 mm at 14 weeks and 15.6 mm at 40 weeks. In comparison, the maxillary

bone length was similar to 14-34 weeks gestational age and present study showed a higher MBL from 34-40 weeks.

The ratio of NBL/FL at 40 weeks GA was skewed and so was the ratios between the MBL and BPD, HC, AC and FL in the early second-trimester. This was probably attributed to the less of number of cases in the group.

LIMITATION

The present study included a small group of patients and was confined to one group population. A large population and a multicentric study in the Indian population to assess the sensitivity and specificity when using our normal reference range as cut-off values are required.

CONCLUSION

Normative data for ultrasonographic measurements of the foetal nasal and maxillary bone lengths throughout pregnancy are provided. Both nasal and maxillary bone length are dependent variables of gestational age as determined by the last menstrual period. There was significant correlation with biparietal diameter, head circumference, abdominal circumference and femoral length. These data potentially allow the prenatal diagnosis of abnormal nasal and maxillary bone length which is a marker for chromosomal defects.

REFERENCES

- Alberman ED, Creasy MR. Frequency of chromosomal abnormalities in miscarriages and perinatal deaths. *Journal of Medical Genetics*. 1977;14(5):313-15.
- Kurinczuk JJ, Hollowell J, Boyd PA, Oakley L, Brocklehurst P, Gray R. Inequalities in infant mortality project briefing paper 4. The contribution of congenital anomalies to infant mortality. Oxford: National Perinatal Epidemiology Unit, 2010.
- Spencer K. Accuracy of Down syndrome risks produced in a first-trimester screening programme incorporating fetal nuchal translucency thickness and maternal serum biochemistry. *Prenatal Diagnosis*. 2002;22(3):244-46.
- Thilaganathan B, Sairam S, Michailidis G, Wathen NC. First trimester nuchal translucency: effective routine screening for Down's syndrome. *Br J Radiol*. 1999;72(862):946-48.
- Nirmala S, Palanisamy V. Measurement of nuchal translucency thickness for detection of chromosomal abnormalities using first trimester ultrasound fetal images. (*IJCSIS*) *International Journal of Computer Science and Information Security*. 2009;6(3):101-06.
- ConorWard O. John Langdon Down: The man and the message, ISSN: 0968-7912 1999;6:1.
- Cicero S, Longo D, Rembouskos G, Sacchini C, Nicolaidis K. H. Absent nasal bone at 11-14 weeks of gestation and chromosomal defects. *Ultrasound Obstet Gynecol*. 2003;22:31-35.
- Zelop CM, Milewski E, Brault K, Benn P, Borgida AF, Egan JF. Variation of fetal nasal bone length in second-trimester fetuses according to race and ethnicity. *J Ultrasound Med*. 2005;24:1487-89.
- Cicero S, Curcio P, Rembouskos G, Sone KJ, Nicolaidis KH. Maxillary length at 11-14 weeks of gestation in fetuses with trisomy 21. *Ultrasound Obstet Gynecol*. 2004;24:19-22.
- Sonek JD, McKenna D, Webb D, Croom C, Nicolaidis K. Nasal bone length throughout gestation: normal ranges based on 3537 fetal ultrasound measurements. *Ultrasound Obstet Gynecol*. 2003;21:152-55.
- Persico N, Molina F, Borenstein M, Azumendi G, Nicolaidis KH. Nasal-bone length in euploid fetuses at 16-24 weeks' gestation by three-dimensional ultrasound. *Ultrasound Obstet Gynecol*. 2010;36(3):285-90.
- Gamez F, Ferreiro P, Salmean JM. Ultrasonographic measurement of fetal nasal bone in a low-risk population at 19-22 gestational weeks. *Ultrasound Obstet Gynecol*. 2004;23(2):152-53.
- Narayani BH, Radhakrishnan P. Mid-second trimester measurement of nasal bone length in the Indian population. *J Obstet Gynaecol of India*. 2013;63(4):256-59.
- Kashikar SV, Lakhkar BN. Assessment of fetal nasal bone length and nasofrontal angle in the second trimester in normal Indian pregnancies. *J Fetal Med*. 2014;1(3):137-41.
- Goldstein I, Reiss A, Rajamim BS, Tamir A. Nomogram of maxillary bone length in normal pregnancies. *J Ultrasound Med*. 2005;24(9):1229-33.

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Date of Submission: **Aug 20, 2018**

Date of Peer Review: **Sep 01, 2018**

Date of Acceptance: **Nov 02, 2018**

Date of Publishing: **Dec 01, 2018**

FINANCIAL OR OTHER COMPETING INTERESTS: None.