
OBSTETRICS

Nomogram of Thai Fetal Maxillary Bone Length at 11-13⁺⁶ Weeks of Gestation

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ABSTRACT

Objectives: To evaluate fetal maxillary bone length during 11-13⁺⁶ weeks of gestation in Thai population.

Material and Method: Thai women with singleton pregnancy between 11-13⁺⁶ weeks of gestation were enrolled. Fetal crown-rump length (CRL), and maxillary bone length (MAX) were measured. A nomogram of MAX was derived. The best fit equations between MAX and CRL, MAX and gestational age (GA) were constructed. The equations were compared with other reported.

Results: A total of 186 Thai pregnant women were recruited. The mean gestational age was 12⁺³ weeks (SD= 6 days). Curve estimation analysis demonstrated a linear relationship between MAX and CRL and GA. A comparison of MAX using the equation derived from a Thai population and the equation derived from a Chinese population demonstrated a significant difference between the two ethnicities ($p < 0.001$).

Conclusion: The nomogram of fetal MAX in the first trimester in Thai population was constructed. The fetal MAX in a Thai population appears to be different from Chinese population.

Keyword: First trimester, Maxillary bone length, Ultrasound

Introduction

Ultrasonographic assessment of fetal facial structures has recently become a part of routine anatomic surveys⁽¹⁾. Imaging of the maxillary bone is now possible with high resolution ultrasound machines. This measurement is important because deviation of the maxillary bone growth may be associated with malformation of the fetal face and feeding problems after birth⁽²⁾. Some syndromes, such as Angelman syndrome, Apert syndrome and Crouzon syndrome; are associated with the maxillary bone hypoplasia⁽³⁾.

Langdon Down observed that in individuals with trisomy 21 'the face is flat and broad'. This facial characteristic might be the consequence of underdeveloped maxillary bones⁽⁴⁾. Anthropometric and radiological studies have demonstrated that the maxillary bones are smaller than normal in patients with Down syndrome⁽⁵⁻¹¹⁾.

Maxillary bone length (MAX) can be measured during first trimester ultrasound examination, and is significantly shorter among fetuses with trisomy 21⁽¹²⁾. Short maxilla is a potentially useful first trimester marker for trisomy 21. It is not clear if there is any variation of

fetal MAX between different ethnic groups, as clearly observed in fetal nasal bone assessment⁽¹³⁾. The aim of this study was to evaluate the fetal maxillary bone lengths during 11-13⁺⁶ weeks of gestation in Thai population.

Materials and Methods

The study population included Thai singleton pregnant women at 11-13⁺⁶ weeks of gestation attending the antenatal care clinic between June 2010 and February 2011 at King Chulalongkorn Memorial Hospital. This study was approved by The Ethic Committee of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand (IRB number 030/53). Gestational age (GA) was calculated from the last menstrual period, and was confirmed by first trimester crown-rump length (CRL) measurement. After informed consent was obtained, basic data were recorded. A transabdominal ultrasound examination was performed to measure fetal CRL, and fetal MAX. Ultrasound machines used in this study were, Voluson E8 (with a curvilinear RAB 2-7D probe), Voluson 730 Expert or Voluson 730 Pro (with a curvilinear RAB 4-8D probe (GE Medical Systems, USA).

The MAX was measured by one sonographer (SC) using the method described by Cicero et al⁽¹²⁾. Firstly; a mid-sagittal view of the fetal profile was obtained. The transducer was then gently angled laterally so that both of the maxillary bone and mandible, including the ramus and condylar process, could be seen. The image was magnified so that the fetal head and upper thorax occupied the whole screen, and each increment in the distance between calipers was only 0.1 mm. Maxillary bone length was measured by placing the calipers on middle of anterior border of maxillary bone through middle of posterior border, the ramus and condylar process of the mandible were excluded (Fig. 1). The image were obtained twice for each case, the larger MAX is used for analysis. Patients were excluded if: (1) maxillary bone length can not be measured, (2) fetal death, (3) fetal structural anomaly or abnormal chromosome, and (4) pregnancy outcome cannot be followed.

Mean and standard deviation (SD) as well as the 5th, 50th, 95th percentiles of maxillary bone length were described for each gestational age. Best fit equations were constructed and were compared with the equations from other populations.

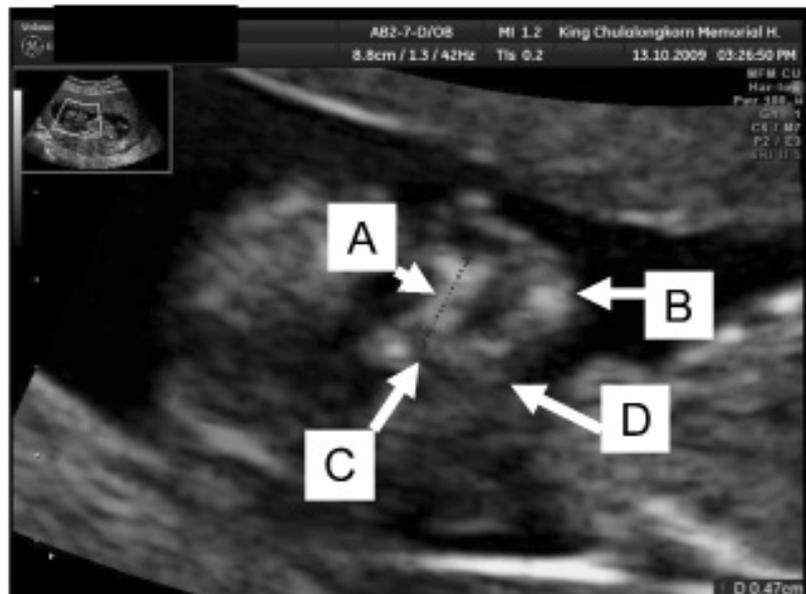


Fig. 1. Ultrasound image of an 11⁺⁶ week fetus demonstrating how maxillary bone length was measured. A, maxilla; B, mandible; C, condylar process; D, ramus.

Results

During the study period, one hundred eighty-six pregnant women between 11-13⁺⁶ weeks of gestation were enrolled. The mean gestational age was 12⁺³ weeks (SD = 6 days). MAX can be measured in all cases. A linear growth function was observed across gestational age. Curve estimation analysis showed a linear relationship between MAX and CRL (Equation 1, Fig. 2). A linear relationship also provided the best fit between MAX and GA (Equation 2, Fig. 3). Regarding to accuracy of measurements, the intraobserver

variability, intraclass correlation coefficient was 0.966 (95% CI, 0.951 to 0.976). Table 1 depicts nomograms of the maxillary bone length.

Equation 1

$$\text{MAX (mm)} = -1.3 + 0.103 \cdot \text{CRL (mm)}$$

(r = 0.765; SD=0.97; p <0.0001)

Equation 2

$$\text{MAX (mm)} = -10.954 + 0.182 \cdot \text{GA (day)}$$

(r = 0.745; SD=0.92; p <0.0001)

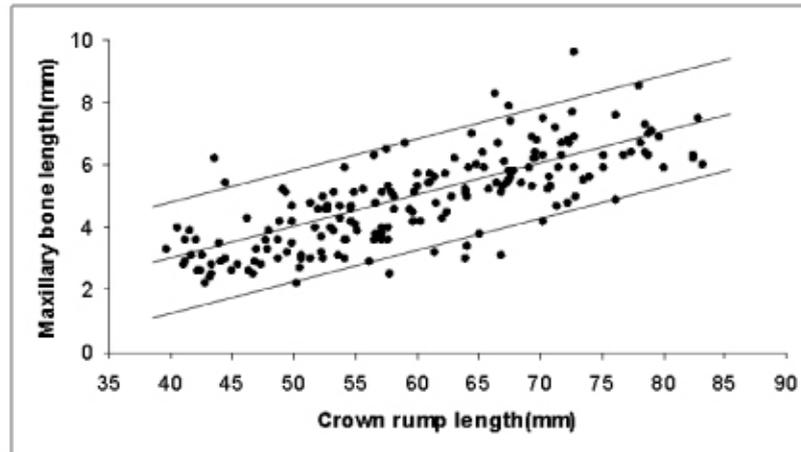


Fig. 2. Relationship between fetal maxillary bone length and crown-rump length in normal fetuses between 11 and 13⁺⁶ weeks of gestation. The middle line represents the regression mean while the upper and lower lines represent 95th and 5th percentiles

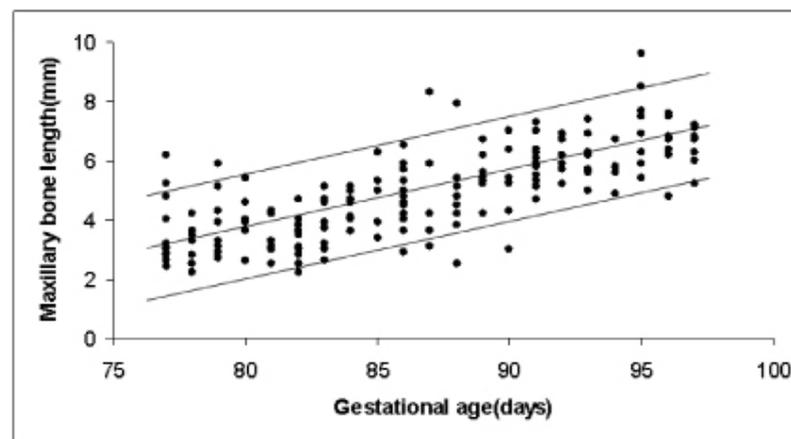


Fig. 3. Gestational-specific nomogram of maxillary bone length in normal fetuses between 11 and 13⁺⁶ weeks of gestation. The middle line represents the regression mean while the upper and lower lines represent the 95th and 5th percentiles

Table 1. Fetal maxillary bone length in Thai population.

GA (weeks)	N	Maxillary bone length (mm)				
		Percentile			Mean	SD
		5 th	50 th	95 th		
11	66	2.4	3.3	5.1	3.3	0.89
12	57	3.0	4.8	7.1	4.8	1.17
13	63	4.9	6.2	7.7	6.2	0.93

GA=Gestational age, N=Number, mm=Millimeters, SD=Standard deviation

Table 2. Comparison of best fit equations of fetal MAX in different populations.

Authors	Population	Study Outcome	r	SD
Cicero et al. ⁽¹²⁾	Caucasian	MAX = 0.708+0.090*CRL(mm)	0.784	-
Leung et al. ⁽¹⁵⁾	Chinese	MAX = -0.01+0.101*CRL(mm)	0.826	0.56
Sivri et al. ⁽¹⁶⁾	Turkish	MAX = 2.328+0.068*CRL(mm)	0.662	-
The present study	Thai	MAX = -1.3+0.103*CRL(mm)	0.765	0.97

MAX : Fetal maxillary bone length; SD : Standard deviation

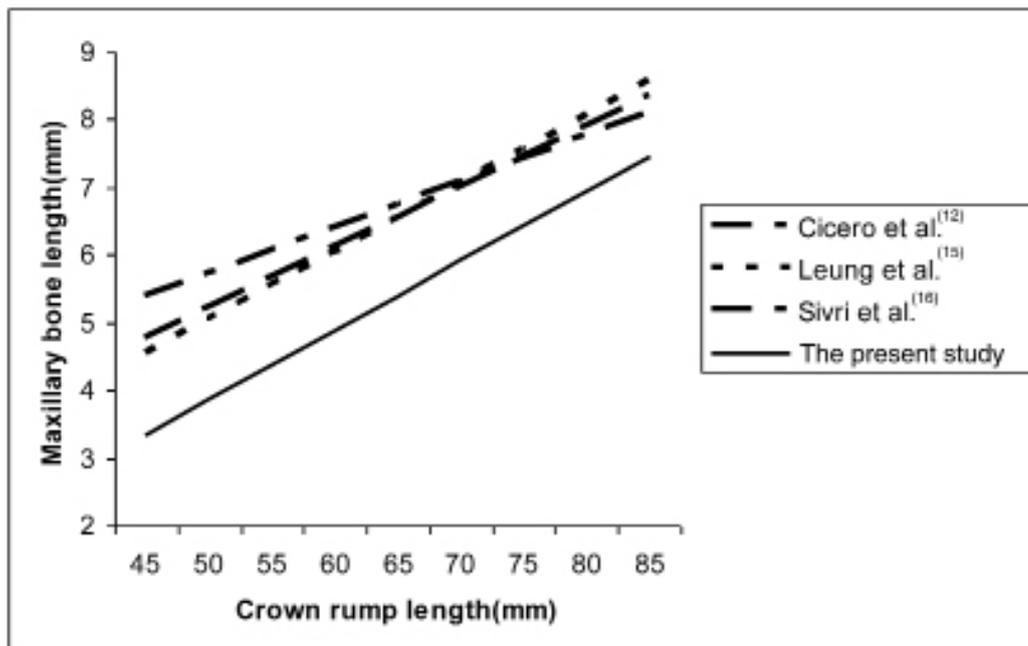


Fig. 4. Comparison between the regression lines derived from Thai population (solid line) in the present study and that by Cicero et al. (long dash), Leung et al. (dash), and Sivri et al. (dash dot)

Discussion

The maxillary bone is an important part of the facial bony structure that plays an important role in the formation of the facial architecture⁽¹⁴⁾. High resolution ultrasonography allowed the detailed assessment of the maxillary bone as early as the first trimester, and measurement of the MAX is possible at 11-13⁺⁶ weeks of gestation. In this study, the nomogram of first trimester maxillary bone length in a Thai population was constructed. A linear growth of maxillary bone length was demonstrated, which was in agreement with other studies^(12,15,16).

Nasal bone length has been observed to be different among ethnic groups⁽¹³⁾, but there is no clear evidence whether there is any variation of the fetal MAX between different ethnicities. We compared our data with the data from previous studies. Comparison between the regression equation from our study and previous studies was summarized in Table 2. All studies were measured with the same methodology. The data from our study was plotted along with data from the Caucasian, Turkish, and Chinese populations (Fig. 4). A comparison between the MAX in this study (Thai population) and a Chinese population⁽¹⁵⁾ was performed using the t-test. A significant difference between the two ethnicities was found ($p < 0.001$). Our study demonstrated that the MAX is significantly shorter during first trimester in the Thai population comparing with the Chinese population. Unfortunately, the standard deviation were not provided in the studies from the Caucasian and Turkish population^(12,16). So, statistical comparison cannot be performed.

In conclusion, the nomogram of maxillary bone length in a Thai population was constructed. It will be helpful for the diagnosis of hypoplasia of the maxillary bone during the first trimester of pregnancy. In a Thai population, the maxillary bone length during the first trimester is significantly different from the Chinese population.

Acknowledgment

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Chulalongkorn University, Bangkok, Thailand. The authors declare that they have no conflicts of interest.

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ค่าความยาวมาตรฐานกระดูกแมกซิลลาของทารกชาวไทยในช่วงอายุครรภ์ 11 ถึง 13⁺6 สัปดาห์

สุกัญญา ไชยราช, ศักนัน มะโนทัย.

วัตถุประสงค์ : เพื่อศึกษาค่าความยาวมาตรฐานกระดูกแมกซิลลาของทารกในช่วงอายุครรภ์ 11 – 13⁺6 สัปดาห์ ในสตรีตั้งครรภ์ชาวไทย

วัสดุและวิธีการ : ทำการตรวจคลื่นเสียงความถี่สูงในระบบสองมิติสตรีตั้งครรภ์ชาวไทยที่มีอายุครรภ์ระหว่าง 11⁺0-13⁺6 สัปดาห์ ที่มาฝากครรภ์ ณ โรงพยาบาลจุฬาลงกรณ์ ในช่วง 10 มิถุนายน พ.ศ.2553 จนถึง 28 กุมภาพันธ์ พ.ศ.2554 จำนวน 186 ราย โดยประเมินการมีชีวิตของทารกในครรภ์ วัด Crown-rump length (CRL) วัด Maxillary bone length (MAX) นำค่าที่ได้มาหาค่ามาตรฐานของกระดูกแมกซิลลา โดยคิดเป็นค่าเฉลี่ยส่วนเบี่ยงเบนมาตรฐาน และ 5th, 50th, 95th percentile ของความยาวกระดูกแมกซิลลาในแต่ละอายุครรภ์ (11, 12 และ 13 สัปดาห์) หาสมการความสัมพันธ์ระหว่างอายุครรภ์ที่เป็นวันกับ Maxillary bone length (MAX) และหาสมการความสัมพันธ์ระหว่าง Crown-rump length (CRL) กับ Maxillary bone length (MAX)

ผลการศึกษา : จากการศึกษาพบว่าสามารถวัดความยาวกระดูกแมกซิลลาของทารกในครรภ์ (Maxillary bone length) ได้ในทุกอายุครรภ์เฉลี่ยที่ทำการศึกษาเท่ากับ 12⁺6 สัปดาห์ (SD 6 วัน) ที่อายุครรภ์ 11 สัปดาห์ ค่าความยาวของกระดูกแมกซิลลาเปอร์เซ็นต์ไทล์ที่ 5, 50, 95 เท่ากับ 2.4, 3.3, 5.1 มิลลิเมตรตามลำดับ โดยมีส่วนเบี่ยงเบนมาตรฐานเท่ากับ 0.89 อายุครรภ์ 12 สัปดาห์ ค่าความยาวของกระดูกแมกซิลลาเปอร์เซ็นต์ไทล์ที่ 5, 50, 95 เท่ากับ 3.0, 4.8, 7.1 มิลลิเมตรตามลำดับ โดยมีส่วนเบี่ยงเบนมาตรฐานเท่ากับ 1.17 อายุครรภ์ 13 สัปดาห์ ค่าความยาวของกระดูกแมกซิลลาเปอร์เซ็นต์ไทล์ที่ 5, 50, 95 เท่ากับ 4.9, 6.2, 7.7 มิลลิเมตรตามลำดับ โดยมีส่วนเบี่ยงเบนมาตรฐานเท่ากับ 0.93 พบความสัมพันธ์ระหว่างกระดูกแมกซิลลา และอายุครรภ์ดังแสดงในสมการ MAX (mm) = -10.954+0.182*GA (day); r=0.745; SD 0.96; p<0.0001 พบความสัมพันธ์ระหว่างกระดูกแมกซิลลา และ Crown-Rump Length ดังแสดงในสมการ MAX (mm) = -1.3+0.103*CRL (mm); r=0.765; SD 0.97; p<0.0001

สรุป : ค่ามาตรฐานของความยาวกระดูกแมกซิลลาของทารกชาวไทยช่วงไตรมาสแรกของการตั้งครรภ์ อาจนำมาใช้ในการวินิจฉัยภาวะ maxillary hypoplasia ได้