



## ULTRASONOGRAPHIC EVALUATION OF MORPHOGENESIS OF CLAVICLE IN ANTENATAL WOMEN

### Radiology

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### ABSTRACT

Of all the long bones in the human skeleton, it is the clavicle which displays the longest period of growth— related activity. Its complex osteologic structure makes morphological analysis extremely difficult. Knowledge of measurements of fetal long bones is useful in both assessment of fetal growth and early detection of congenital defects. To date, very few reference studies were available on the assessment of clavicular length using imaging procedures.

The purpose of the present study was to observe the foetal clavicle length on ultrasonography during various weeks of gestational period and to study the relationship between foetal clavicle length with the other parameters like Biparietal diameter, Head circumference, Abdominal circumference, Femur length and Estimated fetal weight

This study was conducted among 40 antenatal mothers with well-established dates of 14 to 40 weeks of gestational age. After taking an informed verbal consent, ultrasound was performed by the radiologist. The results were tabulated and evaluated. Figures were also included. The measurement of clavicular length can be a useful parameter for the estimation of gestational age and in the detection of congenital anomalies that affect the clavicles.

### KEYWORDS

foetal clavicle length, gestational age, prenatal ultrasound

### INTRODUCTION:

Visualization of the foetus by ultrasound enables us to observe fetal growth from early gestation to term.<sup>1</sup> In recent years, fetal biometry has included head, body and long bone measurements. Fetal biometry is the measurement of the several parts of fetal anatomy and the time dependent changes in body dimensions that occur throughout the pregnancy.<sup>2</sup> The growth rate is rapid especially in the 1st and 2nd trimesters and it changes significantly with the advancement of pregnancy and must be evaluated against normal value at that age.

Fetal biometry can be carried out by two different kinds of studies: cross-sectional or longitudinal. For cross-sectional study, fetuses are examined only once during gestation. This type of study can be performed in a small period of time and the data is easier to collect and analyze statistically. The power of statistics that can be performed on cross-sectional data is suboptimal; they are susceptible to inclusion of fetuses with abnormal growth pattern or poorly established gestational age and may not give the desired information.

A longitudinal study, on the other hand, is one in which a small number of fetuses are investigated serially, at least thrice during the course of pregnancy. In this type of study, fetal age is established in early pregnancy, abnormal growth curves are easily diagnosed; and the statistics provide more relevant and stronger information changes significantly with an increase in the gestational age and must be evaluated against normal value at that age.<sup>3</sup>

A major advantage of fetal biometry is the prenatal diagnosis of various congenital anomalies. Although the growth of many fetal bones has been studied by several investigators, clavicular measurements across gestational age have been previously reported only by a few. Measurement of the clavicle is of special interest since it permits not only the estimation of gestational age, but also detection of severe congenital defects such as cleidocranial dysplasia, Holt-Oram syndrome, etc.<sup>4,5</sup>

### MATERIALS AND METHODS:

This study was conducted among 40 antenatal mothers with well-established dates (confirmed by early ultrasound, appropriate for gestational age) of 14 to 40 weeks gestation to study the foetal clavicle length on ultrasound at the Department of Radiology, Tertiary care hospital, Visakhapatnam. All the subjects had intact fetal membranes, normal amniotic fluid volume and were not in labour at the time of study.

Women of 18 -30 yrs age group, singleton pregnancy with known LMP and regular history of past menstrual cycle were included in the study. Any congenital anomalies of foetus were excluded from the study.

After obtaining informed consent from the subject, ultrasound was performed by the radiologist. Clavicular length was measured as follows: at axial sonographic scanning of the fetus, immediately cephalic to the level of the thoracic inlet, the clavicles with their overall characteristic curvature and configuration were identified.

Additional ultrasound measurements obtained include biparietal diameter (BPD), Abdominal circumference (AC), Head circumference (HC), Femur length (FL), Sonographically estimated fetal weight (SEFW).

### RESULTS:

**Table 1: Showing length of clavicle according to the gestational age**

Gestational age (weeks)	Subjects (n) (total n = 40)	Clavicle length (cm) Mean	Std. Deviation
14	1	0.77	---
15	1	1.16	---
16	2	1.45	.07
17	2	1.65	.07
18	3	1.92	.16
19	3	1.93	.17
20	2	2.18	.09
21	3	2.45	.25
22	3	2.50	.11
23	1	2.42	---
24	4	2.73	.17
25	3	2.81	.16
26	3	2.84	.47
27	2	2.65	.07
28	2	3.16	.04
30	2	3.65	.21
32	1	3.50	---
33	2	3.97	.11
34	1	4.00	---
35	1	4.10	---



**Figure 1: Ultrasound image depicting fetal clavicle at 17 weeks of gestation. (1.74 cm)**



**Figure 2: Ultrasound image depicting both fetal clavicles in one plane at 32 weeks of gestation.**

**DISCUSSION:**

The clavicle is one of the fetal bones demonstrating a linear growth pattern during intrauterine life. Therefore, fetal clavicular length measurement can be used as an additional parameter for estimation of gestational age.

Udoaka did Radiologic Evaluation of Clavicular Morphology in Southern Nigerians and observed that the sternal head of the males was significantly longer than the females ( $P < 0.001$ ) but the body and acromial head lengths were not.<sup>6</sup>

Haldar Arpan observed that OL/TL ratio of clavicle was found to be increasing significantly with increased gestational age. (Pearson Correlation Coefficient= 0.743 and  $P = 0.002$ ). OL/TL ratio of clavicle was found to increase significantly with increase in CRL. (Pearson Correlation Coefficient=0.696 and  $P < 0.003$ ). It was observed that the foetal age was accurately measured by crown rump length in their study which can be enriched by direct measurement of long bones. The radiological and ultrasound techniques could be used to evaluate both whole long bones total length (TL) and their ossified length (OL) in future.<sup>7</sup>

Marcin Wiśniewski conducted quantitative anatomy of the growing clavicle in the human fetus using CT, digital image analysis and observed that with no sex and laterality differences, the clavicle grows logarithmically with respect to its length, width, and volume, and linearly with respect to its projection surface area.<sup>8</sup>

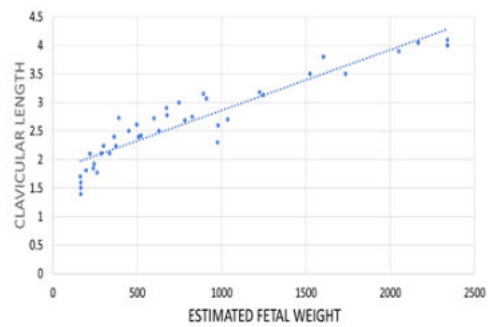
Sherer et al. performed an ultrasound cross-sectional study of 623 consecutive patients between 14- and 42-weeks' gestation, and proved an increase in clavicle length.<sup>9</sup> However, 20 years earlier, Yarkoni et al. had ultrasonically evaluated clavicle length in 85 human fetuses aged 15–40 weeks and reported a commensurate increase in its length. The clavicle length was roughly equivalent to gestational age in weeks—the so-called “simple 1 mm = 1-week rule”.<sup>10</sup> Thus, as stated by these authors, clavicle length could be a useful parameter for the estimation of gestational ages and in the detection of congenital anomalies of the clavicle.

According to Sherer et al., their own measurements were consistently substantially larger than those achieved by Yarkoni et al., and so the latter could considerably overestimate gestational ages by as much as 6 weeks

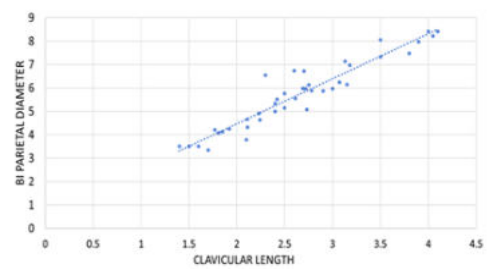
The width of the shoulder girdle is determined by the clavicle length.<sup>10</sup> Furthermore, fetal macrosomia causes the width of the shoulder girdle to be greater than the dimensions of the head, impeding or even preventing a natural delivery.<sup>11</sup> Nevertheless, according to Sherer et al., there were no systematic differences between clavicle length from diabetic ( $n=22$ ) and non-diabetic ( $n= 601$ ) subjects. He stated that inspite of the apparent association between birth weight and clavicle fracture, no data was currently available referring to clavicle length and either shoulder dystocia or clavicle fracture. Perusing the clavicular length may help to predict the risks of the delivery and predisposition to clavicle fractures.<sup>10</sup>

To our opinion, ultrasound morphometric evaluation of the clavicle may be helpful in diagnosing many congenital defects, such as clavicular hypoplasia, often observed in cleidocranial dysplasia, incomplete ossification of the clavicle typical of Edwards syndrome (trisomy 18), and shortening of the clavicle observed in Holt–Oram syndrome, as well as in Goltz syndrome.<sup>11</sup>

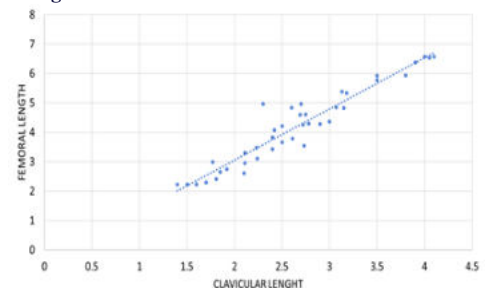
While comparing the results obtained from the present study, the fetal clavicle length is slightly lesser when compared to the study conducted by Sherer et al at the most of the weeks of gestation but after 33 weeks and above both the findings are similar. But the values were slightly greater when compared to Yarkoni et al study. (Graph 4)



**Graph 1: Scatterplot of fetal clavicle length and Estimated Fetal weight**



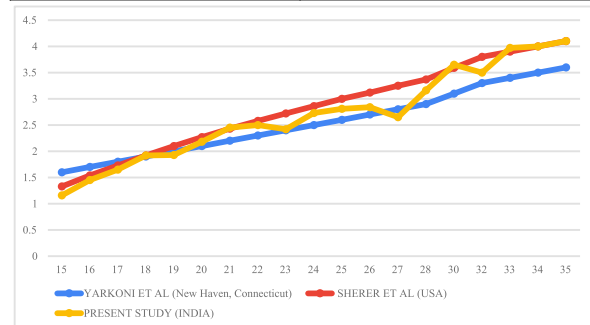
**Graph 2: Correlation between Bi parietal Diameter and fetal clavicle length**



**Graph 3: Correlation between fetal clavicle length and Femoral length**

**Table 2: Relationship between clavicle length (CL) and other measurements**

Measurement	PEARSON'S CORRELATION R
Sonographically estimated fetal weight (SEFW)	0.929
Abdominal circumference (AC)	0.952
Head circumference (HC)	0.952
Biparietal diameter (BPD)	0.948
Femur length (FL)	0.956



**Graph 4: Comparison of foetal clavicle length on ultrasound with other studies**

**CONCLUSION:**

The fetal clavicle increases logarithmically with respect to its length, width, and volume. The obtained morphometric data of the growing clavicle is considered normative for their respective weeks of gestation and may be of relevance in the diagnosis of congenital defects. Clavicular measurements may also prove useful in the detection of macrosomic fetuses at high risk for obstructed labor or shoulder dystocia.

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