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Ultrasound measurements of fetal limb bones

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Key words: ULTRASOUND, FETAL LIMB, GROWTH CURVES, WEEKLY INCREMENT

ABSTRACT

In order to establish the growth patterns of fetal limbs, measurements of femur, humerus, tibia, fibula, radius and ulna were made by ultrasound and related to gestational age. To this end, 2317 normal singleton pregnant women were studied cross-sectionally at 13–40 weeks of gestation. Patients were selected on the basis of a certain last menstrual period, history of regular cycles and at least one ultrasound scan before 16 weeks confirming gestational age. Linear growth of all limb measurements was observed between 13 and 28 weeks of gestation. From this gestational age onwards, a flattening of the growth curve was seen. A second-degree polynomial equation turned out to be the best model to describe this phenomenon. The measurements of all six fetal long bones showed a high correlation with menstrual age ($r \geq 0.99$). The femur displayed the largest mean weekly increments (2.8 mm per week from 13 to 28 weeks and 1.7 mm per week from 29 to 40 weeks of gestation) and the radius had the smallest (2.08 mm per week from 13 to 28 weeks and 1.25 mm per week from 29 to 40 weeks' gestation). Considering inter- and intraoperator variations and the weekly increment of fetal long bone length, a correct evaluation of limb growth is possible for the femur every week before 28 weeks and every 2 weeks after 28 weeks. For the remaining limb bones, a correct evaluation is possible every 2 weeks at all gestational ages.

INTRODUCTION

Sonographic measurement of the ossified shafts of fetal long bones is possible after 12 weeks of gestation. Several studies[1–10] have established standard growth curves for the femur, but only a few authors have described normal values for the humerus, tibia, fibula, radius and ulna[5,8,9]. The few ultrasound studies reporting fetal limb bone length data are not really comparable, in that they are based on study populations with different genetic and socioeconomic characteristics. Furthermore, the techniques employed in these studies were not comparable.

In order to establish the growth patterns of fetal limbs in our population, data on the normal growth of femur, humerus, tibia, fibula, radius and ulna are presented and related to gestational age.

MATERIALS AND METHODS

A total of 2317 normal pregnant women of different socioeconomic levels were investigated in a cross-sectional study. Patients were referred to our Department for routine scanning at 13–40 weeks' gestation. Only one scan per patient was considered for the study. In order to avoid ethnic influences, all the patients were Italian. Patients were selected on the basis of a certain last menstrual period, history of regular cycles and at least one ultrasound scan before 16 weeks confirming gestational age. Pregnancies complicated by fetuses with structural abnormalities, oligohydramnios, stillbirth and multiple pregnancies were excluded from the study. Postnatal examination confirmed that all the newborn were free from structural and chromosomal abnormalities.

The ultrasound examinations were performed with a General Electric RT 3600 (Milwaukee, Wisc.) real-time

Table 1 Inter- and intraobserver variation for each fetal long bone

		Interobserver variation		*Intraobserver variation*
	Mean ± SD (mm)	*Mean difference ± SD* (mm)	*Coefficient of variation* (%)	*Coefficient of variation* (%)
Femur	62.57 ± 13.56	0.94 ± 0.71	1.074	0.976
Humerus	56.01 ± 11.08	0.92 ± 0.75	1.164	0.997
Tibia	53.81 ± 10.56	0.94 ± 0.75	1.292	1.066
Fibula	53.34 ± 10.81	0.96 ± 0.79	1.410	1.162
Radius	47.66 ± 9.46	1.03 ± 0.84	1.572	1.269
Ulna	51.41 ± 10.41	1.09 ± 0.96	1.554	1.318

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Table 2 Reference range (5–95th centile) for fetal femur length (mm)

Weeks	Number of patients	Centile 5	10	25	50	75	90	95
13	30	10.0	10.0	11.0	12.0	12.0	13.0	13.0
14	46	12.8	13.0	14.0	14.0	15.0	15.5	16.0
15	57	14.7	16.0	17.0	17.0	18.2	19.0	19.6
16	92	18.0	19.0	20.0	21.0	22.0	23.0	24.0
17	185	21.0	22.0	23.0	24.0	26.0	27.0	27.0
18	102	25.0	26.0	27.0	28.0	29.0	29.0	30.0
19	78	27.0	28.0	29.0	30.0	30.5	31.0	32.0
20	68	29.0	31.0	32.0	32.5	33.0	34.0	36.1
21	74	33.0	33.0	34.5	36.0	36.5	37.0	37.0
22	52	36.0	36.0	37.0	38.0	39.5	40.0	40.9
23	74	37.0	38.0	39.0	40.0	41.0	42.1	43.0
24	71	39.0	39.0	41.0	43.0	44.5	46.0	46.0
25	68	43.0	44.0	45.0	46.0	48.0	49.0	49.0
26	67	44.8	46.0	47.0	48.0	50.0	51.0	52.1
27	84	48.0	48.0	49.0	51.0	52.0	53.1	54.3
28	77	50.3	52.0	53.0	54.0	54.5	56.0	57.0
29	87	52.0	53.2	54.5	56.0	57.5	58.0	59.0
30	91	55.0	56.0	57.0	58.0	59.0	61.0	61.9
31	77	57.0	58.0	59.0	60.0	62.0	62.8	64.0
32	93	60.0	60.0	62.0	63.0	64.0	66.0	66.0
33	103	61.0	61.0	63.0	65.0	66.0	68.0	68.0
34	98	62.0	63.0	64.5	66.0	67.5	70.0	70.0
35	85	63.7	65.0	66.5	68.0	69.5	71.0	72.0
36	85	66.0	67.0	68.0	70.0	71.0	73.0	74.5
37	91	68.0	70.0	71.0	72.0	74.0	74.4	75.0
38	95	69.0	70.5	71.5	73.0	75.0	75.0	77.0
39	102	71.7	72.0	73.0	74.5	76.0	78.0	80.0
40	85	72.0	73.0	75.0	76.0	77.0	79.0	80.0

Table 3 Reference range (5–95th centile) for fetal humerus length (mm)

Weeks	Number of patients	Centile 5	10	25	50	75	90	95
13	31	10.0	10.0	10.0	11.0	11.7	12.0	12.9
14	46	12.0	12.0	12.0	13.0	13.0	14.0	14.2
15	57	14.3	15.0	15.7	16.0	17.0	18.0	18.0
16	92	17.1	18.0	18.5	20.0	21.0	23.0	23.0
17	185	20.0	21.0	22.0	23.0	24.0	25.0	25.2
18	102	23.0	24.0	25.0	26.0	27.0	27.0	28.0
19	78	25.0	26.0	27.0	28.0	29.0	29.0	30.0
20	68	27.9	28.0	29.0	30.0	31.0	32.0	32.0
21	74	30.0	30.0	30.5	32.0	33.0	35.0	35.0
22	52	33.0	34.0	34.5	35.0	36.5	37.0	37.0
23	74	35.2	36.0	37.0	38.0	38.5	39.0	40.0
24	71	36.0	37.0	37.5	40.0	41.5	42.0	43.0
25	67	40.0	41.0	41.5	42.0	44.0	45.0	45.0
26	67	41.0	42.0	43.5	44.0	46.5	47.0	47.0
27	84	43.0	44.0	45.0	46.0	48.0	49.0	50.0
28	77	45.0	46.0	47.0	49.0	50.0	50.8	51.0
29	87	47.0	47.2	49.0	50.0	51.5	53.0	54.0
30	89	49.0	50.0	51.0	52.0	54.0	55.0	56.0
31	77	51.0	52.0	53.0	54.0	56.0	57.0	58.0
32	93	54.0	54.0	55.0	56.0	57.0	59.0	59.8
33	103	55.0	56.0	56.5	58.0	58.5	60.0	60.3
34	98	55.0	56.0	57.0	59.0	60.5	62.0	63.0
35	85	56.0	58.0	59.0	60.0	61.0	63.0	63.1
36	85	58.0	59.0	60.0	62.0	63.0	64.0	65.0
37	91	59.0	60.0	61.9	63.0	65.0	66.0	66.0
38	95	60.0	61.0	62.5	64.0	65.5	66.0	67.5
39	102	60.2	62.0	63.0	65.0	66.0	68.0	70.0
40	83	61.0	62.6	64.0	66.0	69.0	72.0	74.0

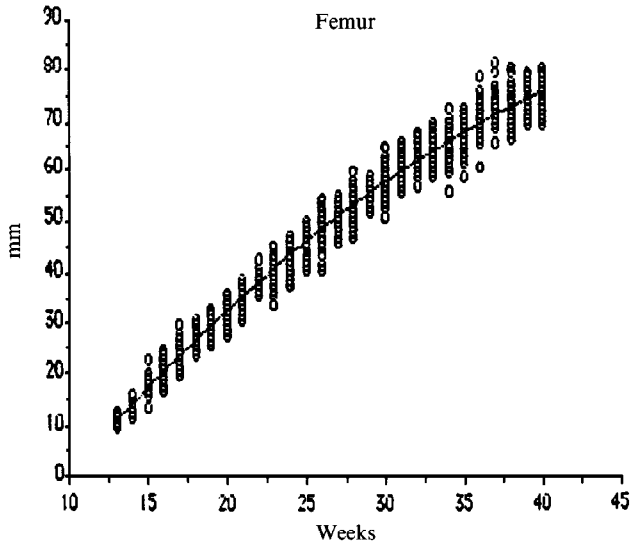

Figure 1 Individual femur measurements obtained in 2317 fetuses and best fitting curve

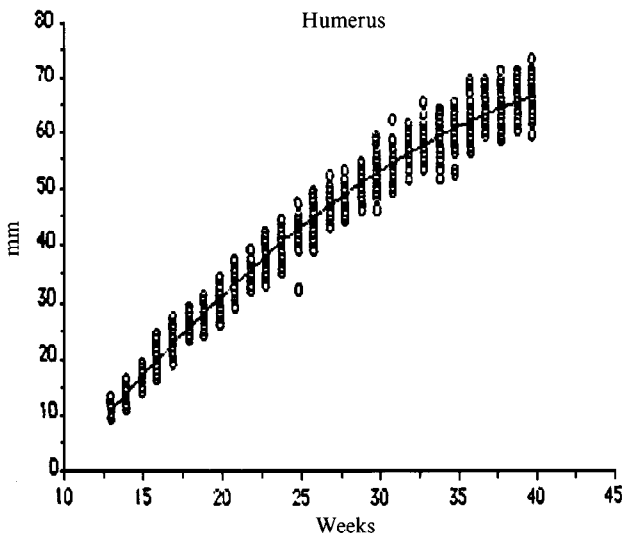

Figure 2 Individual humerus measurements obtained in 2313 fetuses and best fitting curve

scanner with a 3.5 MHz linear transducer and an ultrasound velocity of 1540 m/s. A freeze-frame was used when the full fetal limb bone length was visualized and the bone was orthogonal to the sound beam; then electronic calipers were employed to measure bone length. The fetal limb bones were measured on the long axis from the greater trochanter to the end of the ossified shaft, according to the technique described by O'Brien and Queenan[1,3]. All measurements were taken by two experienced physicians. Measurements from femur and humerus were performed from 13 weeks onwards, while for the remaining bones measurements were obtained only after 15 weeks.

In order to evaluate the reproducibility of the measurements, 50 patients were studied by two independent observers (C.E. and P.R.) and the differences in measurements were calculated for each fetus. To this end, the 50 patients had three different consecutive measurements of limb bone length taken by each observer who was unaware of the results obtained by the other. We ob-

Table 4 Reference range (5–95th centile) for fetal tibia length (mm)

Weeks	Number of patients	Centile 5	10	25	50	75	90	95
15	49	14.0	15.0	16.0	16.0	17.0	17.6	18.0
16	90	18.0	18.5	19.0	20.0	21.0	22.0	22.0
17	181	21.0	22.0	22.0	22.0	23.0	24.0	24.0
18	97	21.3	22.0	22.0	23.0	23.0	24.0	24.0
19	74	24.0	24.0	25.0	26.0	26.0	27.0	27.0
20	68	27.0	27.0	28.0	29.0	29.5	30.0	30.0
21	71	31.0	31.0	32.0	32.0	33.0	33.0	33.0
22	49	31.0	32.0	33.0	33.0	34.0	34.0	34.0
23	70	35.0	35.0	36.0	37.0	37.5	38.0	38.0
24	71	36.0	37.0	38.0	39.0	40.0	40.0	40.9
25	66	39.0	39.0	40.0	40.5	41.0	42.0	42.0
26	65	40.0	41.0	42.0	43.0	43.0	44.0	44.0
27	82	42.0	42.7	43.9	45.0	45.5	46.0	46.0
28	75	44.0	44.0	45.0	46.0	46.5	47.0	47.0
29	85	44.0	46.0	47.0	48.0	50.0	50.0	51.0
30	90	48.0	48.0	49.0	49.5	50.0	51.0	51.5
31	75	50.0	50.0	51.0	52.0	52.5	53.0	53.0
32	92	52.0	52.7	53.0	55.0	56.0	56.5	56.9
33	98	53.0	54.0	54.5	55.0	57.0	59.0	60.0
34	94	55.0	55.0	56.0	57.0	57.0	58.0	61.0
35	83	56.0	57.0	58.0	59.0	60.0	62.2	64.0
36	83	57.0	57.0	59.0	60.0	61.0	62.5	64.0
37	89	58.0	59.0	60.0	61.0	62.7	63.0	64.5
38	93	58.5	59.8	60.0	62.0	63.0	64.0	65.0
39	101	59.0	60.0	61.5	63.0	64.0	65.0	65.8
40	84	59.5	60.8	62.0	64.0	65.2	66.5	67.0

Table 5 Reference range (5–95th centile) for fetal fibula length (mm)

Weeks	Number of patients	Centile 5	10	25	50	75	90	95
15	46	13.8	14.0	14.0	15.0	16.0	16.0	16.0
16	76	16.0	16.0	17.0	18.0	18.0	18.9	19.0
17	141	19.0	19.0	20.0	21.0	21.5	22.0	22.0
18	82	20.0	20.0	21.0	21.0	22.0	23.0	23.0
19	70	22.0	23.0	24.0	25.0	26.0	26.0	27.0
20	62	26.6	27.0	27.5	28.0	29.0	29.0	30.0
21	65	30.0	30.0	31.0	31.0	32.0	32.0	33.0
22	47	30.0	30.0	31.0	31.0	32.0	33.0	33.0
23	65	35.0	35.0	35.0	36.0	37.0	37.0	37.2
24	64	37.0	37.0	38.0	39.0	39.0	40.0	40.0
25	61	37.5	38.6	39.0	40.0	40.5	41.0	41.4
26	62	39.0	40.7	41.0	42.0	43.0	44.0	44.0
27	77	42.0	43.0	43.5	44.0	44.5	45.0	46.0
28	71	43.0	43.0	44.5	45.0	45.5	46.0	46.9
29	73	44.2	45.0	46.0	47.0	48.0	48.0	49.0
30	79	46.0	47.0	48.0	48.5	49.0	50.0	50.0
31	66	47.8	48.0	48.5	49.0	50.5	51.0	52.4
32	85	51.0	51.0	52.0	53.0	54.0	54.9	55.0
33	92	52.0	53.0	53.0	54.0	55.0	57.0	58.0
34	86	53.0	54.0	54.5	57.0	57.0	59.0	61.0
35	77	56.0	57.0	58.0	59.0	60.0	62.0	63.0
36	72	56.3	57.0	58.5	59.0	60.5	62.0	63.5
37	82	57.0	58.0	59.0	60.0	62.0	63.0	64.0
38	85	58.0	59.0	60.0	61.0	62.0	63.0	64.0
39	88	58.0	59.5	61.0	62.0	63.0	64.0	65.6
40	77	58.5	60.0	61.8	63.0	64.0	65.0	66.2

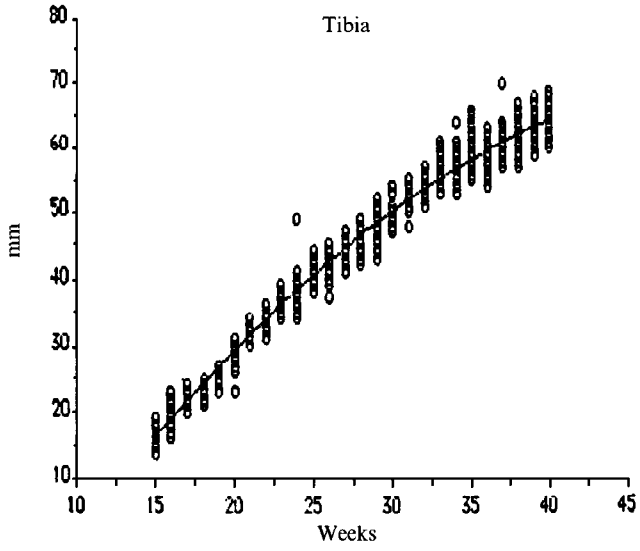

Figure 3 Individual tibia measurements obtained in 2175 fetuses and best fitting curve

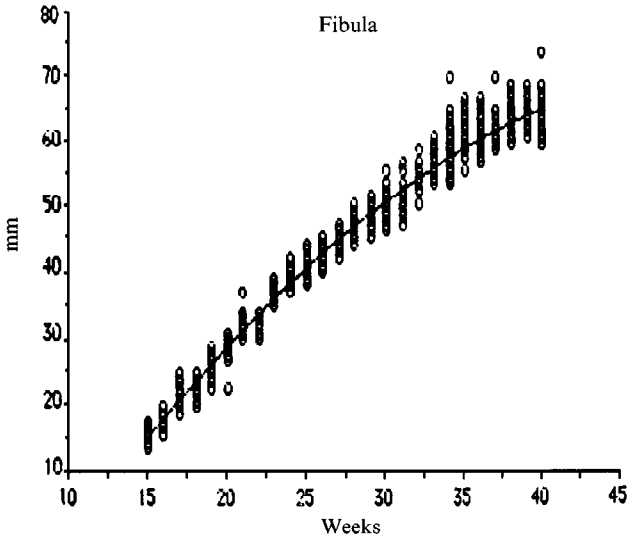

Figure 4 Individual fibula measurements obtained in 1951 fetuses and best fitting curve

tained three measurements for each bone, for each fetus, for each observer. From the three measurements a mean ± SD was calculated. Intraobserver coefficients of variation (SD × 100/mean) from this mean were obtained for each bone, in each fetus, for each observer. There was no significant difference between the intraobserver coefficients of variation and there were no differences between the coefficients of variation for different bone lengths. The averages of the coefficients of variation for one observer are reported in Table 1. Interobserver coefficient of variation from each bone was calculated from the mean ± SD obtained from the mean measurement of the first observer and the mean measurement from the second observer for each bone and for each fetus. The averages of the coefficients of variation are reported in Table 1. The maximum inter- and intraoperator variations were 3.0 mm and 2.0 mm, respectively.

The normal distribution of the data was analyzed by the *F*-test. Regression analysis was used to establish the relationships between long bone length and gestational age. The weeks of gestation were calculated as complete weeks from the first day of the last normal menstrual period. Differences in weekly increments were evaluated by unpaired *t*-test.

Table 6 Reference range (5–95th centile) for fetal radius length (mm)

Weeks	Number of patients	Centile						
		5	*10*	*25*	*50*	*75*	*90*	*95*
15	49	13.0	13.4	15.0	15.0	16.0	17.0	17.0
16	92	16.1	17.0	18.0	19.0	20.0	20.0	21.0
17	185	18.0	18.0	19.0	19.0	20.0	21.0	22.0
18	99	18.0	18.0	19.0	20.0	21.0	22.0	23.0
19	73	20.0	20.0	21.0	22.0	23.0	23.0	24.0
20	68	22.0	22.0	23.0	23.5	24.0	25.0	25.0
21	74	25.0	25.0	26.0	27.0	28.0	29.0	29.0
22	50	27.0	27.0	28.5	29.0	30.3	30.5	31.0
23	71	30.0	31.0	31.5	32.0	33.0	34.0	34.0
24	71	31.0	32.0	33.0	34.0	35.0	37.0	37.5
25	65	34.0	35.0	35.0	36.0	37.0	38.0	39.0
26	65	35.0	36.0	37.0	38.0	39.0	40.0	41.0
27	83	37.0	38.0	39.0	40.0	40.5	42.0	42.0
28	76	38.0	39.0	40.0	41.0	41.5	42.0	43.0
29	84	40.0	40.0	40.5	42.0	43.5	44.0	44.0
30	89	41.0	42.0	43.0	44.0	45.0	46.0	47.0
31	75	43.0	44.0	45.0	46.0	46.0	47.0	48.0
32	90	43.0	44.0	45.0	47.0	48.0	49.0	50.0
33	99	45.0	45.0	46.5	48.0	49.5	51.0	52.0
34	97	46.0	46.0	47.0	49.0	50.0	52.0	53.9
35	83	47.0	48.0	49.0	50.0	52.0	53.0	54.3
36	83	47.6	48.0	50.0	52.0	53.0	54.0	54.7
37	89	49.0	50.0	51.5	52.0	54.0	55.0	57.0
38	91	49.5	50.0	52.0	53.0	54.0	55.0	57.0
39	100	50.0	52.0	52.5	54.0	55.0	56.0	58.0
40	85	50.5	52.5	53.5	56.0	58.0	59.5	61.0

Table 7 Reference range (5–95th centile) for fetal ulna length (mm)

Weeks	Number of patients	Centile						
		5	*10*	*25*	*50*	*75*	*90*	*95*
15	38	15.0	15.0	15.0	16.0	17.0	17.7	18.0
16	91	18.0	18.0	19.0	20.0	21.0	22.0	22.0
17	177	20.0	21.0	22.0	22.0	23.0	23.0	24.0
18	99	21.0	21.0	22.0	23.0	23.0	24.0	24.0
19	73	23.0	24.0	25.0	26.0	26.0	27.0	27.8
20	68	27.0	27.0	28.0	29.0	29.0	30.0	31.0
21	70	30.0	30.0	31.0	32.0	33.0	34.0	34.0
22	50	32.0	32.0	33.0	34.0	34.0	35.0	35.0
23	72	34.0	34.0	35.0	36.0	36.5	37.0	38.0
24	71	36.0	36.0	37.0	38.0	40.0	40.0	40.0
25	66	38.0	38.0	39.0	40.0	40.3	41.0	41.0
26	66	40.0	41.0	42.0	43.0	44.0	44.0	45.0
27	82	41.0	42.0	43.0	44.0	44.5	45.0	45.0
28	74	44.0	45.0	45.5	46.0	47.0	48.0	48.0
29	84	45.0	45.0	46.5	47.0	48.0	49.0	49.0
30	88	46.0	47.0	48.0	49.0	50.0	51.0	51.0
31	74	48.0	49.0	50.0	51.0	52.0	52.0	53.0
32	90	50.0	51.0	52.0	53.0	54.0	55.0	55.0
33	100	51.0	52.0	53.0	54.0	55.0	57.0	57.0
34	94	52.0	52.0	54.0	55.0	55.5	57.0	58.0
35	82	55.0	55.0	56.0	57.0	59.0	60.3	61.0
36	84	55.0	55.0	57.0	58.5	60.0	60.5	61.0
37	89	56.0	57.0	58.0	59.0	60.0	61.0	62.0
38	93	56.0	57.8	59.0	60.0	61.0	62.0	62.5
39	101	57.5	59.0	60.0	61.0	63.0	64.0	64.0
40	84	59.0	60.0	61.0	62.5	65.0	66.0	67.0

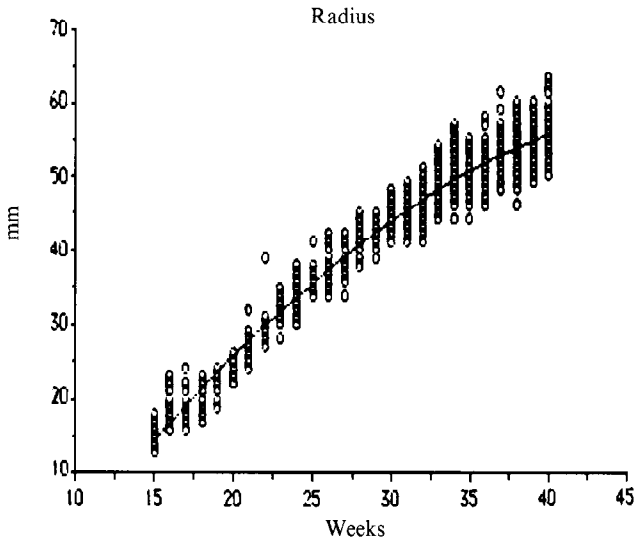

Figure 5 Individual radius measurements obtained in 2186 fetuses and best fitting curve

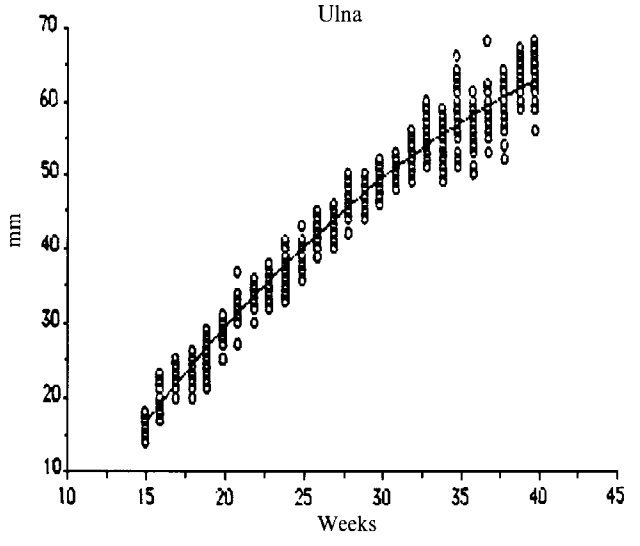

Figure 6 Individual ulna measurements obtained in 2160 fetuses and best fitting curve

RESULTS

For each weekly interval considered, the *F*-test showed a normal distribution of data for all the parameters measured.

A second-degree polynomial equation turned out to be the best model describing the relationship between femur length ($y = -37.15 + 4.159x - 0.033x^2$; $r = 0.994$; residual SD = 2.085; $p < 0.0001$), humerus length ($y = -36.468 + 3.739x - 0.039x^2$; $r = 0.993$; residual SD = 1.975; $p < 0.0001$), tibia length ($y = -32.294 + 3.739x - 0.033x^2$; $r = 0.994$; residual SD = 1.619; $p < 0.0001$), fibula length ($y = -36.563 + 3.963x - 0.037x^2$; $r = 0.994$; residual SD = 1.697; $p < 0.0001$), radius length ($y = -29.090 + 3.371x - 0.031x^2$; $r = 0.988$; residual SD = 1.980; $p < 0.0001$), ulna length ($y = -31.550 + 3.709x - 0.034x^2$; $r = 0.993$; residual SD = 1.702; $p < 0.0001$) and gestational age in weeks (x). The femur was measured in 2317, humerus in 2313, tibia in 2175, fibula in 1951, radius in 2186 and ulna in 2160 patients.

The calculated polynomial growth curves for each limb are presented in Figures 1–6 and reference values (5–95th centile) are listed in Tables 2–7.

A linear growth of all limb bone measurements from 13 to 28 weeks' gestation was observed, which was followed by a flattening of the growth curve. The weekly increment for each limb bone was evaluated in two gestational periods: 13–28 weeks and 29–40 weeks (Table 8).

Table 8 Weekly increment (mean ± SD)(mm) for each fetal limb bone in two gestational periods

	Weekly increment			
	13–28 weeks	*29–40 weeks*	*t*	*p*
Femur	2.80 ± 0.70	1.75 ± 0.58	39.275	< 0.001
Humerus	2.50 ± 0.85	1.42 ± 0.51	45.751	< 0.001
Tibia	2.23 ± 1.07	1.54 ± 0.81	17.057	< 0.001
Fibula	2.43 ± 1.56	1.42 ± 1.02	17.005	< 0.001
Radius	2.08 ± 0.93	1.25 ± 0.75	22.906	< 0.001
Ulna	2.31 ± 0.85	1.38 ± 0.61	29.159	< 0.001

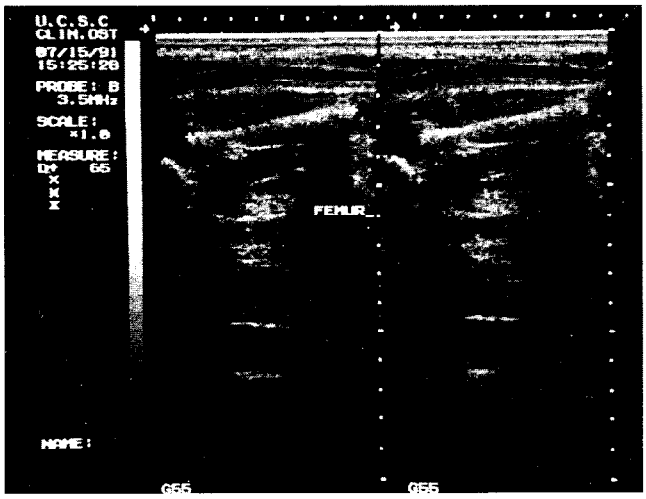

Figure 7 Typical view of the femur suitable for femur length measurement

Figure 8 Typical view of the humerus suitable for humerus length measurement

DISCUSSION

This study demonstrated a progressive growth of fetal limbs throughout pregnancy. The models obtained showed a high coefficient of correlation between long bone length and gestational age. There was a rapid increase in limb bone growth from 15 to 28 weeks, followed by a decrease in the weekly increment.

Recently, the ultrasonic measurement of fetal bones has been suggested as a valuable index of fetal growth[11–18]. Most measurements have been obtained only for the femur and the humerus (Figures 7 and 8), as they are less mobile than distal limb bones and it is technically easier to obtain satisfactory images of the femur. The fibula, the radius, the tibia and the ulna are more difficult to scan adequately, and in most of the previous studies the tibia/fibula and the radius/ulna have been measured as a complex instead of measuring each bone individually, as in our study. However, the tibia and the fibula can be differentiated because the fibula is lateral to the tibia (Figure 9). The radius and the ulna can be well

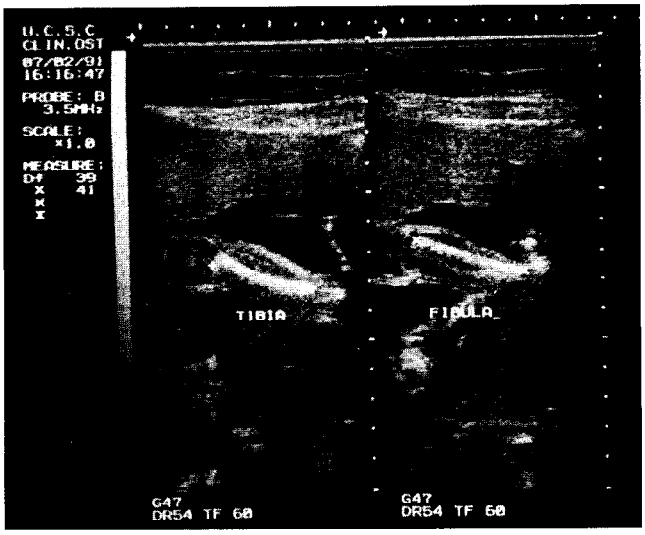

Figure 9 Typical views of the tibia and fibula suitable for tibia and fibula length measurements

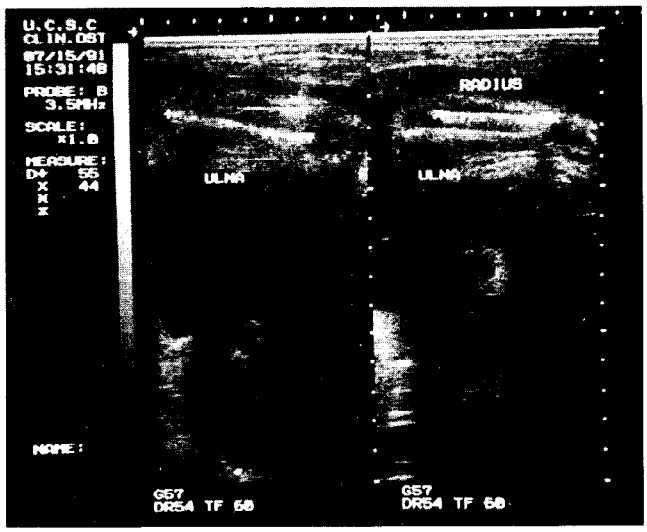

Figure 10 Typical views of the ulna and radius suitable for ulna and radius length measurements

differentiated and measured when the arm is in a supine position because the two bones are lying exactly parallel (Figure 10). In a prone position, the crossing of two bones requires two different sonar planes to obtain measurements. The ulna appears longer than the radius proximally, but distally both bones end at the same level.

Comparing our cross-sectional study of limb bone measurements with those of other investigators who measured tibia/fibula and radius/ulna separately[6,8,10], we found similar mean values for all bones in the second trimester. In the third trimester, mean values reported by Jeanty and colleagues[5,6] and Merz and colleagues[9,10] for humerus, ulna, radius and fibula are lower than our mean values. The centile ranges show greater differences between the various authors. The range between the 5th and 50th and between the 95th and 50th centiles is narrower in our study than in the other studies. These differences are probably due to variations in the characteristics of the examined population or to differences in technique.

There are many problems in obtaining accurate measurements of limb bones and in evaluating their growth[19]. The limb length measurement may be affected by several factors: both the angle of the beam to the long axis of the bone and the type of transducer (linear vs. curvilinear vs. sector) can change the amount of artifactual echoes at the extremities of the bones. Also, there is the factor of the level of experience of the operator, which can be assessed by differences of intraobserver variation. For our study, we used only measurements obtained on the same machine at an angle of 90° (long axis of the bone orthogonal to the sound beam) to minimize these factors.

Interobserver variation plays, therefore, an important role, particularly in the evaluation of limb growth. When we consider the weekly increment of the limb bone lengths and the interobserver variation, the mean ± SD can cause overlapping of values, particularly after 28 weeks of gestation. This means that, for a correct evaluation of fetal limb bone growth, measurements should not be made within a period of at least 2 weeks from the last scan or inaccuracies will occur. Only femur growth prior to 28 weeks, when the weekly increment is 2.8 mm ± 0.7 SD, can be accurately evaluated every week.

CONCLUSION

We have shown that fetal long bone lengths show a high correlation with gestational age and a low interobserver variation, thus suggesting their usefulness in the assessment of menstrual age as an alternative basis, when it is impossible to obtain reliable measurements of the biparietal diameter (e.g. deep pelvic engagement of the vertex, dolichocephaly). Long bone length may be used for monitoring fetal growth and for diagnosing bone dysplasias. However, taking into account the interobserver variation and the weekly increment, a correct evaluation of growth can be made after only a 2-week interval between scans, except for the femur which can be measured at weekly intervals up to 28 weeks of gestation.

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