Practical biometric ratios of first-trimester screening

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Summary

Purpose: The authors aimed to determine some practical contributive biometry ratios of the first trimester screening in order to note more accurate measurements and recognize abnormal/mistaken measurements. *Materials and Methods:* All medical records of singleton pregnancies whose first-trimester screening that was performed between the years of 2004-2010, were evaluated retrospectively. Singleton pregnancies with detected/suspicious anatomical or genetic fetal anomalies, any systemic disease, and familial genetic diseases were excluded. The following ratios were calculated and compared: measurements of biparietal diameter [BPD], head circumference [HC], abdominal circumference [AC], femur length [FL], and crown rump length [CRL] of included fetuses, to each other were calculated. Mean and standard deviations of the ratios were determined for each gestational weeks of $11^{0\text{-}6}$, $12^{0\text{-}6}$, and $13^{0\text{-}6}$. *Results:* A total of 1,615 singleton pregnancies were included in the data analyses according to exclusion and inclusion criteria. Mean maternal age was 29.5 ± 4.6 years. Mean gestational age of the fetuses was 12.6 ± 0.6 weeks. Mean and standard deviation of the ratios were as follows; CRL/BPD: 3.0 ± 0.2; AC/BPD: 3.0 ± 0.2; CRL/AC: 1.0 ± 0.1; CRL/HC: 0.8 ± 0.1; CRL/FL: 8.8 ± 1.6; BPD/FL: 2.9 ± 0.6; AC/FL: 8.9 ± 1.6; HC/FL: 11.1 ± 2.2, and HC/AC: 1.3 ± 0.1. Among these ratios the standard deviation was small in the ratios of CRL/BPD, AC/BPD, CRL/AC, CRL/HC, and HC/AC. The equations of these ratios were derived from linear regression analyses. The AC/BPD, and CRL/AC ratios had lower R^2 values than others, indicating a rather constant ratio. *Conclusions:* The ratios of CRL/BPD, AC/BPD, and CRL/AC seem more practical to be used in the first-trimester fetal ultrasonography practice.

Key words: Practical; Ratio; Screening; First Trimester; Pregnancy; Ultrasonography; Fetus.

Introduction

Within the two recent decades, ultrasonography gained an important place in first-trimester screening and much information has been gained regarding fetal sonography related to normal and abnormal fetuses [1]. There have been many nomograms constructed for everyday clinical practice. However, expertise is still mandatory for the evaluation of many aspects of fetal sonography [2]. Therefore, some practical ratios, if present uniformly, might be helpful for sonography trainees as well as experts to recognize mistaken or abnormal measurements during their trainings.

In this study the authors aimed to determine some practical contributive biometry ratios related to first-trimester screening of singleton pregnancies using all parameters gained in these examinations.

Materials and Methods

All medical records of singleton pregnancies screened between 2004 and 2010 were analyzed retrospectively. Data of singleton pregnancies who were screened at 11^{0}-13^{6} gestational weeks, was used for study analyses. Singleton pregnancies with any detected/suspicious anatomical or genetic fetal anomalies, maternal systemic disease, and familial genetic diseases were excluded.

First-trimester screenings were performed accordingly to the criteria previously reported in the literature [3]. Data of the measurements of biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL), humerus length (HL), and crown rump length (CRL) of included fetuses, gestational age, and maternal age were used for statistical analyses. The ratios CRL/BPD, AC/BPD, CRL/AC, HC/AC, CRL/HC, CRL/FL, BPD/FL, AC/FL, HC/FL, BPD/HL, and AC/HL were calculated for each fetus and their percentiles, mean values, and standard deviations were calculated and compared according to each gestational week of $11^{0\text{-}6}$, $12^{0\text{-}6}$, and $13^{0\text{-}6}$. Comparative ratios according to gestational weeks were performed with the Student's t test. The equations of the graphs of gestational week vs biometric ratios were determined by linear regression analyses. The statistical significance was set as $p < 0.05$. Statistical analyses were performed using the SPSS version 17.0.

Results

A total of 1,615 singleton pregnancies were included in the data analyses according to exclusion and inclusion criteria. The mean maternal age was 29.5 ± 4.6 years and mean gestational age of the fetuses was 12.6 ± 0.6 weeks. The mean values are shown in Table 1.

Among these ratios, the standard deviation was small in the ratios of CRL/BPD, AC/BPD, CRL/AC, CRL/HC, and HC/AC. The equations of these ratios derived from the linear regression analyses are shown in Table 2. The AC/BPD and CRL/AC ratios had lower R^2 values than others, indicating a rather constant ratio. Linear regression graphics are shown in Figures 1 and 2.

Comparisons between fetal sexes showed no differences in all of the ratios. When the fetuses were compared according to maternal age (< 35 and ≥ 35 years),

Revised manuscript accepted for publication March 29, 2012

Table 1. — *Biometric ratios according to gestational weeks.*

			CRL\BPD	AC\BPD	CRL\AC	HC\AC	CRL\HC	CRL\FL	BPD\FL	AC\FL	HC\FL	BPD\HL	AC\HL
11^0-11^6 Week n = 372	Mean		3.0	3.0	1.0	1.3	0.8	9.9	3.4	10.1	12.9	2.9	8.7
	Std. deviation		0.2	0.2	0.1	0.1	0.1	1.6	0.6	1.6	2.2	0.8	2.5
	Percentile	5	2.6	2.7	0.9	1.1	0.7	7.6	2.5	7.8	9.5	1.4	4.1
		50	3.0	3.0	1.0	1.3	0.8	9.7	3.3	10.0	12.7	2.9	8.8
		95	3.3	3.4	1.1	1.4	0.9	12.6	4.3	13.0	16.6	4.3	13.0
12^0-12^6 Week n = 909	Mean		3.0	3.0	1.0	1.3	0.8	8.7	2.9	8.8	11.0	2.5	7.9
	Std. deviation		0.2	0.2	0.1	0.1	0.1	1.4	0.5	1.4	1.8	0.5	1.6
	Percentile	5	2.7	2.7	0.9	1.1	0.7	6.6	2.2	6.7	8.3	1.7	5.1
		50	3.0	3.0	1.0	1.3	0.8	8.6	2.9	8.8	10.8	2.6	7.7
		95	3.3	3.4	1.1	1.4	0.9	11.2	3.7	11.2	14.0	3.2	10.9
13^0-13^6 Week n = 334	Mean		3.0	3.0	1.0	1.3	0.8	7.6	2.5	7.6	9.3	2.1	6.6
	Std. deviation		0.2	0.2	0.1	0.1	0.1	1.3	0.4	1.2	1.5	0.2	0.6
	Percentile	5	2.8	2.7	0.9	1.1	0.8	6.0	1.9	5.9	7.1	1.8	5.5
		50	3.0	3.0	1.0	1.3	0.8	7.4	2.5	7.4	9.0	2.1	6.7
		95	3.4	3.4	1.1	1.4	0.9	10.2	3.2	10.2	12.1	2.7	7.7

Table 2. — *Equations of the graphs of gestational week vs biometric ratios.*

	Gestational week	Constant	R^2	*p*
CRL/BPD	0.71	2.11	0.49	$p < 0.001$
AC/BPD	0.014	2.86	0.001	$p > 0.05$
HC/AC	0.0249	1.564	0.028	$p < 0.001$
CRL/AC	0.019	0.75	0.03	$p < 0.001$
CRL/HC	0.031	0.40	0.13	$p < 0.001$
BPD/FL	-0.51	9.39	0.32	$p < 0.001$
CRL/FL	-1.32	25.33	0.257	$p < 0.001$
AC/FL	-1.500	27.657	0.313	$p < 0.001$
HC/FL	-2.136	37.847	0. 357	$p < 0.001$
BPD/HL	-0.393	7.468	0.219	$p < 0.001$
AC/HL	-1.233	23.304	0.209	$p < 0.001$

only the BPD/FL ratio was higher in the younger maternal age group (2.95 ± 0.56 vs 2.86 ± 0.54; p = 0.042). Furthermore, placental sites of the fetuses had no impact on the ratios.

Discussion

The authors have clarified and learned much more regarding prenatal life and its dynamics with the help of ultrasonography. Yet, there still seems more to be clarified and that is why many ongoing enhancements related to sonography techniques are attempted and earlier screening strategies aim to rule out fetal abnormalities with extremely low false positive and negative rates.

Nomograms derived from normative values related to these previous observations have assisted and are still used in daily practice. On the other hand, sonography is an area of expertise used in prenatal screening [2]. In this sense, some practical biometry ratios related to prenatal screening might be helpful as a feedback during sonography. In the current study seeking practical ratios, the authors found that CRL/BPD, AC/BPD, CRL/AC, CRL/HC, and HC/AC ratios might be helpful with their lower standard deviation and lower R^2 values only in AC/BPD and CRL/AC ratios. However the easiest ones to keep in mind appear to be CRL/BPD and AC/BPD which are approximating three and CRL/AC which is approximating one. This present study discovered some practical ratios for the first time as compared to those found in the literature. In Table 3, the biometric ratios calculated in the previous studies in the literature are compared with the present study [4-6].

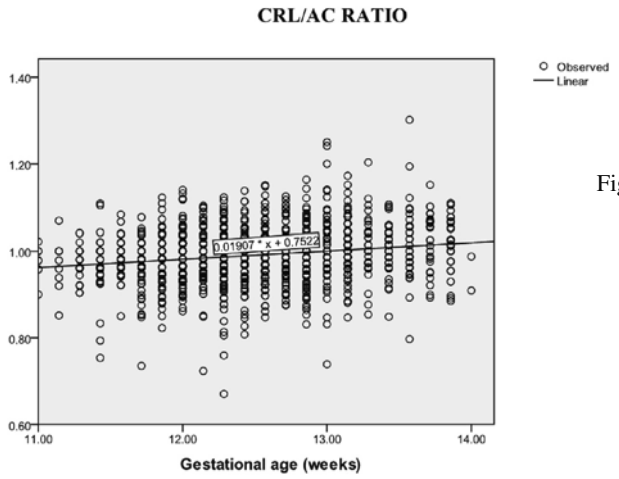

Fig. 1

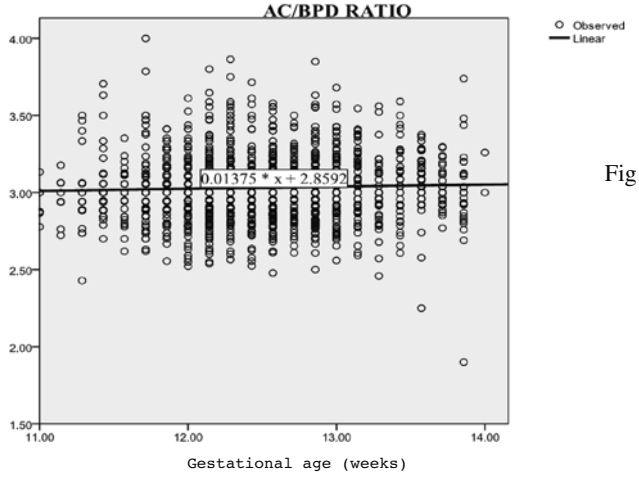

Fig. 2

Figure 1. — Linear regression graphic of the CRL/AC ratio.
Figure 2. — Linear regression graphic of the AC/BPD ratio.

Table 3. — *Comparison of biometric ratios among some studies.*

		HC/AC			BPD/FL				FL/CRL¶			FL/AC¶			HC/FL			
		a	*b*	*c*	*a*	*b*	*c*	*d*¶	*a*	*b*	*c*	*a*	*b*	*c*	*a*	*b*	*c*	*d*¶
11^0-11^6 Week	5th percentile	1.1	*	1.1	2.6	*	2.5	3.4	7.2	*	7.6	8.1	*	7.8	*	*	9.5	11.8
	Median	1.2	*	1.3	3.7	*	3.3	4.8	9.6	*	9.7	10.8	*	10.0	*	*	12.7	16.9
	95th percentile	1.4	*	1.4	5.2	*	4.3	7.7	14.5	*	12.6	16.1	*	13.0	*	*	16.6	29.4
12^0-12^6 Week	5th percentile	1.1	*	1.1	2.3	*	2.2	2.6	6.7	*	6.6	6.9	*	6.7	*	*	8.3	9.3
	Median	1.2	*	1.3	3.2	*	2.9	3.3	8.7	*	8.6	8.8	*	8.8	*	*	10.8	11.9
	95th percentile	1.4	*	1.4	4.2	*	3.7	4.8	12.3	*	11.2	12.0	*	11.2	*	*	14.0	16.7
13^0-13^6 Week	5th percentile	1.1	*	1.1	2.1	*	1.9	2.2	6.0	*	6.0	6.1	*	5.9	*	*	7.1	7.8
	Median	1.2	*	1.3	2.7	*	2.5	2.7	7.6	*	7.4	7.5	*	7.4	*	*	9.0	9.5
	95th percentile	1.4	*	1.4	3.4	*	3.2	3.4	10.2	*	10.2	9.6	*	10.2	*	*	12.1	12.2
14^0-14^6 Week	5th percentile	1.1	1.12	*	1.9	1.7	*	2.0	5.3	*	*	5.4	4.82	*	*	6.08	*	6.9
	Median	1.2	1.23	*	2.3	1.87	*	2.3	6.5	*	*	6.5	5.4	*	*	6.55	*	8.1
	95th percentile	1.4	1.33	*	2.8	2.06	*	2.8	8.3	*	*	8.0	6.04	*	*	7.05	*	9.9

a: von Kaisenberg *et al*.; b: Snijders *et al*.; c: Present Study; d: Johnsen *et al*.; ¶: The ratios were recalculated as 1/ratio in study.

Kustermann *et al*. showed that HC/AC did not show any significant variation with gestational age or CRL [7]. In the study of von Kaisenberg and the present study, this ratio was constant with gestational age as well [4].

In the study of the Johnsen *et al*., maternal age, fetal sex, and cephalic index influenced the FL/BPD ratio, whereas only fetal sex influenced FL/HC [6]. In the present study, the authors also found no effect of maternal age (except BPD/FL), fetal sex, and placental site on the ratios. However the ratios of previous studies do not seem to be practical ones as CRL/BPD, AC/BPD, and CRL/AC. On the other hand, good reproducibility of most measurements of fetal biometry in early pregnancy by abdominal ultrasound has been demonstrated [4, 8]. CRL and BPD showed high reproducibility beginning at nine weeks of gestation onwards, whereas AC is only reliable from 11 weeks onwards, but, FL showed poor reproducibility before 14 weeks of gestational age. Therefore the ratios CRL/BPD, AC/BPD, and CRL/AC seem to be reliable as well.

Conclusion

The ratios of CRL /BPD; AC/BPD, and CRL/AC seem more practical to be used in the first trimester fetal ultrasonography practice to check for abnormal or mistaken measurements.

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