MORPHOMETRIC STUDY OF FETAL STOMACH DIMENSIONS

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MORPHOMETRIC STUDY OF FETAL STOMACH DIMENSIONS (Abstract): Introduction. Inability to view the fetal stomach is associated with a large number of congenital anomalies with a poor prognosis. Because a dilated stomach is a marker of gastrointestinal obstruction, ultrasound examining of the fetal stomach, including evaluation of stomach dimensions, is mandatory. Material and methods. 135 pregnant women were included in the study; they were examined with transvaginal and transabdominal ultrasound between January 2016 and January 2019. In each case, sagittal, transverse and longitudinal diameters of the stomach as well as fetal biparietal diameter and abdominal circumference were measured. Results.In our sudy we found a linear growth of stomach dimensions during pregnancy, as well as the existence of statistically significant correlations between the diameters of the stomach, the gestational age, biparietal diameter and abdominal circumference. Conclusions. The ratio between the size of the stomach and other parameters can be used in order to assess the evolution of the fetal stomach. The correct evaluation of digestive tract length and normal reference values are important for clinical practice, especially with regard to proper planning, prognosis and postoperative management of stomach congenital anomalies.
Key-words: STOMACH, LONGITUDINAL, TRANSVERSAL, SAGITTAL DIAMETER, ULTRASOUND, MEASUREMENTS

INTRODUCTION

The stomach plays a key role during intrauterine life in amniotic fluid circulation. After being swallowed by the fetus, it reaches the stomach, where it' absorbed, transferred towards the small intestine, and will arrive back in the amniotic cavity after fetal urinary activity. For this reason, a malformation of the stomach will affect not only the dimensions and appearance of the viscus, but also the amount of amniotic fluid. When it is filled with amniotic fluid, the stomach can be visualized in the upper left quadrant of the fetal abdomen.

Because the inability to view the fetal stomach is associated with a large number of congenital anomalies with a poor prognosis and a dilated stomach is a marker of gastrointestinal obstruction (e.g. duodenal atresia), ultrasound examining of the fetal stomach is mandatory (1,2).

In a study of McKenna from 1995 (2) 52% of fetuses who presented a small stomach at ultrasound exam, had an abnormal evolution. For this reason, measuring the dimensions of the stomach is important and should not be missing from a standard ultrasonographic evaluation. Millener et al (3) reported a rate of 48% of fetuses with congenital malformations from the cases where the stomach could not be visualized at 14 weeks of gestational age, but that percentage dropped to 43 percent if the absence of visualization persisted after 48 weeks. In contrast to these studies, Pretorius et al. (4) reported a rate of 100% abnormal evolution in cases where the stomach could not be viewed.

Most early ultrasound visualization of the fetal stomach is possible starting with the ninth week, and the gastric dimensions can be measured starting with the tenth week. The stomach curvatures, fundus, body and pylor, can be visualised beginning with the 14th week. It's not just the look and size of the stomach are important, but also demonstrating its peristaltic movements. The size of the stomach can be a

marker for congenital malformations of the digestive tract, as well as for intestinal motility disorders (1,5,6).

The aim of this study is to present the values of the dimensions and dynamics of their fetal stomach during pregnancy.

Material and method

135 pregnant women were included in the study ; they were examined with transvaginal and transabdominal ultrasound between January 2016 and January 2019. The evolution of pregnancy and delivering were normal. In each case, sagittal, transverse and longitudinal diameters of the stomach as well as fetal biparietal diameter and abdominal circumference were measured. Gestational age was calculated from the date of the last menstrual period. Statistics analysis was performed using SPSS v. 19.

Gestational age groups (gestational age, GA) were noted as follows :

- Group 1-13-15 weeks ;
- Group 2-weeks 16-18 ;
- Group 3-weeks 19-21 ;
- Group 4-weeks 22-24 ;
- Group 5- weeks 25-27 ;
- Group 6-weeks 28-30 ;
- Group 7-weeks 31-33 ;
- Group 8-weeks 34-36 ;
- Group 9-weeks 37-40 ;

The variables included in the study were :

- The length of the stomach (the longitudinal diameter)-Longstom, L ;
- Transverse diameter-transvstom, T ;
- Sagittal diameter-apstom, S ;
- Biparietal diameter-DBP ;
- Abdominal circumference-AC.

RESULTS

Each group of gestational age included 15 cases.

For weeks 13-15, the values obtained from the statistical analysis were the following (table 1).

For longitudinal diameter, measured values are between 3.5 and 8.4 mm, with a mean of 6.18 ± 1.51 mm.

For transverse diameter, measured values are between 2 and 6 mm with a mean of 4,38 ±1.25 mm.

For sagittal diameter, measured values are between 1.6 and 5.4 mm, with a mean of 3.4 ± 1.07 mm.

For weeks 16-18, the results look like this (table 2).

- For the longitudinal diameter of stomach the mean value is 9.84 ± 2.85 mm with values contained in the interval 6-15.5 mm
- For transverse diameter the mean value is 5.95 ± 2.1 mm, the values being in the range 2.7-9,5 mm
- For sagittal diameter the mean is 7.78± 3.77 mm, the measured values being in the range 3-15.1 mm

Note that all mean values have grown from the previous group of gestational age.

For weeks 19-21, the results look like this (table 3).

For longitudinal diameter, mean value is 3.52 ±11.62 mm with minimum value of 6.7 mm and maximum value of 17.5 mm.

For transverse diameter mean value is 8.16 mm ± 3.03, with a minimum of 3.8 mm and a maximum of 13.8 mm.

For saggital diameter, the mean value is 10.8±3.18 mm, the minimum value is 6.1 mm, and the maximum value is 16.2 mm.

The results of the statistical analysis for weeks 22-24 are summarized in table below (table 4).

In this group, the longitudinal diameter mean value is 15.33± 5.95 mm, values being between 7.3-26.3 mm. For the transverse diameter, the mean value is 8.92 ±3.32 mm values being within 4.3-14.3 mm. The sagittal diameter has a mean value of 11.57 ± 4.09 mm values being contained between 5.5-20.1 mm.

For 25-27 weeks, the results look like this (table 5).

- the mean value of longitudinal diameter is 17.46 ± 6.37 mm, with a minimum of 8.9 and a maximum of 28.5 mm.
- the mean value of transverse diameter is 8.24 ± 2.63 mm, with a minimum of 4.7 mm and a maximum of 12.9 mm
- the mean value of the sagittal diameter is 14.72 ± 6.26 mm, with a minimum of 5.80 mm and a maximum of 24.8 mm

For weeks 28-30, the values obtained from the statistical analysis are presented below (table 6).

Longitudinal diameter values are between 8.2-37.2 mm with a mean value of 20.98 ± 9.81 mm. Transverse diameter values are between 5.6-24.8 mm with a mean of 13.54 ± 6.34 mm. Sagittal diameter values are between 7.2-27.5 mm, with a mean of 18.79 ± 6.69 mm.

TABLE 1

Statistics				
		L1315	T1315	S1315
N	Valid	15	15	15
Mean		6.1867	4.3800	3.4067
STD. Error of Mean		39132,	, 32414	, 27868
Median		6.2000	4.6000	3.5000
Mode		6.20	3.10	3.50
Std. Deviation		1.51557	1.25539	1.07933
Variance		2.297	1.576	1.165
Skewness		-253	-648	-057
STD. Error of Skewness		, 580	, 580	, 580
Minimum		3.50	2.00	1.60
Maximum		8.40	6.00	5.40

TABLE 2

Statistics				
		L1618	T1618	S1618
N	Valid	15	15	15
	Missing	120	120	120
Mean		9.8400	5.9533	7.7800
STD. Error of Mean		, 73800	54282,	, 97342
Median		9.8000	5.9000	7.8000
Mode		6.00[to]	2.70[to]	3.00[to]
Std. Deviation		2.85827	2.10233	3.77003
Variance		8.170	4.420	14.213
Skewness		, 350	, 227	, 474
STD. Error of Skewness		, 580	, 580	, 580
Minimum		6.00	2.70	3.00
Maximum		15.50	9.50	15.10

TABLE 3

Statistics				
		L1921	T1921	S1921
N	Valid	15	15	15
	Missing	120	120	120
Mean		11.6200	8.1667	10.8067
STD. Error of Mean		, 90901	, 78393	82216,
Median		11.5000	8.1000	10.8000
Mode		6.70[to]	3.80[to]	6.10[the]
Std. Deviation		3.52059	3.03613	3.18422
Variance		12.395	9.218	10.139
Skewness		, 234	, 361	, 155
STD. Error of Skewness		, 580	, 580	, 580
Minimum		6.70	3.80	6.10
Maximum		17.50	13.80	16.20

For weeks 31-33, the results look like this (table 7).

Longitudinal diameter values are in the interval 9.3-43.6 mm with a mean of 25.54 $\pm$ 10.19 mm. Transverse diameter values are in the interval 6.5-22.7 mm with a mean of 12.49 $\pm$ 4.65 mm. Longitudinal diameter values are in the interval 8.3-33.4 mm, with a mean of 19.24 $\pm$7.81 mm.

For weeks 34-36, results are presented in the table below (table 8).

Longitudinal diameter values are in the in-

TABLE 4

Statistics				
		L2224	T2224	S2224
N	Valid	15	15	15
	Missing	120	120	120
Mean		15.3333	8.9267	11.5733
STD. Error of Mean		1.53681	, 85782	1.05702
Median		14.9000	8.9000	11.8000
Mode		7.30[to]	4.30[to]	5.50[to]
Std. Deviation		5.95203	3.32232	4.09380
Variance		35.427	11.038	16.759
Skewness		, 301	, 163	, 406
STD. Error of Skewness		, 580	, 580	, 580
Minimum		7.30	4.30	5.50
Maximum		26.30	14.30	20.10

TABLE 5

Statistics				
		L2527	T2527	S2527
N	Valid	15	15	15
	Missing	120	120	120
Mean		17,4667	8,2467	14,7267
Std. Error of Mean		1,64521	,67984	1,61736
Median		17,1000	7,9000	14,8000
Mode		8,90[a]	4,70[a]	5,80[a]
Std. Deviation		6,37189	2,63300	6,26401
Variance		40,601	6,933	39,238
Skewness		,206	,377	,100
Std. Error of Skewness		,580	,580	,580
Minimum		8,90	4,70	5,80
Maximum		28,50	12,90	24,80

TABLE 6

Statistics				
		L2830	T2830	S2830
N	Valid	15	15	15
	Missing	120	120	120
Mean		20,9800	13,5400	18,7933
Std. Error of Mean		2,53470	1,63910	1,72744
Median		19,8000	12,3000	19,7000
Mode		8,20[a]	5,60[a]	7,20[a]
Std. Deviation		9,81684	6,34821	6,69034
Variance		96,370	40,300	44,761
Skewness		,309	,493	-,411
Std. Error of Skewness		,580	,580	,580
Minimum		8,20	5,60	7,20
Maximum		37,20	24,80	27,50

terval 10.4-44.7 mm with a mean of 24.98 ± 10.62 mm. Transverse diameter values are within 7.2-20.9 mm with a mean of 15.55 ± 4.76 mm. Sagittal diameter values are in the interval 8.8-39,2 mm with a mean of 22.12 ± 9.12 mm.

The results of the statistical analysis for weeks 37-40 are listed below (table 9).

Longitudinal diameter values are in the interval 19.6-43.1 mm with a mean of 30.45 ± 7.39 mm. Transverse diameter values are in the interval 10.4-16.7 mm, with a mean of 12.84

TABLE 7

Statistics				
		L3133	T3133	S3133
N	Valid	15	15	15
	Missing	120	120	120
Mean		25,5400	12,4933	19,2400
Std. Error of Mean		2,63288	1,20319	2,01858
Median		25,8000	11,5000	17,9000
Mode		9,30[a]	6,50[a]	8,30[a]
Std. Deviation		10,19711	4,65993	7,81791
Variance		103,981	21,715	61,120
Skewness		,071	,706	,394
Std. Error of Skewness		,580	,580	,580
Minimum		9,30	6,50	8,30
Maximum		43,60	22,70	33,40

TABLE 8

Statistics				
		L3436	T3436	S3436
N	Valid	15	15	15
	Missing	120	120	120
Mean		24,9800	15,5533	22,1267
Std. Error of Mean		2,74367	1,23083	2,35652
Median		24,5000	17,8000	21,4000
Mode		10,40[a]	7,20[a]	8,80[a]
Std. Deviation		10,62619	4,76698	9,12676
Variance		112,916	22,724	83,298
Skewness		,231	-,542	,350
Std. Error of Skewness		,580	,580	,580
Minimum		10,40	7,20	8,80
Maximum		44,70	20,90	39,20

TABLE 9

Statistics				
		L3740	T3740	S3740
N	Valid	15	15	15
	Missing	120	120	120
Mean		30,4533	12,8400	24,2933
Std. Error of Mean		1,90855	,47598	1,55953
Median		30,2000	12,5000	25,5000
Mode		19,60[a]	10,40[a]	14,50[a]
Std. Deviation		7,39178	1,84344	6,04004
Variance		54,638	3,398	36,482
Skewness		,188	,583	-,295
Std. Error of Skewness		,580	,580	,580
Minimum		19,60	10,40	14,50
Maximum		43,10	16,70	32,50

$\pm$ 1.84 mm. Sagittal diameter values are in the interval 14.5-32.5 mm, with a mean of 24.89 $\pm$ 6.04 mm.

We analyzed statistically the correlation between gestational age, the size of the stomach, abdominal circumference and biparietal diameter. Evaluation of statistical significance of the correlation has been made on the basis of Pearson coefficient (table 10).

It can be seen that all the variables are statistically significant correlated (p value $\leq$ 0.01). Of these, the strongest correlation is

TABLE 10

Correlations							
		varstagest	lungst	transvst	apst	DBP	CA
varstagest	Pearson Correlation	1	,733**	,651**	,751**	,891**	,851**
	Sig. (2-tailed)		,000	,000	,000	,000	,000
	N	135	135	135	135	135	135
lungst	Pearson Correlation	,733**	1	,919**	,979**	,879**	,779**
	Sig. (2-tailed)	,000		,000	,000	,000	,000
	N	135	135	135	135	135	135
transvst	Pearson Correlation	,651**	,919**	1	,924**	,724**	,667**
	Sig. (2-tailed)	,000	,000		,000	,000	,000
	N	135	135	135	135	135	135
apst	Pearson Correlation	,751**	,979**	,924**	1	,794**	,794**
	Sig. (2-tailed)	,000	,000	,000		,000	,000
	N	135	135	135	135	135	135
DBP	Pearson Correlation	,891**	,879**	,724**	,794**	1	,989**
	Sig. (2-tailed)	,000	,000	,000	,000		,000
	N	135	135	135	135	135	135
AC	Pearson Correlation	,851**	,779**	,667**	,794**	,989**	1
	Sig. (2-tailed)	,000	,000	,000	,000	,000	
	N	135	135	135	135	135	135

**. Correlation is significant at the 0.01 level (2-tailed).

between gestational age and sagittal diameter, followed by the longitudinal and transverse diameter. Regarding the biparietal diameter, the strongest correlation is between it and the longitudinal diameter, and for abdominal circumference, the strongest correlation is with longitudinal diameter.

DISCUSSION

The study of the evolution of dimensions of the stomach according to gestational age was achieved using real-time ultrasonografic examination. There are several studies that have measured the dimensions of the stomach during pregnancy as an index of the normal or pathological evolution of the digestive tract. If, after repeated investigations, the stomach cannot be viewed, the fetuses have a higher incidence of malformation defects and abnormal volume of amniotic fluid.

Brumfield et al. (7) have noticed that out of the 26 fetuses with stomach that could not be viewed, 65 percent had digestive tract malformations, and the survival rate was only 29%. The remaining 35% of fetuses with no visible structural abnormalities, had abnormal volume of amniotic fluid, and survival among them was 50%. However, there is no universally accepted standard regarding the ability of the stomach size to predict the existence and prognosis of congenital digestive tract malformations.

In the study of Kumral Kepkep (7) there was a significant correlation between fetal size and gestational age of the stomach and abdominal circumference. The same correlation has been observed in the study of Goldstein et al. (5) which included 152 fetuses evaluated between 9 and 40 weeks of gestational age. Sase et al. (6), in a study that included 386 fetuses between 18 and 39 weeks, they found that the surface of the stomach correlate with gestational age and biparietal diameter and volume of stomach. However, the coefficient of correlation between gestational age and stomach area has the lowest value. The authors have stated that we can use gastric area ratio, defined as the ratio between the surface of the stomach and abdomen area crosssection measured at the level of the stomach, to track the evolution of the stomach because this ratio is constant throughout pregnancy. Furthermore, they noted that the standard deviation of dimensions of the stomach increases with gestational age, which makes the size of the stomach to have a limited predictive capability regarding congenital anomalies of the digestive system, especially in the latter part of pregnancy. In the study of Nagata and Cooper (8) measurements were performed on 618 fetuses between 16 and 41 weeks of gestational age. The authors described 4 stages of evolution of the dimensions of the stomach during pregnancy. Thus, the authors have re-

ported an increase in linear dimensions between weeks 16/17 and 26/27 (phase 1), then the dimensions were constant during 26/27-32/33 weeks (phase 2), increased again during 32/33-36/37 weeks (phase 3) , then tumbled during the last weeks of pregnancy (phase 4). Kepkep et al have contradicted these findings, stating that, in their study, it was observed a linear increase throughout pregnancy, explaining that the results may be due to gastric peristaltic movements, which has influenced the results of the measurements.

In this study, we have found correlations between the stomach size, gestational age and biparietal diameter and abdominal circumference Also, as in the above mentioned studies, we have found that the standard deviation values have increased.

The incapacity to visualize the stomach before the 14th week may be due to reduced amounts of amniotic fluid when fetus swallows, a quantity that cannot fill the stomach. In addition, a unique transabdominal ultrasound examination may not be enough. In Kepkep Kumral et al.(7) study, if the stomach could not be visualized, the examination was repeated after 15-30 minutes, or, in a few cases, the next day, and in all cases the stomach could be viewed.

Perkindil et al. (9) reported that the value of abdominal circumference increased linearly up to week 24, then this value rose slightly by the end of pregnancy and found that the ratio between the circumference of the stomach and abdominal circumference may be used to appreciate the dimensions of the fetal stomach. The same conclusion presented Kepkep et al. who asserted that the value of this ratio is 1/3, constant throughout pregnancy. The same thing was said about the ratio between anteroposterior diameter of the fetal stomach and gestational age.

CONCLUSIONS

The correct evaluation of digestive tract length and normal reference values are important for clinical practice, especially with regard to proper planning, prognosis and postoperative management of stomach congenital anomalies.

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