

Fetal thoracic aorta doppler in cases with intrauterine growth restriction

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Summary

Purpose: Considering the accompanying hemodynamic changes Doppler studies have recently been performed for early diagnosis of intrauterine growth restriction (IUGR) cases with high morbidity and mortality. In the present study, Doppler study of the fetal thoracic aorta was conducted and the sensitivity and specificity of the study was assessed in the diagnosis and follow-up of IUGR, as well as prediction of pregnancy outcome.

Methods: This study included 44 IUGR cases and 52 healthy pregnant women (as a control group); Doppler waveforms of the fetal aortas were used to predict fetal outcome in pregnancies complicated with IUGR. Due to the short interval between the diagnosis of IUGR and delivery, the Doppler measurement could be redone for only 11 pregnant women in the control group; Doppler measurement could be done twice.

Results: There was no significant difference between the study group and the control group in terms of maternal age. There were significant differences in terms of gestational age, birth weight, pulsatility index, blood pressure and first minute apgar score. Of the 44 IUGR cases, there were additional pathologies such as hypertension, DM and oligohydroamniosis, while there was no significant malfunction in the control group.

Conclusion: We observed a decrease in the aortic blood flow and a high pulsatility index, which was an independent variable in the IUGR group. A high PI was strongly correlated with bad pregnancy outcome, fetal distress and a high cesarean section rate.

Key words: Intrauterine growth retardation; Fetal thoracic aorta; Doppler.

Introduction

One of the main targets of perinatologists is the early diagnosis of intrauterine growth restriction (IUGR), which carries a risk of morbidity and mortality approximately 3-10 times higher when compared with normal pregnancies. The fetuses with IUGR may provide insufficient compensation mechanisms when compared with the normal fetus and eventually a fetal distress syndrome will develop [1].

In addition to detailed information concerning the fetal weight and the gestational age, the diagnosis of IUGR has become easier with the routine use of ultrasound. IUGR may be related to hemodynamic alterations due to failure of fetal-maternal circulation, and in recent years, Doppler ultrasound has been utilized for early diagnosis in cases where risk of prenatal morbidity and mortality is considerably higher. In the present study, the relation between IUGR and the prediction of fetal distress using Doppler examination of the fetal thoracic aorta was investigated.

Patients and Methods

An approach to intrauterine growth restriction by Doppler wave analyses focused on the fetal thoracic aorta was investigated. The study group was hospitalized and included 44 pregnant women who were diagnosed with IUGR. The control group included 52 healthy pregnant women who had applied to the outpatient center of our hospital. The control group was matched in age, number of pregnancies and gestational age.

Cases of pregnant women who did not have a definite menstruation date and those who had been using oral contraceptives in order to avoid pregnancy were excluded from the study. In order to make a diagnosis of IUGR, measurements such as fetal abdominal circumference, biparietal diameter, and femur length values were considered. Fetal biometry measurement was below the 10th percentile and pregnancy growth restriction in following sonographic examinations. The same obstetrician, using a Toshiba SonoLayer SSA-270A color Doppler ultrasound device, made all of the measurements. Usher and Molcam normograms were used for diagnosis of IUGR.

With cases receiving the IUGR diagnosis – since the interval before the labor was very short – a second round of Doppler analyses was performed on only 11 cases. In the control group, four measurements were performed at an interval of four weeks. All of the measurements were made when no fetal movement or respiration were present. The fetal thoracic aorta was seen by the aid of a real time ultrasound and color Doppler waveform. The measurements were done when four cardiac cycles which displayed similar maximum systolic velocities appeared on the screen simultaneously. In all cases, the Pulsatility Index (PI), which is an independent index, was calculated as an outcome measure.

Clinically, cases were evaluated in terms of the cessation of growth until labor by ultrasonographic biometry, the amount of the amniotic fluid, results obtained from antenatal and intrapartum cardiotocography, and the mothers' medical condition. When the obtained results were assessed, the control group was compared with the IUGR group based on PI, one minute Apgar Scale, birth weight, form of labor, maternal age, amount of amniotic fluid, stillbirth, caesarean section or normal labor and hypertension during pregnancy. The student's t-test was applied when comparing values between the groups; values of $p < 0.05$ were accepted as statistically significant.

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Results

In the present study, the 44 cases in the IUGR group and 52 cases comprising the control group were compared according to maternal age, gestational age, birth weight, and pulsatility index (Table 1). Pregnancy outcome in terms of route of delivery and other study parameters is shown in Table 2. Of the 44 IUGR cases, 34 had an additional pathological condition such as hypertension, diabetes and oligohydramnios which might cause complications during pregnancy (Table 3). No pathological condition was determined in the control group.

When assessing the fetal Apgar scores, for one minute Apgar, 7 and over was accepted as normal while less than 7 was considered abnormal. Forty cases in the IUGR group (91%) and six cases in the control group (12%) were considered to have a value corresponding to a low Apgar score. The PI was abnormally high in 24 (54.5%) of the 44 IUGR cases and in seven (13.5%) of the 52 control cases. The difference between the groups was statistically significant ($p < 0.001$). The alteration in the PI of the fetal thoracic aorta in the IUGR cases where an additional pathological condition was present is shown in Table 3. The PI value tended to increase when pathological conditions which cause utero-placental blood flow to decrease, such as preeclampsia, chronic hypertension, etc., were present (Table 4).

Of the 44 cases in the IUGR group, 33 cases (75%) developed fetal distress syndrome. Of these 33 cases, stillbirth was observed in three cases (7%). Of the 52 cases in the control group, five cases (9.6%) underwent cesarean section; two cases underwent an elective cesarean section, two cases had developed fetal distress, and one case required caesarean section due to cephalopelvic disproportion. Of the 33 cases in the IUGR group who had fetal distress syndrome, 17 cases that underwent caesarean section due to fetal distress had high PI values. The three cases of stillbirth and four cases of the eight in the IUGR group that underwent normal labor, had high PI values also.

Discussion

Compared to the control group, the PI values in the IUGR group displayed a significant increase. Previous studies have also reported a significant increase in the PI [2-4]. These values reveal significant hemodynamic alterations at the aorta of the fetus in intrauterine developmental retardation. Particularly, the PI, an independent variable, is an important parameter which displays the resistance of the vascular bed at the distal end of the measurement site. It has been reported that this value is not influenced by the gestational age [3, 5-7]. However, the PI value of the thoracic aorta may not reflect only the vascular hemodynamics of the placenta. The total resistance of the measured site displays the resistance of the fetal circulatory system distal to the measured site. Thus, the placental resistance at the vascular bed of the internal organs and the lower extremities is added to that of the

Table 1. — *Essential data of the cases.*

	IUGR Group (n=44)	Control Group (n=52)	p value
Maternal age (x \pm SD)	25.61 \pm 4.37	25.79 \pm 5.81	>0.2
Age by gestation (x \pm SD)	31.52 \pm 5.28	35.27 \pm 3.73	<0.001
Birth weight (g) (x \pm SD)	1790 \pm 628	3374 \pm 379	<0.001
Systolic blood pressure (x \pm SD) (mmHg)	129 \pm 18	116 \pm 11	<0.001
Diastolic blood pressure (x \pm SD) (mmHg)	84 \pm 15	75 \pm 8	<0.01
PI (x \pm SD)	2.03 \pm 0.24	1.69 \pm 0.08	<0.001

Table 2. — *Pregnancy outcome in terms of route of delivery and other study parameters.*

	Control group (n=52)	IUGR group (n=44)
Normal Labor	47	8
Cesarean section	5	17
Stillbirth	—	3
Additional pathologies	—	34
Low Apgar score	6	40
High PI value	7	24
Fetal distress	2	33

Table 3. — *Additional pathological conditions observed with IUGR.*

	N	%
IUGR + Preeclampsia	16	37
IUGR + Chronic hypertension	3	7
IUGR + Oligohydroamnios	7	16
IUGR + Preeclampsia + Oligohydroamnios	5	11
IUGR + Over term	1	2.5
IUGR + Over term + Oligohydroamnios	2	5

Table 4. — *Fetal aorta PI values when additional pathological conditions were present with IUGR.*

	PI
IUGR + Chronic hypertension	2.22
IUGR + Preeclampsia	1.97
IUGR + Oligohydroamnios	1.73
IUGR + Preeclampsia + Oligohydroamnios	2.08
IUGR + Over term	1.76
IUGR + Over term + Oligohydroamnios	2.00
IUGR	1.88

placental bed. Our approach to IUGR cases can be summarized as daily NST till maturation was achieved and a decision to perform a caesarean section when fetal distress had developed.

In a study carried out by Laurin *et al.*, 93% of the IUGR cases that had developed fetal distress had high PI values [8]. In conditions where fetal thoracic aorta blood flow is considered abnormal, it is well known that maternal hypertension may be accompanied by intrauterine developmental retardation [5, 8]. In the present study, high PI values were determined in ten cases out of 16 (71%) cases of IUGR due to maternal hypertension. Similarly, in cases which had abnormal blood flow, oligohydramnios was common [8]. High PI values were

determined in all seven of seven cases who had oligohydramnios. It has been reported that alterations in velocity waveforms at the descending fetal aorta appeared before cardiotocographical changes [4, 9]. In our study, alterations observed in the fetal aorta velocity waveform partially reflected the changes observed in the IUGR group due to blood flow irregularity caused by chronic hypoxia related to IUGR. Similar findings in other studies support these data [3, 4, 8-10].

The fetuses, which are particularly affected by chronic hypoxia, may face severe damage caused by the stress of labor. The fetuses with IUGR may provide insufficient compensation mechanisms when compared with the normal fetus and eventually a fetal distress syndrome may develop [1]. Doppler studies may precede additional information in the prediction of fetal outcome, timing and route of delivery.

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