



Moderate Asphyxia in Intrauterine Growth Restriction of the Fetus - Cardiotocography and Ultrasound Methods of Diagnosis

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Abstract

Asphyxia remains an important cause for neonatal morbidity and mortality. The tests in themselves cardiotocography (NST), sonography, Doppler studies which are used for antenatal fetus surveillance are aimed at timely diagnosing the signs of the fetus asphyxia. The objective of the current research is to study which modifications in the cardiotocography (NST), arterial and venous Doppler correlate most strongly with moderate asphyxia $pH < 7.20$ and base excess (BE) < -12 mmol/l, regarding pregnancies which are complicated with intrauterine growth restriction of the fetus. At delivery totally 32 are the cases with moderate fetus asphyxia $pH < 7.20$ and BE < -12 mmol/l. Loss in reactivity in the non-stress test shows sensitivity 76.9%, specificity 46%, positive predictive value (PPV) 12.8%, negative predictive value (NPV) 95.1%, odds ratio (OR) 2.84, $p < 0.051$.

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The presence of spontaneous decelerations in the cardiotocography shows sensitivity 26.7%, specificity 87.1%, PPV 21.1, NPV 90.2%, odds ratio (OR) 2.45, $p < 0.166$, the elevated pulsatility index of umbilical artery shows sensitivity 14.3%, specificity 50%, PPV 3.1%, NPV 83.8%, OR 0.17, $p < 0.022$, absent end-diastolic velocity of the umbilical artery shows sensitivity 84.6%, specificity 60.3%, PPV 18%, NPV 97.4%, OR 84, $p < 0.007$, the elevated pulsatility index for veins (PIV) shows sensitivity 7.1%, specificity 52.8%, PPV 1.7%, NPV 83.5% OR 0.09, $p < 0.020$, reversed a-wave ductus venosus shows sensitivity 75%, specificity 39.4%, PPV 10.5% NPV 94.3% OR 1.9, $p < 0.334$. Concerning pregnant women with intrauterine growth restriction of the fetus the prognostication of moderate fetus asphyxia at delivery $\text{pH} < 7.20$ and $\text{BE} < -12 \text{ mmol/l}$ with the highest specificity of antenatal testing is the absent end-diastolic blood velocity of umbilical artery and the reversed a-wave ductus venosus in Doppler studies.

Key words: fetus asphyxia at delivery; intrauterine growth restriction of the fetus.

1. Introduction

Asphyxia is determined as a state of broken gas exchange, long-lasting standing which cause progressive hypoxemia, hypercapnia and development of metabolic acidosis.

The metabolic acidosis is defined as low pH and base deficit ($\text{BE} < -12 \text{ mmol/l}$) [1,5]. American College of Obstetricians and Gynecologists (ACOG) defines intrauterine growth retardation as fetuses with weigh below 10th percentile for the respective gestation week [3,9,10].

Intrauterine growth retardation is the second common cause after premature birth for increased risk of perinatal complications such as hypoxemia, academia, low Apgar score and with negative effect on neonatal results [8].

2. Materials and Methods

A prospective cohort study for the period 2012-2016 conducted at University Hospital Obstetrics and Gynecology "Maichin Dom", includes 140 pregnant women with intrauterine growth restriction of the fetus, out of whom 84 pregnant women with pre-eclampsia and intrauterine growth restriction of the fetus and 56 pregnant women with intrauterine growth restriction of the fetus as a result of placental insufficiency.

The growth restricted fetuses are these ones with abdominal circumference $< 10^{\text{th}}$ percentile and pulsatility index of the umbilical artery (AUMB) above two standard deviations for the respective gestation age.

They are arranged in three groups $\{-26+0 - 31+6\}$, $\{32+0 - 35+6\}$, $\{>36\}$ gestation week studied by means of cardiotocography, sonography and Doppler study of the uterine arteries, the umbilical artery, the middle cerebral artery, ductus venosus(DV) maximum to 3 days before delivery. The excluding criteria are as follows:

(a) fetal malformations

(b) abnormal fetal karyotype

(c) chorioamnionitis.

All pregnant women are examined by cardiotocography or fetus non-stress tests, with test continuity of 20 minutes. A non-stress test is viewed as normal, when the presence of accelerations of the fetus heart rate determining the test as reactive, has been ascertained.

The test reactivity is in line with the gestation age, respectively 26-29 gestation weeks, two 10-beat accelerations, each sustained for 10 seconds, 30-36 gestation weeks, two 15-beat accelerations, each sustained for 15 seconds, after 36 gestation weeks, two 20-beat accelerations, each sustained for 20 seconds. A non-stress test is regarded as abnormal when the pointed out criteria for reactivity are absent.

Doppler study of arterial and venous vessel umbilical artery, middle cerebral artery and ductus venosus have been conducted on all pregnant women. In Doppler study which includes the umbilical artery the measured pulsatility index is determined as abnormal when there is an increase above 2 standard deviations (SD) for the respective gestation week or absent/reversed end-diastolic velocity.

The pulsatility index for veins (PIV) of ductus venosus is determined as abnormal when it is above 2 SD for the respective gestation week and the ascertainment of reversed a-wave of ductus venosus during atrial systole.

The Doppler study has been conducted when there is absence of fetal movements of the fetus as well as movements of the mother.

A definition of pre-eclampsia referring to systolic pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg from two consecutive measurements within four hour interval, after 20 gestation week in previous normotensive condition and determined proteinuria from 300 mg for 24 hours or in albumin 2+ in normal urine, when there is incapability for 24 hour diuresis.

As regards the connection with the acid-base status at delivery, the antenatal testings have been conducted as close as possible to the delivery day. A blood test from the umbilical artery for determination of the values of pH and BE, the blood is taken out from the segment of umbilical cord clamped at delivery of the fetus.

The following values were accepted as abnormal: pH < 7.20 and BE < - 12 mmol/l from the umbilical artery. The specificity, the sensitivity, the positive and negative predictive value for each and every parameters have been worked out. The results were analyzed using SPSS 17.0

3. Results

140 pregnant women with intrauterine growth restriction of the fetus have been studied, out of whom 84 cases with pre-eclampsia and growth restriction of the fetus and 56 cases with growth restriction of the fetus as a result of placental insufficiency.

The average age of the female patients is 30 years of age, who gave birth through elective or urgent Caesarean

section. All pregnant women are examined by means of cardiotocography, sonography and Doppler of arterial and venous vessels of the fetus.

The main indications of delivery are pre-eclampsia (40.7%) in pregnant women, and the main indications in terms of fetus are the determined by means of sonography intrauterine growth restriction (IUGR – 51.4%). Moderate asphyxia pH<7.20 and BE< - 12 mmol/l from arterial blood has been ascertained in 32 from the new born babies (22.8%) Table 2.

The non-reassuring fetal heart rate test is the most frequently conducted abnormal test in pregnant women (82 cases (58.6%)). Absent end-diastolic velocity has been ascertained in 62 fetuses (44.3%). The modifications in the venous vessels - the elevated pulsatility index (PIV) of ductus venosus in 72 fetuses (51.4%), reversed a-wave of ductus venosus in 21 fetuses (15%).

The sensitivity, the specificity, the positive predictive value (PPV) and the negative predictive value (NPV) of the both tests have been worked out - cardiotocography and Doppler of the fetus vessels which are pointed out in Table 1 - towards pH < 7.20 and BE< - 12 mmol/l. Loss of reactivity in the non-stress test shows sensitivity 76.9%, specificity 46%, positive predictive value (PPV) 12.8%, negative predictive value (NPV) 95.1%, odds ratio (OR) 2.84, $p < 0.051$. The presence of spontaneous decelerations in the cardiotocography shows sensitivity 26.7%, specificity 87.1%, PPV 21.1%, NPV 90.2%, OR 2.45, $p < 0.166$, the elevated pulsatility index of the umbilical artery shows sensitivity 14.3%, specificity 50%, PPV 3.1%, NPV 83.8%, OR 0.17, $p < 0.022$, absent end-diastolic velocity of the umbilical artery shows sensitivity 84.6%, specificity 60.3%, PPV 18%, NPV 97.4%, OR 84.0, $p < 0.007$, the elevated pulsatility index for veins of ductus venosus shows sensitivity 7.1%, specificity 52.8%, PPV 1.7%, NPV 83.5% OR 0.09, $p < 0.020$, reversed a-wave of ductus venosus shows sensitivity 75%, specificity 39.4%, PPV 10.5%, NPV 94.3% OR 1.9, $p < 0.334$. We have found out that regarding newborns suffering from perinatal morbidity – 12 (8.6%) of whom have bronchopulmonary dysplasia, 2 (1.6%) of whom have necrotizing enterocolitis, 11 (7.9%) of whom have intraventricular haemorrhage. Mortality in postnatal has been registered regarding 11 (7.9%) newborns.

Table 1: Prediction of pH< 7,20 and BE<-12 mmol/l by individual antenatal testing parameters

Test	sensitivity(%)	specificity(%)	PPV(%)	NPV(%)	OR	P
Non-reactive non-stress test	76.9	46.0	12.8	95.1	2.84	0.051
Deceleration	26.7	87.1	21.1	90.2	2.45	0.166
AUMB elevated PI	14.3	50.0	3.1	83.8	0.17	0.022
AUMB absent EDV	84.6	60.3	18.0	97.4	84.0	0.007
DV elevated PIV	7.1	52.8	1.7	83.5	0.09	0.020
DV reversed a-wave	75.0	39.4	10.5	94.3	1.9	0.334

Table 2: Maternal demographics, Doppler and perinatal characteristics

Characteristic	N	%
maternal age(years, median (range))	29.1(17-44)	
parity		
para 0	73	52.1
para 1	37	26.4
para >2	30	21.4
Non-reactive non-stress test	82	58.6
Abnormal Doppler parameters		
AUMB absent EDV	62	44.3
Elevated DV Doppler index	72	51.4
Reversed DV a- wave	21	15
Gestational age at delivery (weeks, (median range))	30.4(26.0-39+6)	
Indication for delivery		
non-reassuring fetal heart rate	37	26.4
non-reassuring Doppler parameters	3	2.5
pre-eclampsia	57	40.7
IUGR	72	51.4
Elective Caesarean delivery	82	58.7
Cord artery pH<7.20	32	22.8
Neonatal morbidities		
bronchopulmonary dysplasia	12	8.6
necrotizing enterocolitis	2	1.6
Grade III/IV intraventricular haemorrhage	11	7.9
Neonatal death	11	7.9

4. Discussion

According to data of The World Health Organization 19% of all mortalities in neonatal period are due to asphyxia at birth. There is no golden standard for clinical or laboratory diagnosis of asphyxia at birth since there are no objective specific markers and because of the fact that the use of separate markers can also lead to accurately setting the diagnosis asphyxia. The recommendations are aiming at improvement of perinatal care of pregnant women, the use of cutting-edge technologies and staff training in terms of newborn care [2].

The fetuses with intrauterine growth restriction as a result of preeclampsia or placental insufficiency are at high risk of asphyxia at birth. The changes start intrauterine as a result of damaged blood flow which is caused by increased resistance in utero-placental unit and in umbilical arteries leading to decreased oxygen content,

hypoxia in the tissues and development of metabolic acidosis. These changes are occurring at a slower pace, they are growing within days to weeks [4].

The use of monitoring tests – cardiotocography, sonography, Doppler of arterial and venous vessels in pregnant women with intrauterine growth retardation - aims at determining the time of delivery and decreasing the neonatal morbidity and mortality. The relation between the antenatal tests with acid-base status of the newborn enables the determination of a test with highest predictive value or combination of tests which will assist in antenatal determining of the condition of the fetus [6,11].

In the current study the comparison of the tests shows that the loss in reactivity in the cardiotocography has high negative predictive value which determines the key role of cardiotocography in monitoring the condition of the retarded fetuses. The absent end-diastolic blood velocity of umbilical artery and the reversed a-wave ductus venosus in Doppler studies are in strict correlation with the changes in the acid-base condition of the fetus at delivery [7].

5. Conclusion

Concerning pregnant women with intrauterine growth restriction of the fetus the prognostication of moderate fetus asphyxia at delivery $pH < 7.20$ and $BE < - 12$ mmol/l with the highest specificity of antenatal testing is the absent end-diastolic blood velocity of umbilical artery and the reversed a-wave ductus venosus in Doppler studies.

The advent of absent end-diastolic blood velocity of the umbilical artery together with the reversed a-wave ductus venosus is indicative of urgent delivery regarding pregnancies complicated with intrauterine growth restriction of the fetus.

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