

Reduction of Doppler indexes in the middle cerebral artery in uncomplicated pregnancies at 40 weeks and beyond. What does it mean?: an original research.

Running head: Doppler in the Middle Cerebral Artery at 40 weeks.

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Abstract.

Objective

The aim of our data is reveal correlation between Doppler in the Middle Cerebral Artery and fetal suffering during labor in uncomplicated pregnancies at 40 weeks and beyond.

Design

1020 uncomplicated pregnant women at 40 weeks and beyond were examined by Doppler in umbilical artery and the Middle Cerebral Artery 48 hours before delivery. We analyzed fetus's condition during labor and just after.

Setting

After analyzing the state of the fetus in labor, we included 2 groups of women in the study: 1 - who gave vaginal birth without signs of fetal distress and 2-the labor ended with a cesarean section caused by fetal distress. In addition, we divided the entire group of women by Apgar score.

Population

260 women who were examined by Doppler in umbilical artery and the Middle Cerebral Artery 48 hours before delivery were included in the study because they met the inclusion criteria.

Methods

All women were divided into 2 groups according to fetus distress during labor (vaginal delivery and emergency Cesarean Section caused fetal distress). And according to newborn's condition just after delivery (Apgar score ≤ 7 and >7 on the 1st minute)

Result

In group of women with caesarean section caused by fetal distress pulsatility indexes were significant lower, than in group of women with vaginal labor (PI=1,12 and 0,98 respectively $P < 0,01$, CPR 1,44 and 1,26 respectively $P < 0,01$). We found out trigger level for pulsatility indexes as 0.835, if pulsatility indexes less 0.835 we have adverse perinatal outcome during labor. When $PI \leq 0,835$ fetal distress were in 66,7% cases, if $PI > 0,835$ in 39,1% cases ($P < 0,001$, OR= 3,1). When $PI \leq 0,835$ newborns had Apgar ≤ 7 in 37,5% and Apgar more than 8 in 20,3% ($P < 0,01$, OR-2,3)

Conclusion

Pulsatility indexes were lower in group of women whose newborns were in worse condition during delivery or just after than in group of women having babies in better conditions.

Pulsatility indexes in the Middle Cerebral Artery can be an indicator of fetal distress and can be useful as a marker of its poor outcome after delivery. Our data will certainly be useful for practical physicians. On the basis of these, it is possible to identify groups of risk of pregnant women with gestation age of more than 40 weeks.

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Key words: Doppler study, middle cerebral artery, pulsatility index, cerebroplacental ratio, brain-sparing effect.

Tweetable abstract

Pulsatility indexes(PI) in the Middle Cerebral Artery can be an indicator of fetal distress in uncomplicated pregnancy 40 weeks and beyond.

Introduction

Currently, the pages of periodicals are actively discussing the time and the way of delivery in cases of intrauterus growth restriction syndrome (IUGR), including multicenter studies in major centers of Europe, Canada and the USA [1-2]. The question of the timing and methods of post-term delivery of a normal pregnancy in 40 weeks of gestation or more remains poorly studied. While the practicing obstetricians face this dilemma several times a day.

The frequency of post-term pregnancy, according to various sources, ranges from 0.8-4% to 8-10% [3]. It is a well-known fact that during pregnancy lasting more than 40 weeks of gestational period (more than 280 days) there are involutive changes in the placenta which can lead to fetal hypoxia.

This is manifested in the following: changes in the placenta during ultrasound examination - petrificates, oligohydramnios, lack of growth in fetal biometric parameters during dynamic studies, large sizes of the fetus, decreased motor activity [4].

Doppler plays a great practical role to identify groups of fetuses in chronic hypoxia, that need to be closely monitored and treated. Evaluation of blood flow indexes in the middle cerebral artery gives better results in the diagnosis of intrauterine hypoxia than with a similar assessment of the umbilical artery [5].

It is currently known that in a state of chronic hypoxia, the so-called brain-sparing phenomenon in the fetus occurs when cardiac output with maximally oxygenated blood flows to the fetal brain [6-8].

There are a lot of researches of identification decrease in doppler indexes in the middle cerebral artery (MCA) at the phenomenon of brain sparing in the cases of IUGR[9-18].

The aim of our study was to analyze Doppler studies in umbilical arteries and middle cerebral artery in pregnant women during pregnancy of 40 weeks or more in uncomplicated pregnant women. Compare these dates with the outcome of delivery and the state of newborns after childbirth. Based on the dates identify a risk group among the above women for the development of hypoxic fetal damage during childbirth.

Materials and methods.

In our study, we performed Doppler in CMA, umbilical cord arteries, as well as cerebro-placental ratio for the period from 2014 to 2017 based on Maternity hospital #9, Saint-Petersburg, Russia. 1020 uncomplicated pregnant women at 40 weeks and beyond were examined by Doppler in umbilical artery and the Middle Cerebral Artery 48 hours before delivery. We analyzed fetus's condition during labor and just after. We estimated association of these measures with the percentage of caesarean section caused by fetal distress during labor and low Apgar score at 1 and 5 minutes after birth.

The study included patients with a gestational period of 40 weeks or more. The exclusion criteria were pregnant women with severe somatic pathology (chronic diseases, severe anemia, bronchial asthma, destructive diseases of the spine, etc.), as well as with pregnancy complications (preeclampsia, eclampsia, chronic uterine-placental insufficiency with IUGR, HELP- syndrome), having indications for planned caesarean section. Also multiple pregnancies, pregnant with scars on the uterus after myomectomy, caesarean section, pregnant with breech and transverse fetal position were excluded from the analysis.

Ultrasound and doppler examination of all pregnant women was carried out by Volusson E6, Volusson S6, Medison Accuvix V20 devices using transabdominal convex probes 3.5-5 MHz.

Doppler in the umbilical cord vessels was carried out in a free loop, that is, distant from the site of the umbilical cord attachment to the placenta and confluence with the fetal body. A study of blood flow in the middle cerebral artery was carried out with an increased image of the fetal head, by color Doppler the middle cerebral artery was detected, and the calipers of the spectral doppler were located on this vessel just above the Viliziev circle. The Doppler indices in the above-mentioned vessels were measured

several times (3-5) and the best, i.e. the lowest indices for the umbilical cord artery and the highest for the middle cerebral artery, were taken into the final results.

The frequency filter was set at 60 Hz, the angle of insolation did not exceed 30°, the width of the reference volume was selected to overlap the diameter of the vessel (Fig. 1). Blood flow profile registration and evaluation were performed during of fetus's motor rest and apnea, at rhythmic and normal heart rate corresponding to gestational period. Preference was given to automatic estimation of blood flow rates. We used standard Doppler indices, for cerebro-placental ratio (CPR) the ratio of pulsation index (PI) in the middle cerebral artery (MCA) to PI in the umbilical artery (UA) is taken.

The study included only that results performed no more than 48 hours before birth activities (!).

During that period, we analyzed 260 birth histories of pregnant women with a gestational period of more than 40 weeks at the time of ultrasound and Doppler examination.

The analysis of the study indicators of pregnant women was carried out using the STATISTICA for Windows system.

Results.

We had the following characteristics of the measures analyzed in 260 pregnant women (Table 1).

In the group of women with vaginal delivery, that is, the condition of the fetus did not require operative delivery, blood flow rates looked as follows (Table 2).

In the group of women whose delivery finished with caesarean section caused by fetus distress, blood flow rates were as follows (Table 3).

The figures below clearly show differences in pulsation index (PI) and cerebro-placental ratio (CPR) in groups of women with vaginal delivery and caesarean section (Fig.2- Figure 2. Spreading of pulsatility indices in two study groups. Fig 3.- Figure. 3 Spreading of cerebroplacental ratio in two study groups)

As can be seen from the obtained results, the lower indexes in the middle cerebral artery associated with poor condition of fetuses during labor, which requires emergency delivery by emergent caesarean section.

After statistic analyses of our dates we revealed trigger level of PI in MCA for increased risk of caesarean section. We established for PI in the middle cerebral artery this level is 0.835 (Table 4).

Also, if we had $CPR < 1$ and $PI \text{ in the MCA} \leq 0,835$, the risk of Apgar score at the 1st minute less than 7 points is significantly increased (Table 5):

Discussion and conclusions

In our study, Doppler indexes in the Middle cerebral arteries were significantly lower in the group of women whose delivery was complicated by fetus distress which required emergency delivery by caesarean section surgery.

In addition, during our study, there were 2 deaths of a newborn. In one case, at the gestation period of 40 weeks, 6 days, a Doppler study was carried out, the PI value in the MCA was 0.54, the $CPR < 1$. An emergency caesarean section was performed, as a result of which a child was born with 1 Apgar score at 1st minute, resuscitation measures

were ineffective. The cause of death on autopsy: asphyxia, which arose as a result of an acute disorder of utero-placental blood flow.

In the second case, the pregnant woman felt reduce of fetal movement in a period of 38 weeks and 6 days, by doppler a decrease in blood flow resistance indices was revealed: PI in the MCA was 0.63, CPR < 1, during cardiotocography deep decelerations were revealed, in connection with it an emergency cesarean section was performed. As a result, a live boy was born with Apgar score at 1st minute 4 points, despite the intensive care measures, the child died 2 hours after giving birth. Pathological diagnosis: intranatal asphyxia, massive aspiration of meconial near-ground waters. The last case was not included in the study due to a gestational period of less than 40 weeks, in addition, in a history of pregnant women, previous births occurred by caesarean section.

Ott, investigating a cohort of 447 pregnant women, revealed the predictive significance of CPR for an unfavorable neonatal condition. Performing Doppler 10 days before childbirth, they took as normal values of this indicator as more than 1.1 [19]. With CPR < 1.1, the percentage of emergency delivery by caesarean section increased from 7.6% to 24.6%. However, the results are difficult to compare, since the group of women studied included pregnant women with a gestation period of not only more than 40 weeks, but also earlier ones, as well as pregnancies complicated by hypertension. Polish researchers Ropacka-Lesiak et al. examined Doppler indexes in the Middle cerebral artery in 148 patients with uncomplicated full-term pregnancy [20]. As a result, it was concluded that the pulsation index (PI) in the middle cerebral artery (MCA) has greater prognostic significance than the resistance index (RI) in relation to impaired fetal heart rate during delivery, impaired acid-base ratio in umbilical cord blood.

Palacio et al. in their study of pregnant women at 41-42 weeks 6 days proposed norms for resistance indices in MCA and UA [21]. The normal values of these indicators were slightly wider than previously reported in the literature. The researchers determine these changes in blood flow by involutive processes in the placenta, which leads to an increase of neonatal mortality and their worse condition immediately after childbirth, and are similar to those that occur in IUGR. However, in post-term pregnancy, there is no increase in PI in the umbilical cord arteries, which indicates the absence of a chronic course of vascular pathology in the placenta.

Jain et al. also investigated CPR as a prognostic marker for fetal adaptation reduction. They found that decreased CPR correlated with fetal distress in childbirth, the need for newborn intensive care unit [22]. Comparing CPR and blood flow rates in the umbilical cord artery, they concluded that the first indicator has a specificity higher for diagnosing the condition of fetal-placental blood flow.

We can make a conclusion to our study that PI in the MCA can be an indicator of fetal distress and can be useful as a marker of its poor outcome after delivery. Our data will certainly be useful for practical physicians. On the basis of these, it is possible to identify groups of risk of pregnant women with gestation age of more than 40 weeks, for whom more careful observation is required, rejection stimulating therapy during childbirth, timely operative delivery in order to prevent damage to the neonatal nervous system.

So we made a special algorithm of management such group of women in hospital and outpatient cases (Fig. 4- Algorithm of management of women with pregnant gestation age 40 weeks and more)

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Contribution to authorship:

Semenova E.R.- took part in conception of investigation, carrying out examinations and collect results, analyzing results and writing up this work.

Ruhliada N.N.- took part in conception and edition of writing this work.

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Tab.1 Parameters in examined group:

Indicator	Mean value	Min. ÷ Max
Age	29,69±4,50	18÷41
Fetal weight at birth, gr	3543,73±420,46	2400÷4880
Fetal growth at birth, cm	52,42±1,97	47÷59
Apgar scale for 1 min	7,70±0,73	1÷8
Apgar scale for 5 minutes	8,69±0,76	0÷9
Amniotic index	88,54±49,88	0÷270

Tab. 2. Doppler parameters in umbilical arteries and middle cerebral arteries in group of women with vaginal delivery.

Indicator	mean value	standard deviation	Minimum	Maximum	Mediana
Amniotic index, mm	87,70	45,34	9	240	74
S/D in MCA	3,03	0,64	1,73	5,45	3,01
IR in MCA	0,65	0,08	0,34	0,93	0,67
PI in MCA	1,12	0,24	0,56	2,16	1,12
S/D in AU	2,37	0,31	1,66	3,31	2,34
IR in AU	0,52	0,09	0,34	0,85	0,53
PI in AU	0,81	0,17	0,46	1,34	0,8
CPR	1,44	0,46	0,5773	3,1666	1,3814
Fetal weight at birth, gr	3567,5	369,81	2670	4500	3550
Apgar scale for 1 min	7,80	0,62	2	8	8
Apgar scale for 5 minutes	8,81	0,52	5	9	9
Age	30,17	4,75	18	41	30

Tab. 3. Doppler parameters in umbilical arteries and middle cerebral arteries in group of women with cesarean section.

Indicator	mean value	standard deviation	Minimum	Maximum	Mediana
Amniotic index, mm	89,60	55,26	0	270	80
S/D in MCA	2,65	0,58	1,68	4,57	2,46
IR in MCA	0,61	0,09	0,37	0,8	0,59
PI in MCA	0,98	0,24	0,57	2,15	0,93
S/D in AU	2,39	0,30	1,75	3	2,38
IR in AU	0,54	0,08	0,37	0,75	0,55
PI in AU	0,82	0,16	0,51	1,34	0,8

CPR	1,26	0,41	0,58	2,75	1,18
Fetal weight at birth, gr	3513,65	476,71	2400	4880	3500
Apgar scale for 1 min	7,58	0,84	1	8	8
Apgar scale for 5 minutes	8,55	0,98	0	9	9
Age	29,11	4,12	19	40	29

Tab.4. Evaluation of trigger level in study groups.

Indicator	Vaginal delivery	Caesarian section	Total	P<0,01 OR-2,32065
CPR >= 1	122	80	202	
Percentage	60,40%	39,60%		
CPR < 1	23	35	58	
Percentage	39,66%	60,34%		
Total	145	115	260	
Percentage	55,77%	44,23%	100,00%	

PI in CMA >0,835	129	83	212	P<0,001 OR-3,10843
Percentage	60,85%	39,15%		
PI in CMA <= 0,835	16	32	48	
Percentage	33,33%	66,67%		
Total	145	115	260	
Percentage	55,77%	44,23%	100,00%	

Tab. 5. Statistical analysis of Doppler indices in groups, divided according to neonatal outcome.

INDICATOR	Apgar scale for 1 min 8 and more	Apgar scale for 1 min 7 and less	Total
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CPR >= 1	161	41	202	
Percentage	79,70%	20,30%		
CPR < 1	38	20	58	*
Percentage	65,52%	34,48%		
Total	199	61	260	OR-,06675 2
Percentage	76,54%	23,46%	100,00%	
PI in CMA >0,835	169	43	212	
Percentage	79,72%	20,28%		
PI in CMA <= 0,835	30	18	48	*
Percentage	62,50%	37,50%		
Total	199	61	260	OR- 2,35814
Percentage	76,54%	23,46%	100,00%	