The Journal of Obstetrics and Gynecology of India (November–December 2019) 69(6):509–513
https://doi.org/10.1007/s13224-019-01250-2

ORIGINAL ARTICLE

Association Between Fetal Middle Cerebral Artery and Umbilical Artery Doppler Ratio with Fetal Distress in 38–40 Weeks of Gestation

Sara Masihi[1] · Roshan Nikbakht[1] · Mojgan Barati[1] · Mohammad Momen Gharibvand[1] · Azam Jadidi[1]

Received: 15 January 2019 / Accepted: 24 June 2019 / Published online: 17 July 2019

Abstract

Background and Objective Knowing the factors affecting fetal distress is of particular importance in improving prognosis in newborns. The study aimed to determine the relationship between fetal middle cerebral artery pulsatility indexes and umbilical artery Doppler ratio with fetal distress at 38–40 weeks of gestation.

Materials and Methods In this prospective cohort, 181 consecutive pregnant women with 38–40 weeks of gestational age were selected by a non-random convenience sampling method from January 2016 to January 2017. Women with labor pain and embryos with chromosomal and structural disorder were excluded. Color Doppler sonography was done for all of them, and the association of this ratio with fetal distress consequently was assessed as well.

Results In this study, abnormal amniotic fluid index (AFI) (1.1%), low birth weight (< 2500 g) (5.5%), emergency cesarean (11.6%), neonatal intensive care unit (NICU) admission (12.2%), low 5th minute Apgar (< 7) (0.6%), abnormal fetal monitoring (10.5%), fetal distress (11.6%), meconium aspiration syndrome (10.5%), and respiratory distress (3.9%) were present. The mean cerebroplacental ratio was 1.9. There was a significant association between low fetal middle cerebral artery pulsatility index and umbilical artery Doppler ratio with fetal distress, abnormal monitoring, and urgent cesarean ($P=0.006$). The cutoff 1.94 led to sensitivity, specificity, positive predictive value, and negative predictive value of 80.95, 50, 17.5, and 95.2%, respectively.

Conclusion It may be concluded that in our study a cutoff for fetal middle cerebral artery to umbilical artery ratio of 1.94 at 38 weeks was considered statistically significant in predicting fetal distress at 38–40 weeks. However, further studies with larger sample size and multi-center sampling would develop more definite results for wider application.

Keywords Cerebroplacental ratio · Color Doppler · Middle cerebral artery Doppler · Pulsatility Index · Umbilical artery Doppler

Introduction

Fetal distress leading to hypoxia-related neural tissue injury is a bothersome issue in the prenatal period [1]. Disordered fetal oxygen during labor may be affected by different mechanisms aggravated due to hypertension, diabetes mellitus, inflammatory diseases, chorioamnionitis, preterm labor, and fetal growth retardation leading to the exacerbated fetal distress [2]. Ultrasonographic fetal assessment with bi-dimensional color Doppler would help to diagnose the structural anomalies, rhythm abnormalities, and disordered fetal circulation [3]. Fetal growth retardation may be diagnosed by ultrasonography to prevent further problems, especially hypoxia, acidosis, and fetal death [4].

There are different prenatal tests to determine the optimal fetal oxygen supply such as biophysical profile, amniotic

Sara Masihi is a Associated Professor in Fertility Infertility and Perinatology Research Center, Ahvaz Jundishapur University of Medical Sciences. Roshan Nikbakht is a Associated Professor in Fertility Infertility and Prinatology Research Center, Ahvaz Jundishapur University of Medical Sciences. Mojgan Barati is a Associated Professor in Fertility Infertility and Prinatology Research Center, Ahvaz Jundishapur University of Medical Sciences. Mohammad Momen Gharibvand is a Associated Professor, Radiologist and Sonologist, Ahvaz Jundishapur University of Medical Sciences. Azam Jadidi is Resident Assistant Professor in Ahvaz Jundishapur University of Medical Sciences.

✉ Roshan Nikbakht
rosnikba@yahoo.com

[1] Obstetrics and Gynecology, School of Medicine, Fertility Infertility and Prinatology Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

fluid index (AFI), non-stress test (NST), contraction stress test (CST), and Doppler assessment of umbilical and middle cerebral arteries [5–7]. Doppler indices indirectly demonstrate blood flow impedance in these arteries, and there is a significant association between abnormal Doppler indices and fetal hypoxia, acidosis, and perinatal complications [3, 8], which are especially useful in the assessment of fetal health in high-risk pregnancies [9]. Crovetto has revealed that the increased ultrasonographic impedance in the umbilical artery and the decreased impedance in the middle cerebral artery are associated with fetal distress and academia [10]. Hence, in this study, we assessed the association between the fetal middle cerebral artery and the umbilical artery ratio on color Doppler sonography with fetal distress at 38-40 weeks of gestation.

Materials and Methods

The study protocol complies with the Helsinki Declaration and was approved by the Research Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (IR.AJUMS.REC.1396.1141-FIRC-9620). Institutional review board approval was obtained. In this prospective cohort, 181 consecutive subjects with 38-40 weeks of gestation pregnancy were enrolled at the University Hospitals in Ahvaz, Southwest of Iran from January 2016 to January 2017. The inclusion criteria for entering the study included women with 38–40 weeks of gestational age. They had uncomplicated pregnancies. Fetal age was based on the first trimester. Exclusion criteria were women with labor pain and the presence of chromosomal and structural disorders. A non-stress test (NST) and amniotic fluid index (AFI) were assessed weekly until pregnancy termination. Color Doppler ultrasonography assessment of middle cerebral and umbilical arteries was done (My Lab 70, Italy), and then, pulsatility index of the middle cerebral artery to umbilical artery was determined. It was compared according to the other variables, especially fetal distress. The umbilical artery was measured with color Doppler ultrasonography, and the waveforms were detected at the free loop portion of the umbilical cord. The middle cerebral artery was determined by color flow mapping at a transverse section of the fetal head at the level of the lesser wing of the sphenoid bone. All of the records were measured in the absence of fetal breathing and movement with the fetal heart rate between 120 and 160 bpm. Each record was calculated by at least three consecutive waves.

Pregnancy was terminated when NST was inactive, AFI less than 5 cm, BPS less than 8/10, and gestational age more than 40 weeks. Fetal monitoring was done routinely. A number of normal vaginal deliveries, cesarean sections via forceps, induced, or spontaneous were recorded. The newborn assessment included fifth minute Apgar, NICU admission, umbilical pH, cesarean for fetal distress, abnormal NST, meconium aspiration, and respiratory distress. Also, the association between these findings with CPR was assessed.

Data analysis was performed among 181 subjects using the SPSS (version 24.0) [Statistical Procedures for Social Sciences; Chicago, Illinois, USA]. The Chi-square, Fisher, independent-sample-T, Pearson, ROC analysis, and ANOVA tests were used, and P values less than 0.05 were considered statistically significant.

Results

The mean age was 29 ± 4.3 years. The mean body mass index was 29.8 ± 4.2 kg/m^2. The mean gravid and parity were 2 and 1, respectively. The mean gestational age was 38 weeks, and 22.7% of pregnant women were working out of the home. Hypertension, gestational diabetes, and other background diseases were reported by 3.9, 8.3, and 14.4%, respectively. Abnormal AFI, low birth weight (< 2500 g), emergency cesarean, NICU admission, low fifth minute Apgar (< 7), abnormal fetal monitoring, fetal distress, meconium aspiration syndrome, and respiratory distress were present in 1.1, 5.5, 11.6, 12.2, 0.6, 10.5, 11.6, 10.5, and 3.9%, respectively. The color Doppler results are demonstrated in Table 1.

As shown in Table 2, there was a significant association between low fetal middle cerebral artery and umbilical artery Doppler ratio with fetal distress, abnormal monitoring, and urgent cesarean.

The cutoff 1.94 led to sensitivity, specificity, PPV, and NPV of 80.95, 50, 17.5, and 95.2%, respectively (Fig. 1).

As shown in Table 3, the association between CPR with fetal distress was significant in non-diabetics ($P = 0.010$), patients without other background diseases ($P = 0.038$), and cesarean sections ($P = 0.008$).

Discussion

Knowing the factors affecting fetal distress is of particular importance in improving the prognosis of newborns. Therefore, this study investigated the relationship between fetal

Table 1 Color Doppler findings

Variable	Mean (SD)	Limit
Cerebral artery pulsatility index	1.4 (0.4)	0.6–2.5
Umbilical artery Pulsatility index	0.8 (02)	0.4–1.9
Cerebral/umbilical artery pulsatility index ratio	1.9 (0.6)	0.8–5

Table 2 Association between color Doppler findings with complications

Complication	CPR		
	Mean	SD	*P* value
AFI			
Normal	1.93	0.64	< 0.05
Abnormal	1.97	0.83	
LBW			
Yes	1.84	0.64	< 0.05
No	1.94	0.64	
Cesarean			
Emergency for fetal distress	1.72	0.55	0.017
NICU			
Yes	1.94	0.64	< 0.05
No	1.93	0.64	
fifth minute Apgar			
7	1.75	–	< 0.05
8	1.78	0.88	
9	1.84	0.56	
10	1.96	0.64	
Fetal monitoring			
Normal	1.98	0.64	0.022
Abnormal	1.67	0.56	
Fetal distress			
Yes	1.58	0.48	0.006
No	1.98	0.64	
Meconium aspiration syndrome			
Yes	1.89	0.57	< 0.05
No	1.94	0.65	
Respiratory distress			
Yes	1.62	0.51	< 0.05
No	1.95	0.64	

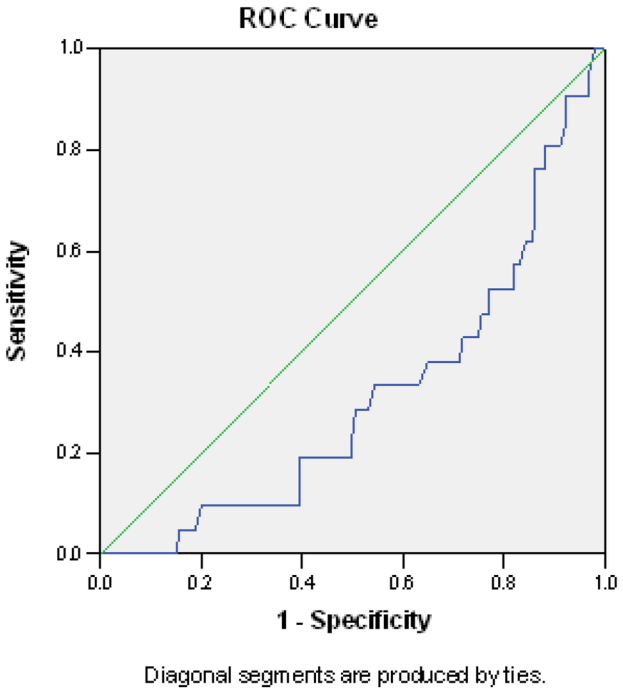

Fig. 1 Roc curve and its components

Table 3 Association between CPR and fetal distress, according to other variables

	CPR				
	Fetal distress				
	Yes		No		*P* value
	Mean	SD	Mean	SD	
Job					
Housewife	1.67	0.49	1.95	0.59	0.038
Out of home	1.36	0.39	2.08	0.81	
Hypertension					
Yes	–	–	1.90	0.55	0.852
No	1.58	0.48	1.99	0.65	
Diabetes mellitus					
Yes	1.41	0.23	1.73	0.28	0.010
No	1.60	0.50	2.00	0.66	
Other diseases					
Yes	1.81	0.55	2.06	0.62	0.007
No	1.54	0.47	1.97	0.65	
Labor					
NVD	1.75	0.44	2.01	0.69	0.008
C/S	1.57	0.49	1.96	0.59	

middle cerebral artery and umbilical artery Doppler ratio with fetal distress at 38–40 weeks of gestation. Among the subjects, 11.6% had fetal distress and CPR was low at 37.6%. The best cutoff point was 1.94 with sensitivity, specificity, PPV, and NPV of 80.95, 50, 17.5, and 95.2%, respectively.

Monteith et al. [11] determined that the CPR is a useful tool in differentiating the at-risk fetus in both intrauterine growth restriction (IUGR) and the appropriate for gestational age, because the detection of a brain-sparing effect is significantly associated with an adverse perinatal outcome in IUGR.

In a study in 2016, Karlsen et al. investigated the efficacy of the middle cerebral artery index alone and its relation to the fetal umbilical artery in predicting prenatal complications. The results of this study showed that the use of ultrasonography of the middle cerebral artery with a percentile below 10% has a better prediction of early delivery due to respiratory distress, hospitalization of newborn infants in the NICU, and unpleasant complications compared to the use of the middle cerebral artery index with a percentile below 10%

alone. Finally, they concluded that the middle cerebral artery velocity index to the fetal umbilical artery and cerebroplacental levels less than 5% and 10% were associated with poor prenatal effects [12] which is in line with the findings of our research.

Ropacka-Lesiak et al. [13] reported index CPR showed the highest sensitivity in the prediction of both the intrapartum abnormal FHR (74.1%) and the adverse neonatal outcome (87.8%) as same as our findings. In this study, a significant increase in the prevalence of emergency cesarean sections was noted in the group with CPR ratios < 1.1 (24.6% vs. 7.6%).

Ghosh et al. [14] reported that in an abnormal Doppler group, perinatal outcome was also not significantly different, but neonatal intensive care unit admission was significantly increased, that is consistent with our study.

In the study by Schreurs et al. [15], it was reported that low CPR is related to some pregnancy outcomes, including fetal distress, which is consistent with our study.

Cavallaro et al. [16] reported that concomitant use of other indices such as AC growth velocity as parallel as CPR would be useful to predict fetal distress, and this matter may be assessed in Iranian women in future studies.

The review study by Khalil AA et al. [17] demonstrated that rate of operative delivery for presumed fetal distress and neonatal admission was 17.2% and 3.9%, respectively. Our findings showed that NICU admission was more than three times. They showed that CPR multiples of median (MoM) was an independent predictor for NICU admission at term, while birth weight was not that is consistent with our findings.

Atabay I et al. [18] reported 7.1% of fetal distress with and without NICU admission, and 85.8% of them with NICU admission were nulliparous. The rate of fetal distress is less than the study. They determined fetal distress increased in the fetus with a low CPR, and patterns of Doppler of two subgroups were heterogeneous. Parity affected the frequency of fetal distress. In our study, the frequency of fetal distress was not calculated based on parity or gravidity, but the association between CPR and fetal distress was the same.

Curtin et al. [19] reported abnormal Doppler was associated with more placental pathology in the fetus with suspected fetal growth restriction (FGR), but we did not evaluate this association.

Conclusion

It may be concluded that in our study a cutoff for fetal middle cerebral artery to umbilical artery ratio of 1.94 at 38 weeks was considered statistically significant in predicting fetal distress at 38–40 weeks. However, further studies with larger sample size and multi-center sampling would develop more definite results for wider application.

Limitations

One of the most important limitations of this study was the incompleteness of some of the data that were excluded from the study.

Acknowledgements The authors acknowledge financial support by the vice chancellor for research, Ahvaz Jundishapur University of Medical Sciences.

Funding This study was funded by Ahvaz Jundishapur University of medical Sciences (Grant Number: IR.AJUMS.REC.1396.1141-FIRC-9620).

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

1. Weiner E, Bar J, Fainstein N, et al. Intraoperative findings, placental assessment and neonatal outcome in emergent cesarean deliveries for non-reassuring fetal heart rate. Eur J Obstet Gynecol Reprod Biol. 2015;185:103–7.
2. Leung TY, Lao TT. Timing of caesarean section according to urgency. Best Pract Res Clin Obstet Gynaecol. 2013;27(2):251–67.
3. Everett TR, Peebles DM, editors. Antenatal tests of fetal wellbeing. Seminars in fetal and neonatal medicine. Amsterdam: Elsevier; 2015.
4. Pruetz JD, Votava-Smith J, Miller DA, editors. Clinical relevance of fetal hemodynamic monitoring: perinatal implications. Seminars in fetal and neonatal medicine. Amsterdam: Elsevier; 2015.
5. Hebbar S, Rai L, Adiga P, et al. Reference ranges of amniotic fluid index in late third trimester of pregnancy: What should the optimal interval between two ultrasound examinations be? J Pregnancy. 2015;2015:1–7.
6. Grivell RM, Alfirevic Z, Gyte GM, et al. Antenatal cardiotocography for fetal assessment. Cochrane Database Syst Rev. 2012;12:9.
7. Obstetricians ACo, Gynecologists. Practice bulletin no. 116: management of intrapartum fetal heart rate tracings. Obstet Gynecol, 2010;116(5):1232.
8. Alfirevic Z, Stampalija T, Gyte GM. Fetal and umbilical Doppler ultrasound in normal pregnancy. Cochrane Database of Syst Rev. 2010;2010(8):CD001450.
9. Vannuccini S, Bocchi C, Severi FM, et al. Diagnosis of fetal distress: a practical approach to neonatal diseases. Neonatology. 2018;2018:105–27.

10. Crovetto F, Baffero G, Cesano N, et al. OP3108: fetal middle cerebral artery Doppler at 40 weeks gestation in the prediction of emergency delivery for fetal distress in labour. Ultrasound Obstet Gynecol. 2016;48:156.
11. Monteith C, Flood K, Mullers S, et al. Evaluation of normalization of cerebro-placental ratio as a potential predictor for adverse outcome in SGA fetuses. Am J Obstet Gynecol. 2017;216(3):285e1–6.
12. Karlsen HO, Ebbing C, Rasmussen S, et al. Use of conditional centiles of middle cerebral artery pulsatility index and cerebroplacental ratio in the prediction of adverse perinatal outcomes. Acta Obstet Gynecol Scand. 2016;95(6):690–6.
13. Ropacka-Lesiak M, Korbelak T, Świder-Musielak J, et al. Cerebroplacental ratio in prediction of adverse perinatal outcome and fetal heart rate disturbances in uncomplicated pregnancy at 40 weeks and beyond. Arch Med Sci AMS. 2015;11(1):142.
14. Ghosh S, Mohapatra K, Samal S, et al. Study of Doppler indices of umbilical artery and middle cerebral artery in pregnancies at and beyond forty weeks of gestation. Int J Reprod Contracept Obstet Gynecol. 2016;5(12):4174–9.
15. Vollgraff Heidweiller-Schreurs C, De Boer M, Heymans M, et al. Prognostic accuracy of cerebroplacental ratio and middle cerebral artery Doppler for adverse perinatal outcome: systematic review and meta-analysis. Ultrasound Obstet Gynecol. 2018;51(3):313–22.
16. Kalafat E, Ozturk E, Sivanathan J et al. Longitudinal change in the cerebroplacental ratio and the risk of stillbirth. Ultrasound Obstet Gynecol. 2018.
17. Khalil AA, Morales-Rosello J, Morlando M, et al. Is fetal cerebroplacental ratio an independent predictor of intrapartum fetal compromise and neonatal unit admission? Am J Obst Gynecol. 2015;213(1):54e1–10.
18. Atabay I, Kose S, Cagliyan E, et al. A prospective cohort study on the prediction of fetal distress and neonatal status with arterial and venous Doppler measurements in appropriately grown term fetuses. Arch Gynecol Obstet. 2017;296(4):721–30.
19. Curtin WM, Millington KA, Ibekwe TO et al. Suspected fetal growth restriction at 37 weeks: a comparison of Doppler and placental pathology. BioMed Res Int. 2017.

About the Author

Sara Masihi Sara Masihi is a Researcher (Academic), Associate Professor of Obstetrics and Gynecology, School of Medicine, Fertility Infertility and Perinatology Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.