Analysis of ultrasound clinical early warning system in hyper-coiling umbilical cord

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To the Editor: The umbilical cord is the vital link between the fetus and the placenta. The proper spiral state of the umbilical cord plays a key role in maintaining its function. The umbilical coiling index (UCI) is the number of spiral cycles per 1 cm of length and is normally 0.17, with UCI >0.30 considered hyper-coiling.[1]

Previous studies have identified hyper-coiling umbilical cord significantly associated with adverse pregnancy outcomes.[2] However, many other studies have failed to find a strong correlation between abnormal coiling and adverse outcomes.[3] Whether there are other abnormal ultrasound indicators in the hyper-coiling cord (HC) that can give early warning of adverse pregnancy still needs to be further explored. The present study aims to establish an early-warning system based on ultrasound, and diastolic notch of the bilateral umbilical arteries of the bladder was used to judge the resistance state of the umbilical cord. The diastolic notch of umbilical arteries can more objectively reflect the resistance state of the umbilical cord, and compared with isolated segments of the umbilical cord, the umbilical arteries are located at the proximal end of the umbilical cord, and can better reflect the overall resistance state of the whole umbilical cord without the influence of the spiral position.

This study was approved by the Ethics Committee of Peking University People’s Hospital (No. 2018PHB072-01). Written informed consent was obtained from all participants. The routine fetal ultrasound scans were performed following the practice guidelines of the International Society of Ultrasound in Obstetrics and Gynecology,[4] using a Voluson E8 Expert Machine (GE Healthcare, Kretztechnik, Zipf, Austria).

With the highest UCI >0.60, the condition can be diagnosed as hyper-coiling umbilical cord. According to whether they demonstrated one of the following six high-risk factors we found from our clinical work, patients were divided into complex and simple hyper-coiling umbilical cord groups: (1) The blood flow spectrum of the umbilical artery on one or both sides of the fetal bladder were measured. According to the spectrum shape, the umbilical artery was defined as high resistance or normal type. High resistance type referred to the blood flow spectrum of one or both sides of the umbilical artery, in which the notch in the early diastolic period and the blood flow velocity increased rapidly in the diastolic period, and those that showed none of the above-mentioned were considered normal. (2) We determined whether there was fetal growth restriction (FGR). (3) We measured the peak flow velocity of the middle cerebral artery (MCA) during the diastolic period, and it was defined as faster if it was greater than 1.5 multiples of the median (MoM). The increased peak flow means the adverse state of fetal hypoxia and defined as a risk factor. (4) Amniotic fluid index (AFI) <5 cm was used to diagnose oligohydramnios. (5) The echo of brain parenchyma was enhanced. (6) The spectrum of venous catheter (VC) blood flow was defined as abnormal when there was a reverse A wave.

According to the delivery situation, the patients were divided into three groups. The patients with severe fetal abnormalities or intrauterine fetal death were placed in the terminated pregnancy group; patients with fetal distress found by abnormal fetal heart rate monitoring and termination of pregnancy by emergency cesarean section were divided into the intervention group; patients with normal fetal heart rate monitoring and no fetal distress were selected as the non-intervention group. We reviewed and summarized the prenatal and intrapartum fetal heart rate monitoring, gestational age at delivery, mode of delivery, and neonatal birth weight of the three groups. Birth weight of a newborn less than the 10th percentile was considered to be small for gestational age (SGA). The pregnancy outcomes of the simple and complex HC...
patients were compared whether there were statistical differences. And we compared the distribution of six ultrasound risk factors and UCI in the terminated pregnancy group, intervention group, and non-intervention group. According to the statistical significance results in three groups, discussed the feasibility of establishing a clinical early warning system for HC patients.

The statistical analyses were performed using SPSS 22.0 (IBM, Armonk, NY, USA). The measurement data of normal distribution were expressed by mean ± standard deviation, and we compared the results using Student’s t-test in complex and simple HC group. The counting data were expressed by frequency and were analyzed using $\chi^2$ test and Fisher exact probability. $P < 0.05$ was considered a statistically significant difference.

From January 2019 to March 2021, 32,786 patients were examined by ultrasound in our hospital, and the incidence of HC was 0.12% (38/32,786). Nine patients with severe obstetric complications were excluded, 29 patients were retained in the study. Four cases were in the terminated pregnancy group, 10 cases were in the intervention group, and 15 cases were in the non-intervention group. There were 9 patients with simple HC and 20 patients with complex HC.

All patients in the intervention group (10 cases) were suspected of fetal distress and terminated pregnancy early. Among them, six cases (6/10) had frequent moderate to severe variable deceleration (VD) before delivery, and four cases (4/10) were unresponsive to the continuous non-stress test (NST). In the non-intervention group, 15 patients had normal fetal heart rate monitoring during the pregnancy and perinatal periods.

The distribution proportion of the six high-risk factors was statistically different among the three groups. In the terminated pregnancy group, there were three cases (3/4) that had reverse A waves in the VC, and 0 in the other two groups. There was only one case of high resistance type of umbilical artery and FGR, which occurred in the non-intervention group. The faster peak flow velocity of the MCA in the diastolic period, amniotic fluid volume, and the echo of brain parenchyma were present in the intervention group. The incidences of these three factors in the non-intervention group, intervention group, and terminated pregnancy group were 0, 40%, 100%; 0, 30%, and 50%; 0, 20%, and 50%, respectively. There were also significant differences in the number of high-risk factors among the three groups (5.25 ± 0.99 in terminated pregnancy group, 2.38 ± 1.01 in intervention group, 1.29 ± 0.50 in non-intervention group, $P < 0.001$).

The average UCI of the terminated pregnancy group was 1.04 ± 0.19. There was a statistically significant difference between the terminated pregnancy group and the intervention and non-intervention groups ($P < 0.001$). Compared with the non-intervention group, the average UCI of the intervention group was higher, but there was no statistically significant difference ($P = 0.769$).

Compared with simple HC patients, patients with complex HC had higher proportions of clinical intervention (56.3% vs. 11.1%, $P = 0.027$), higher abnormal fetal heart rate monitoring (56.3% vs. 11.1%, $P = 0.027$), higher preterm birth rate ($P = 0.034$), higher cesarean section rate (87.5% vs. 33.3%, $P = 0.005$), and higher proportion of low birth weight (56.3% vs. 0, $P = 0.005$). There was no significant difference in the average UCI (0.84 ± 0.17 vs. 0.72 ± 0.08, $P = 0.419$), the gestational age of the first detection of HC (30.79 ± 4.85 weeks) vs. 28.64 ± 4.84 (weeks), $P = 0.969$), and the proportion of terminated pregnancies (20% vs. 0, $P = 0.148$) in these two groups.

Simple HC patients were only distributed in the intervention group and non-intervention group, with one case (1/9) and eight cases (8/9), respectively. The distribution of simple and complex HC patients in the three groups was statistically significant different ($P = 0.025$).

Current research suggests that not all patients with HC have adverse pregnancy outcomes.[5] We found that there was no significant difference in the average UCI between the intervention group and non-intervention group. There was additionally no significant difference in average UCI between complex and simple HC patients. This indicated that UCI alone could not be an objective index to determine the intervention mode for clinical practice. However, in the terminated pregnancy, intervention, and non-intervention groups, there were significant statistical differences in the types and number of high-risk factors. Therefore, we suggest that high resistance in the umbilical artery and FGR may be the earliest warning indicators for HC patients who will need clinical intervention. For HC fetuses with these symptoms, doctors should closely observe the peak flow velocity of the MCA in the diastolic period, amniotic fluid volume, and the echo of brain parenchyma, to determine if and when clinical intervention is required, and avoid further deterioration of the fetal condition and lost intervention time. When UCI > 1, the number of high-risk factors was more than 5, or the VCA wave was reversed, there were usually adverse pregnancy outcomes, and clinical intervention was needed.

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