Association between umbilical coiling index and fetal distress

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ABSTRACT

Background and Objective: It is well known that fetal distress is one of the important causes of fetus peri-natal morbidity and mortality. In this study, we sought to evaluate the association between umbilical coiling index and fetal distress.

Materials and Methods: This research was a case-control study conducted on 90 term pregnant women. Study group had fetal distress (abnormal fetal heart rate, meconium staining, Apgar score less than 7 in fifth minute and pH of umbilical cord arterials < 7.2) and control group did not have above complications. After fetus birth, umbilical coiling index was calculated and heparinised blood of umbilical cord arteries was sent to laboratory for checking acidity. Finally, data was analyzed using SPSS software (version 18) using t-test and Pearson correlation test.

Results: The mean umbilical coiling index was 0.23 ±0.13 coils/cm and 0.30± 0.13 coils/cm in case and control groups, respectively, which had meaningful difference (p=0.017). However, there was a significant correlation (p=0.03) between umbilical coiling index and bradycardia, but there was no significant association between umbilical coiling index and meconium staining, tachycardia, and acidity of umbilical cord arterials (p>0.05). Roc curve demonstrated that umbilical coiling index had the ability to be used to predict fetal distress and the best point for predicting fetal distress was 0.23 coils/cm

Conclusion: Fetal heart bradycardia had significant association with umbilical coiling index and it could be used to predict fetal distress

1. Introduction

The umbilical cord is the vital life line of fetus. This unique life line needs optimal protection, provided by Wharton's jelly, the coiling of the umbilical vessels and the amniotic fluid. Coiling makes the umbilical cord flexible and strong at the same time, and provides resistance to external forces that could compromise blood flow (1-3). The reason of cord coiling is unknown. The hypotheses include torsion by active or passive movements, which cause rotation of the embryo around its umbilical cord axis, different umbilical vascular growth, fetal hemodynamic forces and arrangement of muscular fibers in umbilical arterial wall (1, 3- 6). In 1954, umbilical coiling was first quantified by Edmonds who divided total number of coils by umbilical cord length in centimeters and called it "The index of twist'', but later Strong et al named it "The umbilical cord index" (5-8). In recent years, a number of publications have assessed the correlation between cord coiling and prenatal outcomes such as still birth, preterm labor, fetal growth restriction, fetal distress and abnormal UCI has been reported to be related to fetal distress (1,2,6,7).

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Nevertheless, there is not enough data on umbilical cord index(UCI) and its association with fetal distress, especially fetal heart variation. The present study aimed to evaluate fetal distress, especially fetal heart rate variation with abnormal umbilical cord coiling indices.

2. Materials and Methods

This case-control study was performed at Shahed University-affiliated teaching hospitals in Tehran (Iran) between 2010 and 2012 on ninety umbilical cords. Term pregnant women (according to LMP and sonologic confirmation) admitted to labor ward for delivery entered the study. Mothers with body temperature >37.8^{o}C, multiple pregnancies, cigarette smoking or drug abuse were excluded from the study. These definitions were used in this study (8, 9): bradycardia: baseline fetal heart rate (FHR<120 beat/minutes), tachycardia: baseline FHR> 160 beat/minutes, late decelerations: smooth, uniform decelerations of FHR that begin after the onset of a contraction and end after the contraction stops, variable deceleration: abrupt and angular decreasing in appearance of fetal heart rate and has a variable temporal association with uterine contraction. Pregnancy complicated by bradycardia, tachycardia, late and variable deceleration, meconium in amniotic fluid and Apgar score less than 7 at 5 minutes were included as case group and if pregnant women had not above complications, were included as control group. Ninety pregnant women were evaluated (45 as control group and 45 as case group).

Sample size was calculated considering mean UCI in Kashanian et al study, α=0.05 and β= 0.1 (10). The local university research ethics committee approved this study. Immediately after delivery, two clumps inserted on the umbilical cord and umbilical cord length between them was measured with a tape. A complete vascular coil was defined as a 360° complete round coiling of the vasculature, and the number of these complete vascular coils was determined at the length of the cord between the two clumps. Then, the number of vascular coils was divided by the length of cord in centimeters to determine the umbilical coiling index (UCI). If the UCI was less than 10th percentile (0.17), it was considered as hypo-coiled, and it was considered hyper-coiled if more than 90th percentile (0.37).

Between 10th and 90th percentile (0.17- 0.37), it was considered as normal coiled (10). Blood sample of umbilical cord artery was sent to laboratory to determine its acidity. Maternal age, parity, maternal diabetes (both gestational diabetes and overt diabetes), maternal hypertension (both pregnancy induced hypertension and chronic hypertension), anemia (maternal hemoglobin <10 mg/dL), maternal thyroid disease, neonatal weight, neonatal weight, Apgar score at 5 minutes, meconium in amniotic fluid and abnormality in fetal heart rate (late or variable deceleration, bradycardia, tachycardia) were recorded. UCI was compared with independent t test and ANOVA between the two groups and Pearson correlation was used to assess the association between UCI and qualitative variability. Sensitivity and specificity were calculated to determine its predictive value. The greatest amount of overall sensitivity and specificity was considered as the cut-off point. P values less than 0.05 were regarded as statistically significant.

3. Results

Mean age of pregnant women in control and case groups were 25.42 ± 4.48 and 27.82 ± 3.86 years, respectively. Demographic and obstetrics history of pregnant women in the two groups had no significant difference. In the study group, 30 (66.7%) fetuses had bradycardia, 5 (11.1%) tachycardia, 7 (22.6%) late deceleration and 23 (74.2%) variable deceleration. Beat to beat variations were not seen in 3 (6.7%) cardiograms of fetuses.

Meconium in amniotic fluid was determined in 14 (31.1%) fetuses. Mean umbilical arterial pH was 7.29 ± 0.09 in case group and 7.36 ± 0.06 in control group, which had a significant difference. Mean UCI was 0.2394± 0.1373coil/cm and 0.3084± 0.138coil/cm in case and control groups, respectively, which was statistically different (p=0.017) (Figure 1). The correlation between UCI and fetal distress variability in study group was demonstrated in Table 1. As seen, UCI had only statistically significant correlation with bradycardia (Table 1). Three subgroups of UCI (norm coiled, hypo coiled and hyper-coiled) in control and study groups were assessed (Table 2). In this study, there was a significant association (p=0.001) between hypo-coiled and fetal heart late deceleration. On the other hand, there was no

significant association between hypocoiled and hypercoiled with tachycardia, meconium in amniotic fluid and umbilical arterial pH less than 7.2. Roc curve was performed to assess whether UCI can identify babies at risk of distress. It was demonstrated that UCI could predict fetal distress (Figure 2).
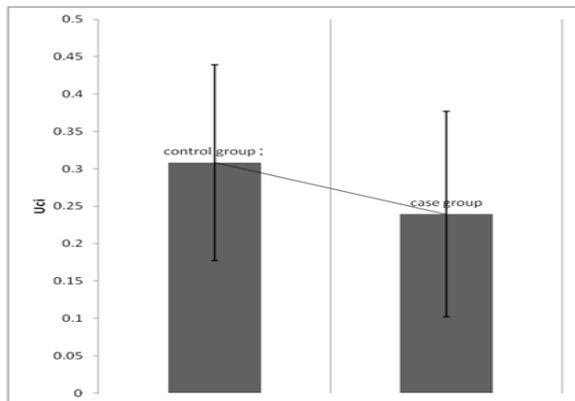

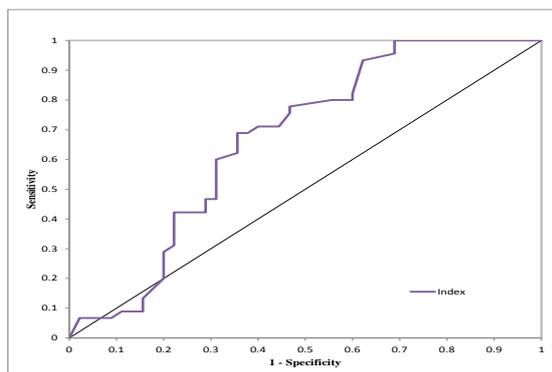**Figure 1**. To compare UCI in control and case groups

Figure 2. Roc curve to demonstrate the ability of UCI to predict fetal distress

Table 1. To show the relationship between mean of UCI and fetal distress variability

Fetal distress variability	Mean UCI($\pm$ Standard deviation)	P value
Bradycardia	0.2313±0.1462	0.034
Tachycardia	0.3076±0.1335	0.529
Late deceleration	0.1438±0.1026	0.003
Variable deceleration	0.2579±0.1449	0.157
Meconium in amniotic fluid	0.2336±0.1122	0.236
Umbilical arterial PH	0.3026±0.1223	0.411

Table 2. To compare three subgroups of UCI in control and case groups

UCI (number of coils /centimeter)	group				P-value Chi square
	Control		study		
	Count	N %	Count	N %	
Hypo < 0.17	3	6.7%	17	37.8%	
Norm 0.17 - 0.37	30	66.7%	19	42.2%	0.002
Hyper > 0.37	12	26.7%	9	20.0%	

In this study, the cut-off point of greatest amount of overall sensitivity and specificity was 0.2375. The sensitivity and specificity were 64% and 69%, respectively, at this point.

4. Discussion

Problems and abnormalities of the umbilical cord play a significant role in perinatal morbidity and mortality. Because the umbilical cord is the lifeline of fetus, any abnormality in cord established in early gestation, can lead to disruption of fetal-placental blood flow that may have chronic (growth retardation) and acute (fetal intolerance to labor and fetal demise) effect on fetal well-being (11-14). The aim of this study was to find the association between UCI and fetal distress. The mean UCI in our study was 0.27 coils/cm, which was similar to the study performed by EZi Makhai et al (15). There was a statistically significant difference between mean UCI in case and control groups. This research showed a significant association between UCI and bradycardia and also a significant association between low umbilical vascular coiling and late deceleration of FHR. Rana et al evaluated the association between UCI and prenatal outcome and concluded that low UCI was associated with FHR abnormality during labor and delivery (11). Kashanian et al evaluated UCI and adverse prenatal outcome; it was shown that fetal distress, Apgar score and meconium passage had statistically significant association with UCI (10).

A few studies have concluded that abnormal FHR in low and high UCI were higher than normal coiled group and both hypo and hyper coiling were significantly associated with intrapartum fetal heart rate abnormalities, which can be suggested as a marker for diagnosis of a fetus at risk (4, 16). Chitra et al and other researchers found that FHR deceleration is associated with both low and high coiling index

(2, 17, 18). Our findings and above-mentioned studies indicate that abnormal UCI is an indicator of FHR abnormality, especially FHR deceleration. Fetuses with lean and/or hypo-coiled umbilical cord showed a noticeable decrease in umbilical vein blood flow and umbilical hyper-coiling leads to a reduction of umbilical cord blood flow and increased fetal cardiac workload (11, 19). Nevertheless in our study we did not find any significant association between UCI and meconium stained amniotic fluid, which has also been observed in Rami et al and Mittal et al studies (7, 17). However, the result is not in agreement with those of Kashanian et al and Devaru et al (10, 20).

In the present study, pH of umbilical arteries was not significantly associated with low UCI. Only a few studies assessed this association. These studies found a significant association between acidity of umbilical arteries lower than 7.05 and hypo-coiling (1, 2). One possible explanation for this discrepancy is that in this study, only one neonate had umbilical artery pH less than 7.1. One mechanism that may explain why umbilical coiling is beneficial has been proposed by Reynolds (2). "The close association between umbilical arteries and vein raises the possibility of a dynamic interaction between these vessels. The arterial coils around the vein along the length provide multiple variations of pressure in an additive fashion". This mechanism may discuss adverse prenatal outcomes, especially abnormality in fetal heart rate (FHR).

Conclusion

We suggest determining umbilical coiling index as a routine part of post-partum placental examination. It is a simple procedure and it may explain a proportion of unexplained fetal heart deceleration and stillbirth.

Acknowledgment

Conflict of Interest: None to declare.

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