

The umbilical coiling index in complicated pregnancy

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Abstract

Objective: To evaluate umbilical cord coiling in pregnancies with adverse outcome.

Study design: Umbilical cords and hospital records of 565 consecutive cases with an indication for histological examination of the placenta were studied. The umbilical coiling index (UCI) was determined as the number of complete coils divided by the length of the cord in centimeters, by an observer blinded for pregnancy outcome. Data on obstetric history and pregnancy outcome of each case were obtained from the hospital records. We calculated odds ratios and their 95% confidence interval to evaluate the strength of associations between pregnancy outcome and abnormal cord coiling.

Results: Fetal death (OR 4.09, 95% CI 2.22–7.55), chorioamnionitis (OR 1.77, 95% CI 1.09–2.88), fetal structural or chromosomal abnormalities (OR 1.78, 95% CI 1.08–2.95), and lower Apgar score at 5 min ($p = 0.03$) were associated with undercoiling (UCI below the 10th percentile, using reference values from uncomplicated pregnancies). Fetal death (OR 3.74, 95% CI 1.89–7.40), iatrogenic preterm delivery (OR 1.91, 95% CI 1.04–3.49), umbilical arterial pH < 7.05 (OR 3.63, 95% CI 1.44–9.17), fetal structural or chromosomal abnormalities (OR 1.79, 95% CI 1.01–3.16), thrombosis in fetal placental vessels (OR 2.64, 95% CI 1.37–5.06), chronic fetal hypoxia/ischemia (OR 1.82, 95% CI 1.09–3.05), and lower weight for gestational age ($p = 0.01$) were associated with overcoiling (UCI above the 90th percentile).

Conclusions: Our findings confirm that adverse perinatal outcome is associated with both undercoiling and overcoiling of the umbilical cord.

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1. Introduction

The umbilical cord is the vital lifeline of the fetus and cord abnormalities can lead to fetal morbidity and mortality. This unique lifeline therefore needs optimal protection, provided by Wharton's jelly, the coiling of the umbilical vessels and the amniotic fluid. When one looks at a normal cord, the first thing that catches one's attention is the helical pattern of the umbilical vessels. Coiling makes the umbilical cord flexible and strong at the same time, and provides resistance to external forces that could compromise blood

flow. The helical course of the umbilical vessels can be observed as early as 28 days post-conception, and is clearly present in about 95% of fetuses from 7 weeks post-conception onwards [1]. The origin 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 [1], differential umbilical vascular growth rates [2], fetal hemodynamic forces [3], and the arrangement of muscular fibers in the umbilical arterial wall [4].

For a long time little attention has been paid to umbilical cord problems, presumably because these could not be identified during pregnancy and labour. At present, abnormalities of the cord can be visualised antenatally using ultrasonography. In recent years a number of publications

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have appeared about abnormalities in cord coiling, suggesting that overcoiling and undercoiling of the umbilical cord are both associated with adverse perinatal outcome [5–10]. However the results of these studies are equivocal in several respects. Whereas some studies showed significant associations between abnormal cord coiling and preterm delivery, fetal death, fetal growth restriction, operative delivery for fetal distress and meconium staining of amniotic fluid, others did not. These conflicting results are likely to be due to methodological differences and sometimes methodological shortcomings.

The aim of our study was to establish with which adverse pregnancy outcomes undercoiling and overcoiling of the umbilical cord vessels were associated in our obstetric tertiary referral center. Since December 1998, evaluation of the umbilical coiling index (UCI), which is the number of coils per centimeter, is included in the routine pathological examination of the placenta. Therefore, we were able to perform a cohort study on a large number of cases in which histologic examination of the placenta was done for clinical reasons.

We also included the histological findings of the placenta in the analysis. All of the earlier studies [6], except one, lacked data on placental histology.

Finally, our study is the first to use reference values for the UCI from exclusively uncomplicated pregnancies.

2. Materials and methods

2.1. Study population

This study was conducted at the departments of Perinatology and Pathology of the University Medical Center Utrecht, a tertiary referral center in The Netherlands. During the study period 5354 patients delivered. We examined the cords of all placentas from singleton pregnancies that were referred for histological examination from December 1998 to May 2002 (565 cases, 10.6% of all deliveries). Clinical indications for histological examination of the placenta were fetal demise, fetal growth restriction, preterm delivery, structural and/or chromosomal abnormalities of the infant, pre-eclampsia, diabetes mellitus, either gestational or pre-existent, macroscopic abnormalities of the placenta, fetal asphyxia, and signs of intra-uterine infection. Pregnancies complicated by these conditions were included in the study. The referral for placental examination was independent of umbilical cord coiling status.

2.2. Data collection

The placentas were examined by an expert perinatal pathologist (PN), blinded for patient characteristics and pregnancy outcome. All specimens were unfixed. The length of the cord was measured and the number of complete (360°)

helices of the umbilical vessels was counted. The umbilical coiling index was calculated as the number of coils divided by the cord length in centimeters, as introduced by Strong et al. [7] In some cases only part of the cord could be studied, because a segment of the cord was used for fetal acid–base testing after birth and subsequently discarded.

Previous studies [6,8,10] proposed to classify the umbilical cord as: undercoiled (with an UCI smaller than the 10th percentile), normocoiled (with an UCI between the 10th and 90th percentile), and overcoiled (with an UCI above the 90th percentile). Following these guidelines we defined undercoiling as an UCI < 0.07 coils/cm, and overcoiling as an UCI > 0.30 coils/cm (overcoiled cords). These cut-offs (for the 10th and 90th percentile) were derived from an earlier study of the UCI in normal pregnancies in our institution during the same time period, designed and executed to provide reference values for normal cord coiling [11].

A case record form was completed for each subject, detailing the medical and obstetrical history. The investigators completing these forms (EvA, MdL) were blinded to the UCI. Information was obtained on gestational age at delivery, parity, maternal age, obstetric history, Apgar scores, fetal blood gasses, meconium staining of the amniotic fluid, sex and birth weight of the infant, preterm delivery, interventional delivery for fetal distress, small for dates infants, large for dates infants, fetal structural or chromosomal abnormalities, perinatal death, pre-eclampsia, diabetes mellitus, either gestational or pre-existent, maternal medication use, substance abuse, and neonatal events. Parity was defined as the number of previous pregnancies of at least 20 weeks of gestational age. Gestational age at delivery was calculated by the best estimate according to menstrual history and/or first trimester ultrasound. Preterm delivery was defined as a delivery before 37 completed weeks of gestation. Moderate to severe preterm delivery was defined as delivery before 34 completed weeks of gestation. We chose to distinguish between spontaneous and iatrogenic preterm delivery, since these two pathologies have different etiological backgrounds. Small for dates infants and large for dates infants were defined as having a birth weight below the 10th percentile or above the 90th percentile for the Dutch population, respectively [12]. Meconium staining of amniotic fluid was determined by the presence of any degree of meconium in the fluid noticed during delivery. Fetal death was defined as spontaneous death in utero at a gestational age of at least 20 weeks.

The placenta and umbilical cord were examined macroscopically for placental weight, umbilical cord length, number of umbilical coils, insertion of the umbilical cord, and microscopically for signs of chorioamnionitis, funiculitis umbilicalis, chronic hypoxia/ischemia, accelerated or delayed maturation of the placenta, and thrombosis of the fetal placental vessels. Chronic fetal hypoxia/ischemia was defined as an increase in nucleated red blood cells in the fetal circulation of the placental villi [13]. Accelerated/delayed

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