

MS Rogers ■

To assess the predictive value of ultrasonic assessment of umbilical cord morphology for intrapartum foetal distress

Key Messages

1. Umbilical coiling index (UCI) and umbilical cord entanglement are independent factors in the generation of oxidative stress in the neonate during labour.
2. Umbilical coiling is not completed at the end of the first trimester as originally thought.
3. Late changes in coiling direction result in a poor agreement between second trimester ultrasound measurements and the actual UCI at birth.
4. Whilst second trimester measurement of UCI was predictive of foetal distress in labour, its sensitivity was poor and it was not predictive of oxidative stress or base deficit in the neonate.

Introduction

The coiling of the umbilical cord is thought to be fully developed by the end of the first trimester of pregnancy, and does not change after this.¹ During the second trimester, the relative amount of amniotic fluid is greater than at term, allowing better visualisation of the umbilical cord by ultrasound.² The true umbilical coiling index (UCI), determined at delivery, should therefore be accurately predicted by ultrasound values obtained in the second trimester, provided these can be reliably obtained. In view of the strong associations between UCI, cord entanglement, and cord compression, second trimester measurements of UCI should also be predictive of the tightening of cord entanglement, and of foetal distress. As most pregnancies are now subjected to a routine ultrasound scan screening for congenital malformation at around 20 weeks of gestation, additional information regarding the structure and position of the umbilical cord can be obtained at minimal cost.

Methods

This study was conducted from September 2000 to August 2002, and was divided into phase 1 and phase 2.

Phase 1

There are practical difficulties with performing intrapartum studies on patients recruited earlier in pregnancy, as the date and timing of labour cannot be predicted, and cord blood collection can only be performed when births occur during office hours (due to technician availability). Therefore, two pilot studies were conducted to evaluate the feasibility of using isoprostane measurements in cord blood as a measure of oxidative stress instead of organic hydroperoxides (OHP) and to evaluate the relationship between the thickness of Wharton's jelly, the UCI and cord entanglement, and their contribution to the incidence of operative delivery for foetal distress.

Phase 2

To identify variations in cord structure by ultrasonic examination in the second trimester of pregnancy in a cohort of women after delivery, when the incidence of operative intervention for foetal distress and of cord entanglement were recorded as primary outcome measures. The incidence of operative delivery for foetal distress was compared between pregnancies with hypo-coiled umbilical cords (UCI <10th percentile) and those with normally coiled umbilical cords. The actual UCI was also measured at the time of delivery in order to assess the agreement between second trimester ultrasound measurements and the true structure. Perinatal outcome was assessed in terms of oxidative stress.

Results

Phase 1a

A stepwise multiple regression analysis showed that in cord arterial blood, variation in plasma 8-isoprostane concentration was significantly increased by

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Table 1. Variation in cord length according to the sex of the baby and the type of nuchal cord entanglement*

Type of nuchal cord entanglement	Male		Female	
	No.	Median cord length (range) [cm]	No.	Median cord length (range) [cm]
No cord around neck	36	54 (48-64)	29	52 (47-60)
Loose cord	24	63.5 (56-67)	9	61 (54-65)
Tight cord	21	55 (50-72)	12	50.5 (42-557)

* Kruskal-Wallis test, P<0.005

Table 2. Incidence of cord entanglement in males and females according to the degree of umbilical coiling and amount of Wharton's jelly

	No cord entanglement		Cord entanglement		P value (Chi squared test)
	Male	Female	Male	Female	
Coiling					0.02
Hypo	3	3	15	4	
Normal	24	15	18	13	
Hyper	9	11	10	2	
Wharton's jelly					0.47
Low	12	6	10	3	
Normal	16	11	23	13	
High	7	10	10	5	

tight cord entanglement (P<0.001), suspected foetal distress (P<0.001), low UCI (P<0.005), and male sex (P<0.05). The adjusted R² value was 0.48, compared to 0.26 for OHP, 0.16 for pH, and 0.09 for base excess, suggesting that isoprostane is a more accurate predictor of perinatal outcome.

Phase 1b

When comparing tight with loose cord entanglement, there were no significant differences either in the percentage of Wharton's jelly or in the UCI. Loose nuchal cords were significantly longer than tight ones (P<0.05) and male babies had longer cords than females (P<0.05). Table 1 shows a breakdown of cord length according to both sex of the baby and cord entanglement. Table 2 shows the incidence of cord entanglement in males and females according to the degree of umbilical coiling and amount of Wharton's jelly.

Phase 2

An adequate portion of umbilical cord for UCI measurement was visualised within 3 to 4 minutes, in 99% (528/531) cases. The intra-class coefficients were 0.83 (95% confidence interval [CI], 0.66-0.91; P<0.0001) for inter-observer variation and 0.89 (95% CI, 0.83-0.93; P<0.0001) for intra-observer variation. The inter-observer and intra-observer differences did not vary in any systematic way over the range of measurement. Second trimester measurements of UCI are therefore reliable. The levels of agreement between second trimester UCI using cut-off values of the ≤10th, and ≥90th percentiles, and classifications after birth using criteria from Strong et al³ were very poor (kappa=0.005). The sensitivity of ultrasound for detecting hyper-coiling was 17.3% (9/52), and for detecting hypo-coiling was 9.1% (5/55). This was explained by the high incidence of mixed coiling patterns (right and left helices), which occurred in about 25% of cases. There was no significant difference in

the UCI between cords with left- or right-handed coiling, but hypo-coiling predominated amongst cords with a mixed pattern.

In 273 cases in which cord arterial isoprostane was measured, the concentrations were significantly higher in cases with tight cord entanglement than with loose or no entanglement (P<0.001). A multiple regression analysis confirmed that tight cord entanglement (P<0.001) and UCI (P<0.05) were independent determinants of isoprostane concentration, with evidence of foetal distress just failing to contribute significantly to the variance (P=0.09).

Discussion

In view of the findings of the two preliminary pilot studies, it was determined that isoprostane assays should replace OHP and malondialdehyde for the remainder of the study. It was also determined that a post-delivery measurement of Wharton's jelly would not contribute useful information, and could therefore be abandoned. The three studies confirm that, although the UCI is associated with cord compression, its measurement in early pregnancy is made redundant by changes occurring in middle and late pregnancy.

The original objective of phase 2 of the study was to recruit 800 women to test the hypothesis that measurement of second trimester UCI would be predictive of foetal oxidative stress. However, our original assumption that the second trimester measurements would be predictive of the actual situation at birth was disproved by the high incidence of mixed coiling in the population studied. We concluded that it was doubtful whether any real benefits would ensue from attempting further study, and did not pursue any cost/benefit analysis. The study was therefore terminated when sufficient data had accrued to establish the secondary

objective that umbilical coiling and cord entanglement were independent determinants of the oxidative stress to the foetus during labour.

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