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ORIGINAL ARTICLE

Velamentous cord insertion: is it associated with adverse perinatal outcomes?*

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Abstract

Introduction: Velamentous cord insertion (VCI) can be identified on prenatal ultrasound with an incidence of around 1%. We set out to examine the association between VCI and perinatal outcomes.

Methods: This was a retrospective cohort study of 482 812 pregnancies using the California vital statistics birth cohort dataset linked with patient discharge dataset from 2006 during which 2327 (0.48%) were complicated by VCI. Outcomes examined included intrauterine fetal demise (IUFD), small for gestational age (SGA), preterm delivery, manual removal of the placenta and cesarean delivery. Statistical analysis was performed using Chi squared tests and multivariable logistic regression analyses.

Results: Pregnancies with VCI, compared to those without, were associated with an increased risk of IUFD (2.6% versus 0.28%, $p = 0.001$), SGA (16.93% versus 10.17%, $p = 0.001$), preterm delivery <37 weeks (12.5% versus 9.10%, $p = 0.001$), manual removal of placenta (14.47% versus 0.76%, $p = 0.01$) and postpartum hemorrhage (6.66% versus 2.88%, $p = 0.001$). Adjusting for confounders, the adjusted odds of IUFD were more than nine times in pregnancies with VCI (aOR 9.56; 95% CI 6.76–13.5) than those without.

Discussion: VCI is associated with an increased risk of adverse perinatal outcomes such as IUFD, SGA, preterm delivery <37 weeks, need for manual removal of placenta and post-partum hemorrhage. Routine identification of the placental cord insertion site should be considered. Close surveillance of these pregnancies should be undertaken. Future research should focus on the optimal management including the gestational age for delivery of these pregnancies.

Introduction

In most singleton pregnancies, the umbilical cord inserts into some aspect of the placental mass, whether central or at the edge (marginal insertion). However, in 0.5% to 1.7% of singleton pregnancies the umbilical cord inserts onto the fetal membranes, thus termed ''velamentous'', and the blood vessels traverse between the amnion and the chorion before finally reaching the placenta [1,2]. Earlier studies have concluded that even though some adverse perinatal outcomes were increased in the velamentous cord insertion (VCI) group, because this finding could not be routinely identified on ultrasound, the utility of studying the effects of VCI were questioned [1]. However, as ultrasound technology has evolved, the ability to identify the umbilical cord insertion has vastly improved over prior decades. A recent study reported that velamentous insertion of the umbilical cord can be reliably detected prenatally by ultrasound in 99% of cases [3]. Furthermore, though VCI can develop in the later stages of pregnancy, there is evidence that in most cases cord insertion may be reliably diagnosed as early as 11–14 weeks of gestation [4].

Given improved detection, an increasing number of studies have reported that VCI is associated with a number of adverse perinatal outcomes. These include increased risk of fetal growth restriction, preterm labor, abnormal intrapartum fetal heart rate pattern, low Apgar scores at 1 and 5 min, neonatal death and placental abruption [1,2,5–9]. Yet, these associations are not universally observed, likely because VCI is uncommon such that most studies have been limited by small sample size of actual velamentous cases to observe significant differences in outcomes.

Given this background, we conducted a retrospective cohort study to examine both the risk factors associated with

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VCI as well its association with perinatal outcomes. Specifically, we hypothesized that there would be an association with intrauterine fetal demise.

Methods

In order to address the questions above, we conducted a retrospective cohort study of singleton pregnancies delivered in California in 2006 using birth/infant death certificates data linked with hospital discharge diagnoses. These linked data included maternal antepartum and postpartum hospital records for the nine months prior to delivery and one-year post-delivery, as well as birth records and all infant readmissions occurring within the first year of life. Linkage of data was performed by the California Office of Statewide Health Planning and Development (OSHPD) Healthcare Information Resource Center under the State of California-Health and Human Services Agency. Using the ''record linkage number'', which is a unique alphanumeric encrypted social security number unique to the mother and the baby. The linked pairs of birth/delivery records include information associated with a mother/baby pair from the baby's discharge data record, the mother's discharge data record and the birth certificate data. All associated records (prenatal, postnatal, transfers and infant readmissions) are identified by a variable ''_BRTHID'' and are sorted in admission date order. Discharge diagnoses were encoded by International Classification of Diseases, version 9 (ICD-9). This study was approved by the Committee on Human Research (CHR) at the University of California as well as the California OSHPD and the Committee for the Protection of Human Subjects (CPHS), California Health and Human Services Agency.

The primary predictor was specifically having a VCI coded and these women were compared to those without a velamentous cord or other abnormal placentation, such as vasa previa, placenta previa or accreta. The primary outcome examined was intrauterine fetal demise (IUFD). Secondary outcomes included small for gestational age (SGA), preterm delivery (PTD) <37 weeks, manual removal of the placenta, cesarean delivery, postpartum hemorrhage (PPH), preeclampsia and neonatal seizures. Statistical analysis was performed using STATA v9.0 (StataCorp, College Station, TX) statistical software. First, we examined the association between patient characteristics including demographics and obstetric history and the presence of a VCI. Next, we examined the association between the VCI and the perinatal outcomes of interest. We then examined the association between VCI and perinatal outcomes, stratified by gestational age. Categorical variables were compared with the chi-square test. Multivariable analyses were utilized to control for such potential confounders as parity, maternal age, ethnicity, education and gestational age. Statistical significance was designated at a p value < 0.05 or a 95% confidence interval that did not include unity.

Results

There were a total of 2327 pregnancies, or 0.48% of our cohort, complicated by VCI. Velamentous cord insertions were present more frequently in women 35 and older (0.61%

Table 1. Predictors of velamentous cord insertion.

	Velamentous (%) $N = 2327$	Non-Velamentous (%) $N = 480\,485$	p value
Maternal age			<0.001
≥35	0.61	99.39	
<35	0.46	99.54	
Ethnicity			<0.001
White	0.60	99.40	
Black	0.49	99.51	
Hispanic	0.39	99.61	
Asian	0.50	99.50	
Other	0.46	99.54	
Parity			<0.001
Nullip	0.41	99.59	
Multip	0.58	99.42	

versus 0.46%, $p = 0.001$), women who were White (0.60% versus 0.39–0.50%, $p < 0.001$) and multiparous women (0.58% versus 0.41%, $p < 0.001$) (Table 1).

In univariate analyses, the velamentous group had a higher frequency of IUFD (2.60% versus 0.28%, $p = 0.001$), SGA (16.93% versus 10.17%, $p < 0.001$), PTD < 37 weeks (12.50% versus 9.1%, $p < 0.001$), manual placental removal (14.47% versus 0.76, $p < 0.001$), primary cesarean (18.99% versus 13.65%, $p = 0.001$) and PPH (6.66% versus 2.88%, $p < 0.001$). Associations with preeclampsia, neonatal seizures and endometritis were not statistically significant (Figure 1). When adjusted for race/ethnicity, maternal age, education and parity, the same associations were found to persist except for cesarean delivery, the association with which was no longer statistically significant (Table 2). The two biggest associations remaining were IUFD (aOR 9.56 [95% CI: 6.76–13.53]) and manual placental removal (aOR 22.92 [95% CI: 2.03–26.22] (Table 2).

The prevalence of IUFD in the velamentous versus non-velamentous cord insertion groups was then stratified by gestational age. Of the women that delivered between 24 and 28 weeks, the prevalence of IUFD in the presence of a VCI as compared to a non-VCI was 61.1% versus 17.2% ($p < 0.01$). By contrast, of the women who delivered at 37 to 42 weeks, the prevalence of IUFD in the presence of VCI as compared to non-VCI was 1.0% versus 0.1% ($p < 0.001$). So, while the absolute risk differences were greatest at earlier gestational ages, when adjusted for potential confounders, the adjusted odds of an IUFD in the setting of VCI were actually the highest at term (aOR 12.8, [95% CI 7.46–22.07]) (Table 3).

The odds of an IUFD in the setting of VCI were also higher for multiparous patients than nulliparous women (aOR 10.87 [95% CI 6.98–16.9] versus aOR 7.92 [95% CI 4.52–13.88] (Table 3) and in women 35 and older (aOR 12.12 [95% CI 6.9–21.1] versus women younger than 35, aOR 8.27 [95% CI 5.3–13.0] (Table 3).

Discussion

In this large cohort study, we found that maternal age >35, White race and multiparity are associated with an increased prevalence of VCI though the absolute risk difference is small. More interestingly, the presence of a VCI was associated with multiple adverse outcomes, including an
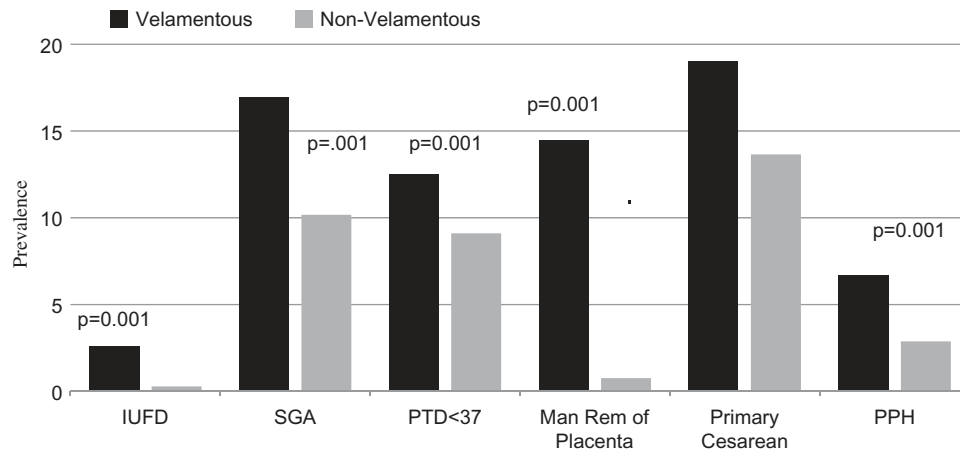
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Figure 1. Univariate analysis of perinatal outcomes.

Table 2. Multivariate analysis of perinatal outcomes.

	Velamentous N (%)	Non-Velamentous N (%)	aOR	95% CI
IUFD	**2.6 % (60)**	**0.3 % (1441)**	**9.56**	**6.76–13.5**
SGA	**16.9 % (393)**	**10.2% (49 012)**	**1.69**	**1.50–1.91**
PTD <37	**12.5% (291)**	**9.1 % (43 726)**	**1.37**	**1.21–1.56**
Preeclampsia	3.4% (79)	2.9% (13 934)	1.11	0.88–1.39
Neonatal Seizures	0.13% (3)	0.07% (336)	1.76	0.56–5.49
Manual Placental Removal	**14.5% (337)**	**0.8% (3844)**	**22.92**	**20.0–26.2**
Cesarean (Primary)	19.0% (442)	13.7% (65 830)	0.97	0.87–1.09
PPH	**6.7% (156)**	**2.9% (13 934)**	**2.35**	**2.00–2.78**
Endometritis	1.0% (23)	0.7% (3363)	1.35	0.89–2.04

Bold values are statistically significant.

Table 3. Presence of IUFD in the velamentous versus non-velamentous group stratified by gestational age at delivery, parity and maternal age.

	Velamentous % (N)	Non-Velamentous % (N)	aOR	95% CI
GA				
24–28 wks	61.1% (11)	17.2% (243)	3.25	0.82–12.97
29–32 wks	22.9% (8)	5.2% (237)	5.61	2.12–14.89
33–36 wks	8.0% (19)	0.8% (302)	9.38	4.87–18.06
≥37 wks	1.0% (20)	0.1% (412)	12.84	7.46–22.07
Parity				
Nullip	1.2% (13)	0.2% (288)	7.92	4.52–13.88
Multip	1.8% (21)	0.2% (492)	10.87	6.98–16.90
Maternal age				
Mat age ≥35	3.2% (16)	0.3% (269)	12.12	6.9–21.1
Mat age <35	2.5% (46)	0.3% (1050)	8.27	5.3–13.0

increased risk of IUFD, SGA, preterm delivery <37 weeks, manual extraction of the placenta and postpartum hemorrhage. These findings carry several clinical implications. Many ultrasound units now attempt to image and report placental cord insertion. Though AIUM and ACOG [10] do not require documentation of placental cord insertion, the AMA CPT 2012 Code Book requires documentation of placental cord insertion site in order to bill for both an OB >14 weeks (76805) and a Level II/detailed ultrasound (76811). Thus, as the finding of VCI becomes more frequently identified in the prenatal period, outcome information will be important for counseling patients.

Another important finding is that there was no difference in the risk of cesarean delivery seen (aOR 0.97). This would suggest that if a vasa previa is ruled out with endovaginal ultrasound with Doppler, a vaginal delivery can be planned in the setting of a VCI. In addition, due to the high incidence of manual extractions of the placenta (14%), techniques to prevent retained placenta and thus to avoid the increased hemorrhagic and infectious morbidity of a manual extraction should be considered.

Unfortunately, what is unclear from the current study is what to do beyond counseling regarding these outcomes associated with a VCI. Should women undergo antenatal testing, serial growth ultrasounds or earlier delivery to prevent stillbirth? This study does not answer such questions. In addition, this and other previous work has focused on whether VCI is present or not, but are all VCIs the same? Another question to explore is whether the distance of the VCI to the placental edge makes a difference. Similarly, the location of the VCI, near the lower uterine segment versus at the fundus may be related to the outcomes seen. Though this has been evaluated in the vasa previa population [11], the presence of VCI in the lower uterine segment but not crossing the cervix has not been studied. Given the frequency of this finding in the general population, this would require a large and potentially multicenter prospective trial but as the diagnosis of placental cord insertion becomes more precise these may become clinically relevant issues.

Despite the relatively large size of this study, we recognize that there are limitations. Such retrospective cohort studies are always subject to potential confounding. In order to minimize such confounding, we conducted multivariable logistic regression analyses to control for potential confounders. Although with discharge data there is always concern for possible misclassification, given that our prevalence of VCI is similar to what is reported in the literature, this effect is unlikely to be significant. Additionally, this study may have ascertainment bias as providers are more likely to search for a cause if an adverse outcome occurs. For example, if there was an IUFD, the provider may have been more likely to examine the placenta and to send it to pathology whereas if the outcome was normal, the placenta gets discarded. Other outcomes such as SGA and preeclampsia also commonly undergo placental

pathology. However, we found greater rates of SGA, but no difference in preeclampsia, suggesting that some of these differences are likely real. Further, study validity is also supported by a similar example of ascertainment bias, which was seen in studies that evaluated the relationship between myomas and perinatal outcomes. Coronado et al. [12], in 2000, performed a population-based study using birth certificate data and found an increased risk of placental abruption (OR 3.87), first trimester bleeding, dysfunctional labor, breech presentation (OR 3.98) and an increased risk of cesarean delivery (OR 6.39). This study of myomas was limited by the same ascertainment bias, as women with complications might be more likely to have their myomas recorded in the medical record. However, in 2010, Stout et al. [13] performed a retrospective cohort study using ultrasound data rather than birth certificate data and found very similar statistically significant associations but the effect size was smaller when examining placental abruption (OR 2.1), malpresentation (OR 1.5), or cesarean delivery (OR 1.2). Thus, while the actual effect size may not be 10-fold as seen in the current study, it does seem likely that a positive association exists between velamentous insertion and the outcomes analyzed such as IUFD.

An additional limitation is that we did not have specific ultrasound information, so we were unable to examine such issues as distance from the placental mass or location of the cord insertion in the uterus. We believe these are important issues and suggest that future studies examine such characteristics.

Despite these limitations, there appears to be an association between VCI and adverse perinatal outcomes and the study can be used by clinicians in counseling patients when the diagnosis is made. Future studies that are large and prospective and/or those that use an ultrasound database should be performed to further elucidate the implications of this finding. As more VCIs are diagnosed prenatally, clinical studies examining various management options should be conducted.

Declaration of interest

There are no conflicts of interest to report.

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