Risk Factors for Umbilical Cord Prolapse at the Time of Artificial Rupture of Membranes

Tetsuya Kawakita, MD[1] Chun-Chih Huang, PhD[2,3] Helain J. Landy, MD[4]

[1] Department of Obstetrics and Gynecology, MedStar Washington Hospital Center, Washington, District of Columbia
[2] Department of Biostatistics and Epidemiology, MedStar Health Research Institute, Hyattsville, Maryland
[3] Georgetown-Howard Universities Center for Clinical and Translational Science, Washington, District of Columbia
[4] Department of Obstetrics and Gynecology, MedStar Georgetown University Hospital, Washington, District of Columbia

Address for correspondence Tetsuya Kawakita, MD, Department of Obstetrics and Gynecology, MedStar Washington Hospital Center, 101 Irving Street, NW, 5B45, Washington, DC 20010 (e-mail: tetsuya.x.kawakita@gmail.com).

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Abstract

Objective The aim of the study was to examine the association between cervical exam at the time of artificial rupture of membranes (AROM) and cord prolapse.

Study Design We conducted a retrospective cohort study using the data from the Consortium on Safe Labor. We included women with cephalic presentation and singleton pregnancies at $\geq$ 23 weeks' gestation who underwent AROM during the course of labor. Multivariable logistic regression was used to calculate the adjusted odds ratio (aOR) with 95% confidence interval (95% CI), controlling for prespecified covariates.

Results Of 57,204 women who underwent AROM, cord prolapse occurred in 113 (0.2%). Compared with dilation 6 to 10 cm + station $\geq$ 0 at the time of AROM, <6 cm + any station and 6–10 cm + station ≤ -3 were associated with increased risks of cord prolapse (<6 cm + station ≤ -3 [aOR, 2.29; 95% CI, 1.02–5.40]; <6 cm + station -2.5 to -0.5 [aOR, 2.34; 95% CI, 1.23–4.97]; <6 cm + station $\geq$ 0 [aOR, 3.31; 95% CI, 1.39–8.09]; and 6–10 cm + station ≤ -3 [aOR, 5.47; 95% CI, 1.35–17.48]).

Conclusion Cervical dilation < 6 cm with any station and 6 to 10 cm with station ≤ -3 were associated with a higher risk of cord prolapse.

Keywords
- artificial rupture of membranes
- cervical dilation
- cord prolapse
- fetal station
- risk factors

Umbilical cord prolapse complicates 0.11 to 0.18% of live births.[1–3] Umbilical cord prolapse causes poor perfusion to the fetus due to compression of the cord between the presenting fetal part and the birth canal. Associated perinatal mortality varies from 0 to 3% when cord prolapse occurs among women monitored on a labor and delivery unit.[4] Emergent delivery, typically via cesarean delivery, is needed when umbilical cord prolapse is suspected.

Maternal and fetal risk factors for cord prolapse include malpresentation,[5–8] second twin,[5,8] prematurity,[7,9] multiparity,[6,7] polyhydramnios,[7] and unengaged presenting part.[9] Iatrogenic factors, particularly obstetric interventions, are responsible for around 50% of cases,[8] including induction of labor,[10] artificial rupture of membranes (AROM),[3,8] application of a fetal scalp electrode (FSE),[8] insertion of an intrauterine pressure catheter (IUPC),[3,8] cervical ripening with a balloon catheter,[11] and external cephalic version.[3,8] Reports in the literature conclude conflicting results regarding the risk of cord prolapse associated with AROM—cord prolapse after AROM is either seen in a majority of cases (62%)[3] or not a statistically significant effect.[12] Though AROM with an unengaged fetal head is considered to be a risk factor for

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cord prolapse, little published information exists. The aim of the study was to examine the association between cervical dilation/fetal station at the time of AROM and cord prolapse.

Methods

We conducted a retrospective cohort study from the Consortium on Safe Labor (CSL). The CSL included 228,562 deliveries at 23 weeks' gestation or greater between 2002 and 2008 in 12 clinical centers with 19 hospitals across 9 American College of Obstetricians and Gynecologists (ACOG) districts.[13] Data were abstracted from the electronic medical record and mapped to predefined categories at the data coordinating center. All participating institutions obtained Institutional Review Board (IRB) approval. IRB approval by MedStar Institutional Review Board also was obtained for this analysis.

The study group included women with singleton gestations in cephalic presentations at ≥23 weeks' gestation who attempted vaginal delivery and who underwent AROM during the course of their labor. The analysis was limited to women whose cervical examinations were available within 10 minutes from the time of AROM.

Outcomes were compared between women with and without cord prolapse. We examined maternal demographics, including maternal age, parity, gestational age at delivery, race/ethnicity, previous cesarean deliveries, maternal body mass index (BMI; kg/m^2), pregnancy-associated hypertension (gestational hypertension, preeclampsia, HELLP [hemolysis, elevated liver enzyme, low platelet] syndrome, and eclampsia), and diabetes (pregestational and gestational). Labor and delivery data including cervical exam within 10 minutes from the time of AROM, induction of labor, induction methods, use of FSE, and use of IUPC were examined. Because cervical dilation and fetal station can be linked, we examined cervical exam as groups (dilation < 6 cm + station −3 or higher, −2.5 to −0.5, or ≥0; dilation ≥6 + station −3 or higher, −2.5 to −0.5, or ≥0). Dilation 6 to 10 cm and station ≥0 was used as a reference group. The frequencies of cord prolapse were described based on cervical dilation (<6 and 6–10 cm) and station (≤ − 3, −2, −1, 0, and >0).

Student's *t*-test or Mann–Whitney *U* test was used to assess continuous variables. The chi-square analysis or Fisher's exact test was used for the analysis of categorical variables. Multivariable logistic regression analysis was used to calculate adjusted odds ratios (aOR) and 95% confidence interval (CI), controlling for parity, gestational age, race/ethnicity, BMI, cervical exam, and FSE. Firth's penalized maximum likelihood estimation was applied to remedy the potential problem of rare events in our logistic regression model.[14] For all tests, a *p*-value < 0.05 was used to define significance. Statistical analysis was performed using SAS 9.4 (SAS Institute Inc, Cary, NC).

Results

Of 57,204 women who underwent AROM, cord prolapse occurred in 113 (0.2%) (►**Fig. 1**). Demographic data are presented in ►**Table 1**. Women who experienced cord prolapse were older, more likely to deliver at an earlier gestational age, and have less cervical dilation, higher station, less effacement, and more use of FSE compared with those who did not have cord prolapse (all $p < 0.05$). There were no differences in parity, race/ethnicity, previous cesarean delivery, pregnancy-associated hypertension, diabetes, induction of labor, the method of induction of labor, and IUPC.

Risk factors for cord prolapse are presented in ►**Table 2**. After adjusting for potential confounders including parity, gestational age, race/ethnicity, BMI, cervical exam, and FSE, factors that were statistically significantly associated with

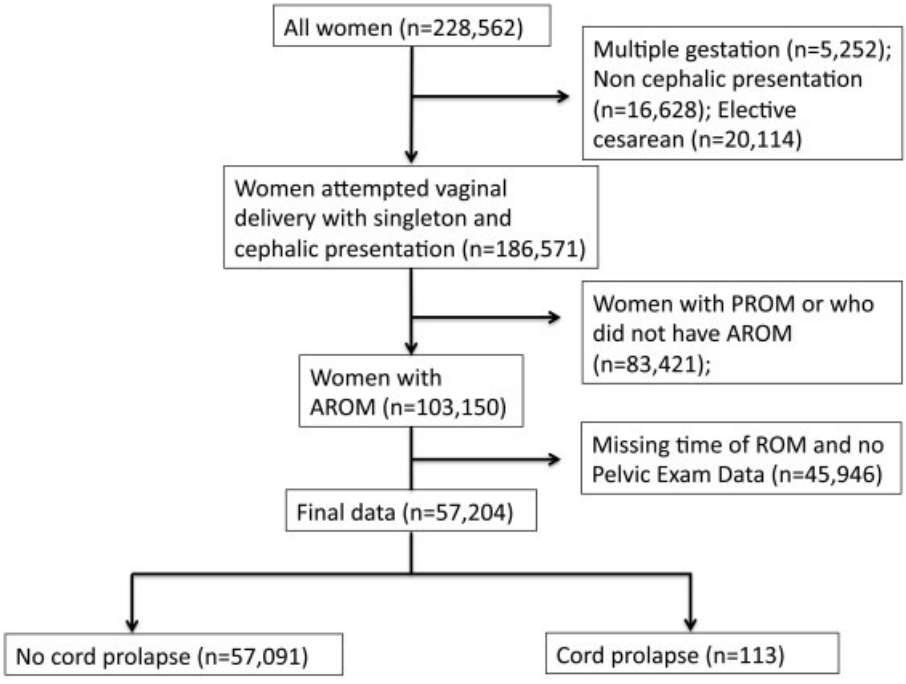

Fig. 1 Selection of the cohort. AROM, artificial rupture of membranes; PROM, premature rupture of membranes.

Table 1 Demographic data

	No cord prolapse ($n = 57,091$)	Cord prolapse ($n = 113$	*p*-Value
Maternal age (y)	27.0 (±6.0)	28.5 (±6.1)	<0.01
Parity	1 (0–3)	1 (0–3)	0.85
Gestational age (wk)	39.0 (±1.6)	38.7 (±1.7)	0.01
Race/ethnicity			
White	29,747 (52.1)	67 (59.3)	0.21
Black	10,043 (17.6)	20 (17.7)	
Other/unknown	17,301 (30.3)	26 (23.0)	
History of previous cesarean delivery	2,154 (3.8)	1 (0.9)	0.13
Body mass index (kg/m^2); ($n = 48,754$, 96 due to missing data)	30.2 (±5.8)	31.3 (±6.1)	0.07
Pregnancy-associated hypertension	5,129 (9.0)	16 (14.2)	0.055
Diabetes (pregestational and gestational)	3,149 (5.5)	8 (7.1)	0.47
Cervical dilation at the time of AROM	4.5 (2–9)	4 (2–7)	<0.01
Station at the time of AROM	−1 (−3 to 0)	−2 (−3 to 0)	<0.01
Dilation and station at the time of AROM categorical			
Dilation 0–5.9 cm + station ≤ −3	6,079 (10.6)	15 (13.3)	<0.01
Dilation 0–5.9 cm + station −2.5 to −0.5	28,081 (49.2)	68 (60.2)	
Dilation 0–5.9 cm + station ≥ 0	3,484 (6.1)	11 (9.7)	
Dilation 6–10 cm + station ≤ −3	625 (1.1)	3 (2.7)	
Dilation 6–10 cm + station −2.5 to −0.5	9,171 (16.0)	7 (6.2)	
Dilation 6–10 cm + station ≥ 0	9,681 (17.0)	9 (8.0)	
Effacement (%)	90 (60–100)	80 (50–100)	<0.01
Effacement categorical			
0–59	5,020 (8.8)	17 (15.0)	0.01
60–79	11,698 (20.5)	29 (25.7)	
80–100	40,373 (70.7)	67 (59.3)	
Induction of labor	27,380 (48.0)	55 (48.7)	0.88
Method of induction			
Misoprostol	1,184 (4.3)	1 (1.8)	0.94
PGE2	1,414 (5.2)	4 (7.3)	
Misoprostol and PGE2	80 (0.3)	0 (0)	
Mechanical	119 (0.4)	0 (0)	
Mechanical + (misoprostol or PGE2)	815 (3.0)	1 (1.8)	
Oxytocin	9,956 (36.4)	22 (40.0)	
Missing method	6,173 (22.5)	13 (23.6)	
Fetal scalp electrode	14,962 (26.2)	39 (34.5)	0.04
Intrauterine pressure catheter	13,259 (23.2)	31 (27.4)	0.29

Abbreviations: AROM, artificial rupture of membranes; PGE2, prostaglandin E2.
Note: Data shown as mean ± standard deviation, *n* (%), or median (10th–90th percentile).

cord prolapse were cervical dilation < 6 cm with any station, cervical dilation 6 to 10 cm with station −3 or higher, and earlier gestational age. Greater gestational age was associated with a lower risk of cord prolapse (aOR, 0.88; 95% CI, 0.80–0.97). Compared with dilation 6 to 10 cm + station 0 or lower at the time of AROM, dilation <6 cm + any station at the time of AROM and dilation 6 to 10 cm + station −3 or higher at the time of AROM were associated with a higher risk of cord prolapse (dilation <6 cm + station −3 or higher [aOR, 2.29; 95% CI, 1.02–5.40]; <6 cm + station −2.5 to −0.5

Table 2 Risk factors for cord prolapse

Variables	Adjusted OR (95% CI)
Parity	1.05 (0.91–1.17)
Gestational age	0.88 (0.80–0.97)
Race: Black	0.85 (0.50–1.40)
Race: Other/Unknown	0.72 (0.45–1.12)
Race: White	Reference
BMI at admission $\geq$ 30 kg/m^2	1.14 (0.66–2.06)
BMI at admission 25–29.9 kg/m^2	0.73 (0.40–1.36)
BMI at admission missing	1.06 (0.54–2.10)
BMI at admission $<$ 25 kg/m^2	Reference
Dilation 0–5.9 cm + station ≤ -3	2.29 (1.02–5.40)
Dilation 0–5.9 cm + station -2.5 to -0.5	2.34 (1.23–4.97)
Dilation 0–5.9 cm + station $\geq$ 0	3.31 (1.39–8.09)
Dilation 6–10 cm + station ≤ -3	5.47 (1.35–17.48)
Dilation 6–10 cm + station -2.5 to -0.5	0.83 (0.31–2.16)
Dilation 6–10 cm + station $\geq$ 0	Reference
FSE	1.27 (0.85–1.88)

Abbreviations: BMI, body mass index; CI, confidence interval; FSE, fetal scalp electrode; OR, odds ratio.

[aOR, 2.34; 95% CI, 1.23–4.97]; <6 cm + station 0 or lower [aOR, 3.31; 95% CI, 1.39–8.09]; and 6–10 cm + station −3 or higher [aOR, 5.47; 95% CI, 1.35–17.48]). Although aOR was highest in dilation 6 to 10 cm + station −3 or higher, there were no statistically significant differences between dilation 6 to 10 cm + station −3 or higher at the time of AROM and dilation <6 cm with any station at the time of AROM (data not shown).

Frequencies of cord prolapse according to cervical dilation and station are presented in ►**Fig. 2**. The frequency of cord prolapse was lowest in women who underwent AROM with dilation 6 to 10 cm and station −1 to −1.5 (3/1,000 AROM) and highest in women who underwent AROM with dilation 6 to 10 cm and station −3 or higher (4.8/1,000 AROM). Frequencies of cord prolapse were 1.9 to 3.2 per 1,000 in women who underwent AROM with dilation < 6 cm.

Comment

In this large, multi-institutional cohort of women who underwent AROM with a singleton gestation and cephalic presentation, we found that cervical dilation < 6 cm with any fetal station at the time of AROM, cervical dilation 6 to 10 cm with station −3 or higher, and earlier gestational age were associated with higher risks of cord prolapse.

Our study found that AROM before dilation of 6 cm was associated with a doubled risk of cord prolapse, a noteworthy finding since AROM is a commonly used procedure to shorten the length of labor. Several randomized controlled trials have shown that early AROM (dilation ≤4 cm) was associated with shorter time to delivery by >2 hours compared with the standard management (AROM at dilation ≥5 cm).[15,16] However, these studies were not large enough to examine rare outcomes such as cord prolapse. In the study by Macones et al, the rate of cord prolapse was 0.7% (2/292) in early AROM group, whereas 0% (0/293) in the standard management group.[15] Because of the retrospective nature of our study, we can only assess association. Although early AROM may shorten the length of labor, this benefit should be balanced against a doubled risk of cord prolapse, recognizing that the overall incidence of cord prolapse was still low. Further studies are warranted to confirm this association.

We also sought to understand a potential association between cord prolapse and fetal station. It is a common belief that unengaged fetal station is associated with a cord prolapse, though little published data exist. In a small study

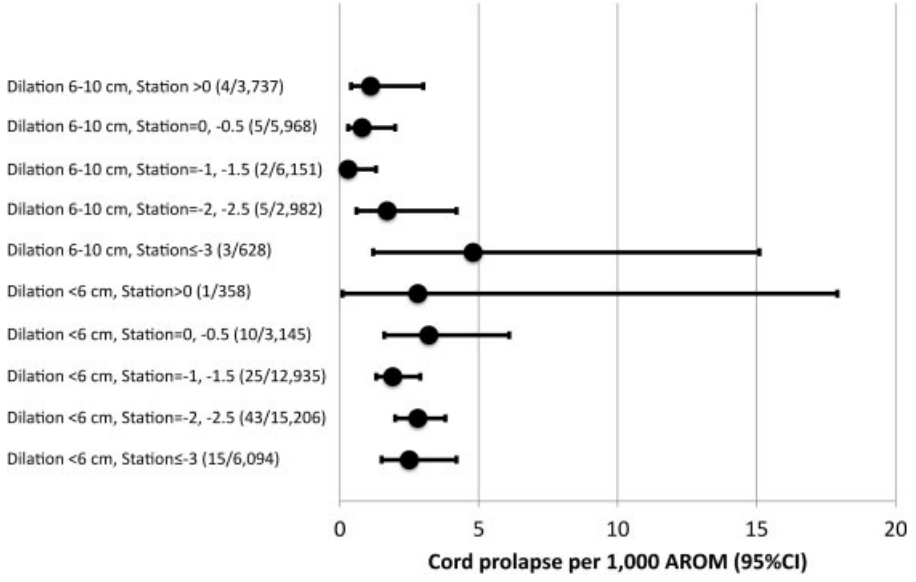

Fig. 2 Frequencies of cord prolapse according to cervical dilation and station. AROM, artificial rupture of membranes; CI, confidence interval. Frequencies are shown as number of cord prolapse per 1,000 artificial rupture of membranes.

of 37 women with cord prolapse, Roberts et al reported no statistically significant difference between fetal station at the time of admission and fetal station at the time of cord prolapse.[9] These authors concluded that an unengaged fetal station was associated with a higher risk of cord prolapse. However, their study included women with spontaneous rupture of membranes and did not compare fetal station at the time of rupture of membranes between women with and without cord prolapse. Our study found that an unengaged fetal station (-3 or higher) was associated with a higher risk of cord prolapse compared with station (0 or lower) in patients with cervical dilation 6 to 10 cm at the time of AROM. Therefore, clinicians need to be aware of higher risk of cord prolapse with unengaged fetal heads even if cervical dilation is 6 cm or greater.

The major strength of the study is the large cohort from nine ACOG districts, which makes our data generalizable. Although previous studies examined the risk factors for cord prolapse, we specifically focused on the risk factors at the time of AROM. Since AROM is common obstetric intervention, our data add important information about risk factors for cord prolapse at the time of AROM. However, our study is not without limitations. First, a large number of women (45,946) were excluded due to the missing information on rupture of membranes or cervical examinations at the time of AROM. When comparing the group of women with missing data with women included in the analysis, the missing group had a similar frequency of cord prolapse (0.23 vs. 0.20%; $p = 0.28$). There were no substantive differences in maternal age, parity, gestational age, race/ethnicity, and BMI between the two groups. In addition, the CSL was conducted between 2002 and 2008, and it is possible, though unlikely, that differences in patient population and labor management could exist that would make our findings less applicable, especially since the frequency of cord prolapse in our study was similar to that of others.[1–3] Because of the retrospective nature of the study, some cervical examinations were not documented at the time of AROM. Therefore, we only included women with available cervical examinations within 10 minutes from the time of AROM. Lastly, information on the provider level and method of AROM, which may alter the risk of cord prolapse, was not available in the database.

In conclusion, cervical dilation < 6 cm with any fetal station at the time of AROM, cervical dilation 6 to 10 cm with station -3 or higher, and earlier gestational age were associated with higher risks of cord prolapse. When considering AROM before 6-cm dilation, clinicians should balance the increased risk of cord prolapse and the benefit of early AROM. When AROM is indicated before 6 cm dilation or engaged fetal heads, careful palpation or ultrasound examination may be considered due to the increased risk of cord prolapse.

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