Electronic Fetal Monitoring Patterns With and Without Continuous Amnioinfusion

Brock E. Polnaszek, MD; Jessica Chen, MD; Rodolfo Fernandez-Criado, MD, MPH; Anna Palatnik, MD; Susan Cohen, MD; Methodius G. Tuuli, MD, MBA, MPH; Adam K. Lewkowitz, MD, MPHS

ABSTRACT

Background: This pre-specified analysis of a randomized controlled trial compared electronic fetal monitoring patterns among participants with and without amnioinfusion.

Methods: Data from the parent randomized trial included 26 term singleton nulliparous participants who developed risk factors for fetal neurologic injury. For this secondary analysis, the primary outcome was total deceleration area—a pattern predictive of neonatal acidemia and morbidity. Secondary outcomes included electronic fetal monitoring patterns (eg, variability).

Results: There were no differences in total deceleration area between the no amnioinfusion group and the amnioinfusion group (28 550 [8800–57 400] mm^2 [IQR] vs 31 500 [21 700–47 785] mm^2 [IQR], respectively; $P = .84$). Specific secondary outcomes differed by amnioinfusion.

Conclusions: These results highlight the need for prospective data to identify the optimal amnioinfusion administration technique that reduces morbidity.

BACKGROUND

There is no established optimal intrauterine resuscitation technique of amnioinfusion administration during labor and delivery that best reduces variable decelerations and prevents cesarean delivery.[1-5] Recent systematic reviews and meta-analyses highlight the need to study specific amnioinfusion administration techniques, such as continuous infusion, to understand how amnioinfusion administration techniques impact clinical care.[3,6,7] Randomized prospective data examining the effects of continuous amnioinfusion administration on electronic fetal monitoring patterns such as total deceleration area are limited.[3,4] Total deceleration area is an established electronic fetal monitoring pattern predictive of neonatal acidemia and morbidity leading up to delivery.[8-10] In this pre-specified secondary analysis of a pilot randomized trial, we aimed to compare electronic fetal monitoring patterns between nulliparous participants with and without a continuous amnioinfusion.

METHODS

The parent trial was conducted from June 2022 through April 2023 on the labor and delivery unit of a single tertiary care center (NCT05513690). (See Appendix for full study protocol.) Briefly, patients with singleton pregnancies at ≥37 weeks of gestation admitted for labor and delivery were eligible. Patients with major fetal anomalies, active substance use disorders, contraindications to intrauterine pressure catheter placement (eg, placenta previa), fetal growth restriction, active COVID-19, or inability to consent were excluded. Those who consented and developed intrapartum risk factors for fetal neurologic injury (suspected chorioamnionitis, persistent maternal fever, or fetal heart tracings concerning fetal acidemia) were randomized to amnioinfusion or no amnioinfusion. Study patients received standard obstetrical and intrapartum care at the discretion of their obstetrical providers, including emergent delivery if indicated. The amnioinfusion group received an intrauterine temperature probe and pressure catheter to administer a continuous room temperature amnioinfusion. The no amnioinfusion group received only the temperature probe.

• • •

Author Affiliations: Warren Alpert Medical School of Brown University, Department of Obstetrics and Gynecology, Division of Maternal Fetal Medicine, Women and Infants Hospital, Providence, Rhode Island (Polnaszek, Chen, Fernandez-Criado, Tuuli, Lewkowitz); Medical College of Wisconsin, Department of Obstetrics and Gynecology, Division of Maternal Fetal Medicine, Milwaukee, Wisconsin (Polnaszek, Palatnik); Medical College of Wisconsin, Department of Pediatrics, Division of Neonatology, Milwaukee, Wisconsin (Cohen).

Corresponding Author: Brock E. Polnaszek, MD, Medical College of Wisconsin, Department of Obstetrics and Gynecology, Division of Maternal Fetal Medicine, Milwaukee, Wisconsin 53045; email bpolnaszek@mcw.edu; ORCID ID 0000-0002-2092-9576

Because there is no established or optimal amnioinfusion administration technique,[4-5] we utilized our existing institutional protocol where amnioinfusion was administered with a 600 mL normal saline bolus and subsequent continuous rate of 180 mL/hour until delivery. Electronic fetal monitoring recordings were obtained with external or internal monitors, as determined clinically by the primary obstetric provider.

Electronic fetal monitoring patterns were collected in 10-minute intervals from randomization until delivery using established methods.[8] Three physicians certified in electronic fetal monitoring (JC/RF/BEP) collected patterns following delivery independently using the *Eunice Kennedy Shriver National Institute of Child Health and Human Development* definitions of electronic fetal monitoring patterns. Two of the accessors (JC/RF) were blinded to the study objective and all disagreements were adjudicated by the third (BEP). Total deceleration area also was calculated.[8-10] Deceleration area was estimated as the sum of the areas within the deceleration, and each deceleration area was estimated as .5 x duration x depth and summed as a measure of both quantity and severity of decelerations.[8-10] The Women and Infants Hospital Institutional Review Board approved this study prior to enrollment (#18008938).

For this secondary analysis, the primary outcome was total deceleration area. Secondary outcomes included category I/II/III, baseline, variability, acceleration, and deceleration electronic fetal monitoring patterns in each interval. Descriptive and bivariate analyses compared electronic fetal monitoring patterns between those with and without continuous amnioinfusion using Mann-Whitney U test or Fisher exact test accordingly.

RESULTS

Of the 26 maternal-fetal dyads randomized in the parent trial cohort, there were no significant differences in baseline characteristics, including median time from

Table 1. Cohort Characteristics

Characteristics	Amnioinfusion N = 13 (Intervention)	No Amnioinfusion N = 13 (Control)	*P* value
Maternal antibiotics	6 (46%)	7 (54%)	> .99[a]
Acetaminophen	10 (77%)	12 (92%)	.59[a]
Maternal fever > 38.0 °C	1 (8%)	3 (23%)	.59[a]
White blood cell count	22 259 ± 37 255	12 085 ± 4806	.91[b]
Prolonged rupture > 18 hours	4 (31%)	3 (23%)	> .99[a]
Amnioinfusion outside protocol	0 (0%)	3 (23%)	.22[a]
Prolonged second stage	2 (15%)	2 (15%)	> .99[a]
Length of time from admission to delivery, hours	30.83 ± 18.65	30.97 ± 22.31	.79[b]
Epidural	13 (100%)	13 (100%)	> .99[a]
Stage 2 length, hours	1.77 ± 1.43	1.99 ± 2.11	> .99[b]
Estimated blood loss, mL	577 ± 385	558 ± 333	.79[b]
3rd or 4th degree laceration	2 (15%)	0 (0%)	.48[a]
Randomization to delivery, minutes	230 [90–400]	250 [120–390]	.86[a]
Mode of delivery			.29[b]
Vaginal	10 (77%)	6 (46%)	
Operative vaginal delivery	1 (8%)	1 (8%)	
Cesarean delivery	2 (15%)	6 (46%)	
Gestational age, weeks	38.7 ± 1.4	38.8 ± 1.5	.79[b]
Birth weight, grams	3138 ± 401	3323 ± 388	.14[b]

Data are mean (SD) or number (percent) or median [interquartile].

[a]Fisher exact test.

[b]Wilcoxon rank sum test.

Table 2. Electronic Fetal Monitoring Patterns by Presence or Absence of Continuous Amnioinfusion for Fetuses with Risk Factors of Neurologic Injury

Electronic Fetal Monitoring Characteristics	No Amnioinfusion N = 13; 319 Intervals	Amnioinfusion N = 13; 344 Intervals	*P* value
Primary Outcome: Total deceleration area			
Cumulative total deceleration area, mm^2	28 550 [8800–57 400]	31 500 [21 700–47 785]	.84[a]
Secondary Outcomes: NICHD definitions			
Category I	138 (43.3%)	135 (39.2%)	.29[b]
Category II	180 (56.4%)	204 (59.3%)	.45[b]
Category III	1 (0.3%)	5 (1.5%)	.12[b]
Baseline			
Beats per minute, average	135 [125–150]	145 [140–153]	< .001[a]
Normal	292 (91.5%)	306 (88.9%)	.26[b]
Bradycardia	13 (4.1%)	0 (0%)	< .001[b]
Tachycardia	14 (4.4%)	38 (11.1%)	.001[b]
Variability			
Absent/minimal	27 (8.5%)	27 (7.9%)	.72[b]
Moderate	292 (91.5%)	315 (91.6%)	.99[b]
Marked	0 (0%)	2 (0.6%)	.17[b]
Accelerations			
Number of accelerations, median	0 [0–2]	1 [0–2]	.34[a]
Present	149 (47.0%)	179 (52.3%)	.17[b]
Decelerations			
Number of decelerations, median	0 [0–2]	1 [0–2]	.25[a]
Present	145 (45.9%)	181 (52.8%)	.08[b]
Late	102 (32.0%)	106 (30.8%)	.75[b]
Variable	59 (18.5%)	94 (27.3%)	.007[b]
Early	15 (4.7%)	2 (0.6%)	.001[b]
Prolonged	11 (3.5%)	14 (4.1%)	.68[b]

Abbreviation: NICHD, National Institute of Child Health and Human Development.

Interval defined as 10 minutes of electronic fetal monitoring data from randomization to delivery; data median [interquartile range] or mean (percentage).

[a]Fisher exact test.

[b]Wilcoxon rank sum test.

randomization until delivery (250 [120–390] minutes [IQR] in the no amnioinfusion vs 230 [90–400] minutes [IQR] in amnioinfusion group; $P = .86$) (Table 1). The most common indication for randomization was minimal variability with decelerations. There was no significant difference in the primary outcome of total deceleration area (28 550 [8800–57 400] mm^2 [IQR] in the amnioinfusion group vs 31 500 [21 700–47 785] mm^2 [IQR] in the amnioinfusion group; $P = .84$). However, those randomized to continuous amnioinfusion had a higher baseline fetal heart rate (145 [140–153] vs 135 [125–150] beats per minute [IQR], $P < .001$) and fewer intervals with either bradycardia (0% vs 4.7%; $P < .001$) or early decelerations (0.6% vs 4.7%; $P < .001$). Those randomized to amnioinfusion also had more intervals with tachycardia (11.1% vs 4.4%; $P < .001$) and variable decelerations (27.3% vs 18.5%; $P < .001$). The remaining electronic fetal monitoring patterns were not statistically different (Table 2).

DISCUSSION

There was no difference in total deceleration area during labor and delivery with and without continuous amnioinfusion among term nulliparous birthing people who developed intrapartum risk factors for fetal neurologic injury. Additionally, in the parent trial, there was no difference in any clinically meaningful neonatal data, such as umbilical artery cord blood gas values of acidemia pH <7.1, base excess, lactate, and composite or individual neonatal morbidity health outcomes.[5] Continuous amnioinfusion resulted in a higher baseline, less frequent bradycardia, and early decelerations and more frequent tachycardia and variable decelerations. The clinical impact and interpretation of these differences in secondary outcomes remains challenging in the context of our secondary analysis of a pilot trial, yet the unanticipated increase in variable decelerations is noteworthy. These data suggest that amnioinfusion administration techniques (continuous vs intermittent) affect electronic fetal monitoring patterns.

Strengths of this study include the randomized prospective data with 230 minutes of continuous amnioinfusion administration technique and subsequent electronic fetal monitoring patterns. Interpretation of these data are limited by the small sample size, lack of multiparous participants, lack of comparison of continuous to bolus amnioinfusion as a control, and known prognostic limitations of electronic fetal monitoring for reducing neonatal morbidity. Amnioinfusion should continue to be administered for the approved indication of reducing variable decelerations and preventing cesarean delivery. Amnioinfusion for reducing neonatal neurologic injury remains investigational and for research purposes. Nevertheless, these data highlight that amnioinfusion administration technique impacts electronic fetal monitoring patterns currently used in labor management. These results further support the need for prospective studies to identify the optimal amnioinfusion administration technique that may reduce morbidity.

Funding/Support: This study received funding from the Foundation for Society for Maternal-Fetal Medicine (SMFM) 2021 Danielle Peress, MD Memorial Fund and Gerber Foundation Research Novice Award.

Financial Disclosures: None declared.

REFERENCES

1. American College of Obstetricians and Gynecologists (College); Society for Maternal-Fetal Medicine, Caughey AB, Cahill AG, Guise JM, Rouse DJ. Safe prevention of the primary cesarean delivery. *Am J Obstet Gynecol.* 2014;210(3):179-193. doi:10.1016/j.ajog.2014.01.026

2. Raghuraman N. Response to category II tracings: does anything help?. *Semin Perinatol*. 2020;44(2):151217. doi:10.1016/j.semperi.2019.151217

3. Polnaszek BE, Rossen J, Bligard KH, et al. intrapartum amnioinfusion for recurrent variable decelerations and neonatal morbidity: a systematic review and meta-analysis. *Clin Exp Obstet Gynecol.* 2024;51(3):75. doi: 10.31083/j.ceog5103075

4. Polnaszek B, López JD, Clark R, Raghuraman N, Macones GA, Cahill AG. Marked variability in intrapartum electronic fetal heart rate patterns: association with neonatal morbidity and abnormal arterial cord gas. *J Perinatol*. 2020;40(1):56-62. doi:10.1038/s41372-019-0520-9

5. Polnaszek BE, Rossen J, Scarpaci M, et al. Amnioinfusion for reducing umbilical artery lactate among fetuses at risk of neurologic injury: a pilot randomized clinical trial. *Am J Obstet Gynecol MFM.* 2024;6(10):101446. doi:10.1016/j.ajogmf.2024.101446

6. Hofmeyr GJ, Lawrie TA. Amnioinfusion for potential or suspected umbilical cord compression in labour. *Cochrane Database Syst Rev.* 2012;1(1):CD000013. doi:10.1002/14651858.CD000013.pub2

7. Davis JD, Sanchez-Ramos L, McKinney JA, Lin L, Kaunitz AM. Intrapartum amnioinfusion reduces meconium aspiration syndrome and improves neonatal outcomes in patients with meconium-stained fluid: a systematic review and meta-analysis. *Am J Obstet Gynecol.* 2023;228(5S):S1179-S1191.e19. doi:10.1016/j.ajog.2022.07.047

8. Cahill AG, Tuuli MG, Stout MJ, López JD, Macones GA. A prospective cohort study of fetal heart rate monitoring: deceleration area is predictive of fetal acidemia. *Am J Obstet Gynecol*. 2018;218(5):523.e1-523.e12. doi:10.1016/j.ajog.2018.01.026

9. Talmor M, Rotem R, Wientraub AY, Yaniv Salem S. The correlation between total deceleration and acceleration surface areas on electronic fetal monitoring and neonatal cord blood pH in postdate pregnancies. *Int J Gynaecol Obstet.* 2023;161(3):870-876. doi:10.1002/ijgo.14558

10. Geva N, Geva Y, Katz L, et al. Correlation between total deceleration area in CTG records and cord blood pH in pregnancies with IUGR. *Arch Gynecol Obstet.* 2024;310(3):1425-1431. doi:10.1007/s00404-023-07240-0

advancing the art & science of medicine in the midwest

WMJ

WMJ (ISSN 2379-3961) is published through a collaboration between The Medical College of Wisconsin and The University of Wisconsin School of Medicine and Public Health. The mission of *WMJ* is to provide an opportunity to publish original research, case reports, review articles, and essays about current medical and public health issues.

Visit www.wmjonline.org to learn more.