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Should delivery timing for repeat cesarean be reconsidered based on dating criteria?*

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Abstract

Purpose: We sought to examine if the method of pregnancy dating at five increasing term gestational ages is associated with increasing neonatal morbidity.

Materials and methods: A cohort of women who underwent elective repeat cesarean delivery at ≥37 weeks' gestation were identified from the NICHD MFMU Network registry. We excluded women who were in labor, those carrying a fetus with a congenital anomaly, those with a non-reassuring fetal heart tracing, and those with preeclampsia, preexisting chronic hypertension or diabetes. Composite neonatal morbidity was defined for our study as any of the following: NICU admission, hypotonia, meconium aspiration, seizures, need for ventilator support, NEC, RDS, TTN, hypoglycemia, or neonatal death. We compared composite neonatal morbidity rates among infants born at five different gestational age cutoffs according to their method of pregnancy dating.

Results: At 39 and 40 weeks' gestation, the lowest rate of neonatal complications was seen in pregnancies dated by first trimester ultrasound (5.8% and 5.5%, respectively), while those with the highest neonatal morbidity rates were seen when dated by a second or third trimester ultra-sound (8.1% and 6.0%, respectively); $p < .001$. Additionally within each pregnancy dating category, the neonatal morbidity rates declined from 37 to 40 weeks' gestation and then significantly increased at 41 + 0 weeks' gestation.

Conclusion: Even with suboptimal dating methods, amongst women undergoing elective repeat cesarean delivery, neonatal morbidity was lowest when delivery occurred between 40 and 40 + 6 weeks gestation.

Keywords

Cesarean delivery; neonatal morbidity; pregnancy dating; repeat cesarean; respiratory morbidity

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Disclosure statement

The authors have no conflicts of interest to report.

Introduction

The current standard of care for delivery timing for elective repeat cesarean is 39 weeks' gestation based upon the estimated date of confinement (EDC) [1]. When scheduling an elective cesarean delivery, the date chosen should reflect the optimal time to minimize neonatal morbidity. The focus on delaying delivery to 39 weeks' gestation is based on evidence demonstrating that neonatal morbidity is lower at 39 weeks' gestation than at earlier gestational ages [2–5]. However, the gestational age is estimated in the majority of patients with varying accuracy, so it is unclear whether these findings are generalizable to all such dating approaches.

Determination of the EDC is usually based on a combination of the last menstrual period (LMP) and information gathered through ultrasound measurements. In the event of an unknown or unsure LMP, the EDC is determined based on ultrasound measurements. Many studies have been performed to date to demonstrate which criteria are most accurate in determining an EDC, but little data exist on how the inaccuracies of dating may impact neonatal morbidity. These data would be particularly useful to aide in deciding at what gestational age an elective repeat cesarean should be performed, particularly when patients present late to care. We sought to determine whether method of dating the pregnancy at five increasing term gestational ages was associated with increasing neonatal morbidity.

Materials and methods

After obtaining IRB approval, we identified women who underwent an elective repeat cesarean delivery, not in labor, from a National Institute of Child Health and Human Development Maternal fetal Medicine Units (NICHD MFMU) Network registry (hereafter referred to as the cesarean registry) [6]. As a part of a multicenter observational study involving 19 centers between 1999 and 2002, the cesarean registry was established to collect data on maternal complications in women undergoing cesarean delivery or vaginal birth after cesarean delivery. All women delivered at a gestational age of 20 weeks or greater or delivered an infant weighing ≥500 g. Between 1999 and 2000, women who underwent successful vaginal birth after cesarean delivery or primary or repeat cesarean delivery were enrolled. Between 2001 and 2002, women with repeat cesarean delivery and successful vaginal birth after cesarean delivery were enrolled. Women who underwent either cesarean delivery or vaginal birth after cesarean delivery were identified from the labor and delivery log book or a computer database at each participating center. At delivery, information was collected through chart review, and information regarding perioperative morbidity was collected from discharge summaries.

We limited our analysis to women who underwent an elective repeat cesarean delivery of a singleton gestation at five different term delivery time intervals:(1) 37 + 0 − 37 + 6 weeks' gestation, (2) 38 0 − 38 + 6 weeks' gestation, (3) 39 + 0 − 39 + 6 weeks' gestation,(4) 40 + 0 − 40 + 6 weeks' gestation, or (5) ≥41 + 0 weeks' gestation. In each gestational age category, the EDC was determined by a first, second, or third trimester ultrasound, which may or may not have been consistent with LMP. Women who were pregnant with a fetus affected by a congenital anomaly were excluded. Women with hypertension, preeclampsia, pregestational diabetes, or who had a non-reassuring fetal heart tracing were also excluded. Composite neonatal morbidity was defined in our study as any of the following: NICU admission, hypotonia, meconium aspiration, seizures, need for ventilator support, NEC, RDS, TTN, hypoglycemia, or neonatal death. We further constructed a composite neonatal respiratory morbidity variable, which was composed of RDS, TTN, and/or need for ventilator support in the first 24 h after delivery. We compared these composite morbidity rates among infants born at five different gestational age cutoffs according to their method of pregnancy dating.

Data are presented as *n* (%), with categorical data compared between groups using the Fishers-Exact test. Poisson regression analysis was performed to account for maternal and obstetric confounders and potential mediators that may have influenced the association between pregnancy dating method, gestational age at delivery, and composite neonatal morbidity. Potential confounders included maternal age and race. All analyses were conducted using SAS version 9.2 (SAS Institute Inc, Cary, NC) and SPSS version 21.0 (IBM SPSS, Armonk, NY). A p value < .05 was considered statistically significant.

Results

A total of 15,602 women underwent repeat cesarean delivery at one of the five term gestational age categories. We identified 5486 women who were dated by first trimester ultrasound, 8393 by second trimester ultrasound, and 1723 by third trimester ultrasound. The majority of the sample was white and younger than 35 years old at delivery (Table 1).

The composite neonatal morbidity rate at term was lowest when the pregnancy was dated by first trimester ultrasound and repeat cesarean delivery occurred at 40 + 0 − 40 + 6 weeks' gestation (5.5%) (Table 2). The incidence of neonatal morbidity was statistically significantly lower when the pregnancy was dated by first trimester ultrasound at 39 + 0 − 39 + 6 weeks' or greater than or equal to 41 + 0 weeks' gestation compared to when the pregnancy was dated by other methods ($p = .019$ and $p < .001$, respectively). The incidence of neonatal morbidity among women dated by first trimester ultrasound was significantly lower across gestational age categories at 38 + 0 − 38 + 6 weeks', 39 + 0 − 39 + 6 weeks', 40 + 0 − 40 + 6 weeks', and greater than or equal to 41 + 0 weeks' gestation; ($p < .001$).

Similarly, the composite respiratory neonatal morbidity rate at term was the lowest when the pregnancy was dated by first trimester ultrasound and repeat cesarean delivery occurred at 40 + 0 − 40 + 6 weeks' gestation (2.4%) relative to other term gestational ages (Table 3). There was no statistically significant difference in neonatal respiratory morbidity among women dated by second or third trimester ultrasound for women delivered at 38 + 0 − 38 + 6 weeks' or 39 + 0 − 39 + 6 weeks' gestation. Neonatal composite overall and respiratory morbidity tended to be the highest at 37 + 0 − 37 + 6 weeks, continually decreasing until 40 + 0 − 40 + 6 weeks, and then began increasing again after 41 + 0 weeks' gestation. With the exception of deliveries at 37 + 0 − 37 + 6 weeks' gestation, neonatal composite overall and respiratory morbidity tended to be the highest when pregnancy dating was by a third trimester ultrasound and was lowest when pregnancy dating was by first or second trimester ultrasound.

Poisson regression demonstrated women whose pregnancies were dated by a third trimester ultra-sound had a significantly increased risk of neonatal morbidity, aRR (95% CI) = 1.24 (1.04 – 1.48), when compared with those women who were dated by first trimester ultrasound (Table 4). Additionally, women who were delivered at all gestational ages after 37 + 0 – 37 + 6 weeks' gestation were less likely to deliver an infant with one of the composite neonatal morbidities compared with those women who delivered at 37 + 0 − 37 + 6 weeks gestation. Non-White race was also a significant risk factor for composite neonatal morbidity (aRR (95% CI) = 1.16 (1.04, 1.30)).

Discussion

Our data suggest that the lowest rates of composite and respiratory neonatal morbidity occur when pregnancy dating is by first trimester ultrasound and delivery occurs at 40 + 0 − 40 + 6 weeks' gestation. When pregnancies are dated by ultrasound, the rates of neonatal composite and respiratory morbidity generally increase the later, and the dating ultrasound was performed in the pregnancy. Although it is commonly accepted that the earlier an ultrasound is performed, the more accurate the dating is for the pregnancy, there is substantial literature questioning whether or not LMP dating increases the percentage of falsely categorized preterm infants [7–14]. This is likely because dating by LMP operates under the assumption that ovulation occurs 14 d after the first day of the LMP, when in fact for many women, ovulation occurs later. We have limited our analysis to term deliveries; however, a large secondary analysis by Duryea et al., which assessed neonatal outcomes among all US births dated by the best obstetric estimate compared to the LMP alone supports our findings [7]. This analysis found statistically significantly higher rates of NICU admission, need for assisted ventilation, and surfactant use, among infants born to women dated by best obstetric estimate compared with those dated by LMP [7]. Still, we recognize the limitations of using the LMP alone for dating purposes, which is why we limited our sample to pregnancies dated by ultrasound confirmation. The data presented in our study confirm two important points among women who are dated by an ultrasound and not by LMP alone: (1) neonatal composite and respiratory morbidity tends to be the highest among women dated by later ultrasound; and (2) neonatal composite and respiratory morbidity significantly decrease when repeat cesarean delivery takes place after 39 + 0 weeks' gestation relative to earlier term delivery. These findings are also supported by earlier studies of the accuracy of ultrasound dating [15].

We acknowledge that there are a number of limitations to our study. The cesarean registry lacked complete information on truly elective cesarean delivery; however, we suspect by limiting our analysis to repeat cesarean deliveries, not in labor, we have captured an accurate representation of the typical elective cesarean delivery scheduled for 39 + 0 weeks' gestation. The cesarean registry also lacked data on other important covariates regarding fetal status leading up to delivery (i.e. growth restriction, anemia, etc.) that could have altered the composite neonatal morbidity outcome. Additionally, there was not a way to evaluate how ultrasound dating may have had a different impact on neonatal morbidity if it was, or was not, consistent with LMP, as this granularity in the data was not apparent. However, the cesarean registry sourced clinical data from a population-wide study of >57,000 women who underwent cesarean delivery at 19 different US obstetric centers. As a result, this allowed us to obtain broad clinical data on a large cohort of women identified who delivered by cesarean at term. Another issue is that data for gestational age by week were available, but we were unable to examine outcomes by a finer gradation of gestation such as by day or half week. It may be that delivery in the latter half of 38 weeks' gestation or first half of 40 weeks' leads to incremental improvements in outcomes and requires additional study. Lastly, data in the cesarean registry is over 10 years old and does not account for the potential that ultrasound dating may have gained further accuracy with increasing technological advances since that time.

We conclude that the overall neonatal composite morbidity as well as neonatal respiratory morbidity is impacted by both the method of dating the pregnancy and the gestational age at delivery, even in term pregnancies. Our results support previous findings that dating the pregnancy by first trimester ultra-sound is less likely to produce infants affected by prematurity-associated morbidity. While this may not serve as a substitute for prenatal ultrasound dating obtained in the course of routine prenatal care, it does suggest that among women whose pregnancies are dated by ultrasound, first trimester ultrasound dating is more accurate than third trimester ultrasound dating. Additionally, our results support the current ACOG guidelines for repeat elective cesarean delivery scheduling at no earlier than 39 + 0 weeks, and suggests the lowest neonatal composite and respiratory morbidity is associated with delivery closer to 40 + 0 weeks' gestation. The neonatal morbidity associated with dating by late ultrasound may also support the need for fetal lung maturity testing prior to delivery in such women.

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Table 1.

Maternal characteristics of women with ultrasound dating delivered by repeat cesarean at term ($N = 15{,}602$).

	37 + 0 – 37 + 6 weeks (*N* = 1593)	**38 + 0 – 38 + 6 weeks (*N* = 6662)**	**39 + 0 – 39 + 6 weeks (*N* = 5146)**	**40 + 0 – 40 + 6 weeks (*N* = 1552)**	**> = 41 + 0 weeks (*N* = 649)**
Race/ethnicity					
White	849 (10.0)	3198 (37.6)	2959 (34.8)	1022 (12.0)	488 (5.7)
Non-White	744 (10.5)	3464 (48.9)	2187 (30.9)	530 (7.5)	161 (2.3)
Maternal age > = 35 years	403 (11.6)	1587 (45.5)	1113 (31.9)	286 (8.2)	101 (2.3)
Dating					
1st tri US	583 (10.6)	2654 (48.4)	1676 (30.6)	422 (7.7)	151 (2.8)
2nd tri US	805 (9.6)	3458 (41.2)	2929 (34.9)	857 (10.2)	344 (4.1)
3rd tri US	205 (11.9)	550 (31.9)	541 (31.4)	273 (15.8)	154 (8.9)

Values are expressed as *N* (%).

Table 2.

Composite neonatal morbidity for repeat cesarean delivery at 37 versus 38 versus 39 versus 40 versus ≥41 weeks' gestation based on dating method (N = 15,602).

	37 – 37 + 6 weeks (N = 1593)	38 – 38 + 6 weeks (N = 6662)	39 – 39 + 6 weeks (N = 5146)	40 – 40 + 6 weeks (N = 1552)	> = 41 + 0 weeks (N = 649)	p value
Dating						
1st trimester US (N =5486)	96 (16.5)	203 (7.7)	97 (5.8)	23 (5.5)	10 (6.6)	<.001
2nd trimester US (N = 8393)	107 (13.3)	319 (9.2)	205 (7.0)	51 (6.0)	30 (8.7)	<.001
3rd trimester US (N = 1723)	31 (15.1)	60 (10.9)	44 (8.1)	15 (5.5)	20 (13.0)	<.001
p value	.044	.811	.019	.076	<.001	

Values are expressed as N (%).

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Table 3.

Neonatal respiratory morbidity for repeat cesarean delivery at 37 versus 38 versus 39 versus 40 versus >41 weeks' gestation (*N* = 16,860).

	37 – 37 + 6 weeks (*N* = 1593)	**38 – 38 + 6 weeks (*N* = 6662)**	**39 – 39 + 6 weeks (*N* = 5146)**	**40 – 40 + 6 weeks (*N* = 1552)**	**> = 41 weeks (*N* = 649)**	***p* value**
Dating						
1st trimester US (*N* = 5486)	61 (10.5)	137 (5.2)	59 (3.5)	10 (2.4)	7 (4.6)	.001
2nd trimester US (*N* = 8393)	61 (7.6)	176 (5.1)	121 (4.1)	35 (4.1)	18 (5.2)	.001
3rd trimester US (*N* = 1723)	21 (10.2)	34 (6.2)	24 (4.4)	9 (3.3)	12 (7.8)	.009
p value	.025	.223	.169	.030	<.001	

Values are expressed as *N* (%).

Table 4.

Regression analysis for risk of composite neonatal morbidity.

	aRR (95% CI)	*p* value
Dating method		
1st trimester US	Reference	
2nd trimester US	1.10 (0.98, 1.23)	.108
3rd trimester US	1.24 (1.04, 1.48)	.018
Delivery gestational age (weeks)		
37 + 0 – 37 + 6	Reference	
38 + 0 – 38 + 6	0.60 (0.52, 0.70)	<.001
39 + 0 – 39 + 6	0.46 (0.39, 0.54)	<.001
40 + 0 – 40 + 6	0.38 (0.30, 0.48)	<.001
> = 41 + 0	0.60 (0.46, 0.79)	.0002
Race		
White	Reference	
Non-White	1.16 (1.04, 1.30)	.009
Maternal age ≥35 years	1.07 (1.00, 1.02)	.111