OBSTETRICS

The impact of extending the second stage of labor to prevent primary cesarean delivery on maternal and neonatal outcomes

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BACKGROUND: A low rate of primary cesarean delivery is expected to reduce some of the major complications that are associated with a repeat cesarean delivery, such as uterine rupture, adhesive placental disorders, hysterectomy, and even maternal death. Since 2014, and in alignment with the American College of Obstetricians and Gynecologists and the Society for Maternal–Fetal Medicine, we changed our approach to labor dystocia, defined as abnormal progression of labor, by allowing a longer duration of the second stage of labor.

OBJECTIVE: To examine the effect of prolonging the second stage of labor on the rate of cesarean delivery, and maternal and neonatal outcomes.

MATERIALS AND METHODS: In a historical control group, we compared maternal and neonatal outcomes over 2 periods. Period I (9300 patients): from May 2011 until April 2014, when a prolonged second stage in nulliparous women was considered after 3 hours with regional anesthesia or 2 hours if no such anesthesia was provided. Second-stage arrest was defined in multiparous women after 2 hours with regional anesthesia or 1 hour without it. Period II (10,531 patients): from May 2014 until April 2017, allowed nulliparous and multiparous women continuing the second stage of labor an additional 1 hour before diagnosing second-stage arrest. Singleton deliveries at or beyond 37 weeks' gestation were initially considered for eligibility. We excluded women with high-risk pregnancies and known fetal anomalies. For comparing means, we used the *t* test. If variables were not normally distributed, we used the Mann–Whitney test instead. For comparing proportions, we used the χ^2 test with continuity correction.

RESULTS: The primary cesarean delivery was decreased in nulliparous women from 23.3% (819 of 3515) in period I to 15.7% (596 of 3796) in period II (relative risk [RR], 0.67; 95% CI, 0.61–0.74), a trend that was also significant in multiparous women (10.9%, 623 of 5785, in period I vs 8.1%, 544 of 6735, in period II; RR, 0.75; 95% CI, 0.67–0.84). The rate of operative vaginal deliveries in nulliparous women was higher in period II than in period I (19.2%, 732 of 3515, vs 17.7%, 622 of 3796, $P < .0001$). Rates of third- and fourth-degree laceration and of shoulder dystocia were also higher in period II. The rate of arterial cord pH < 7.0 and the rate of admission to the neonatal intensive care unit were higher in period II, but the early neurological outcome was not different when comparing the 2 periods.

CONCLUSION: The new policy of labor management successfully decreased primary cesarean deliveries, with a small rise in instrumental deliveries. However, it also increased the other immediate maternal and neonatal complications. A higher rate of lower umbilical artery cord pH was the most significant finding; however, the early neurological outcome did not change. It is possible that the ongoing adjustment to the new labor protocol will avoid, in the future, maternal and neonatal complications. The long-term maternal and neonatal consequences of our new approach will be evaluated in future studies.

Key words: academia, cesarean delivery, dystocia, early neurologic outcome, epidural analgesia, epidural anesthesia, failure to progress in labor, maternal and fetal outcome, neonatal intensive care unit, operative vaginal delivery, second-stage arrest, second-stage of labor, third- and fourth-degree laceration

Cesarean delivery (CD) is associated with higher morbidity and mortality than vaginal birth.[1,2] More than one-third of all indications for primary CD are due to labor dystocia in the second stage of labor,[3,4] defined as an abnormal descent of the fetal head. However, since the labor curve was initially introduced,[5] it has been continuously challenged. Even recently, the relevance of the Friedman curve has been questioned again. Zhang et al[6] have shown that the Friedman curve cannot be used as a mean labor curve but, rather, as an idealized labor curve. On the other hand, Cohen and Friedman[7] claim that the new approach to labor curve mischaracterized the Friedman curve.

From their 2014 obstetric care consensus on the safe prevention of primary CD, the American College of Obstetricians and Gynecologists (ACOG) and the Society for Maternal–Fetal Medicine (SMFM) allow an additional 1 hour of extended pushing in the second stage of labor for nulliparous and multiparous women before diagnosing second-stage arrest.[8–10]

Thus far, only 1 randomized controlled trial has specifically addressed the effect of this change in obstetric practice on maternal and neonatal outcomes. In that trial, a policy of extending the second stage of labor for at least 1 hour in nulliparous women with epidural anesthesia decreased the incidence of CD by more than one-half, compared with the common practice (19.5%, 8 of 41, vs 43.2%, 16 of 37; RR, 0.45; 95% CI, 0.22–0.93). Unfortunately, the trial was underpowered to detect important differences in the frequency of adverse maternal or neonatal outcomes between groups.[11]

Following the ACOG/SMFM consensus in 2014,[10] we changed our approach to labor dystocia, mainly by

Cite this article as: Zipori Y, Grunwald O, Ginsberg Y, et al. The impact of extending the second stage of labor to prevent primary cesarean section on maternal and neonatal outcomes. Am J Obstet Gynecol 2019;220:191.e1-7.

0002-9378/$36.00

https://doi.org/10.1016/j.ajog.2018.10.028

AJOG at a Glance:

Why was this study conducted?

To examine the effect of prolonging the second stage of labor on the rate of cesarean delivery, and maternal and neonatal outcomes.

Key Findings

The primary cesarean delivery was decreased in nulliparous and in multiparous women after prolonging the second stage of laor. The rate of arterial cord pH below 7.0, the rate of admission to the neonatal intensive care unit, and the rate of third and fourth degree laceration was increased after prolonging the second stage of labor.

What does this add to what is known?

The decrease in primary cesarean delivery after prolonging the second stage of labor was associate with a higher rate of immediate maternal and neonatal complications.

allowing a longer duration of the second stage of labor. The objective of our study was to compare between 2 periods of time, namely, before and after the ACOG/SMFM recommendations, to assess the effect of the new policy not only on the mode of delivery but also on other maternal and fetal outcomes.

Materials and Methods

Study procedures

This was a retrospective, single-center cohort study, in a large tertiary referral hospital. The study was approved by the hospital's research ethics board, which also waived the authors from obtaining an informed consent because of the retrospective and anonymous data collection. Singleton deliveries at or beyond 37 weeks' gestation were initially considered for eligibility. Gestational age was determined from the menstrual history and confirmed from the measurement of fetal crown−rump length at a first-trimester scan. Exclusion criteria were as follows: nonvertex presentation, trial of labor after cesarean delivery, high-risk pregnancy (multiple gestation, preeclampsia, diabetes mellitus, intrauterine growth restriction), known fetal anomalies, and intrauterine fetal demise. We compared maternal and neonatal outcomes over 2 distinct time periods in relation to the duration of the second stage of labor: period I, from May 2011 until April 2014; and period II, from May 2014 until April 2017. Second stage of labor was defined from complete cervical dilation to delivery. In general, a passive second stage with delayed pushing for at least 1 hour was permitted before active pushing. In the "classic labor curve" during period I, a prolonged second stage in nulliparous women was considered after 3 hours with regional anesthesia or 2 hours if no such anesthesia was provided. Second stage arrest was made in multiparous women when time exceeded 2 hours with regional anesthesia or 1 hour without it.[12,13] The "new labor curve" of period II allowed nulliparous and multiparous women continuing the second stage of labor for an additional 1 hour before diagnosing second-stage arrest.[8−10]

The primary outcome of our study was early neonatal outcome, including umbilical artery cord pH and base excess, and early neurological outcome. The secondary outcome included other maternal and fetal parameters that are described in this section. Data were collected from the combined maternal and fetal clinical records, and included antenatal, intrapartum, and postpartum characteristics. We also recorded infants' diagnoses, interventions, and follow-up, both in the delivery room and during their stay in the nursery or neonatal intensive care unit (NICU). The primary outcome of the study was the rate of primary CD. Maternal secondary outcomes were as follows: the rate of operative vaginal delivery, post-partum hemorrhage (PPH), need for blood transfusion, third- and fourth-degree laceration, and chorioamnionitis. Estimated blood loss of >500 mL in a vaginal delivery and >1000 mL in a CD were used to define PPH. Clinical criteria for chorioamnionitis were maternal fever with 2 or more of the following: maternal tachycardia, fetal tachycardia, leukocytosis, uterine tenderness, and malodorous amniotic fluid.[14] Neonatal secondary outcomes included shoulder dystocia, Apgar scores at 1 and 5 minutes, umbilical artery cord pH, and base excess (obtained from all patients), admission to the NICU, length of stay in the NICU, perinatal death, and abnormal early neurological outcome. Routine neurological assessment at the NICU included observation for alertness, posture, spontaneous movements, breathing and crying, physical examination for tone (active and passive), and infantile primitive reflexes (Rooting, Sucking, Moro, Grasp). The full neurological assessments were performed by a neonatologist and, in uncertain cases, by a pediatric neurologist.

Statistical analysis

For comparing means, we used the *t* test. If variables were not normally distributed, we used the Mann−Whitney test to compare medians. For comparing proportions, we used the χ^2 test with continuity correction and calculated nonadjusted relative risks (RR) with 95% confidence intervals (CI). Confounder-adjusted relative risks were calculated using multivariate binomial log-linear regression model. A P value <.05 was considered statistically significant.

Results

In period I, a total of 9300 women met inclusion criteria, and in period II, 10531 women met inclusion criteria. As seen in Table 1, baseline characteristics such as maternal age, body mass index, being nulliparous, induction of labor, provision of epidural anesthesia, gestational age, and birthweight at delivery were similar between the 2 periods. However, the rate of oxytocin augmentation was significantly higher in period I (30.3%, 2817 of 9300) than in period II (21.4%, 2251 of 10,531). Induction of labor was performed.

TABLE 1
Maternal and fetal baseline characteristics

	Period 1 (n = 9300)	Period 2 (n = 10,531)	*P* value[a]
Maternal age, y, mean ± SD	29.97 ± 8.1	30.29 ± 9	NS
Body mass index, kg/m^2, mean ± SD	28.93 ± 4	28.84 ± 4	NS
Nulliparous, n (%)	3515 (37.8%)	3796 (36 %)	NS
Induction of labor, n (%)	1534 (16.5%)	1758 (16.7)	NS
Epidural analgesia, n (%)	7276 (78.2%)	8349 (79.3%)	NS
Gestational age at delivery, wk, mean ± SD	39.57 ± 2.1	39.66 ± 2.2	NS
Duration of second stage of labor, h, mean ± SD			
In nulliparous women	2.06 ± 0.9	2.29 ± 0.8	<.0001
In multiparous women	1.09 ± 0.2	1.13 ± 0.2	NS
Oxytocin use during labor, n (%)	2817 (30.3%)	2251 (21.4%)	<.0001
Birthweight at delivery, g, mean ± SD	3363 ± 863	3344 ± 799	NS

NS, not significant; *SD*, standard deviation.

[a] $P < 0.05$ is considered significant.

Zipori et al. The impact of extending the second stage of labor. Am J Obstet Gynecol 2019.

Some of the results were analyzed separately for nulliparous and multiparous women.

Nulliparous women

As shown in Table 1, the median duration of the second stage of labor was significantly longer in period II (2.29 hours ± 0.8) than in period I (2.06 hours ± 0.9). As shown in Table 2, the incidence of primary CD decreased from 23.3% (819 of 3515) in period I to 15.7% (596 of 3796) in period II ($P < .0001$). In the second stage of labor, the incidence of CD decreased from 12.2% (429 of 3515) in period I to 6.5% (247 of 3796) in period II ($P < .0001$). The incidence of operative vaginal delivery in nulliparous women significantly increased from period I to period II (17.7%, 622 of 3515, vs 19.2%, 732 of 3796, $P < .0001$), but the overall incidence (nulliparous and multiparous) of operative vaginal delivery was not different between the 2 periods (8.5%, 790 of 9300, vs 9.1%, 958 of 10,531, $P = .09$).

Multiparous women

As shown in Table 2, the incidence of primary CD was lower in period II compared with period I (10.9%, 623 of 5785, vs 8.1%, 544 of 6735, $P = .0466$).

Secondary maternal outcomes (Table 2) indicate a higher incidence of PPH and third- and fourth-degree perineal lacerations in period II than in period I. Nevertheless, by extending the second stage of labor, no difference was noted in the need for blood transfusion or the incidence of chorioamnionitis.

Neonatal outcomes are presented in Table 3. The significant changes with the "new labor practice" were a higher rate of umbilical artery cord pH ≤ 7.0 (0.48%, 51 of 10,531, vs 0.04%, 4 of 9300, $P < .0001$) and base excess less than or equal to −12 (0.31%, 33 of 10,531, vs 0.02%, 2 of 9300, $P < .001$), a higher rate of shoulder dystocia (0.4%, 42 of 10,531, vs 0.2%, 19 of 9300, $P = .016$), and a higher rate of admission to the NICU (1.5%, 158 of 10,531, vs 1%, 93 of 9300, $P < 0.001$) compared to the earlier period. Subanalysis of the 51 cases with umbilical artery cord pH ≤ 7.0 in period II showed that 90% were delivered by either operative vaginal delivery or CD. Other common measures such as Apgar score at 1 and 5 minutes, length of stay in the NICU, neonatal sepsis, and perinatal death rate were similar between the groups. No difference between the groups was found in early the postnatal neurological assessment.

Comment

Main findings

Our contemporary approach to labor dystocia, as recommended by ACOG/SMFM,[10] significantly decreased the primary CD rate, in both nulliparous and multiparous women. However, this practice of extending the second stage of labor was associated with a small rise in operative vaginal deliveries among nulliparous women, as well as with increases in other immediate maternal complications, specifically, higher rates of PPH and of third- or fourth-degree perineal lacerations. In assessing the neonatal complications, we noticed a higher rate of low umbilical artery cord pH in period II, but the early neurological outcome did not change.

Clinical implications

The benefits of safe prevention of primary CD by extending the duration allowed for the second stage of labor must be weighed against the potential adverse maternal and neonatal outcomes.

Although several reports have raised concerns about the new ACOG/SMFM consensus recommendations and have

TABLE 2
Maternal outcomes

	Period 1 (n = 9300)	Period 2 (n = 10,531)	*P* value[a]	Relative risk (unadjusted) (95% CI)	Relative risk (adjusted) (95% CI)
Cesarean delivery, n (%)					
In nulliparous women[b]	819 (23.3%)	596 (15.7%)	<.0001	0.67 (0.61−0,74)	0.63 (0.58−0,70)
In multiparous women[c]	623 (10.9%)	544 (8.1%)	.0466	0.75 (0.67−0.84)	0.72 (0.67−0.84)
Operative vaginal delivery, n (%)					
In nulliparous women[a]	622 (17.7%)	732 (19.2%)	<.0001	1.08 (0.99−1.2)	1.1 (1.06−1.14)
In multiparous women[b]	169 (2.9%)	221 (3.3%)	.13	1.12 (0.92−1.4)	1.03 (1.015−1.04)
Third- and fourth-degree laceration, n (%)	92 (1%)	137 (1.3%)	.024	1.27 (0.98−1.66)	0.99 (0.77−1.3)
PPH, n (%)	126 (1.4%)	246 (2.3%)	<.001	1.72 (1.39−2.13)	0.99 (0.82−1.23)
Blood transfusion, n (%)	47 (0.5%)	53 (0.5%)	1	—	—
Chorioamnionitis, n (%)	9 (0.1%)	10 (0.09%)	1	—	—

CI, confidence interval; *NS*, not significant; *PPH*, postpartum hemorrhage.

[a] $P < .05$ is considered significant; [b] Of the total births for nulliparous women during period I; [c] Of the total births for multiparous women during period II.

Zipori et al. The impact of extending the second stage of labor. Am J Obstet Gynecol 2019.

called for more cautious and less drastic changes in obstetric care,[15,16] we are in agreement with a number of pivotal reports on which the guideline statement was originally based.[17,18] Theoretically, with modern obstetric care, a lower rate of CD is expected to reduce some of the major complications that are associated with repeat CD, such as peritoneal adhesions, uterine rupture, and adhesive placental disorders.[19−21] The latter 2 complications may be associated with a greater need for hysterectomy and with maternal mortality in subsequent pregnancies.[22,23] Recent reports have even suggested that CD, specifically in the second stage of labor, was associated with a 2-fold increase in the risk of spontaneous preterm birth before 32 weeks' gestation in a subsequent pregnancy.[24]

PPH is still the leading cause of maternal deaths from direct obstetric causes.[25,26] Several risk factors for PPH have been reported and are often interdependent[27,28]; thus, we could not provide a solid answer as to whether a higher rate of PPH in our study was secondary to the prolonged second stage itself or to the need for operative vaginal or cesarean deliveries after a prolonged second stage. Despite the higher rate of PPH, the absolute incidence of PPH in both periods was within the acceptable range (1−5%) according to the literature. It is important to emphasize that the need for blood transfusion, as an indicator of the severity of PPH, was not different between the 2 periods.

Women with an obstetric anal sphincter injury (OASIS), whether third- or fourth-degree, are at much greater risk for an immediate wound breakdown and infection,[29,30] as well as long-term sequela of pelvic floor dysfunction. Among 343 primiparous with clinically diagnosed OASIS at the time of delivery, Richter et al reported a sustained fecal incontinence incidence of 9%.[31] Equally important, OASIS can seriously affect quality of life, with more reports on dyspareunia, urinary incontinence, and postpartum depression secondary to perineal pain.[32−34] Similar to the PPH outcome, the small rise in the incidence of OASIS in period II of our study, albeit significant, is still much lower than the reported incidence in the literature. Along this line, a recent meta-analysis of 8 studies reported that OASIS occurred in 5.7% of nulliparous women.[35] In addition, we believe that the awareness of OASIS a has increased during recent years, so the higher incidence of OASIS during period II may be at least partially attributed to a more accurate diagnosis of this complication.

With the new obstetric practice, more newborns had a lower umbilical artery cord pH $\leq$ 7.0. As the risk of neonatal morbidity and mortality is reported to be inversely related to arterial cord pH values, with the highest risks at pH values <7.0,[36,37] our finding appears worrisome at first glance. It is noteworthy, however, that umbilical cord blood acid−base analysis at delivery has an important limitation that should be considered when interpreting our results: the majority of newborns with umbilical artery cord pH $\leq$ 7.0 were delivered by operative vaginal or CD delivery, suggesting that the combination of prolonged second stage and nonspontaneous vaginal delivery may be associated with a lower umbilical artery cord pH. This notion is again in agreement with the ACOG/SMFM statement that the increased morbidity may not be entirely related to the duration of the second stage per se but, rather, to interventions in response to it.[10] The reassuring finding from our study is that a routine postnatal assessment in the NICU (all our neonates with cord pH < 7 are routinely admitted to the NICU), including early neurological evaluation,

TABLE 3
Neonatal outcomes

	Period 1 (n = 9300)	Period 2 (n = 10,531)	*P* value	Relative risk (95% CI)
Apgar score at 1 min, mean ± SD	8.82 ± 0.4	8.81 ± 0.4	.326	—
Apgar score at 5 min, mean ± SD	9.87 ± 0.1	9.88 ± 0.1	.528	—
Apgar score at 5 min <7, n	18 (0.19%)	21 (0.2%)	.5	—
Shoulder dystocia, n	19 (0.2%)	42 (0.4%)	.016	1.92 (1.08−3.4)
Arterial cord pH ≤ 7.0, %	4 (0.04)	51 (0.48)	<.0001	9.98 (3.6−27.6)
Admission to NICU, %	93 (1)	158 (1.5)	<.001	1.53 (1.18−1.98)
Length of stay in the NICU, days	11.25 ± 5.1	9.94 ± 4.6	.105	—
Sepsis, n (%)	7 (0.075%)	13 (0.12%)	.2	—
Perinatal death, n (%)	4 (0.04%)	3 (0.03%)	.7	—
Abnormal early neurological outcome (number)	9 (0.1%)	11 (0.1%)	1	—

CI, confidence interval; *NICU*, neonatal intensive care unit; *SD*, standard deviation.
Zipori et al. The impact of extending the second stage of labor. Am J Obstet Gynecol 2019.

found no difference between the groups over the 2 periods of the study. In other words, it appears that the higher incidence of low umbilical cord pH did not contribute to early neonatal complications. In addition, the rate of umbilical cord pH < 7.0 (0.48%), observed in period II of our study, was slightly higher than that reported in the literature, 3.7 per 1000 term births.[38] Ideally, normal acid−base nomograms with prolonged second stage, as well as the long-term effect of a lower umbilical artery cord pH, are yet to be evaluated. The higher rate of admission to the NICU in period II resulted from the policy to admit all newborns with umbilical cord pH < 7, and they were usually discharged after a short period of observation. Although the rate of shoulder dystocia was higher in period II, it was still within the acceptable range according to the literature.

Two recent studies conducted before and after the implementation of the ACOG/SMFM consensus recommendations showed a significant decrease in the CD rate but found no other differences in the immediate maternal and/or neonatal outcomes. Thuillier et al reported a decline in the CD rate from 9.4% (308 of 3283) before to 6.9% (211 of 3068) after the protocol change (odds ratio, 0.71; 95% CI, 0.59−0.85).[39] In contrast to the CD rate in the United States, which ranges from 23% to nearly 40%, and to the World Health Organization's CD goal of 10−15% for all deliveries,[10,40] the authors noted a peculiar and much lower rate of CD in their population. Moreover, their median (Q1−Q3) duration of the second stage before diagnosing arrest of labor was 300 minutes (range, 180−360 minutes), which is a priori well beyond the recommended time frame as suggested by the ACOG/SMFM,[10] thus raising concerns in regard to the safety of their approach. Similarly, in their quality improvement project (434 before guidelines vs 401 after guidelines implementation), Bell et al described a cumulative drop in CD rate with an odds ratio of 0.63 (95% CI, 0.46−0.88).[41] Contrasting with the above studies, the longer duration (3-years period in each arm) of the current study, as well as the 3-fold larger sample, enabled better comparison of differences in the frequency of the maternal and neonatal secondary outcomes between the study periods.

Study strengths and weaknesses

Thus far, the current study is the largest to compare maternal and neonatal outcomes, including neonatal pH and early neurological assessment, between 2 obstetric periods of practices in regard to safe prevention of primary caesarean delivery. Although the 2014 ACOG/SMFM guidelines[8] were embraced by many institutions, it is still possible that future studies will shift back to randomly assess, on a large scale, the 2 approaches of allowing vs not allowing an additional 1 hour in the second stage of labor. We had to analyze and interpret our data very carefully because of the retrospective design of the study being a historical cohort. Nevertheless, the generalizability of our results was strengthened by the fact that the time difference spent in the second stage of labor between the 2 groups was statistically significant, thus truly reflecting changes in protocols and obstetric care over 2 distinct time periods.

Conclusion

The maximum time spent in the second stage of labor beyond which all women are diagnosed with second-stage arrest is still a matter of controversy. It seems that there is a "price to pay" for decreasing the primary CD, but it is possible that the ongoing adjustment to the new approach to the second stage of labor will lead to decreases in future maternal

and neonatal complications. The long-term maternal and neonatal consequences of our new approach will be evaluated in future studies. ■

Acknowledgment

The authors wish to thank Anat Reiner-Benaim and Ronit Almog for their assistance is statistical analysis.

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Received May 14, 2018; revised Oct. 15, 2018; accepted Oct. 17, 2018.

The authors report no conflict of interest.

This study was presented at the 38th Annual Meeting of the Society for Maternal—Fetal Medicine (SMFM), Dallas, TX, Jan. 29—Feb. 3, 2018 (Poster #387).

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