Progress of induced labor in trial of labor after cesarean delivery

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OBJECTIVE: The purpose of this study was to compare the first stage of labor progress in women who undergo an induction of labor after cesarean delivery with women who have spontaneous labor after cesarean delivery.

STUDY DESIGN: We conducted a retrospective cohort study of consecutive women who had been admitted for delivery with a vertex-presenting fetus who achieved vaginal delivery after cesarean delivery. We compared women who underwent an induction of labor after cesarean delivery with women with spontaneous labor after cesarean delivery. Labor curves were constructed with a repeated-measures analysis; interval-censored regression was used to estimate the median time spent to dilate 1 cm, stratified by induction status, and adjusted by obesity, macrosomia, epidural, and previous vaginal delivery.

RESULTS: Of 473 laboring women with a previous cesarean delivery, 234 women (49%) were induced. After adjustment for obesity, macrosomia, epidural, and previous vaginal delivery, women who underwent an induction had significantly longer labors than those women who experienced spontaneous labor. The median time to dilate from 4-10 cm took 5.6 hours (95% confidence interval, 1.8—18.0 hours) in the induction group and 3.2 hours (95% confidence interval, 1.0—10.3 hours) in the spontaneous labor group ($P < .01$). The time to progress 1 cm in dilation from 3-7 cm was different; however, after 7 cm, the time to progress 1 cm was not statistically different.

CONCLUSION: Women who undergo an induction of labor after cesarean delivery have a longer latent labor phase, but a similar active phase than those women who experience spontaneous labor. When making the diagnosis of labor dystocia for women who undergo an induction of labor after cesarean delivery, clinicians should use the same normative standards for labor treatment of women without a previous cesarean delivery as has been shown in previous work.

Key words: cesarean delivery, induction, labor, labor arrest

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Over the last 40 years, the rate of cesarean delivery in the United States has risen from 5.8% in 1970 to approximately 32% in 2007.[1,2] The recent increase in the rate of cesarean deliveries has corresponded with a low vaginal birth after cesarean delivery (VBAC) rate of 8% in 2005, largely because of concerns over the safety of labor after cesarean delivery. This concern persisted despite guidelines that stated that most women with a history of up to 2 cesarean births should be offered VBAC.[3]

In 2010, the National Institutes of Health formed a consensus development conference and released a statement regarding the current state of VBACs.[4] This statement focused on the development of 6 key questions, with 1 specifically targeted around the critical gaps in evidence for decision-making. The investigators cited a lack in knowledge regarding intrapartum management and clinical course that was related specifically to induction. A recent study has shown that the rates of induction of labor for women who undergo a VBAC attempt are 28%.[5] Much of the recent literature regarding induction of labor after cesarean delivery has focused on predictive factors of success and safety.[4,6,7] There are limited contemporary data regarding normal labor progress in women who undergo an induction of labor after previous cesarean delivery and specifically whether normal labor progress in these women differs from labor with spontaneous labor after cesarean delivery.

The objective of this study was to compare labor progress of women who undergo labor after cesarean delivery in the first stage of labor between women in spontaneous labor and those with induced labor.

Materials and Methods

This was a retrospective cohort study from 2004-2008 of all consecutive women who were admitted for delivery with singleton gestations who reached the second stage of labor (10-cm dilation) and delivered vaginally. Women who were eligible for this cohort had a vertex-presenting fetus that had been confirmed by ultrasound on presentation to labor and delivery. Women included in this study had a history of cesarean delivery. All pregnancies with known fetal anomalies were excluded from this study. This study occurred at a single, academic teaching hospital and was approved by the Washington

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Criteria for labor after cesarean eligibility were consistent with the American College of Obstetricians and Gynecologists Practice Bulletin on VBAC that was current during the enrollment period.[8] Women were considered ineligible if they had an absolute contraindication for VBAC such as a history of vertical or low vertical hysterotomy. Women who had an absolute contraindication for vaginal delivery, such as a placenta previa, were also considered ineligible for this study. Women who had an unknown scar were considered candidates for VBAC if they did not have any risk factors for a vertical hysterotomy such as preterm birth at the approval of the attending physician. An indication for previous cesarean delivery that may recur (such as arrest of descent, arrest of dilation, or failed induction of labor) was not considered a contraindication to VBAC. However, this information was often used when patients were counseled before proceeding with labor after cesarean delivery.

Trained research personnel extracted detailed maternal sociodemographic information, obstetric and medical history, intrapartum course, and neonatal outcomes from the medical record. The admitting attending physician determined the diagnosis of spontaneous labor. Cervical examination data that were extracted included the time of the examination and the cervical dilation in centimeters. Patients typically were examined every 2 hours; resident physicians were the primary providers to perform the cervical examinations. Our institution has a culture of active management of labor, although specific protocols for the management of labor were at the discretion of the managing attending physician. Induction was performed with oxytocin or oxytocin and a Foley balloon catheter. Our institutional policy for oxytocin administration for women who undergo labor after cesarean delivery is to start the oxytocin at 2 mU/min and to increase by 2 mU/min every 20 minutes until the uterine contraction pattern is adequate or until a maximum of 20 mU/min.

Women who underwent induction of labor after cesarean delivery were compared with those with spontaneous labor. Baseline characteristics were examined. Categoric variables were examined with the use of the χ^2 test or Fisher exact test; continuous variables were examined for normality with the use of the Shapiro-Francia test. The Student *t* test was used to compare normally distributed continuous variables; the Mann-Whitney *U* test was used for variables not normally distributed.

Labor curves were constructed for women who underwent an induction and were compared with those women with spontaneous labor. Interval-censored regression was used to estimate the median duration of labor, centimeter by centimeter, stratified by induction status. The specific time of each advancement in cervical dilation is not precisely known, because cervical dilation is not measured constantly; therefore, only the times at which a cervical examination occurred were known. These time intervals (from 1 cervical examination to the next cervical examination) were fitted to a log-normal distribution, and the median duration at each interval of dilation was estimated.

A repeated-measures analysis with a ninth-degree polynomial model was used to create average labor curves. These were stratified by labor induction status (induction vs spontaneous). The starting point for the labor curve construction was set at 10 cm, because all patients in this study reached the second stage. This backward construction was performed because women arrive at the hospital typically after cervical dilation has already occurred, and the exact timing of the progression before arriving at the hospital is unknown. The curves were then reversed, with time increasing from left-to-right along the x-axis according to the typical representation of time progression. Potentially confounding factors that were identified in univariate and stratified analyses were considered with the use of backwards-stepwise regression; only significant factors remained in the final models. The final models were adjusted for maternal obesity, previous vaginal delivery, use of regional anesthesia, and fetal macrosomia (defined as birthweight >4000 g). All analyses were performed using Stata software (version 10.0; StataCorp, College Station, TX) and SAS software (version 9.2; SAS Institute Inc, Cary, NC).

Results

Of the 10,564 women in our birth cohort, there were 473 women included in this study who achieved VBAC and whose labor type could be ascertained. Of these, 234 women (49%) underwent an induction of labor. Baseline characteristics are featured in Table 1. Women who were induced were more likely to deliver at a greater gestational age and be of lower gravidity. They were less likely to have a previous vaginal delivery. They were more likely to be obese, have an epidural, and deliver a macrosomic infant. As expected, the induction group was less likely to have a Bishop score $\geq$5 at admission. There were no differences in maternal age, rate of African American race, or rate of spontaneous vaginal delivery. There was also no difference between the rates of hypertension in pregnancy or pregestational or gestational diabetes mellitus. Approximately 12% of the induction group and 9% of the spontaneous group had a "recurring indication" for previous cesarean delivery. There were no differences between the 2 groups in the rates of previous indication for cesarean delivery documented by the provider as failure to progress, failed induction, cephalopelvic disproportion, or arrest of labor. Women in the induction group had a significantly longer second stage of labor compared with the spontaneous group.

The indications for induction for labor are listed in Table 2. Information was only available for 106 of the 234 women who were undergoing induction, and women could have >1 indication for induction. For women with a known indication for induction, the most common reasons were elective, premature rupture of membranes, preeclampsia, and oligohydramnios.

Women who underwent an induction of labor had a longer total time in labor