OBJECTIVE: The purpose of this study was to assess the influence of the duration of active second-stage labor on maternal and neonatal outcomes.

STUDY DESIGN: Secondary analysis of the Pushing Early Or Pushing Late with Epidural trial that included 1862 nulliparous women with epidural analgesia who were in the second stage of labor. According to duration of active second-stage labor, we estimated the proportion of spontaneous vaginal deliveries (SVD) with a newborn infant without signs of asphyxia (5-minute Apgar score $\geq 7$ and arterial pH $>7.10$). We also analyzed maternal and neonatal outcomes according to the duration of expulsive efforts.

RESULTS: Relative to the first hour of expulsive efforts, the chances of a SVD of a newborn infant without signs of asphyxia decreased significantly every hour (1- to 2-hour adjusted odds ratio, 0.4; 95% confidence interval [CI], 0.3–0.6; 2- to 3-hour adjusted odds ratio, 0.1; 95% CI, 0.09–0.2; >3-hour adjusted odds ratio, 0.03; 95% CI, 0.02–0.05). The risk of postpartum hemorrhage and intrapartum fever increased significantly after 2 hours of pushing.

CONCLUSION: Faced with a decreasing probability of SVD and increased maternal risk of morbidity after 2 hours, we raise the question as to whether expulsive efforts should be continued after this time.

Key words: duration of active second-stage labor, maternal complications, nulliparous women


The second stage of labor commences at full dilation and is divided into 2 phases: the passive second stage when the fetal head progresses passively in the maternal pelvis and the active second stage that corresponds to the phase of active expulsive efforts. Prolonged second stage of labor (>2 or 3 hours, according to the articles) is associated with an increased risk of maternal complications, operative vaginal delivery, perineal trauma, chorioamnionitis, and postpartum hemorrhage (PPH), but not with an increased risk of adverse neonatal outcomes.1-7 However, in most studies that are related to a prolonged second stage of labor, passive and active second stages were not differentiated. Because the point of onset of the second stage is difficult to determine, especially when the vaginal examinations during labor are less frequent, a measurement bias in these studies cannot be excluded.8 Conversely, the time of commencing expulsive efforts usually is documented accurately. As regards the management of the second stage of labor, no previous cohort study has analyzed maternal and neonatal outcome indicators specifically as a function of the duration of the active phase of the second stage of labor.

Several trials have been published about the management of the second stage of labor as regards a policy of immediate or delayed pushing, with controversial results. The Pushing Early Or...
Pushing Late with Epidural (PEOPLE) trial is 1 such trial. A metaanalysis of these trials found a decreased risk of rotational or mid-pelvic instrumental deliveries in the delayed pushing group but found nonsignificant reductions of instrumental deliveries, cesarean section deliveries, and adverse neonatal outcomes. The authors of that metaanalysis concluded that there is a benefit of delayed pushing in hospitals with high rates of rotational or mid-pelvic procedures but that there is no advantage in hospitals with low rates of these procedures. Thus today, there are still considerable variations in the management of the second stage of labor, according to hospital protocols, obstetricians’ habits, and experience.

With respect to the duration of the active phase of the second stage of labor, we hypothesized that, after a certain duration of pushing, maternal and neonatal risks may outweigh the benefits of continued pushing. The purpose of our study was to evaluate the rate of spontaneous vaginal delivery with a newborn infant with no signs of asphyxia according to the duration of the active second stage. We also assessed the influence of the duration of active second stage of labor on maternal and neonatal outcomes to try to determine a “maximal” duration of pushing efforts, adjusting for the second-stage management and delayed or immediate pushing.

**Materials and Methods**

We conducted a secondary analysis of all patients (n = 1862) who were included in the PEOPLE trial, which was a multicenter randomized controlled trial that compared early and delayed pushing with epidural analgesia between October 1994 and September 1996 in 12 academic centers (10 in Canada, 1 in the United States, and 1 in Switzerland). Nulliparous women at term (≥37 weeks of gestation) with a singleton vertex fetus were eligible and were assigned randomly at the beginning of the second stage. Exclusion criteria were abnormal fetal heart rate monitoring during the first stage of labor, maternal fever during the first stage of labor, adverse events during the pregnancy (hypertension, hemorrhage, fetal malformation, intrauterine growth retardation), and any condition that necessitated shortening of the second stage of labor. The clinical trial was approved by the Ethics Committee of Laval University.

First, we described the maternal and neonatal baseline characteristics and obstetrics practices in our population. Second, according to the duration of the active phase of the second stage of labor, we determined the rate of spontaneous vaginal delivery with a newborn infant with no signs of asphyxia in each randomized group (immediate or delayed pushing groups). Finally, we conducted univariable and multivariable analyses to assess the association between the duration of expulsive efforts and adverse maternal or neonatal outcomes.

Statistical analysis was performed with Stata software (version 10.0; Stata Corp, College Station, TX). We used the χ² test to compare proportions and the Fisher exact test when the population size was small (n < 5). To compare continuous variables, we used analysis of variance, and the variances were assessed by the Bartlett’s test.

For multivariable analysis, we used unconditional logistic regression models to adjust for confounding. Adjusted analysis controlled for maternal age (continuous), gestational age (continuous), ethnic origin (categorical), body mass index at admission (continuous), birthweight (continuous), position of the fetal head at full dilation (categorical), group of randomization (binary; early or late pushing group), and mode of delivery (categorical). For analysis of third- and fourth-degree tear, we also adjusted because of episiotomy and its technique (categorical: none, median, or mediolateral episiotomy). Goodness-of-fit was examined with the Hosmer-Lemeshow test.

**Results**

Maternal and neonatal characteristics are summarized in Table 1. Median du-

- Duration of pushing efforts, min: 99.8
- Maternal age, yr: 28.1 ± 4.9
- Ethnic origin, n (%): White 1616 (86.9), Asian 133 (7.1), Other 110 (5.9)
- Body mass index at admission, kg/m²: 28.6 ± 4.2
- Gestational age, wk: 39.8 ± 1.2
- Onset of labor, n (%): Spontaneous 1289 (69.2), Induction 574 (30.8), Oxytocin 292, Rupture of membranes 156, Prostaglandins 275
- Duration of pushing efforts, min: Late pushing group 81.8 ± 61.2, Early pushing group 117.9 ± 70.9
- Position of the fetal head at full dilation, n (%): Anterior 1198 (64.3), Transverse 200 (10.7), Posterior 210 (11.3), Missing 254 (13.6)
- Mode of delivery, n (%): Spontaneous vaginal delivery 1026 (55.1), Assisted vaginal delivery 736 (39.5), Cesarean 100 (5.4)
- Episiotomy in cases of vaginal delivery, n (%): None 1095 (58.8%), Median 459 (27.7%), Mediolateral 308 (16.5%)
- Birthweight, g: 3469 ± 421

* Data are given as mean ± SD; † n = 1762; ‡ forceps, vacuum, manual, or instrumental rotation.

increased after 2 hours of pushing (interval 2–3 hours: adjusted OR, 1.6; 95% CI, 1.0–2.5; pushing >3 hours: adjusted OR, 2.5; 95% CI, 1.5–4.1; reference: pushing <1 hour). The risk of intrapartum fever was also associated significantly with the duration of the active second stage of labor. In the multivariable analysis, the risks of third- and fourth-degree tears were comparable for all classes of the duration of the active second stage (Table 2).

In this context of continuous intrapartum surveillance, neonatal arterial pH and 5-minute Apgar score were not influenced by pushing duration (Table 3). Neonatal trauma and admission in the neonatal intensive care unit increased with the duration of the active second stage of labor in univariable analysis. After adjustment for confounding variables, none of the adverse neonatal outcomes that were studied were associated significantly with pushing duration (Table 2).

**Comment**

During the active phase of the second stage of labor, the probability of spontaneous vaginal delivery of an infant with a 5-minute Apgar score ≥7 and pH at birth >7.10, decreases every hour. After 2 hours of pushing, the risk of intrapartum fever and PPH increases significantly. However, our results suggest that,

| TABLE 2 |
| Maternal and neonatal outcomes according to pushing duration: univariable and multivariable analysis, with the use of logistic regression models |

<table>
<thead>
<tr>
<th>Outcome</th>
<th>1–2 h</th>
<th>2–3 h</th>
<th>&gt;3 h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crude odds ratio (95% CI)</td>
<td>Adjusted odds ratio (95% CI)</td>
<td>Crude odds ratio (95% CI)</td>
</tr>
<tr>
<td>Primary outcome: spontaneous vaginal delivery of an infant without a sign of asphyxia</td>
<td>0.4 (0.3–0.6)</td>
<td>0.4 (0.3–0.6)</td>
<td>0.1 (0.09–0.2)</td>
</tr>
<tr>
<td>Operative delivery</td>
<td>2.3 (1.8–3.0)</td>
<td>2.3 (1.7–3.0)</td>
<td>9.3 (6.9–12.5)</td>
</tr>
<tr>
<td>Postpartum hemorrhage</td>
<td>1.6 (1.1–2.3)</td>
<td>1.2 (0.8–1.8)</td>
<td>2.6 (1.8–3.9)</td>
</tr>
<tr>
<td>Third- and 4th-degree perineal tear b</td>
<td>1.3 (0.8–2.1)</td>
<td>1.0 (0.6–1.6)</td>
<td>2.5 (1.6–3.9)</td>
</tr>
<tr>
<td>Intrapartum fever</td>
<td>2.0 (1.1–3.4)</td>
<td>1.8 (1.0–3.2)</td>
<td>2.8 (1.6–5.0)</td>
</tr>
<tr>
<td>5-minute Apgar score &lt;7</td>
<td>1.7 (0.5–5.2)</td>
<td>1.1 (0.3–3.6)</td>
<td>1.0 (0.2–4.3)</td>
</tr>
<tr>
<td>Arterial pH ≤7.10</td>
<td>1.5 (0.8–2.7)</td>
<td>1.6 (0.8–3.0)</td>
<td>0.5 (0.2–1.2)</td>
</tr>
<tr>
<td>Neonatal trauma</td>
<td>1.3 (0.8–2.1)</td>
<td>1.2 (0.7–2.0)</td>
<td>2.2 (1.4–3.6)</td>
</tr>
<tr>
<td>Admission in neonatal intensive care unit</td>
<td>1.2 (0.7–2.2)</td>
<td>1.1 (0.6–2.0)</td>
<td>2.1 (1.2–3.7)</td>
</tr>
</tbody>
</table>

Reference: pushing duration <1 hour. CI: confidence interval.

b Adjustment: maternal age, gestational age, ethnic origin, body mass index at the admission, birthweight, position of the fetal head at full dilation, group of randomization (early or late pushing), mode of delivery (except for the primary outcome and operative delivery); adjustment also on episiotomy and its technique (median or mediolateral).

Some parts of the text have been reformatted to improve readability and coherence. The table layout has also been simplified and adjusted to fit within the text.
in the context of continuous fetal surveillance in the second stage of labor, a prolonged duration of the active second stage does not increase the risk of adverse neonatal outcome.

There are few previous publications that specifically have addressed the impact of the duration of expulsive efforts on the fetal and neonatal well-being.\(^1\)\(^-\)\(^7\) These studies had a small sample size and were focused on biologic outcomes (pH and lactates). In our study, the population is large and homogenous (nulliparous women with uncomplicated pregnancies at term with epidural analgesia) and is derived from a multicenter trial cohort. The collection of data was prospective and rigorous, especially with respect to the hours of pushing, with missing data for only 4 subjects. We classified pushing duration into 4 classes and demonstrated an increased risk for intrapartum fever and PPH. In previous studies concerning prolonged duration of the active second stage of labor, by the performance of an operative delivery when severe fetal heart surveillance during the active second stage is difficult to estimate accurately, because the exact duration of the first stage of labor is difficult to estimate accurately, we did not adjust for it. First-stage duration might have an influence on maternal and neonatal outcomes.

Sung et al\(^1\)\(^5\) found that a second stage of labor of >4 hours was associated with an increase in unintentional hysterotomy extensions at cesarean delivery and prolonged operative time. In the PEO-ple trial, there were no data about adverse events that occurred during cesar-
ean delivery (such as hysteroscopy or bladder injury). These complications may be more frequent in the case of cesarean delivery after 2 or 3 hours of pushing efforts, compared with cesarean deliveries performed during the first 2 hours of active second stage of labor.

In 1989, Fusi et al. were the first to describe an association between maternal pyrexia and the use of epidural analgesia in labor. Other authors found similar results. However, the exact influence of epidural analgesia on thermoregulation is still controversial. In our population of nulliparous women with epidural analgesia, there was a significantly increased risk of maternal intrapartum fever that was associated with pushing duration. We cannot determine whether this result is due to patent infection or unbalanced thermoregulation.

Analysis of risk factors that were associated with a prolonged active second stage of labor could lead to the identification of measures to decrease the duration of expulsive efforts and the associated maternal morbidity. In particular, fetal malposition at full dilation rates in a higher risk of prolonged second-stage labor. In contrast to other risk factors such as fetal weight, fetal malposition can be modified with simple obstetric maneuvers. The routine assessment of fetal head position at full dilation before pushing is initiated, and the use of manual rotation might reduce the duration of pushing and the rate of cesarean deliveries.

In our logistic regression analysis, we assessed whether the association between the risk of PPH and the duration of pushing was mediated potentially by the mode of delivery. Cesarean delivery is associated with both duration of pushing and risk of PPH. The adjusted OR for PPH was significantly less than the crude OR, and the confidence interval for the effect excluded the null effect only when the duration of pushing was >3 hours. It remains possible that prolonged pushing is associated with technically difficult cesarean deliveries, in which the risk of hysterotomy extension is increased. Thus, cesarean delivery would be on the chain of causality between pushing duration and PPH.

PPH is well known to be a common cause of maternal death and morbidity. Considering that the risk of PPH increases significantly after 2 hours of expulsive efforts and the chance to have a spontaneous vaginal delivery of an infant with no signs of asphyxia is 20% after this time, in our study, it is justified to ask the question as to whether operative delivery (instrumental delivery or cesarean delivery) should be considered after 2 hours of pushing. However, our study did not allow us to assess whether maternal morbidity would have been reduced if an operative delivery had been performed systematically after 2 hours of pushing. A policy of assisted delivery or cesarean delivery after 2 hours of pushing could decrease the risk of PPH that is associated with uterine atony and difficult cesarean deliveries. However, such a policy could also increase the risk of PPH because of an increased rate of cesarean and instrumental delivery. Our study does not provide a definitive answer to that question, but it does provide additional information to assist a physician in a patient’s counseling in such situations. Our study revises the age-old debate as to the appropriate criteria for defining an “adequate” or, for that matter, a “failed” trial of labor, which is the ultimate diagnostic conundrum in obstetrics. This unresolved challenge applies both to the first and the second stage of labor. Only a well-designed randomized controlled trial that would compare neonatal and maternal outcomes between (1), a policy of limiting pushing to 2 hours and (2), a policy of no fixed limit on the duration of the active second stage will answer the question of when to stop pushing.

ACKNOWLEDGMENT
Participants in the Pushing Early Or Pushing Late with Epidural study group: steering committee: William D. Fraser, MD, Sylvie Marcoux, MD, PhD, Isabelle Krauss, MD, MSc, Joanne Douglas, MD, and Céline Goulet RN, PhD; center investigators and research assistants: J. Chabot, MD, J. Flamand, RN, L. Laperrèrie, BN, CHUQ–Pavillon St François d’Assise, Quebec, Canada; P. Fish, MD, and G. Hamel, RN, Hôpital de Chicoutimi, Chicoutimi, Quebec, Canada; R. Sabbah, MD, and L. Vincelli, RN, Hôpital Sacré-Coeur de Montréal, Montreal, Quebec, Canada; G. Tawagi, MD, O. Rosag, MD, and J. Belcher, RN, Ottawa Civic Hospital, Ottawa, Ontario, Canada; F. Galerneau, MD, M. Klein, MD, J. Swenerton, MD, B. Weibe, RN, and E. Nickel, RN, BC Women’s Hospital, Vancouver, British Columbia, Canada; K. Milne, MD, J. Fuller, MD, and L. Watson, RN, St. Joseph’s Hospital, London, Ontario, Canada; O. Irión, MD, K. Rifat, MD, and V. Mentha (midwife), Hôpitaux Universitaires de Genève, Geneva, Switzerland; S. Bottoms, MD (deceased), and B. Steffy, RN, Hutzel Hospital, Detroit, Michigan; M. Helewka, MD, S. Lucy, MD, and S. Erickson, RN, St Boniface Hospital, Winnipeg, Manitoba, Canada; N. Okun, MD, A. Guest, MD, A. Stuart, MD, and D. Schimeck, RN, University of Alberta Hospital, Edmonton, Alberta, Canada; M. Sermer, MD, and M. Balley, MD, Toronto General Hospital, Toronto, Ontario, Canada; D. Blouin, MD, Y. Claproad, and D. Beau lieu, RN, Center Hospitalier Universitaire de l’Estrie, Sherbrooke, Quebec, Canada; data management committee: Michel Bouviain, MD, PhD, Sylvie Bérubé, PhD, and Isabelle Faron; safety and efficacy monitoring committee: François Meyer, MD, PhD, Aïda Blairam, MD, PhD, and Jean-Marie Moutquin, MD.

REFERENCES


