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COMPARISON OF A TRIAL OF LABOR WITH AN ELECTIVE SECOND CESAREAN SECTION

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ABSTRACT

Background In an attempt to reduce the rate of cesarean section, obstetricians now offer a trial of labor to pregnant women who have had a previous cesarean section. Although a trial of labor is usually successful and is relatively safe, few studies have directly addressed the maternal and perinatal morbidity and mortality associated with this method of delivery.

Methods We performed a population-based, longitudinal study of 6138 women in Nova Scotia who had previously undergone cesarean section and had delivered a singleton live infant in the period from 1986 through 1992.

Results A total of 3249 women elected a trial of labor, and 2889 women chose to undergo a second cesarean section. There were no maternal deaths. The overall rate of maternal morbidity was 8.1 percent; 1.3 percent had major complications (a need for hysterectomy, uterine rupture, or operative injury) and 6.9 percent had minor complications (puerperal fever, a need for blood transfusion, or abdominal-wound infection). Although the overall rate of maternal complications did not differ significantly between the women who chose a trial of labor and the women who elected cesarean section (odds ratio for the trial-of-labor group, 0.9; 95 percent confidence interval, 0.8 to 1.1), major complications were nearly twice as likely among women undergoing a trial of labor (odds ratio, 1.8; 95 percent confidence interval, 1.1 to 3.0). Apgar scores, admission to the neonatal intensive care unit, and perinatal mortality were similar among the infants whose mothers had a trial of labor and those whose mothers underwent elective cesarean section.

Conclusions Among pregnant women who have had a cesarean section, major maternal complications are almost twice as likely among those whose deliveries are managed with a trial of labor as among those who undergo an elective second cesarean section. (N Engl J Med 1996;335:689-95.)

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IN the United States and Canada, up to one quarter of all infants are delivered by cesarean section¹⁻⁵; approximately half these procedures are performed only because the woman has had a previous cesarean section.¹ For years, allowing labor after a previous cesarean section was thought to be dangerous, and many clinicians recommended that any woman who had had a cesarean section should deliver all subsequent babies by cesarean section. However, others have questioned the necessity for elective cesarean section in many such cases and have considered a trial of labor after a previous cesarean section a reasonable strategy. In 1980, the Consensus Development Conference on Cesarean Childbirth was convened at the National Institutes of Health to consider whether a subsequent cesarean section was always necessary.⁶ The participants concluded that vaginal delivery after previous low transverse cesarean section was a safe and acceptable option.⁶ In May 1985, the National Consensus Conference on Aspects of Cesarean Birth in Canada recommended that a trial of labor be offered to women with "one previous low transverse cesarean section, a singleton vertex presentation, and no absolute indication for cesarean section (such as placenta previa)."⁷ Among women who attempt a trial of labor after a previous low transverse cesarean section, 60 to 80 percent have vaginal deliveries,⁸⁻¹² and morbidity is lower among women who have a vaginal delivery after a previous cesarean section than among women who elect to undergo a second cesarean section.^{10,13,14} The relevant issue, however, is the mor-

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idity and mortality associated with the trial of labor and not the risk associated with vaginal delivery after a previous cesarean section. We therefore studied maternal and perinatal morbidity and mortality in a group of women who underwent either a trial of labor or an elective second cesarean section after a previous cesarean delivery.

METHODS

Study Design

The study data were obtained from the Nova Scotia Atlee Perinatal Database of the Reproductive Care Program of Nova Scotia, Canada, for the years 1986 through 1992. The program includes 2 tertiary care hospitals, 7 regional hospitals, and 18 community hospitals. Data collection began in 1980 at the tertiary care hospitals, in 1986 at the regional hospitals, and in 1988 at the community hospitals. In Nova Scotia, tertiary care hospitals provide care for pregnant women with all levels of risk. Regional hospitals provide care for women at low or moderate risk and refer women with high-risk pregnancies to tertiary care hospitals. Community hospitals provide care for low-risk women and refer higher-risk women to hospitals with appropriate levels of care.

From 1986 to 1988, approximately 80 percent of pregnant women in the province were registered in the perinatal data base, but after 1988 all women who delivered infants with birth weights of 500 g or more or at 20 weeks' gestation or later were registered. Standardized information was obtained on each pregnancy at the time of the initial prenatal visit and thereafter throughout the pregnancy and postpartum periods by trained nurses or physicians. This information was abstracted from the medical records and discharge summaries by trained health-records personnel and coded for data entry. All complications and conditions were coded by the medical-records personnel according to a standard coding scheme.

After the National Consensus Conference in 1985, physicians were encouraged to discuss a trial of labor with all pregnant women who had undergone a previous low transverse cesarean section. The recommendation to proceed with a trial of labor or elective cesarean section was usually made in the outpatient setting by a physician. The decision to perform a second cesarean section when the infant was not delivered during a trial of labor was based on obstetrical indications such as the failure of labor to progress or fetal-pelvic disproportion and was made by the physician in charge.

There were 82,488 births from 1986 through 1992 in Nova Scotia. Of the 6457 women who had previously undergone one cesarean section, 319 were excluded from our analysis for the following reasons: nonvertex presentation (119 women); multiple gestation (118 women); a previous cesarean section with a vertical or T-shaped incision (37 women); placenta previa (36 women); maternal herpes simplex infection (7 women); and previous uterine surgery such as myomectomy (2 women).

During labor, uterine activity and the fetal heart rate were monitored. When indicated, oxytocin was used for induction and augmentation of labor. Analgesia with nitrous oxide, narcotic analgesia, and pudendal, epidural, and general anesthesia were used when necessary.

The 3249 women who attempted vaginal delivery after one previous low transverse cesarean section and the 2889 women who elected to undergo a second cesarean section were compared with respect to certain demographic and maternal characteristics, and perinatal and maternal morbidity and mortality were evaluated. Women were classified with respect to morbidity as having no complications, major complications, or minor complications. Major complications were defined as the need for hysterectomy, uterine rupture, and operative injury, whereas minor complications were defined as puerperal fever, the need for a blood transfusion, and abdominal-wound infection. Women with multiple major complications or both major and minor complications were

counted only once and coded as having major complications; women with multiple minor complications were counted only once and coded as having minor complications.

Hysterectomy was defined as the surgical removal of the uterus and cervix, with or without adnexectomy. Uterine rupture was defined as a defect that involved the entire wall of the uterus, that was symptomatic, and that required operative intervention. Operative injury included extension of the uterine incision with laceration of one or both uterine arteries or laceration of the bladder, ureter, or bowel. Sources of puerperal fever (temperature, $>38.0^{\circ}\text{C}$) included uterine, urinary, pulmonary, or wound infection and sepsis. Urinary tract infections were diagnosed when culture showed more than 100,000 colonies per milliliter. Pulmonary infection included all cases of pneumonia. The diagnosis of sepsis was made only if the woman had positive blood cultures. Transfusions were performed at the discretion of the physician. Abdominal-wound infection was defined as the presence of purulent material at the wound site and was noted by the attending physician.

Statistical Analysis

For statistical analysis, we used Stata software (Stata, College Station, Tex.) and Epi Info, version 6 (Centers for Disease Control and Prevention, Atlanta). Initial comparisons were made with the chi-square test or Fisher's exact test for categorical data and Student's *t*-test or analysis of variance for continuous data. Maternal age, parity, tobacco use, type of hospital, marital status, and attendance at a prenatal class and the infant's birth weight were examined for interaction and confounding. Our analysis revealed no significant interaction among these covariates. Multivariate logistic-regression analysis was used to control for the simultaneous effects of covariates. Adjusted odds ratios and 95 percent confidence intervals were derived from the estimated regression coefficients.

RESULTS

Of the 6138 women, 3249 (52.9 percent) chose to undergo a trial of labor, and 2889 (47.1 percent) elected a second cesarean section. The characteristics of the women in the two groups are shown in Table 1. Women 19 years old or younger and those 30 years old or older were more likely to attempt a trial of labor than to undergo elective cesarean section. Although all the women had undergone only one previous cesarean section, 1030 also had had at least one successful vaginal delivery (either before the pregnancy in which they underwent a primary cesarean section or as a result of a previous successful trial of labor). Among these 1030 women, those who had had one previous vaginal delivery and those who had had two or more were 3.2 and 4.0 times as likely, respectively, to undergo a trial of labor as women who had had no previous vaginal deliveries. Women who attended prenatal classes were more likely to undergo a trial of labor than those who did not. Elective second cesarean section was twice as likely to occur at a regional hospital as at a tertiary care hospital and 2.5 times as likely to occur at a community hospital. The infants' Apgar scores and the rates of admission to a neonatal intensive care unit were similar in the two groups. The perinatal mortality rate was 9 per 1000 live births in the trial-of-labor group and 5 per 1000 births in the group that underwent elective cesarean section ($P=0.09$).

Overall, 8.1 percent of the women had a compli-

TABLE 1. CHARACTERISTICS OF PREGNANT WOMEN UNDERGOING A TRIAL OF LABOR OR AN ELECTIVE SECOND CESAREAN SECTION IN NOVA SCOTIA FROM 1986 THROUGH 1992.*

CHARACTERISTIC	TRIAL OF LABOR (N = 3249)	ELECTIVE SECOND CESAREAN SECTION (N = 2889)	ODDS RATIO (95% CI)
	no. (%)		
Maternal age			
≤19 yr	72 (2.2)	47 (1.6)	1.4 (1.0–2.1)
20–24 yr	575 (17.7)	549 (19.0)	1.0 (0.8–1.1)
25–29 yr	1302 (40.1)	1206 (41.7)	1.0†
30–34 yr	966 (29.7)	818 (28.3)	1.1 (1.0–1.2)
≥35 yr	334 (10.3)	269 (9.3)	1.2 (1.0–1.4)
Parity			
1	2468 (76.0)	2640 (91.4)	1.0†
2	547 (16.8)	185 (6.4)	3.2 (2.6–3.8)
≥3	234 (7.2)	64 (2.2)	4.0 (3.0–5.3)
Marital status			
Unmarried	425 (13.1)	322 (11.1)	1.0†
Married	2824 (86.9)	2567 (88.9)	0.8 (0.7–1.0)
Cigarettes smoked/day‡			
0	2068 (66.6)	1933 (69.2)	1.0†
1–10	383 (12.3)	328 (11.7)	1.1 (0.9–1.3)
11–20	392 (12.6)	322 (11.5)	1.1 (1.0–1.3)
≥21	264 (8.5)	209 (7.5)	1.2 (1.0–1.4)
Attendance at prenatal classes§			
No	2590 (86.0)	2578 (91.5)	1.0†
Yes	423 (14.0)	241 (8.5)	1.8 (1.5–2.1)
Infant's birth weight			
<2500 g	166 (5.1)	116 (4.0)	1.4 (1.1–1.8)
2500–2999 g	386 (11.9)	345 (11.9)	1.1 (0.9–1.3)
3000–3499 g	1029 (31.7)	1022 (35.4)	1.0†
3500–3999 g	1081 (33.3)	953 (33.0)	1.1 (1.0–1.3)
≥4000 g	587 (18.1)	453 (15.7)	1.3 (1.1–1.5)
Type of hospital			
Tertiary care	2239 (68.9)	1486 (51.4)	1.0†
Regional	844 (26.0)	1112 (38.5)	0.5 (0.5–0.6)
Community	166 (5.1)	291 (10.1)	0.4 (0.3–0.5)

*Because of rounding, percentages may not total 100. CI denotes confidence interval. Odds ratios express the likelihood that women will choose to undergo a trial of labor, as compared with the likelihood for women in the specified reference category.

†This group served as the reference category.

‡Data on tobacco use were missing for 142 women in the trial-of-labor group and for 97 in the elective-cesarean-section group.

§Data were missing for 236 women in the trial-of-labor group and for 70 in the elective-cesarean-section group.

cation. Complications were major (need for hysterectomy, ruptured uterus, or operative injury) in 1.3 percent and minor (puerperal fever, need for a blood transfusion, or abdominal-wound infection) in 6.9 percent. None of the women died. The overall rates of maternal complications in the two groups were similar (Table 2). Major complications were 1.8 times as likely in the trial-of-labor group as in the elective-cesarean-section group, whereas minor complications were 20 percent less likely.

With respect to major complications, five women in the trial-of-labor group and six women in the elective-cesarean-section group underwent hysterectomy. Ten women in the trial-of-labor group had uterine rupture; two required hysterectomy, and the

remaining eight underwent surgical repair. One woman in the elective-cesarean-section group had a uterine defect requiring repair. Two perinatal deaths occurred among the infants of women in the trial-of-labor group and were related to uterine rupture. The risk of operative injury to the mother was almost twice as high in the trial-of-labor group as in the elective-cesarean-section group. The risk of puerperal fever was 25 percent higher in the elective-cesarean-section group. The risk of requiring a blood transfusion in the two groups was not significantly different. The risk of abdominal-wound infection was more than one and a half times higher in the elective-cesarean-section group than in the trial-of-labor group.

TABLE 2. MORBIDITY IN PREGNANT WOMEN WHO CHOSE A TRIAL OF LABOR OR AN ELECTIVE SECOND CESAREAN SECTION IN NOVA SCOTIA FROM 1986 THROUGH 1992.

MORBIDITY*	TRIAL OF LABOR (N = 3249)	ELECTIVE SECOND CESAREAN SECTION (N = 2889)	ODDS RATIO (95% CI)†
	no. (%)		
Total complications	257 (7.9)	243 (8.4)	0.9 (0.8–1.1)
Major complications	53 (1.6)	24 (0.8)	1.8 (1.1–3.0)
Hysterectomy	5 (0.2)	6 (0.2)	0.6 (0.2–2.4)
Uterine rupture	10 (0.3)	1 (0.0)	5.2 (0.6–45.4)
Operative injury	41 (1.3)	18 (0.6)	1.9 (1.0–3.5)
Minor complications	204 (6.3)	219 (7.6)	0.8 (0.7–1.0)
Puerperal fever	171 (5.3)	185 (6.4)	0.8 (0.7–1.0)
Transfusion	36 (1.1)	39 (1.3)	0.8 (0.5–1.3)
Abdominal-wound infection	43 (1.3)	63 (2.2)	0.6 (0.4–0.9)

*Women with multiple major complications or both major and minor complications were counted only once, as having major complications; those with multiple minor complications were counted only once, as having minor complications.

†Odds ratios have been adjusted for maternal age, parity, smoking status, type of hospital, marital status, attendance at a prenatal class, and infant's birth weight. CI denotes confidence interval. Odds ratios express the likelihood of complications among the women who had a trial of labor as compared with those who elected to undergo cesarean section.

Among the 1030 women who had previously had both a cesarean section and at least one vaginal delivery, overall morbidity increased with an increasing number of previous vaginal deliveries among the women who elected a second cesarean section, although not among the women in the trial-of-labor group (Fig. 1, left-hand panel). However, major complications were almost twice as likely to occur in the trial-of-labor group as in the elective-cesarean-section group, unless a woman had had two successful vaginal deliveries; in that case, major complications were more likely in the elective-cesarean-section group (Fig. 1, center panel). The frequency of minor complications increased with an increasing number of previous vaginal deliveries in the elective-cesarean-section group but not in the trial-of-labor group (Fig. 1, right-hand panel).

Of the 3249 women who underwent a trial of labor, 1962 (60.4 percent) had vaginal deliveries (Table 3). Women 35 years old or older were more likely than others to require a cesarean section after a trial of labor. Women who had had one previous vaginal delivery were 3.3 times as likely as women who had had only a cesarean section to have a successful trial of labor; women with two or more previous vaginal deliveries were 5.0 times as likely. A trial of labor was more likely to be successful in women who attended prenatal classes and was more likely to fail if the infant weighed 4000 g or more or if the trial of labor took place at a regional or community hospital. The infants' Apgar scores, the rates of admission to a neonatal intensive care unit, and peri-

natal mortality were similar for the women in whom the trial of labor did not result in delivery and for those whose labor was successful.

Major and minor complications were more likely to occur in women who required a second cesarean section after a failed trial of labor than if the trial of labor was successful (Table 4); 92.5 percent of major complications in the trial-of-labor group occurred in women who did not deliver their babies after a trial of labor and who therefore required a second cesarean section.

DISCUSSION

The most important issue regarding maternal well-being with respect to a trial of labor after a previous cesarean section is whether a catastrophic complication, such as uterine rupture, will occur and lead to serious morbidity or death. Maternal death during labor and delivery, regardless of the method of delivery, is uncommon. In our study there were no maternal deaths, a finding similar to that reported by Flamm et al.¹⁰ and Rosen et al.¹⁴ Maternal morbidity, on the other hand, was not negligible. Most of the complications, however, were minor and were more likely to occur in women undergoing an elective cesarean section than in those undergoing a trial of labor; the findings of Flamm et al.¹⁰ and Rosen et al.¹⁴ were similar. The frequency of uterine rupture in the trial-of-labor group (0.3 percent) was similar to that in other studies.^{15,16} The number of hysterectomies, a tragic complication for a woman of reproductive age, was similar in the two groups. Op-

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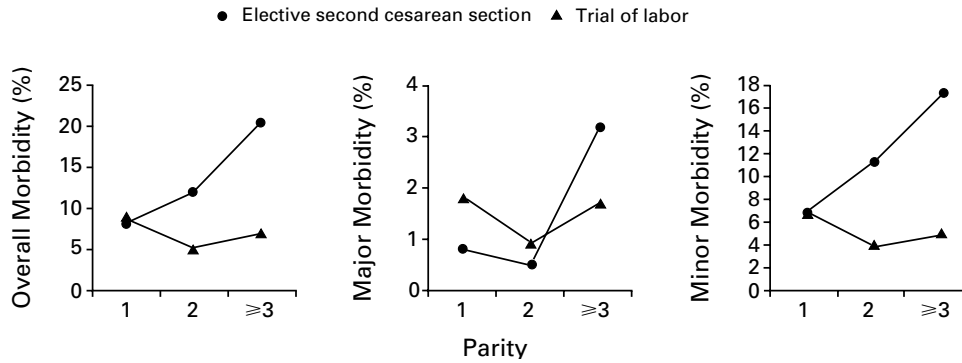


Figure 1. Morbidity as a Function of Increasing Parity among Women Who Elected Cesarean Section or a Trial of Labor after a Previous Cesarean Section. The left-hand panel shows overall morbidity; the center panel, major complications; and the right-hand panel, minor complications.

TABLE 3. CHARACTERISTICS OF PREGNANT WOMEN WHO FAILED TO DELIVER VAGINALLY AFTER A TRIAL OF LABOR AND THOSE WHO DELIVERED VAGINALLY AFTER A TRIAL OF LABOR, IN NOVA SCOTIA, FROM 1986 THROUGH 1992.*

CHARACTERISTIC	FAILED TRIAL OF LABOR (N=1287)	SUCCESSFUL TRIAL OF LABOR (N=1962)	ODDS RATIO (95% CI)
	no. (%)		
Maternal age			
≤19 yr	26 (2.0)	46 (2.3)	0.8 (0.5-1.4)
20-24 yr	253 (19.7)	322 (16.4)	1.1 (0.9-1.4)
25-29 yr	538 (41.8)	764 (38.9)	1.0†
30-34 yr	368 (28.6)	598 (30.5)	1.1 (0.6-1.9)
≥35 yr	102 (7.9)	232 (11.8)	0.6 (0.5-0.8)
Parity			
1	1154 (89.7)	1314 (67.0)	1.0†
2	106 (8.2)	441 (22.5)	0.3 (0.2-0.3)
≥3	27 (2.1)	207 (10.6)	0.2 (0.1-0.2)
Marital status			
Unmarried	159 (12.4)	266 (13.6)	1.0†
Married	1128 (87.6)	1696 (86.4)	1.1 (0.9-1.4)
Cigarettes smoked/day‡			
0	802 (65.5)	1266 (67.2)	1.0†
1-10	158 (12.9)	225 (11.9)	1.1 (0.9-1.4)
11-20	167 (13.6)	225 (11.9)	1.2 (0.9-1.5)
≥21	97 (7.9)	167 (8.9)	0.9 (0.7-1.2)
Attendance at prenatal classes§			
No	1064 (88.0)	1526 (84.6)	1.0†
Yes	145 (12.0)	278 (15.4)	0.8 (0.6-0.9)
Infant's birth weight			
<2500 g	59 (4.6)	107 (5.5)	0.9 (0.6-1.4)
2500-2999 g	157 (12.2)	229 (11.7)	1.2 (0.9-1.5)
3000-3499 g	379 (29.4)	650 (33.1)	1.0†
3500-3999 g	416 (32.3)	665 (33.9)	1.1 (0.9-1.3)
≥4000 g	276 (21.4)	311 (15.9)	1.5 (1.2-1.9)
Type of hospital			
Tertiary care	816 (63.4)	1423 (72.5)	1.0†
Regional	393 (30.5)	451 (23.0)	1.5 (1.3-1.8)
Community	78 (6.1)	88 (4.5)	1.5 (1.1-2.1)

*Because of rounding, percentages may not total 100. CI denotes confidence interval. Odds ratios express the likelihood of a failed trial of labor (and subsequent cesarean section) in the specified group, as compared with the likelihood in the reference group.

†This group served as the reference category.

‡Data were missing for 63 women with a failed trial of labor and for 79 with a successful trial of labor.

§Data were missing for 78 women with a failed trial of labor and for 158 with a successful trial of labor.

TABLE 4. MORBIDITY IN PREGNANT WOMEN WHO FAILED TO DELIVER VAGINALLY AFTER A TRIAL OF LABOR AND THOSE WHO DELIVERED SUCCESSFULLY, IN NOVA SCOTIA, FROM 1986 THROUGH 1992.

MORBIDITY*	FAILED TRIAL OF LABOR (N= 1287)	SUCCESSFUL TRIAL OF LABOR (N= 1962)	ODDS RATIO (95% CI)†
	no. (%)		
Total complications	169 (13.1)	88 (4.5)	1.7 (1.5–2.0)
Major complications	49 (3.8)	4 (0.2)	5.1 (2.8–9.4)
Hysterectomy	4 (0.3)	1 (0.1)	2.7 (0.8–9.4)
Uterine rupture	8 (0.6)	2 (0.1)	3.7 (1.2–11.7)
Operative injury	39 (3.0)	2 (0.1)	5.1 (2.5–10.7)
Minor complications	120 (9.3)	84 (4.3)	1.5 (1.3–1.7)
Puerperal fever	103 (8.0)	68 (3.5)	1.5 (1.3–1.8)
Transfusion	18 (1.4)	18 (0.9)	1.2 (0.8–1.7)
Abdominal-wound infection	43 (3.3)	0‡	—

*Women with multiple major complications or both major and minor complications were counted only once, as having major complications; those with multiple minor complications were counted only once, as having minor complications.

†Odds ratios have been adjusted for maternal age, parity, smoking status, type of hospital, marital status, attendance at a prenatal class, and infant's birth weight. CI denotes confidence interval. Odds ratios express the likelihood of complications among the women with a failed trial of labor (and subsequent cesarean section), as compared with those for whom the trial of labor was successful.

‡There were no abdominal-wound infections in the women in whom the trial of labor was successful.

erative injuries contributed to both total and major morbidity among women who chose a trial of labor after a previous cesarean section.

Women for whom a trial of labor is unsuccessful and who therefore require a second cesarean section have the greatest morbidity. In our study, 63.6 percent of major complications and 28.4 percent of minor complications occurred in women who required cesarean section after an unsuccessful trial of labor. A maternal age of 35 years or more, delivery at a community or regional hospital, a birth weight of 4000 g or more in the infant, and the absence of a history of vaginal delivery were associated with an increased risk of cesarean section due to the failure of a trial of labor. Although a trial of labor ends in vaginal delivery in 60 to 80 percent of women who attempt it after a previous cesarean section,⁸⁻¹² it is a great challenge to identify the women who are most likely to have a successful trial of labor. Recently, researchers have tried to predict the likelihood of success or failure with a trial of labor after a previous cesarean section.¹⁷⁻¹⁹ Previous dysfunctional labor, no prior vaginal delivery, an abnormal fetal-heart-rate tracing, induction of labor,¹⁷ fetal-pelvic disproportion,¹⁸ and fetal growth abnormalities¹⁹ all increased the likelihood that a trial of labor would be unsuccessful.

Because some outcomes associated with a trial of labor after a previous cesarean section are rare, we used population-based data to generate estimates of the risk of complications and death. However, our study is limited by possible selection bias and a pos-

sible lack of generalizability. Because the women were allowed to choose between a trial of labor and an elective second cesarean section, selection bias could have altered our estimates of risk. The results of our study may also not be generalizable to other groups of women, since the management of a trial of labor after a previous cesarean section in Canada may be different from standard practice in other parts of the world. Finally, although neonatal outcomes in the two groups were similar, follow-up information about the infants was not available.

For a woman who has had a previous low transverse cesarean section, a choice must be made between a trial of labor and an elective second cesarean section. In this study, the risk of major complications was greater for women who chose a trial of labor than for those who chose a second cesarean section. This was so because the rate of cesarean section in the women who attempted a trial of labor was 40 percent, and major complications were substantially more frequent than for women who had a second cesarean section without a previous trial of labor. This increased risk more than offset the decreased risks associated with delivery in the 60 percent of women in the same group whose trial of labor was successful.

Clearly, the way to decrease the overall risk entailed by a trial of labor (including the risk of major complications) is by selecting women who have a high probability (perhaps more than 80 percent) of delivering their babies vaginally. In this study, women were more likely to have a successful trial of labor

if they were under 35 years of age, if the child's birth weight was less than 4000 g, and if they delivered in a tertiary care hospital. However, there is as yet no confirmed method of predicting the likelihood that a trial of labor will lead to vaginal delivery for a patient with a previous low transverse cesarean section.

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