Trial of Labor versus Elective Repeat Cesarean Section for the Women with a Previous Cesarean Section: A Decision Analysis

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In order to reduce the cesarean-delivery rate, more and more pregnant women are offered trials of labor (TOL) after their previous cesarean sections. TOL and elective repeat cesarean section (ERCS) have different risks and benefits. We constructed a decision analysis to explore this issue. Probabilities were derived from literature reviews. Health state utilities were derived from the authors' clinical judgement. The analysis considered the disutility of the procedures and the disutilities of the morbidity. Using the baseline assumption, ERCS was superior to TOL. One-way sensitivity analyses showed that the result was insensitive to all of the probability estimates and the disutilities of the morbidity. However, the result was sensitive to the patient's preference for ERCS, successful TOL, or failed TOL. The analysis indicates that the best delivery method for a woman who has had a previous cesarean section depends on patient's preference. More patients' preference studies are needed.

INTRODUCTION

The cesarean-delivery rate in the United States was 21% in 1995 [1]. The Healthy People 2000 project recommended reducing this rate to 15% by the year 2000 [2]. Currently, one-third of the cesarean sections are elective repeat cesarean sections (ERCS) only because the woman has previously had a cesarean section [3-5]. It seems that this goal is impossible to reach because a large number of women in the US have had a previous cesarean section, and this is a principal indication for a cesarean section [5]. One of the strategies proposed to reduce the cesarean-delivery rate is to increase the number of trials of labor (TOL) among women who have had cesarean sections [5]. Among women who attempt a trial of labor after a previous low transverse cesarean section, 60% to 80% have vaginal deliveries, and morbidity is lower among women who have a vaginal birth after cesarean section (VBAC) than among women who elect a repeat cesarean delivery [3,6-8]. However, a major risk of a trial of labor is uterine rupture during labor, which may lead to substantial hemorrhage, fetal hypoxic injury, and hysterectomy. When a trial of labor after cesarean delivery fails and a repeat emergency cesarean delivery is performed, the rate of maternal morbidity (including infection and operative injuries) and the cost increase substantially [5]. Physicians should discuss the risks and benefits of the two different approaches with their patients and patients' choices must be considered [9].

The principle of "Once a cesarean section, always a cesarean section" had dominated obstetric practice for 70 years. Improvements in maternity care have substantially reduced the risk for TOL after a previous cesarean section. In 1984, the American College of Obstetrics and Gynecology revised the above dictum to encourage TOL for women who have a low transverse uterine scar [10-11]. In 1999, Sachs criticized the policy of reducing the cesarean-delivery rate to 15% without any scientific evidence, and he suggested we should concentrate on reducing the number of primary cesarean deliveries only [5]. The best delivery strategy for a woman who has had a previous cesarean section is unclear. The purpose of this study was to implement a decision analysis to determine the preferred delivery method for a pregnant woman without contraindications to labor who has had a previous low transverse cesarean section.

METHODS

Construction of the Decision Tree

We constructed a decision tree to compare TOL and ERCS for the management of a pregnant woman who has had a previous low transverse cesarean section without contraindications to labor. The model was constructed and analyzed using Data 3.5 for Windows (TreeAge Software, Williamstown, Mass). The tree is depicted in Figure 1.

If a TOL is planned, some women will successfully have vaginal deliveries (successful TOL branch). The other women will experience failed TOL; then, they will require a second cesarean section (failed TOL with cesarean section branch).

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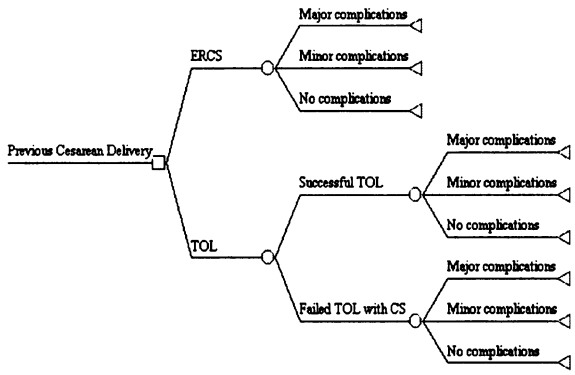
Figure 1. The decision tree to compare TOL and ERCS for the management of a pregnant woman who has had a previous low transverse cesarean section without contraindications to labor. CS denotes cesarean section.



All of the women in TOL group or in ERCS group may possibly experience some morbidity. Women are classified with respect to morbidity as having major complications, minor complications, or no complications. Major complications are defined as the need for hysterectomy, uterine rupture, and operative injury. Hysterectomy is defined as the surgical removal of the uterus and cervix, with or without adnexectomy. Uterine rupture is defined as a defect that involves the entire wall of the uterus, that is symptomatic, and that requires operative intervention. Operative injury includes serious extensions of uterine incisions or injuries to adjacent organs that would potentially involve long-term morbidity or prohibit future vaginal deliveries. Minor complications are defined as puerperal fever, the need for a blood transfusion, and abdominal-wound infection.

Estimating Probabilities

Table 1 lists the baseline probabilities and plausible ranges of uncertain events. Because there are no randomized controlled trials available for this issue, all these probabilities were obtained from the population-based cohort studies. After considering the methodological quality and relevance to our analysis, we used McMahon's study results as our probability point estimates, and used these estimates to calculate their individual 95% confidence intervals for the plausible ranges [3]. The range for successful TOL rate came from the range of the different studies [3,6,8,12-14]. Using a single study to estimate probabilities and ranges is one of the feasible methods suggested by Naglie's tutorial paper [15].

Estimating Outcome Values

When offered the opportunity, about two thirds of women chose TOL over ERCS [11]. Women choosing TOL appeared to desire vaginal birth and its shorter recovery time [16]. However, if a decision was made to undergo TOL, many women changed their preference during labor because of pain and other factors independent of medical risk [17,18]. Women who received an emergency cesarean section had a more negative perception of the birth experience than those who had an ERCS or a vaginal delivery [19].

After considering the above women's preference study results, we estimated the disutilities of the procedures and their morbidity (Table 2). We summed up the disutilities of the procedures and the disutilities of the morbidity together for each branch to get their individual utility. For example, if a woman underwent ERCS with major complications, her disutility will be 0.3 (0.1 + 0.2) and her utility equals to 0.7 (1-0.3).

Table 1. Probability estimates in decision tree.

Variable	Baseline*	Range*
Successful TOL rate	0.604	0.60-0.82 †
Complication rates in ERCS		
Major	0.83%	0.50%-1.16%
Minor	7.58%	6.62%-8.55%
Complication rates in successful TOL		
Major	0.20%	0.00%-0.40%
Minor	4.28%	3.39%-5.18%
Complication rates in failed TOL		
Major	3.81%	2.76%-4.85%
Minor	9.32%	7.74%-10.91%

** Reference No.: [3].*
† Reference No.: [3,6,8,12-14].

Table 2. Disutility estimates for decomposed procedures or health states in decision tree.

Procedures or morbidity	Baseline Disutility	Range
ERCS	0.10	0.05-0.15
Successful TOL	0.10	0.05-0.15
Failed TOL	0.15	0.10-0.20
No complications	0.00	
Major complications	0.20	0.10-0.30
Minor complications	0.05	0.01-0.10

Estimating Cost of Childbirth

We used current cost data at the Beth Israel Deaconess Medical Center in Boston [5]. The cost of their estimations includes both the professional fee and the cost of hospitalization. An ERCS costs approximately $7,700 and a normal vaginal delivery

costs approximately $6,800. A failed TOL and a emergency cesarean delivery cost $9,800. If a mother has a major complication, the cost increases by $4,000. Because they did not provide the cost for minor complications, we estimate the cost will increase $500 for the mother.

Sensitivity Analysis

We performed multiple one-, two-, and three-way sensitivity analyses to test the effects of the probability and disutility estimates and ranges on the decision between ERCS and TOL strategies. To compare the possible effects of the probabilities and disutilities, we ran one-way sensitivity analyses over all ranges (from 0 to 1 or the possible maximal value) of all variables. The threshold value is the value for that variable at which two strategies have equal expected utility. At values more extreme than the threshold value, a new strategy will be preferred. If that threshold value falls within the plausible range for that variable, the result is "sensitive" to that variable [20].

RESULTS

Using the baseline assumption, the expected utility of ERCS was 0.895 and the expected utility of TOL was 0.874 (the marginal value is 0.021). The expected cost of ERCS was $7,771 and the expected cost of TOL was $8,085 (the marginal value is $313). However, when successful TOL rate rose to above 0.70, the expected cost of TOL became less than the expected cost of ERCS.

One-way sensitivity analyses showed that the result was insensitive to all of the probability estimates and disutilities of morbidity. However, the result was sensitive to the patient's preference over ERCS, successful TOL, and failed TOL. This is summarized in Table 3. We also used three-way sensitivity analyses to simultaneously evaluate the effects of the disutilties of ERCS, successful TOL, and failed TOL on the decisions. In Figure 2, we only showed the results when the disutility of the successful TOL (Ustol) equals to 0.1. If patient Ustol decreases, the diagonal line moves to upper left. It is increasingly likely that combined values for the other two variables will yield a result favoring TOL.

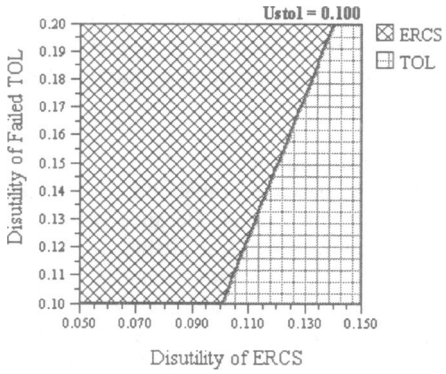
Although the result was insensitive to the successful TOL rate, we were interested in considering its effect combined with the effect of other variable on the decision. We ran two-way sensitivity analyses individually on successful TOL rate versus disutility of ERCS, disutility of successful TOL, and disutility of failed TOL. We found the result was only insensitive to successful TOL rate versus disutility of failed TOL. In Figure 3, we showed the results of the 2-way sensitivity analysis on successful TOL rate and disutility of ERCS. It seemed that the effects of the successful TOL rate on the decision were limited compared with the effects of the disutility of ERCS.

Table 3. One-way sensitivity analyses of the probabilities and disutilities.

Variable	Threshold Value	Sensitive
Successful TOL rate	0.95	N†
Complication rates in ERCS		
Major	0.11	N
Minor	0.49	N
Complication rates in successful TOL		
Major	NT*	N
Minor	NT	N
Complication rates in failed TOL		
Major	NT	N
Minor	NT	N
Disutility		
ERCS	0.121	Y
Successful TOL	0.066	Y
Failed TOL	0.10	Y
major complications	NT	N
minor complications	NT	N

** NT denotes no threshold found for this variable.*
† Y denotes that the analysis is sensitive to this variable; N denotes that the analysis is insensitive.

Figure 2. 3-way Sensitivity Analysis on Disutilities of ERCS, Failed TOL and Successful TOL.

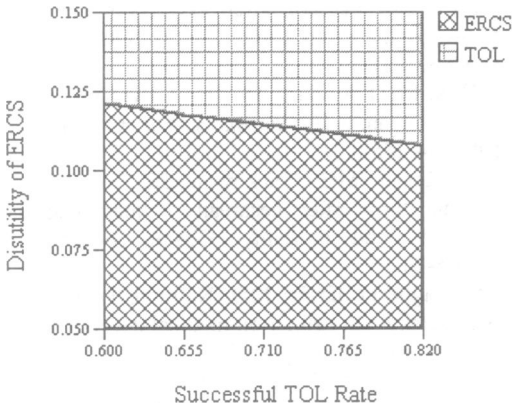


DISCUSSION

Our results indicate that TOL and ERCS are two more or less equivalent strategies for a woman who has had a previous cesarean section. It means that there is no major loss or gain in choosing either TOL or ERCS after considering the assumptions and estimations made in our model. However, the

patient's disutilities of ERCS, successful TOL, and failed TOL decide the best delivery method. Unfortunately, most studies on patients' preference were descriptive or qualitative in nature and examined the factors underlying women's preference for method of birth. All had marked methodological limitations [11]. A large, prospective survey to investigate such kind of pregnant women's preference is needed in order to make practice recommendations. At the very least, physicians need to discuss the risks and benefits of two different approaches with patients and patients' choices must be considered [5,9].

Figure 3. Sensitivity Analysis on Successful TOL Rate and Disutility of ERCS



From economic viewpoints, if two strategies are a "toss-up", but one is substantially less costly, that strategy is clearly the more attractive one [20]. Our cost analysis result showed that if the patient's successful TOL rate is less than 0.70, ERCS will be less costly and it is clearly the better choice. This finding impressed us enough. It changes the template image that TOL can save money but ERCS will cost more. On the contrary, once the patient's successful TOL rate rises above 0.70, TOL will be the better strategy from the economic views. It means that if we carefully select women with a high chance of delivering vaginally, we can not only reduce the morbidity of TOL [3] but also reduce the costs. Ideally, the decision about the type of delivery should be shaped by the recent results in the hospital where the woman plans to deliver her baby [21]. Using electronic medical records in hospitals to develop their own clinical prediction rules to find the factors that will determine the failed or successful TOL may be one good research direction in medical informatics and in clinical epidemiology. These findings can help a woman to decide how she delivers after a previous cesarean section.

Economic costs include both direct costs and opportunity (or indirect) costs. However, financial studies comparing cesarean section and vaginal delivery traditionally have used charges to represent costs [11]. Sachs' article did not clearly state that their data was charge or cost data and even the perspective of their analysis [5]. However, it seemed they had considered the fact that a labor unit was similar to an ICU with respect to costs and a prolonged and difficult labor with vaginal delivery was more costly than a cesarean delivery [5].

This decision analysis only used one single study to construct the decision tree and to estimate the probabilities [3]. Although that study was a population-based, longitudinal study of over 6000 women and was published in New England Journal of Medicine in 1996, the results conducted from 1986 through 1992 may not be applicable to a woman's situation in other hospitals in 1999. However, it is still the currently most reliable study in this field and it provides the woman with a previous cesarean section the most detailed information [9].

The decision tree model does not address the maternal death for two reasons. One is that the maternal mortality rates are too low in the two groups (0.0857 per 10,000 patients in TOL versus 1.78 per 10,000 in ERCS, without statistically significant difference between the two groups [11]). The other one is there is no data available for the maternal mortality distributions between the successful TOL and failed TOL groups.

The decision tree model also does not address the infant outcomes. Five-minute Apgar scores and infant mortality are the only neonatal outcomes found in the literature. Although the meta-analysis study revealed a slightly increased absolute risk (0.85%) for a lower 5-minute Apgar score for the infant whose mother underwent TOL compared with the one whose mother underwent ERCS, Apgar scores do not predict long-term infant outcomes [11]. In McMahon's study, the perinatal mortality rate was 9 per 1000 live births in TOL group and 5 per 1000 live births in ERCS group (P=0.09) [3]. However, they did not provide the infant mortality distributions between the successful TOL and failed TOL groups, neither did other authors [3,6-8,11-14].

CONCLUSION

The analysis indicates that TOL and ERCS are two more or less equivalent strategies for a woman who has had a previous cesarean section. The best delivery method for a woman who has had a previous cesarean section depends on patient's preference. Physicians need to discuss the risks and benefits of the two different approaches with patients and patients' choices must be considered. If the estimation of the patient's successful TOL rate is less than 0.70, ERCS will be less costly. On the contrary, once the estimation of the patient's successful TOL rate rises above 0.70, TOL will be less costly. Using electronic medical records to develop local clinical prediction rules to predict the probability of the successful TOL rate for each individual patient may be a possible future research direction.

Acknowledgments

We gratefully acknowledge Polun Chang, PhD, Dongwen Wang and other reviewers who read this manuscript and offered helpful suggestions. This work was supported in part by contract 1-LM63542 from the National Library of Medicine. JH Chuang receives support from the Medical Research and Advancement foundation in Memory of Dr. Chi-Shuen Tsou and the Medical Scholarship Foundation in Memory of Prof. Albery Ly-Young Shen.

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