



Maternal and Neonatal Outcomes Following Trial of Labor After Two Previous Cesareans: a Retrospective Cohort Study

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Abstract

The objective of this study is to evaluate the maternal and neonatal outcomes of parturients attempting trial of labor (TOL) after two previous CD versus those who had an elective third repeat CD. A retrospective computerized database cohort study was conducted at a single tertiary center between 2005 and 2019. Various maternal and neonatal outcomes were compared between parturients attempting TOL after two CD versus parturients opting for elective third repeat CD. TOL after two CD was allowed only for those who met all the criteria of our departments' protocol. Parturients with identified contraindication to vaginal delivery were excluded from the analysis. A univariate analysis was conducted and was followed by a multivariate analysis. A total of 2719 eligible births following two CD were identified, of which 485 (17.8%) had attempted TOL. Successful vaginal delivery rate following two CDs was 86.2%. Uterine rupture rates were higher among those attempting TOL (0.6% vs 0.1% $p = 0.04$). However, rates of hysterectomy, re-laparotomy, blood product infusion, and intensive care unit admission did not differ significantly between the groups. Neonatal outcomes following elective repeat CD were less favorable (specifically, neonatal intensive care unit admission and composite adverse neonatal outcome). Nonetheless, when controlling for potential confounders, an independent association between composite adverse neonatal outcome and an elective repeat CD was not demonstrated. In a subgroup analysis, diabetes mellitus and hypertensive disorders of pregnancy were found independently associated with failed TOLAC. When following a strict protocol, TOL after two CD is a reasonable alternative and associated with favorable outcomes.

Keywords Multiple cesarean deliveries · Uterine rupture · VBAC · TOLAC

Introduction

Rates of cesarean deliveries (CD) have substantially increased in recent decades to approximately 21% of births worldwide [1] with the most common indication for CD being a previous uterine scar [2]. Repeat CD is associated with significant morbidities including the following: the need for blood transfusion, bowel and bladder injury, and placenta previa with its

related complications [3, 4]. In 1980, the National Institute of Child Health and Human Development Conference on Childbirth concluded that vaginal delivery (VD) after a CD is a relevant alternative. Successful vaginal birth after CD (VBAC) compared to elective repeat CD is associated with fewer complications. However, a failed trial of labor after CD (TOLAC) is associated with serious complications. Therefore, efforts are made in order to identify the best candidates for TOLAC [5].

The American College of Obstetrics and Gynecology (ACOG) committee opinion from 1994 on the issue of TOLAC stated that TOLAC after two or more previous CDs should not be discouraged [6]. Thereafter, institutions consented and allowed TOLAC following two previous CD [7–10]. Subsequently, the ACOG guidelines from 2019 [11] maintains that it is reasonable to consider parturients with two previous low-segment transverse (LSTCS) CD as appropriate candidates for TOLAC following a thorough individual consultation

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assessing their previous and current obstetrical history and their probability of achieving a successful VBAC.

Initiated in 2000, our medical center follows a strict protocol regarding TOLAC in parturients who previously had 2 CD. There is a paucity of data regarding maternal and neonatal risks associated with TOLAC in this specific population. The purpose of this study was to investigate the outcomes of TOLAC following two CD versus a third repeat elective CD and to explore factors associated with successful TOLAC.

Material and Methods

In this retrospective cohort study, all parturients at the Shaare Zedek Medical Center (SZMC) with a history of two previous CD between August 2005 and November 2019 were enrolled. We included parturients between 24 and 42 weeks of gestations who had two prior CDs and subsequently had vaginal vertex births and parturients who chose to have a repeat elective CD. Excluded from the study were parturients with non-vertex presentation, placenta previa, placenta accreta, mullerian uterine anomalies, multifetal gestation other than twins, and parturients without at least one previous vaginal delivery. A comparison was made between those who attempted TOLAC and those who were scheduled for an elective repeat CD.

In general, our department's standard recommendation following previous two CD is to undergo an elective repeat CD. However, TOLAC is discussed with those parturients who express interest in attempting labor after CD. TOLAC is discussed only if all the following criteria are validated. The criteria are as follows: (1) The parturient explicitly expresses her request for TOLAC and comprehends the potential risks, benefits, and alternatives. (2) The parturient had a previous vaginal delivery (VD), either before the first CD or in between the first and second CDs. (3) Both previous uterine incisions were low-segment transverse; there were no extensions or severe adhesions. (4) Fetal estimated weight is < 4000 g. (5) Vertex presentation. Additionally, the onset of labor must be spontaneous; we do not induce or augment labor in parturient with 2 previous CD.

SZMC's medical record database on all labor and deliveries is updated in real time during labor and delivery by attending healthcare professionals and audited periodically by trained technical personnel to ensure validity of the data. Over 95% of Israeli citizens' medical care is covered by the Israeli National Health Plan; hence, continuity of care is granted for long periods of time for most of the patients. Maternal and neonatal records were reviewed and retrieved for relevant data, information was coded and identifiable, and personal information for each patient was protected by anonymization prior to analysis.

Definitions: The terms used were defined as the following: *Uterine rupture*—complete uterine scar ruptures, i.e., involving the occurrence of a full-thickness defect with direct connection between peritoneal space and the uterine cavity. Diagnosis was made by an attending physician during an explorative laparotomy. *Re-laparotomy*—additional abdominal operation performed during hospitalization for delivery [12] *Postpartum hemorrhage* (PPH) was defined using one of the two following definitions: (1) Estimated blood loss of over 500 ml in vaginal delivery (VD) and over 1000 ml in CD [13] (in SZMC, pads are weighted following VD, but in some cases when pads or weighting are not feasible, blood loss is estimated subjectively by the midwife/obstetrician); (2) the transfusion of blood products and/or hemoglobin drop ≥ 4 g/dL. *Prolonged hospitalization*: ≥ 5 days for vaginal deliveries and ≥ 7 days for cesarean deliveries.

Primary outcome was defined as *a composite adverse maternal outcome*: one or more of the following: PPH, hemoglobin drop ≥ 4 g/dL, blood product transfusion, intensive care unit (ICU) admission.

Secondary outcomes were defined as follows:

1. *Composite adverse neonatal outcome*: a composite outcome of one or more of the following: 5-min Apgar score ≤ 7 , neonatal asphyxia, neonatal intensive care unit (NICU) admission, and the need for mechanical ventilation.
2. *Composite adverse maternal and neonatal outcomes* among the group of parturients attempting TOLAC. We compared those who achieved VBAC and those whose attempt at labor was aborted and necessitated in labor CD

Statistical Analysis An initial univariate analysis was carried out, and categorical variables were presented as a percentage and compared using chi-square and Fisher's exact tests as appropriate. Continuous variable presentation was according to each variable distribution, while normal distributed variables were presented as a mean and standard deviation, and those displaying non-normal distribution were presented as median with interquartile range. A comparison was made using Student's *t* test and Mann-Whitney test, accordingly. All analyses were two sided and a *p* value < 0.05 was considered statistically significant.

Data analysis was conducted according to the group category to which the parturient was initially categorized corresponding to her original request. For instance, if a parturient originally requested an elective CD and presented in active labor, resulting in an emergency CD, she remained in the analysis of the planned elective CD group. However, all parturients analyzed in the TOLAC group attempted TOL even if the result was CD. A multivariate analysis using a binary logistic regression model was used in order to account for

the independent association between composite adverse neonatal outcomes, infusion of blood products, and TOLAC versus elective CD after 2 CDs. Adjusted odds ratios (aOR) and 95% confidence intervals (CI) were computed.

A sub-group analysis comparing in-labor CD (=failed TOLAC) versus successful VBAC was conducted. A univariate analysis was followed by a multivariate analysis in order to examine independent factors associated with TOLAC failure.

Data analysis was carried out using SPSS software (version 23 statistical package; IBM, Armonk, NY). The study was approved by the local institutional ethics committee in accordance with the principles of the Declaration of Helsinki (IRB: 001-20-SZMC).

Results

During the study period, 3141 eligible births were identified, of which 422 were excluded in accordance with our exclusion criteria. According to our study inclusion criteria, all parturients with previous 2 CD experienced a previous vaginal delivery. Of the remaining 2719 deliveries, 485 (17.8%) parturients attempted TOLAC and the remaining 2234 (82.2%) had a scheduled elective repeat CD (Fig. 1). Among the 485 parturients attempting TOLAC, 418 achieved vaginal delivery (86.2%), with 26 (26/418, 6.2%) assisted by operative VD. The remaining 13.8% experienced failed TOLAC and required in labor CD.

Table 1 displays various demographic and obstetrical characteristics of the study groups. Parturients who had requested an elective repeat CD were significantly younger and of lower gravidity and parity order. In addition, they had higher rates of conception using advanced reproductive technology, diabetes

(pre-gestational and gestational), and hypertensive disorders of pregnancy.

Maternal Outcomes

Selected maternal outcomes as well as the mode of delivery are presented in Table 2. Our primary outcome—composite adverse maternal outcome rate was similar in both groups; 6.2% of the parturients attempting TOL vs. 4.8% of the parturients who had elective repeat CD ($p = 0.2$).

However, several differences were noted: rates of uterine rupture were lower among those who had elective repeat CD (0.1% vs. 0.6%, $p = 0.04$). Overall, there were six cases of uterine rupture (0.22%), three in each group. Among parturients attempting TOL, two out of three cases of uterine rupture occurred in the latent phase. These parturients presented with fetal distress or abdominal pain. One case was diagnosed unexpectedly as post-partum during a revision of the uterine cavity due to retained placenta. All three cases of uterine rupture among parturients who intended to have an elective CD occurred before active labor, during the latent phase. They all presented with abdominal pain prior to their scheduled elective date and underwent surgery without delay.

Hysterectomy rates also did not differ between the groups. Overall, there were three cases of hysterectomy, two of them were a result of DIC, of which, one case following sepsis and one case following pre-eclampsia presenting as HELLP syndrome (hemolysis, elevated liver enzymes, low platelet count). The third case was secondary to uterine rupture. A non-significant trend of higher rates of re-laparotomy after CD was shown among those who had a planned repeat CD. However, there were only three cases of re-laparotomy, all of which were in the group of elective repeat CD. In two

Fig. 1 Flow chart of the study group

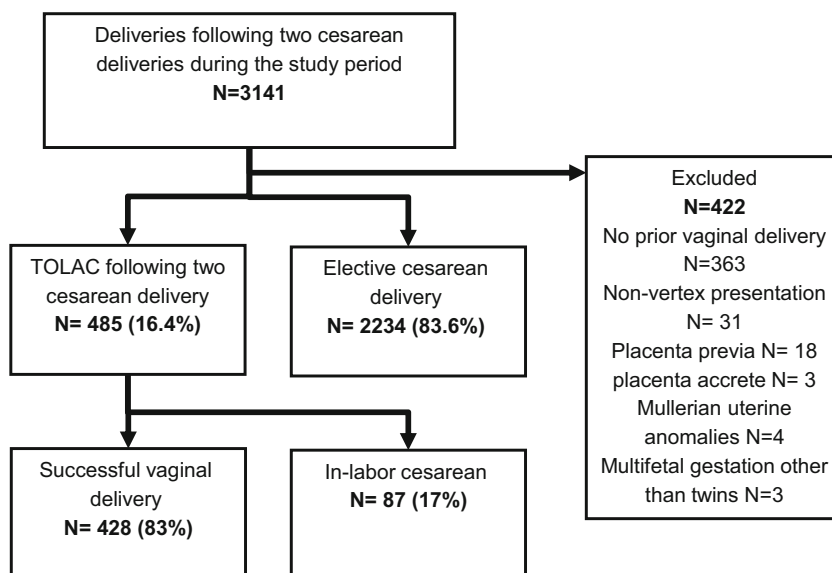


Table 1 Demographic and current delivery characteristics of the study groups

	TOLAC following 2 CD N = 485	Elective planned repeated CD N = 2234	p value
Maternal age (mean ± SD)	34.44 ± 4.32	33.49 ± 5.11	< 0.01
Gravidity (median, IQR)	7 (6–10)	4 (3–6)	< 0.01
Parity (median, IQR)	5 (4–7)	3 (3–5)	< 0.01
Previous miscarriage n (%)	228 (47.0%)	987 (44.2%)	0.26
Fertility treatments n (%)	5 (1.0%)	126 (5.6%)	< 0.01
Diabetes n (%)*	30 (6.2%)	264 (11.8%)	< 0.01
Hypertensive disorders of pregnancy n (%)**	9 (1.9%)	111 (4.9%)	< 0.01
Multifetal gestation n (%)	4 (0.8%)	24 (1.1%)	0.62
BMI (kg/m ²) (mean ± SD)***	29.58 ± 4.76	31.24 ± 5.50	0 < 0.01
Epidural analgesia n (%)	235 (48.5%)	NA	NA
Intrapartum fever n (%)	1 (0.2%)	NA	NA
Episiotomy n (%)	7 (1.4%)	NA	NA

TOLAC, trail of labor after cesarean; CD, cesarean delivery; SD, standard deviation; IQR, interquartile range; NA, not available

*(pre gestational + gestational)

**Hypertensive disorders of pregnancy, a composite of gestational hypertension, preeclampsia, and eclampsia

***Due to missing data N = 71 in TOLAC group and N = 767 in Elective CD group

of the cases, an internal abdominal bleeding was detected and the third was due to an eventration of the small intestine through the Pfannenstiel incision.

There were no differences in the rates between the groups of endometritis, PPH, hemoglobin drop ≥ 4 g/dL and blood products, prolonged hospitalization, and ICU admission.

Neonatal Outcomes

Neonatal outcomes are presented in Table 3. Parturients who had elective repeat CD were scheduled for surgery notably earlier than the TOLAC group and the neonatal birth weights were significantly lower. Consequently, rates of macrosomia neonates were significantly lower in the elective repeat CD

Table 2 Maternal and delivery outcomes of the study groups

	TOLAC following 2 CD N = 485	Elective planned repeated CD N = 2234	p value
Mode of delivery n (%)			
Spontaneous vaginal	392 (80.8%)	NA	NA
Operative vaginal	26 (5.4%)		
Cesarean	67 (13.8%)		
Shoulder dystocia n (%)	3 (0.6%)	NA	NA
Postpartum endometritis n (%)	2 (0.4%)	26 (1.2%)	0.14
Postpartum hemorrhage n (%)	35 (7.2%)	167 (7.5%)	0.84
Hemoglobin drop ≥ 4 g/dL n (%)	14 (2.9%)	74 (3.3%)	0.63
IV iron administration n (%)	0 (0.0%)	9 (0.4%)	0.16
Blood products transfusion n (%)	8 (1.6%)	58 (2.6%)	0.22
Uterine rupture n (%)	3 (0.6%)	3 (0.1%)	0.04
Re-laparotomy n (%)	0 (0.0%)	3 (0.1%)	0.09
Hysterectomy n (%)	1 (0.2%)	2 (0.1%)	0.48
Prolonged hospitalization n (%)	13 (2.7%)	49 (2.2%)	0.51
ICU admission n (%)	0 (0.0%)	1 (0.0%)	0.64
Composite adverse maternal outcome n (%)	30 (6.2%)	107(4.8%)	0.20

TOLAC, trail of labor after cesarean; CD, cesarean deliveries; ICU, intensive care unit; IV, intravenous. Prolonged hospitalization—> 5 days for vaginal deliveries and > 7 days for cesarean deliveries

Maternal composite outcome was defined as one or more of the following: PPH, hemoglobin drop >4 g/dL, blood products infusion, ICU admission

Table 3 Neonatal outcomes of the study groups

	TOLAC following 2 CD <i>N</i> = 485	Elective planned repeated CD <i>N</i> = 2234	<i>p</i> value
Gestational age at delivery, week (median, IQR)	40 (39–40)	38 (38–39)	< 0.01
Birth weight, g (mean ± SD)	3361.2 ± 585.5	3134.5 ± 486.4	< 0.01
Neonatal gender, male <i>n</i> (%)	228 (47.0%)	1139 (51.0%)	0.08
Macrosomia (≥ 4000 g) <i>n</i> (%)	46 (9.5%)	86 (3.8%)	< 0.01
1-Minute Apgar score ≤ 7 <i>n</i> (%)	30 (6.2%)	91 (4.1%)	0.04
5-Minute Apgar score ≤ 7 <i>n</i> (%)	9 (1.9%)	45 (2.0%)	0.82
NICU admission <i>n</i> (%)	23 (4.7%)	191 (8.5%)	0.02
Neonatal asphyxia <i>n</i> (%)	0 (0.0%)	3 (0.1%)	0.55
TTN <i>n</i> (%)	10 (2.1%)	52 (2.3%)	0.72
Mechanical ventilation <i>n</i> (%)	12 (2.5%)	36 (1.6%)	0.19
Composite adverse neonatal outcome <i>n</i> (%)	30 (6.2%)	245 (11.0%)	< 0.01

TOLAC, trail of labor after cesarean; CD, cesarean deliveries; SD, standard deviation; NICU, neonatal intensive care unit; TTN, transient tachypnea of the newborn

Neonatal composite outcome was defined as one or more of the following: 5-min Apgar < 7, asphyxia, NICU admission or the need for mechanical ventilation

group. One-minute Apgar score ≤ 7 was considerably more prevalent among those attempting TOLAC. Rates of NICU admission were higher among those who had elective repeat CD. However, 5-min Apgar scores, TTN, neonatal asphyxia, and mechanical ventilation were comparable between the two groups. Overall, rates of the composite adverse neonatal outcome were significantly higher among those who had planned an elective repeat CD (11.0% vs. 6.2%, $p < 0.01$).

Table 4 displays the results of a multivariate regression model which was conducted in order to account for independent factors associated with composite adverse neonatal outcome. Attempting TOLAC was not independently associated (aOR 0.48, 95% CI 0.22–1.04) with composite adverse

neonatal outcomes while failed TOLAC was found to be independently associated with composite adverse neonatal outcome (aOR 6.08, 95% CI 2.19–16.90).

Failed TOLAC

Table 5 presents selected maternal and delivery characteristics and outcomes of parturients attempting TOL following 2 CD according to the actual mode of delivery. Parturients with failed TOLAC (67/485) were of lower gravidity and parity order with higher rates of multifetal gestation. Rates of macrosomia did not differ between the groups. All parturients planning TOLAC with multifetal gestation failed (4/4). Rates of composite adverse maternal and neonatal outcomes were significantly higher among those who had failed TOLAC (11.9% vs. 5.3% and 29.9% vs 2.4%, respectively, $p < 0.01$ for both). A multivariate analysis controlling for parity, diabetes, hypertensive disorder of pregnancy, and epidural usage had demonstrated an independent association between failed TOLAC and composite adverse maternal outcome (aOR 2.55, 95% CI 1.05–6.22). An additional multivariate analysis controlling for diabetes, hypertensive disorder of pregnancy, gestational age at birth, and neonatal birth weight demonstrated an independent association between failed TOLAC and composite adverse neonatal outcome (aOR 7.05, 95% CI 2.60–19.05). When assessing factors associated with failed TOLAC, diabetes and hypertensive disorders of pregnancy were found positively associated (aOR 3.13, 95% CI 1.30–7.70 and aOR 8.45, 95% CI 2.09–34.12, respectively) while epidural was found to be negatively associated (aOR 0.42, 95% CI 0.24–0.75); an association to parity and gravidity was not demonstrated.

Table 4 Composite adverse neonatal outcome following 2 CD, elective CD vs. TOLAC; results from multivariate analysis

Variables	aOR (95% CI)	<i>p</i> value
In labor CD	6.08 (2.19–16.90)	< 0.01
Meconium aspiration	4.64 (1.69–12.74)	< 0.01
Gestational age at delivery	0.41 (0.36–0.46)	< 0.01
Macrosomia (≥ 4000 g)	0.67 (0.32–1.40)	0.29
TOLAC vs. planned elective CD	0.48 (0.22–1.04)	0.07
Hypertensive disorders of pregnancy**	1.26 (0.72–2.21)	0.41
Diabetes*	1.10 (0.75–1.70)	0.55
Parity	1.03 (0.97–1.09)	0.32

CD, cesarean delivery; TOLAC, trail of labor after cesarean; aOR, adjusted odds ratio; CI, confidence interval

*(pre gestational + gestational)

**Hypertensive disorders of pregnancy, a composite of: gestational hypertension, preeclampsia and eclampsia

Table 5 Maternal, delivery characteristics, and outcomes of parturients undergoing TOL following 2 CD according to actual mode of delivery

	Failed TOLAC <i>N</i> = 67	VBAC <i>N</i> = 418	<i>p</i> value
Maternal age (mean ± SD)	34.82 ± 4.80	35.02 ± 3.24	0.73
Gravidity (median, IQR)	6 (5–9)	7 (6–10)	< 0.01
Parity (median, IQR)	5 (3–6)	5 (4–7)	< 0.01
Fertility treatments <i>n</i> (%)	3 (4.5%)	2 (0.5%)	< 0.01
Multifetal gestation <i>n</i> (%)	4 (5.9%)	0 (0.0%)	< 0.01
Diabetes <i>n</i> (%)*	8 (11.9%)	22 (5.3%)	0.03
Macrosomia (≥ 4000 g) <i>n</i> (%)	6 (9.0%)	40 (9.6%)	0.87
Hypertensive disorders of pregnancy <i>n</i> (%)**	5 (7.5%)	4 (1.0%)	< 0.01
Epidural <i>n</i> (%)	21 (31.3%)	214 (51.4%)	< 0.01
Uterine rupture <i>n</i> (%)	2 (3.0%)	1 (0.2%)	< 0.01
Dehiscence of uterine scar <i>n</i> (%)	0 (0.0%)	0 (0.0%)	NA
Re-laparotomy <i>n</i> (%)	0 (0.0%)	0 (0.0%)	NA
Hysterectomy <i>n</i> (%)	1 (1.5%)	0 (0.0%)	0.01
Composite adverse maternal outcome <i>n</i> (%)	8 (11.9%)	22 (5.3%)	0.04
Composite adverse neonatal outcome <i>n</i> (%)	20 (29.9%)	10 (2.4%)	< 0.01

TOL, trial of labor; CD, cesarean delivery; VBAC, vaginal birth after cesarean; SD, standard deviation; NA, not available

Maternal composite outcome was defined as one or more of the following: PPH, hemoglobin drop > 4 g/dL, blood products infusion, ICU admission

Neonatal composite outcome was defined as one or more of the following: 5-min Apgar < 7, asphyxia, NICU admission or the need for mechanical ventilation

Previous VD

In order to determine whether the “timing” of the VD in the chronological sequence of deliveries played a role in TOLAC success, a sub group analysis was carried comparing between parturients attempting TOL who had VD before the first CD (*n* = 260) and those who had VD between the first and second CD (*n* = 225) (as all parturients attempting TOL following the second CD were comprised the study group). Rates of TOLAC success were comparable (85.8% vs. 86.6%, respectively, *p* = 0.72); in addition, rates of uterine rupture as well as composite adverse maternal outcome did not differ between the groups.

Discussion

In this retrospective cohort study, maternal and neonatal outcomes were compared between parturients with a history of previous two CD attempting TOL versus those who had scheduled a third elective CD. Seventeen percent of parturients with two previous CD met our protocol criteria and expressed their preference for TOLAC. VBAC rates were overall high (86%). Parturients attempting TOL had higher rates of uterine rupture with an overall rate of 0.6%; otherwise, maternal outcomes were comparable. Failed TOLAC was found independently associated with composite adverse neonatal

outcome, in addition to diabetes mellitus and hypertensive disorders of pregnancy.

With the growing incidence of CD worldwide, efforts are made in order to reduce global rates of CD by limiting its unnecessary use as well as encouraging TOLAC [14]. Nonetheless, the complications that may be associated with TOLAC and perhaps VBAC should not be underestimated, with the most serious complication being uterine rupture. Despite its rare occurrence, uterine rupture may pose a life-threatening risk to both mother and fetus [15]. Hence, parturients who can benefit from TOLAC advantages and are at relatively low risk for its associated complications should be selectively identified. Previous studies have described an array of VBAC rates following two CD, ranging between 66 and 75% [10, 16–18], with a pooled rate of 71% [19]. Our VBAC success rates (86%) are higher than those described in the literature. It is possible that this is related to our department’s protocol which requires previous vaginal delivery and spontaneous onset of labor which were proven to be the best predictors for VBAC [20].

Previous studies were inconclusive regarding maternal results associated with TOLAC. Some studies [17] indicated a twofold increase in the risk of composite maternal morbidity, including uterine rupture, bladder injury, or other major operative injuries, while others [19] demonstrated comparable outcomes between the groups. Our study demonstrated a non-significant lower rate of blood transfusion, re-laparotomy, and hysterectomy in the TOLAC group. This result was

demonstrated in previous studies [7, 17, 19] and most probably reflects the increased risk inherent to multiple CD [21, 22]. Previous studies³⁴⁵ demonstrated rates of uterine rupture following two or more previous CD ranging between 0.8 and 3.7% and concluded that uterine rupture was significantly more common in those attempting TOLAC in comparison to those who chose elective repeat CD. On the other hand, one [18] retrospective study did not demonstrate a significant difference in uterine rupture. A meta-analysis [19] determined a pooled risk of 1.36% for a uterine rupture in TOLAC after two CD. Most recently, a retrospective study in our institution had demonstrated that when following our strict departmental protocol, uterine rupture rate did not differ significantly between those attempting TOLAC following one or two CD (0.3% vs 0.6%, respectively, $p = 0.34$). Our data indicated an absolute risk of 0.6% for uterine rupture when attempting TOLAC which is significantly higher when compared to an elective CD (0.6% vs. 0.1%, $p = 0.04$) but it is to our knowledge, the lowest rate described in the literature and does not differ significantly from the risk described for TOLAC following one CD [23]. Despite the fact that all uterine ruptures among elective CD delivery were following contraction, we decided to include these cases because we believe that every parturient with a history of previous CD is at risk for future uterine rupture regardless of the planned mode of delivery. These cases are merely a reflection of reality and highlight the fact the parturients who chose an elective CD are not fully protected of this complication and should be aware of contractions and hasten to hospital. The relatively lower rates of uterine rupture along with the remarkable high VBAC rate might be attributed to several factors related to our departmental protocol: (1) In our institution, labor was not induced nor augmented, unlike previous studies in which 65% of parturients were induced [17]. (2) In our study, only parturients with prior two low-segment transverse incisions were approved for TOLAC, unlike previous studies that included parturients with unknown scars and had higher rates of uterine rupture which reached 5.4% [10, 16]. (3) Previous VD is a mandatory criteria in our institution and was proven to be not only one of the best predictors for a VBAC [24, 25] but also a protective factor for uterine rupture [16, 17].

Rates of composite adverse neonatal outcomes were significantly higher among those who had an elective repeat CD. This difference could have been explained by the difference in gestational age and higher NICU admission rates in the parturients having elective repeat CD [26]. However, when controlling for gestational age and other potential confounders, an independent association to an elective repeat CD was not demonstrated. Similar to our results, other studies [4] showed no significant differences when comparing NICU admission and term neonatal death [16, 19]. Not surprisingly, the rate of the composite adverse neonatal outcome was significantly higher among those who had failed TOLAC. This finding correlates

with other studies that demonstrated poor 1-min Apgar scores that were four times more common among those with a failed TOLAC [18].

The ability to predict successful TOLAC is of great importance as maternal and neonatal morbidity is greater among those who fail TOLAC and require a repeat CD in labor. Our results indicated that failed TOLAC was associated with diabetes and hypertensive disorders, both of which were similarly identified as risk factors for failed TOLAC in other studies [4]. In our study, all parturients attempting TOLAC with multifetal gestation (4/4) failed. Due to our relatively small sample size and the fact that previous studies did not demonstrate an association between multifetal gestation and failed TOLAC, we believe that further studies are needed in order to better examine the association between the two [20]. Macrosomia was previously described as a predictor of a failed TOLAC [27, 28]. Nevertheless, in our study, rates of macrosomia were significantly higher among those attempting TOLAC while rates of macrosomia did not differ between those who achieved VBAC or failed TOLAC. Comparable to findings in a previous study, [29] our results raise the question of the role of macrosomia in failed TOLAC among those parturients who previously delivered vaginally. Further studies are needed in order to address this issue in groups of parturients attempting TOLAC with one previous VD.

This study holds several notable strengths: This is a large-scale population study comprising more than a third of the births in the area studied and 10% of all national births, therefore suitable for generalization. In addition, our database is validated at real time, which assists in eliminating potential information bias. All costs of antenatal care, birth, and postpartum care for mother and child are uniformly covered by the National Health Insurance for the entire study period. Moreover, all mother-child data included were from one hospital with no transfers to other facilities. Both factors alleviate a potential selection bias. Lastly, the adherence to our strict department protocol permitted us to examine the results of a designated, relatively low-risk group of patients. Despite imposing a strict study inclusion criterion, a fair number of parturients were found eligible and attempted a relatively safe TOLAC.

Our study is not without limitations. A possible limitation may be due to our retrospective design and its inherent fault. We were unable to identify and conduct a subgroup analysis of parturients who intended an elective repeat CD and presented in labor and hence underwent urgent surgery. Furthermore, our population has specific characteristics, particularly the motivation for large families. This may preclude in part the ability to generalize our study's results. However, we believe that most of the parturients who are interested in TOLAC following two previous CD share some characteristics in common, which may set a ground for potential partial

generalization. We also recognize that our data collection process did not provide information regarding potential risk factors associated with uterine rupture, such as prior uterine closure technique, the number of previous VBAC, and an unknown number of classical uterine scars in the elective repeat CD group. Nonetheless, we did attempt to control for most recognized factors and excluded all identified parturients who did not meet the ACOG criteria for TOLAC [30].

In conclusion, parturients with a history of two CD attempting TOLAC complying to a strict department protocol have overall comparable and favorable maternal and neonatal outcomes. Therefore, TOL is a reasonable alternative to an elective repeated third CD. Diabetes and hypertensive disorder are associated with failed TOLAC; obstetricians should be aware of these findings when providing consultation.

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Authors' Contribution R Rotem: Protocol development, data collection and management, data analysis, and manuscript writing/editing.

A Hirsch: Protocol development, data collection and management, data analysis, and manuscript writing/editing.

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M Rottenstreich: Protocol development, data collection and management, data analysis, and manuscript writing/editing.

Data Availability Not available

Compliance with Ethical Standards

The study was approved by the local institutional ethics committee in accordance with the principles of the Declaration of Helsinki (IRB: 001-20-SZMC).

Conflict of Interests The authors declare that they have no conflict of interest.

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