

# Predictors of Uterine Rupture After One Previous Cesarean Section: An Unmatched Case–Control Study

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**Background:** Uterine rupture is a rare occurrence but has catastrophic complications during pregnancy. The incidence is relatively higher in scarred uteri because there is a promotion of labor after cesarean section. There is a scarcity of evidence from low-income countries regarding the predictors of uterine rupture after trial labor.

**Objective:** To assess factors determining uterine rupture during labor after the previous cesarean section among mothers delivered at Hawassa University Comprehensive Specialized Hospital from September 2017 to September 2022.

**Methods:** A facility-based unmatched case–control study was done by reviewing 105 patients, which included 35 cases and 70 controls in a 1:2 case-to-control ratio. The association between dependent and independent variables was sought with running binary and multivariate analyses by using the cut point of a p value < 0.05 and 95% CI.

**Results:** The prevalence of uterine rupture is 1.6%. The factors significantly associated with uterine rupture after trial of labor are fetal weight >3.8 kg (AOR: 5.21), antenatal care 4 (AOR: 3.6), labor duration >15 hours (AOR: 10.7), and previous successful vaginal delivery (AOR: 3.4). Poor fetal-maternal outcomes like 91.4% fetal death, 29 hysterectomies, 22 blood transfusions, and 1 death.

**Conclusion:** The prevalence is relatively higher than in developed countries. The number of antenatal care, labor duration, and lower fetal weight are not common findings associated with uterine rupture after trial of labor across the literature, so large-scale studies are needed to develop guidelines for the Ethiopian setup. Improving the quality of obstetrics care given in each level of health system.

**Keywords:** TOL, uterine rupture, scar dehiscence, VBAC, Ethiopia

## Background

Uterine rupture is the pathologic separation of the whole layers of the uterus during pregnancy or labor.<sup>1,2</sup> Rupture of the uterus is a rare incident in an unscarred (0.035%) uterus.<sup>3</sup> In a scarred uterus, it is relatively higher (0.15–2.3%),<sup>4</sup> since the trend of a trial of labor (TOL) after a cesarean section has been progressively increasing in different countries.<sup>5</sup> There is a worldwide campaign to decrease the rate of repeat cesarean sections by strictly allowing selected women to undergo TOL. It has fewer complications, and the success of vaginal birth after cesarean section (VBAC) is around 60–70%; however, it is not without complications; rather, it has a higher chance of uterine rupture.<sup>6–11</sup>

Uterine rupture is a serious emergency obstetrics problem that can cost the lives of the mother and fetus and subsequently requires urgent laparotomy. Then, uterine repair or hysterectomy can be done, depending on the condition.<sup>1,3,4</sup> In addition, the risk of severe bleeding, major vessel involvement, visceral injuries, massive transfusions, and hysterectomies is higher than that of repeat cesarean sections.<sup>1,12,13</sup> According to a recent report, because of the fear of the complication of uterine rupture and maternal anxiety about having an emergency cesarean section. The number of

women who prefer TOL after a cesarean scar showed a progressive decline.<sup>14–16</sup> No matter how, the ACOG recommends giving the option to those mothers who have favorable conditions for VBAC.<sup>6,17</sup>

Multiple studies were done to assess the factors that predict the chance of uterine rupture and failure of TOL after VBAC. On the contrary, studies have identified the factors that determine the success of VBAC.<sup>1,4,5,8,18,19</sup> However, there is no universal agreement on predictors of uterine rupture, and no single factor has been used as a predictor.<sup>20</sup>

According to several pieces of evidence, including Ethiopian guidelines, pregnant ladies with one lower uterine segment cesarean section, no recurring indication, and no contraindication for vaginal delivery will be allowed for TOL.<sup>3,10,17,21,22</sup> However, the above recommendations are evidenced from studies in the developed world where the quality and practice of obstetric care is not similar to resource-limited countries.<sup>2</sup> There has not been any particular research that evaluates the risk factors for uterine rupture during TOL in resource-poor nations like Ethiopia. In low-resource countries like Ethiopia, there is a higher burden<sup>23</sup> of the problem, a severe shortage of expertise, blood products, and infrastructures to manage uterine ruptures and their complications; therefore, the implementation of strict criteria to allow or not allow TOL.<sup>2</sup>

On top of that, significant proportion of the population lives in rural areas and travels long distances to get emergency surgical and obstetric care.<sup>23</sup> Furthermore, TOL needs strict criteria to allow it and extensive monitoring of fetomaternal conditions that make the benefit of TOL uncertain in the low resource settings.<sup>24</sup> Evidence has shown that the risk can be reduced through the proper selection of candidates for TOL and strict intrapartum follow-up,<sup>17</sup> however, most of those pieces of evidence are from the developed world, which makes them difficult to generalize for low-resource settings.

This study assessed the predictors of uterine rupture after one previous cesarean scar in cases managed at one of the specialized hospitals in Ethiopia. No study in the country assessed the risk of uterine rupture in mothers with a previous single cesarean scar, so this will be an insight for further large-scale studies to develop the protocol about the Ethiopian setting.

## Methods

### Study Area and Study Design

Facility-based unmatched case control was conducted in specialized hospital in Sidama region, Ethiopia. Hawassa University comprehensive specialized hospital (HUCSH) is the only specialized hospital located in Sidama region and serving 12 million populations in the catchment areas. HUCSH is located 270 km south to Addis Ababa. It is also a teaching hospital currently giving postgraduate study on obstetrics and gynecology and undergraduate medical students.

### Study Participants

All mothers with previous cesarean section who gave birth either abdominally or vaginally were the source populations. Mothers who were diagnosed with scar dehiscence/rupture were considered as cases and mothers who had successful vaginal delivery after previous cesarean sections were controls. All mothers with uterine rupture/scar dehiscence were taken as cases by using the convenient sampling techniques then mothers who have vaginal delivery after cesarean section, preceding and succeeding the cases were taken as controls to make the proportion 1:2. The data were collected with reviewing charts, log books from operation theatre, nurse registration and delivery room registrations over the five years from September 1, 2017 to September 1, 2022.

### Exclusion Criteria

Case: All mothers who were managed for scar dehiscence in another hospital and referred to HUCSH for management of complications of scar dehiscence were excluded. Those mothers with incomplete data on the chart were also excluded (those with a lack of more than 20% of data). Those with lost charts were excluded. Those with medico-legal cases were excluded since difficult to retrieve charts.

Control: All mothers who gave birth after previous cesarean section in another hospital and were referred for management of obstetric complications will be excluded. Those with incomplete information and lost charts were also be excluded.

## Operation Definitions

Trial of labor: Trying vaginal delivery after previous one cesarean section.

Vaginal birth after cesarean section (VBAC): History vaginal delivery after cesarean delivery.

Antenatal care (ANC): the care of the woman during pregnancy. It aims to promote and protect the health of women and their unborn babies.

## Data Collection Tools and Procedure

The data extraction sheet was created utilizing prior research and the variables to be investigated after analyzing several studies, and it was then evaluated by taking 5% of the sample population at Adare General Hospital in Hawassa city. After double-checking the patient cards, delivery records, and operation theater register, the data were extracted. It consists of sociodemographic, pregnancy-associated, and labor and delivery-associated characteristics. Junior gynecology and obstetrics residents and trained medical interns both participated in the data collection. After data collection, the primary investigator verified the data extraction sheet's accuracy before beginning the analysis.

## Data Management and Analysis

Data were extracted, coded, and entered into the Epidata 3.1 program for cleaning before being exported to SPSS 20 for additional analysis and report writing. Simple frequencies, crosstabs, means, and standard deviation were used in the descriptive statistical analyses to summarize participant sociodemographic data, pregnancy-related variables, and labor and delivery-related features. We investigated the association between scar dehiscence and the independent variables using binary logistic regression with 95% CI. In order to strengthen the findings even further, the variables with bivariate p values less than 0.25 were taken into account in multivariate analyses. The variables will then be deemed to have a statistically significant association with scar dehiscence in multivariate studies if their p-value is less than 0.05. The Nagelkerke R Square and Hosmer and Lemeshow goodness of fit, which were 0.64 and 0.58, respectively, were used to measure the model's fitness. The variance inflation factor (VIF >10) was used to test for multicollinearity between the explanatory variables.

## Results

### Sociodemographic and Pregnancy Related Factors

The study period was from September 2017 to September 2022, and during this time, there were a total of 22,586 deliveries. Among all deliveries, 2100 mothers had previous cesarean sections, and 35 cases of uterine rupture occurred among those with previous cesarean scars. The prevalence of uterine rupture after trial labor was 1.6%. A total of 105 charts were reviewed (35 cases and 70 controls), which makes the response rate 100%. The median age of mothers was 28.54 (4.24) and 28.01 (4.81) for cases and controls, respectively. More than half of cases were from rural areas (51.4%), while only 20% of controls were from rural areas. Two-thirds of controls had ANC follow-ups of more than four; on the contrary, the same proportion of cases had fewer than four ANC visits. When we compare both groups with respect to gravity, 17.1% of cases and 1.4% of controls had more than 5. The majority of mothers in both groups had optimal intervals after previous cesarean scars (Table 1).

### Intrapartum Characteristics of the Mothers

All mothers had spontaneous onset of the labor, and majority of mothers in both groups (91.4% of cases and 71.4% of controls) had no partograph follow-ups. Successful vaginal delivery after cesarean section was reported in 14.3% of cases and 86.1% of controls. Additionally, a large number of macrosomia (40%) reported in cases and 8.6% reported in controls. Of all the rupture cases, 42.9% and 34.3% happened during latent phase of labor and second stage of labor, respectively. There are 8.6% of mothers from cases suffered referral from three and more institutions but no one in controls (Table 2).

### Perioperative Characteristics of Mothers with Uterine Rupture

Upon arrival to the institution, 28.6% of cases had shock. All fetuses were alive in controls, and almost all fetuses in cases were dead except there are 3 fetuses with poor APGAR in cases. There are maternal complications like anemia (22

**Table 1** Sociodemographic and Pregnancy Related Factors

Variables	Responses	Case (35)	Control (70)	P value
		Frequency (%)	Frequency (%)	
Age(years)	<35	29 (82.9)	61 (87.1)	12.958 (0.554)
	≥ 35	6 (17.1)	9 (12.9)	
	Mean (SD)	28.54 (±4.24)	28.01 (±4.81)	
Residency	Urban	17 (48.6)	56 (80)	10.22 (0.001)
	Rural	18 (51.4)	14 (20)	
Educational status	No formal education	12 (34.3)	1 (1.4)	23.3 (0.001)
	Formal education	23 (65.7)	69 (98.6)	
Address	Hawassa city	3 (8.6)	22 (31.4)	0.823 (0.491)
	SNNPR	14 (40)	9 (12.9)	
	Oromia Region	18 (51.4)	39 (55.7)	
Number of ANC visit	Less than 4	23 (65.7)	27 (38.6)	33.373 (0.00)
	Four and above	12 (34.3)	43 (61.4)	
Gravidity	Parity 1–4	29 (82.9)	69 (98.6)	9.2 (0.002)
	Parity ≥5	6 (17.1)	1 (1.4)	
Gestational age	<37 week	1 (33)	2 (2.8)	3.13 (0.73)
	≥ 37 week	34 (33)	68 (97.2)	
Duration since the last uterine scar	< 18 months	0	4 (5.7)	7.47 (0.025)
	19–59 months	22 (62.8)	55 (78.6)	
	>60 months	13 (37.2)	11 (15.7)	
Congenital anomalies	No	35 (100)	70 (100)	
Other medical/obstetric conditions	Yes	1 (2.9)	9 (12.9)	2.7 (0.159)
	NO	34 (97.1)	61 (87.1)	

cases), bladder rupture (3 cases), uterine artery involvement (4 cases) and maternal death (1 cases). Majority (65.6%) and 14.3% of cases were managed with total abdominal hysterectomy and uterine repair (Table 3).

## Factors Associated with Scar Dehiscence

Factors like residency, number of ANC visits, fetal weight, duration of labor, maternal education, TOLAC, gravidity and duration since last delivery had p value less than 0.25 in bivariate analysis but only number of ANC visits, fetal weight, duration of labor and previous vaginal delivery were factors with statistically significant association with uterine rupture after previous cesarean scar p value less than 0.05 in multivariate analysis (Table 4).

## Discussion

The study revealed that fetal weight greater than 3.8 kg, labor duration, number of ANC follow-up and previous vaginal delivery are factors associated with uterine rupture after one previous cesarean section.

**Table 2** Intrapartum Characteristics of the Mothers

Variable	Response	Case (35)	Control (70)	X <sup>2</sup> (P value)
		Frequency (%)	Frequency (%)	
Onset of labor	Spontaneous	35 (100)	70 (100)	
Use of partograph	Yes	3 (8.6)	20 (28.6)	362 (0.45)
	No	32 (91.4)	48 (71.4)	
Obstructed labor	Yes	4 (11.4)	NA	1.2 (0.372)
	No	31 (88.6)	70 (100)	
Trial of instrumental delivery	Yes	1 (2.9)	0	2.1 (0.389)
	No	34 (97.1)	70 (100)	
TOLAC	No	32 (91.4)	60 (85.7)	9.33 (0.77)
	Yes	3 (8.6)	10 (14.3)	
Previous vaginal delivery	Yes	11 (31.4)	49 (70)	14.8 (0.01)
	No	24 (68.6)	21 (30)	
Diagnosis of rupture	Latent phase of labor	15 (42.9)	N/A	
	Active phase of labor	7 (20)	N/A	
	Second stage of labor	12 (34.3)	N/A	
	Postpartum	1 (2.9)	N/A	
SVD	Yes	No	Yes	
Laparotomy delivery	Yes	Yes	No	
Fetal weight	≤3800	14 (41.2)	49 (70)	7.6 (0.003)
	≥3801	20 (58.8)	21 (30)	
Type of referring institution	None (from Home)	0	23 (32.9)	35.9 (0.001)
	Health center	7 (20)	27 (38.6)	
	Primary Hospital	10 (28.6)	15 (21.4)	
	General Hospital	11 (31.4)	2 (2.9)	
	Referral Hospital	7 (20)	3 (4.3)	
Number of health facilities before arrival at HUCSH	None (from Home)	0	25 (35.7)	54.4 (0.002)
	One	5 (14.3)	37 (52.9)	
	Two	27 (77.1)	8 (11.4)	
	Three and above	3 (8.6)	0	
The duration between admission and surgery (in hours)	Median	1	N/A	
	Range	1–3 hour	N/A	
Duration of hospital stay(days)	Median (days)	3	2.19 (±2.3)	
	Range (days)	1–15	1–5	

**Table 3** The Maternal Perioperative Clinical Condition

Variable	Response	Case (35)	Control (70)	X <sup>2</sup> (p value)
		Frequency (%)	Frequency (%)	
Maternal condition on admission	Stable (normal BP)	25 (71.4)	70 (100)	22.9 (0.001)
	Shock	10 (28.6)	0	
Weight of the baby (in grams)	Mean (±SD)	3523.5 (±551)	3252.9 (666.8)	108.59 (0.001)
Status of the baby at birth	Alive with a good APGAR score	0	70 (100)	500.223 (0.001)
	Alive with a low APGAR score	3 (8.6)	0	
	Dead	32 (91.4)	0	
Condition of the mother on discharge	Alive	34 (97.1)	70 (100)	22.424 (0.001)
	Dead	1 (2.9)	0	
Type of uterine rupture	LUST (lower uterine segment transverse cesarean section)	31 (88.5)	NA	
	LUS vertical	3 (8.6)	NA	
	Died before surgery	1 (2.9)	NA	
Intra-operative complication	Bladder rupture	3 (8.6)	NA	
	Uterine artery involvement	4 (11.4)	NA	
Management	Repair	5 (14.3)	NA	
	TAH (total abdominal hysterectomy)	23 (65.6)	NA	
	STH (subtotal hysterectomy)	3 (8.6)	NA	
	TAH and bladder repair	3 (8.6)	NA	
	Died before surgery	1 (2.9)	NA	
Post OP complication	Anemia that requires transfusion	22 (62.8)	NA	

The prevalence of uterine rupture following TOL is 1.6%, which is greater than data from wealthy nations<sup>4,13,25,26</sup> but comparable to African research.<sup>27</sup> It is less than the report from the Norwegian population register.<sup>7</sup> The primary cause of the disparity is the high standard of obstetric care in the developed countries.<sup>23</sup> The trend of employing uterotonics for augmentation during TOL is likely attributable to the higher incidence in the Norwegian research. The number and kind of uterine scars included are not specified in the Norwegian population registration statistics. However, in Ethiopian practice, TOL is only permitted for a single lower uterine transverse scar from a prior cesarean delivery, and the use of uterotonics is not recommended.

In this study, the risk of uterine rupture increased as fetal weight increased and became significant after 3800 g. Having a fetal weight above 3800 g has more than twice the risk than the counterpart, which is in line with other studies, but in this study, the cut point is lower.<sup>7,8,15,28</sup> The difference in cut point can be attributed to sociodemographic disparities. There is no agreement<sup>20</sup> across the studies to consider fetal weight as a predictor for uterine rupture after TOL. Although the cut point identified in this study is 3800 g, the Ethiopian guidelines allow TOL up to a fetal weight of 4000 gm. But the above recommendation is not based on evidence from national studies. And as per the knowledge of the author, this study is probably the first one, so a large-scale study about the Ethiopian setting is mandatory.

**Table 4** Factors Associated with Cesarean Scar Dehiscence

Variables	Response	COR (95% CI)	AOR (95% CI)	P-value
Residency	Urban	1	1	0.7
	Rural	11.47(7.6–17.3)	1.95(0.9 5–4)	
Age (years)	<35	1	1	0.36
	≥35	2.26(1.44–3.54)	0.63(0.23–1.87)	
Number of ANC	<4	3.5(1.32–7.26)	3.6(1.05–12.54)	<b>0.03</b>
	≥4	1	1	
Previous vaginal delivery	Yes	1	1	<b>0.02</b>
	No	2.1(1.92–3.43)	3.4(2.45–5.01)	
Gravidity	1–4	1	1	0.22
	≥5	17.26(1.72–12.44)	4.7(1.48–23.3)	
TOLAC	Yes	1	1	0.33
	No	4.76(1.62–12.87)	3.52(0.18–20.3)	
Maternal education	No formal education	36.35(4.69–200.19)	9.9(1.19 –108.5)	0.071
	Formal education	1	1	
Fetal weight	<3800	1	1	<b>0.0001</b>
	≥3801	6.6(2.26–20.32)	5.21(1.14–23.8)	
Duration since the last uterine scar	19–59 months	1	1	0.09
	Short and long intervals	2.95(1.13–7.08)	3.97(1.05–14.96)	
Duration of labor	<15 hrs.	1	1	<b>0.001</b>
	≥ 15 hrs.	10.43(2.12–51.4)	10.7(1.3–88.4)	

**Note:** Bold font indicates strong association.

Accordingly, mothers having ANC follow-up less than 4 are likely to have uterine rupture than those with more than 4. The impact of ANC in improving maternal and neonatal outcome has been identified by different institutions. According to maternal health survey, ANC follow-up less above 4 has significant positive impact in improving fetomaternal outcome, but sadly the report from EDHS says only 43% of mothers had ANC more than 4 visits.<sup>29,30</sup> Antenatal care follow-up gives an opportunity for the health provider to screen those individuals for favorable factors through assessment of pelvic adequacy, checking for malpresentation and fetal weight estimation. Moreover, it will be an ideal period to counsel about the pros and cons of TOL.<sup>18,31,32</sup>

Accordingly, mothers having ANC follow-up of less than 4 are more likely to have uterine rupture than those with more than 4. The ANC follow-up has a positive impact on improving maternal and neonatal outcomes. According to a maternal health survey, ANC follow-up of less than four has negatively associated with fetomaternal outcomes. But sadly, the report from EDHS says only 43% of mothers had ANC more than four visits.<sup>29,30</sup> Antenatal care follow-up allows the health provider to screen those individuals for favorable factors by assessing pelvic adequacy, checking for malpresentation, and fetal weight estimation. Moreover, it will be an ideal period to counsel about the pros and cons of TOL.<sup>18,31,32</sup>

Not surprisingly, more than 85% of cases visited more than two health institutions before arriving at the managing institution, which is the common trend in the country, and around 48% of cases were referred from primary health



institutions. Primary, secondary, and tertiary-level healthcare facilities make up Ethiopia's healthcare system.<sup>33</sup> Since they serve the majority of populations, primary healthcare institutions including health posts, health centers, and primary hospitals are those that bear the brunt of the burden.<sup>34</sup> The primary healthcare facilities must, however, refer cases to the next level in the referral system due to a severe lack of personnel and resources, such as materials for procedures, blood, and blood products.<sup>35</sup> This referral from one institution to another will unnecessarily prolong the labor and delay the management. On top of that, Ethiopia is one low income some Saharan country where majority of the population is living in the rural area with shortage of road access and transportation which further aggravates the situation. Prolonged labor is an established risk factor for rupture of even unscarred uterus.<sup>18</sup> This study demonstrated that if labor lasts longer than 15 hours, there is a higher risk of rupture. Furthermore, almost all (91.4%) of cases had no intrapartum partograph follow-up which has significant benefit on identifying labor abnormalities during the intrapartum follow-up.<sup>36</sup> Interventions are delayed due to the aforementioned and other complex sociocultural and infrastructure-related causes, which ultimately raises the risk of rupture in scared uteruses earlier than non-scared uteruses. The clinical outcome of the cases in this study shows that there is a significant delay in intervention, which leads to poor maternal and neonatal outcomes (only 5 cases were managed with uterine repair, 29 cases had hysterectomy, and 1 death) and poor neonatal outcomes (91.4% of fetuses were dead and only 3 had low Apgar scores).

As it was already established, the health system in Ethiopia is weak and convoluted; there is inadequate infrastructure development, a considerable lack of blood and blood products, human resources, and an operation setup. As a result, precise criteria are required to choose the candidates for TOL, which calls for a large-scale prospective study in Ethiopia rather than applying evidence from Western studies. The study's strength is that it brought up significant issues that have not been thoroughly investigated in the Ethiopian context and added new elements correlated with TOL, such as labor duration and institution-related characteristics. However, it is a retrospective study from a single institution, which is a limitation.

## Conclusion

The prevalence is relatively higher than the Western setups. A fetal weight greater than 3.8kg, ANC follow-up below four, and labor duration greater than 15 hours are positively associated with uterine rupture after a previous cesarean section, but having past vaginal delivery is negatively associated with it. Therefore, it is mandatory to develop stringent guidelines to select the candidate for TOL considering the Ethiopian health setting, such as the referral system, infrastructure, and intrapartum obstetric care. Poor fetal-maternal outcomes necessitate substantial improvement in the quality of obstetric care, starting with prenatal counseling, antenatal care, intrapartum care, and postpartum care in the Ethiopian health system, specifically primary health institutions.

## Data Sharing Statement

All data needed is included in the manuscript.

## Ethical Clearance and Consent

Ethical clearance was obtained from the Institutional Review Board (IRB) of the College of Medicine and Health Sciences, Hawassa University, Ethiopia, with ethical clearance letter no. RPGe/76/2022. We were waived by the Ethical Review Board of Hawassa University from receiving informed written consent for data collection because of the retrospective nature of the study design. Patients' names or other personal information were not used in data collection or analysis. All methods were performed in compliance with the declaration of Helsinki.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.



## Funding

The authors received no specific funding for this work.

## Disclosure

The authors declare that they have no competing interests.

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