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Maternal and Fetal Risks in Higher Multiple Cesarean Deliveries

Constantin Zwergel and Constantin S. von Kaisenberg

Abstract

The professionalization of women has shifted family planning to increased maternal ages. This has increased the use of assisted reproduction. Therefore, the tolerance toward suboptimal outcome of pregnancy decreases, and self-determined decision-making is on the rise. Once women have made the decision for elective cesarean section in their first pregnancy, subsequent pregnancies may result in multiple cesarean deliveries. This chapter analyzes the risks associated with higher multiple cesarean deliveries, such as bleeding and transfusion, adhesions, bowel and urinary tract injury, and uterus rupture. It also discussed the risks for vaginal birth following cesarean (VBAC) following multiple cesareans. Also there are neonatal risks involved, and women may require specific obstetric anesthesia. The chapter will analyze the risks for the offspring and the mother depending on the number of previous cesarean sections. This may enable detailed counseling of parents before a higher multiple repeat cesarean section is performed.

Keywords: multiple repeat cesarean section, maternal risks, fetal complications, morbidity, outcome

1. Introduction

Cesarean section is a surgical technique of delivery that frequently saves the life of both the mother and the baby. Although many women especially in the Western world have only one or two children, there are many countries and communities in which the availability of effective contraception is limited and larger families are common. The recent World Health Organization (WHO) data on the frequency of cesarean section show that cesarean section has increased dramatically throughout the world in the past two decades [1]. This rise is independent of the stage of development of a country. In addition, the increase in cesarean section rates shows no signs of slowing down. There are at least two significant reasons for this increase, although the phenomenon has not been yet fully understood: the increasing rate in primary cesarean sections and the rapidly decreasing rate of vaginal birth after cesarean section (VBAC) [2]. An increasing rate of cesarean sections results inevitably in a rise of multiple repeat cesarean deliveries.

It is known that multiple cesarean sections are associated with short- and long-term risks for both the mother and the baby [3–7]. There are several significant maternal complications such as visceral injury, uterine rupture, abnormal placentation, hysterectomy, bleeding and transfusions, severe adhesions, etc., most of which increase with an increasing number of repeated cesarean sections. There are also neonatal risks: babies born via multiple repeat cesarean section are more likely to experience breathing difficulties and to require admission to neonatal intensive care [4, 5, 8, 9].

Although cesarean section is now safer than it has ever been before, there are some knowledge gaps, and there is uncertainty among many obstetricians about the risks involved in multiple cesarean sections, especially when the number exceeds four. Thus, we would like to summarize the results of the most important studies investigating maternal and fetal risks in multiple repeat cesarean sections enabling and facilitating the counseling of parents and the decision-making for delivery.

2. Data collection

We did a systematic literature review of PubMed and the Cochrane Database. Search terms used were multiple cesarean section, repeat cesarean delivery, maternal morbidity, neonatal morbidity, maternal and fetal outcome of multiple cesarean section, bladder injury, uterine scar rupture, placenta increta/percreta, hysterectomy, hemorrhage and transfusion, adhesions after repeat cesarean section, vaginal birth after cesarean section, VBAC after cesarean section, and timing of repeat cesarean delivery.

Prior to beginning the search, we defined inclusion and exclusion criteria. Inclusion criteria were randomized controlled trials, cohort studies, case-control studies, systematic reviews, meta-analysis, and the above search terms. Exclusion criteria were comments, letters to the editor, personal communications, and case reports.

The authors selected the articles first through focused review of the abstracts. Eligible studies underwent full text review. We identified a total of 2190 studies of which 1999 were excluded for not meeting either the inclusion criteria or exclusion criteria or for not answering the research question.

A total of 38 studies and 2 Cochrane systematic reviews ranging from 2005 to 2018 were included in the final analysis. All manuscripts were retrieved in electronic PDF format and analyzed in detail.

The references of the most important studies were again checked for eligibility as part of the search strategy. Data from the randomized controlled retrospective trials and Cochrane systematic reviews were extracted by topic, and data were grouped and reanalyzed.

Thus, the result of this chapter is a review of the safety and risks associated with multiple repeat cesarean section for both the mother and the baby. This can be helpful for the counseling of parents and the decision-making of the mode of delivery.

3. Maternal risks

The results of the most important maternal risks of multiple repeat cesarean sections are summarized (**Table 1**). In total eight studies were eligible and were included in this review. Furthermore, each one of the risks is discussed in detail.

The results of **Table 1** demonstrate that the frequency of bowel and bladder injury is about 0.1% with up to three previous cesarean sections and just under 1% thereafter [3–7]. Uterine rupture is <1% up to two cesarean sections but increases thereafter to about 4%. Blood transfusions are common and required in up to 5%. Intensive care does not increase substantially and is less than 2% (and may also be due to underlying diseases). Hysterectomy and placenta accreta are less than 1% for up to three cesarean sections but 2.5–3% in more than four. Severe adhesions are already common in more than one cesarean section.

Maternal risks of multiple repeat cesarean section				
	First CS	Second CS	Third CS	≥4 CS
Bladder injury	0.09% n = 6/6616 [5, 8, 10, 11]	0.06% n = 10/17,378 [3, 5, 8, 10, 11]	0.23% n = 17/7201 [3, 5, 8, 10, 11]	0.81% n = 20/2461 [3, 5, 8, 10, 11]
Bowel injury	0.13% n = 6/6616 [5, 8, 10, 11]	0.09% n = 10/17,378 [3, 5, 8, 10, 11]	0.18% n = 17/7201 [3, 5, 8, 10, 11]	0.85% n = 20/2461 [3, 5, 8, 10, 11]
Uterus rupture	0.43% n = 126/28,810 [8, 12]	0.61% n = 52/8542 [3, 8, 12]	3.71% n = 29/782 [3, 8]	4.34% n = 41/945 [3, 4, 8, 13]
Blood transfusion	4.05% n = 261/6443 [5, 10, 11]	1.58% n = 273/17,280 [3, 5, 10, 11]	2.23% n = 157/7050 [3, 5, 10, 11]	5.35% n = 142/2652 [3, 5, 10, 11, 13, 14]
ICU admission	1.99% n = 127/6374 [3, 8, 10, 11]	0.59% n = 104/17,388 [3, 8, 10, 11]	0.63% n = 45/7106 [3, 8, 10, 11]	1.95% n = 47/2408 [3, 8, 10, 11]
Cesarean hysterectomy	0.69% n = 44/6374 [3, 8, 10, 11]	0.43% n = 75/17,378 [3, 8, 10, 11]	0.91% n = 65/7106 [3, 8, 10, 11]	2.49% n = 66/2652 [3, 8, 10, 11, 13]
Placenta accreta	0.56% n = 46/6374 [8, 10, 11]	0.36% n = 63/17,438 [3, 8, 10, 11]	0.67% n = 48/7106 [3, 8, 10, 11]	2.57% n = 62/2408 [3, 8, 10, 11]
Placenta previa	6.41% n = 398/6201 [10, 11]	1.35% n = 231/17,170 [3, 10, 11]	1.22% n = 85/6955 [3, 10, 11]	2.87% n = 72/2510 [3, 10, 11, 13]
Severe adhesions	0.83% n = 2/242 [5]	7.27% n = 8/110 [5]	20.00% n = 19/95 [5]	15.15% n = 45/297 [5, 13]

Table 1.
 Maternal risks associated with an increasing number of repeated cesarean sections.

3.1 Urological and intestinal injury

The results of **Table 1** demonstrate a slightly increased rate of injury of other intraabdominal organs with increased number of repeat cesarean section. Most of the relevant studies identified a significant difference in both bladder and bowel injuries between lower and higher order elective repeat cesarean section [3–7]. Particularly after more than three prior cesarean sections, the risk of any injury rises substantially [15]. This common finding is probably due to the higher rate of severe adhesions after higher order multiple repeat cesarean section. A frozen situs with multiple severe adhesions needs longer operation time and good surgery skills resulting in higher risks of any injury [16]. Overall a bladder or bowel injury is a quite rare complication in women with multiple repeat cesarean sections.

3.2 Uterine scar rupture

Uterine dehiscence or scar rupture is one of the most feared risks in women with multiple repeat cesarean sections. As expected from the usual clinical experience, the dates of **Table 1** show an increased rate of uterine rupture with rising number of repeat cesarean section, again especially in the group of higher order cesarean section (more than three). Surprisingly in reality, most of the analyzed studies confirm

this trend but also report that multiple prior cesarean deliveries were not significantly associated with an increased risk for uterine rupture [3, 16, 17]. Between the different studies, the definition and counting of incomplete or complete uterine dehiscence, small membranous uterine scar, and real uterine rupture are heterogeneous. Also a uterine rupture can sometimes not be clearly detected. In conclusion, uterine rupture is apparently an existing risk but does not seem to be critical and significant for up to two previous cesarean sections.

3.3 Hemorrhage

The topic hemorrhage includes different maternal characteristics such as total hemoglobin decrease, blood loss >1500 ml, any blood transfusion, or massive blood transfusion (more than 4 units). Therefore there is inconsistency on the investigated characteristics depending on the definitions used.

The results of the trials show (**Table 1**) that the quantity of any blood transfusion and also the rate of ICU admission are higher in the first cesarean section on the one side and in the higher order repeat cesarean section (≥ 4) on the other side than the number of transfusion in the second and third cesarean sections [3, 5, 10, 11, 13, 14]. The increased number of blood transfusions and lengthened intensive care hospitalization following the first cesarean section may be explained by the fact that in this cohort, emergency deliveries and more unexpected situations are included, compared with the cohort of the elective second or third cesarean sections.

Some of the analyzed studies pointed out that there is a significant higher rate of blood loss or any blood transfusion especially in the group of more than three repeat cesarean sections [3, 7, 13, 15, 18]. This may be due to a higher rate of adhesions, visceral injury, and possibly abnormal placentation (see also 3.4.). There are a few trials where no differences in blood transfusions between the cohorts could be found [6, 16].

3.4 Abnormal placental invasion and hysterectomy

Abnormal placental invasion included several characteristics: placenta accreta, increta or percreta, and placenta previa. Placenta accreta is a severe obstetric complication characterized by abnormally deep attachment of the placenta. Placenta increta or percreta describes the more invasive placental attachment to the uterine wall, whereas placenta previa locks the natural birth canal. These placental variations can lead to cesarean hysterectomy and/or a life-threatening maternal hemorrhage.

Like with the other maternal risks, a higher order repeat cesarean section (more than three) means a significant higher rate of placenta praevia, placenta accreta, and hysterectomy (**Table 1**) [3, 8, 10, 11].

Placenta accreta is probably the most clinically significant maternal morbidity subsequent to cesarean delivery because of the association with life-threatening hemorrhage that frequently results in peripartum hysterectomy, cystectomy, and also iatrogenic preterm birth [10, 19–21]. The increase of the incidence of placenta accreta seems to be directly related to the increasing number of multiple cesarean deliveries and is therefore associated with maternal and perinatal morbidities [7, 10, 11].

The incidence of placenta previa also rises together with increased number of cesarean section [3, 8, 10, 11, 22]. Another study pointed out that the rate of placenta previa increased from nearly 1% with one previous cesarean section to about 2.8% with more than three cesarean deliveries [7]. Our results demonstrate (**Table 1**) that even a single prior cesarean delivery can increase the risk for placenta previa [23].

It is also interesting that compared with women with placenta previa and no previous cesarean section, women with placenta previa and more than three cesarean deliveries had a statistically significant increased risk of accreta (3.3–4% vs. 50–67%), hysterectomy (0.7–4% vs. 50–67%), and composite maternal morbidity (15% vs. 83%) [7].

As explained above, placenta previa and placenta accreta were found to be one of the most important risk factors in terms of the need for hysterectomy [19]. Therefore, the rate of hysterectomy after multiple repeat cesarean section rises parallel to the rate of placenta previa and accreta [3, 8, 10, 11, 13].

Altogether the results suggest that abnormal placentation is one of the most significant factors by analyzing the adverse maternal outcome after multiple cesarean section.

3.5 Long-term complications

Long-term complications are essentially due to the risk of severe adhesions after multiple cesarean sections (**Figure 1**). Adhesions can be the consequence of nearly every operation and can represent a serious problem for the delivery of women with multiple repeat cesarean sections.

The results of **Table 1** show that severe adhesions increased parallel to the number of performed repeat cesarean section [10, 24–26]. Especially the rise of the adhesions' rate after more than three cesarean sections is dramatical. Both the incidence and severity of adhesions have been demonstrated to increase with increasing numbers of cesarean deliveries. Adhesions have been also associated with increased operative time, increased blood loss, and increased risk of visceral injury.

Altogether, the rate of severe adhesions after multiple repeat cesarean section is one of the most important keys for maternal outcome after multiple repeat cesarean section.

In summary of the maternal outcome, the risk of some rare but serious maternal morbidities such as visceral injury, hemorrhage, abnormal placentation, hysterectomy, or severe adhesions is importantly increased with the number of multiple repeat cesarean section. There is no clear absolute threshold for the number of cesarean sections, but a total of four or more cesarean deliveries was identified as the critical level for most of the major complications.

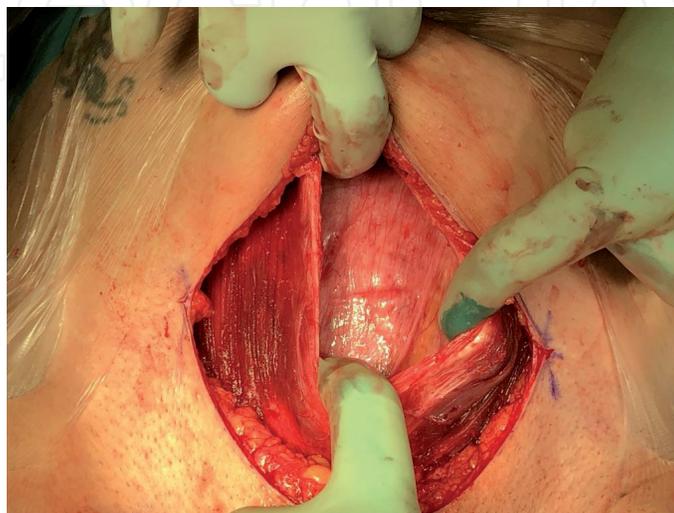


Figure 1.
The Omentum majus is adherent to the anterior uterine wall in a women with three prior cesarean sections (with permission).

4. Fetal risks

Multiple cesarean section may have consequences not only for the maternal but also for the neonatal outcome. Unfortunately, most of the analyzed studies about the risks of multiple cesarean sections place the focus on the mother. Data about the fetal outcome depending on an increased number of cesarean sections are limited. **Table 2** shows an overview for some results of fetal risks in multiple repeat cesarean sections.

There are only 4 studies with a total of 2895 babies that could be looked at [4, 5, 8, 9]. Altogether, there are no significant differences in adverse Apgar score, neonatal intensive care admission, and complications in the neonatal outcome between the groups of lower and higher order repeated cesarean sections. It seems that the neonatal outcome is related to the number of repeat cesarean sections; only some nonsignificant trends were found for adverse fetal outcome. Furthermore, there was no difference in the rate of perinatal death in women with prior cesarean section versus vaginal delivery [27]. More detailed results of neonatal characteristics such as asphyxia, pH-values, fetal defects, and short- and long-term neurological outcome investigating the association with the numbers of repeat cesarean sections could not be found.

There are some studies describing that previous cesarean delivery is associated with an increased risk of preterm birth and small-for-gestational-age fetuses relative to women with no previous cesarean [28, 29]. One trial pointed out that neonates of mothers having multiple repeat cesarean sections were significantly more likely to be born prior to 37 weeks of gestation and therefore had higher rates of complications and admissions, especially adverse respiratory outcome (see also 7) [4]. This aspect may be based on a higher risk potential of women with multiple prior cesarean section (e.g., higher mean maternal age, gravidity, and parity of women who had more than one prior cesarean [5]) and therefore the clinical decision for a preterm elective repeat cesarean section. Preterm birth and fetal growth restriction may also be due to an increased risk of abnormal placentation and uteroplacental dysfunction in association with a prior cesarean section [28].

In conclusion, the results suggest that adverse neonatal outcome depends more on the mode and the timing of delivery than on the number of repeat cesarean section.

Fetal risks of multiple repeat cesarean section				
	First CS	Second CS	Third CS	≥4 CS
Admission to NICU*	13.97% n = 58/415 [5, 8]	20.31% n = 588/2895 [5, 8, 9]	17.70% n = 154/870 [5, 8, 9]	15.81% n = 68/430 [4, 5, 8, 9]
5-min Apgar < 5	9.39% n = 39/415 [5, 8]	2.11% n = 61/2895 [5, 8, 9]	2.18% n = 19/870 [5, 8, 9]	4.49% n = 15/334 [5, 8, 9]
Complications** in fetal outcome	n.k.	21.24% n = 816/3841 [5, 8, 10, 11]	23.07% n = 218/945 [3, 5, 8, 10, 11]	19.56% n = 62/317 [3, 5, 8, 10, 11]

* Neonatal intensive care unit.

** Intraventricular hemorrhage, severe jaundice, severe infection, hypoxic ischemic encephalopathy.

Table 2.
Fetal risks associated with an increasing number of repeated cesarean section.

5. Risks in higher order multiple cesarean sections

Cesarean deliveries by women with more than four prior cesarean sections are very rare and are exceptional cases. Usually the third or fourth cesarean section is combined with tubal ligation. However, in some countries or religious groups with large families and by self-determined decision-making, very high order repeat cesarean deliveries can be observed, in particular if contraception is not desired. Therefore it is critical to know how dangerous it is to perform more than four repeat cesarean sections.

There are not many studies describing women undergoing five or higher multiple cesarean sections. One study with 940 cases demonstrated an increase of the risks of all major complications, and dense adhesions were commonly noticed at cesarean delivery, but only eight women had more than four multiple cesarean deliveries [24]. Another study with a total of 318 women investigated especially the risks of higher order (5–9) repeat cesarean sections and identified no difference in maternal and fetal risks between the group of lower (<4) and higher (>4) repeat cesarean section except for an extended operation time and an increased rate of severe adhesions [16].

As shown in Chapter 4 (maternal risks), multiple cesarean deliveries are in general associated with more adhesions and increased blood loss than only one planned cesarean section. It can therefore be concluded that the surgery and management of higher order (>4) repeat cesarean sections are more difficult and require more planning and operation time and skills. One study with a total of 5007 women pointed out that vertical skin incision in these cases is not associated with improved maternal and fetal outcome [9]. Furthermore, the results of another study suggest that the risks of an urgent multiple cesarean section are in the range of elective multiple cesarean section [6, 18]. There were, however, differences for myometrium herniation during this cesarean section, a need for drainage following surgery, and postoperative fever as well as hospitalization (days), which was held due to the urgency.

6. VBAC and the number of repeat cesarean section

Clinical decision-making for women following multiple prior cesarean deliveries is influenced by limited evidence and the expectations of the mother. Vaginal birth after multiple cesarean deliveries can be an option if women are eligible. In order to provide the currently best available evidence, we extracted and regrouped information from four trials (**Table 3**).

A meta-analysis of 20 studies compared the success rate—and the associated adverse maternal and fetal outcomes of vaginal birth—after one and two cesarean sections (VBAC-1/VBAC-2) with a further repeat multiple cesarean section [30]. Women requesting a trial of labor following two cesarean sections should be informed of a success rate for vaginal delivery of 71.7%, a uterine rupture rate of 1.36%, and of a similar maternal morbidity in both groups. Maternal morbidity of VBAC-2 is comparable to that of multiple cesarean sections. The neonatal morbidity data were too limited to draw valid conclusions [30].

Another trial pointed out that women with three or more prior cesareans who attempt VBAC have similar success rates and maternal morbidity as those with only one prior cesarean, as well as those delivered by elective repeat cesarean [31].

There are also two systematic Cochrane reviews showing no statistically significant differences between a planned repeat cesarean birth and a planned vaginal birth after a cesarean section [32, 33].

Delivery	VBAC successes	Uterine rupture	Hysterectomy	Transfusion
VBAC 1	76.50% n = 38,814/50,685 [30]	0.72% n = 372/50,685 [30]	0.19% n = 42/50,685 [30]	1.21% n = 358/50,685 [30]
Second CS	–	0.61% n = 52/8542 [3, 8, 12]	0.43% n = 75/17,378 [3, 8, 10, 11]	1.58% n = 273/17,280 [3, 5, 10, 11]
VBAC 2	71.70% n = 4064/5666 [30]	1.36% n = 74/5421 [30]	0.56% n = 14/2512 [30]	2.01% n = 39/5666 [30]
Third CS	–	3.71% n = 29/782 [3, 8]	0.91% n = 65/7106 [3, 8, 10, 11]	2.23% n = 157/7050 [3, 5, 10, 11]
VBAC > 2	79.77% n = 71/89 [31]	0.00% n = 0/89 [31]	n.k.	2.20% n = 2/89 [31]
≥4 CS	–	4.34% n = 41/945 [3, 4, 8, 13]	2.49% n = 66/2652 [3, 8, 10, 11, 13]	5.35% n = 142/2652 [3, 5, 10, 11, 13, 14]

VBAC1/VBAC2 = vaginal birth after one/two cesarean sections; CS = cesarean section

Table 3.

Maternal outcome of vaginal birth following multiple cesarean section for VBAC versus a setting of increasing higher multiple repeat cesarean sections.

In conclusion, there was no difference in the maternal morbidity of women with multiple prior cesareans for the mode of delivery in these studies. A history of multiple cesarean deliveries is not associated with an increased rate of uterine rupture in women attempting vaginal birth compared with those with a single prior operation (**Table 3**). However, when looking at uterine rupture alone, the risks increase with each cesarean section (>2 CS: 3.71% and >3 CS: 4.34%).

In conclusion, vaginal birth after multiple cesarean deliveries remains an option for eligible women.

7. Timing of elective repeat cesarean section

In clinical practice obstetricians have to decide when best to perform an elective repeat cesarean delivery. For the decision-making, it is interesting to have knowledge on the gestation with the best neonatal and maternal outcomes. We found five studies in total to be analyzed.

Three retrospective studies with a total of 48,757 women were identified comparing the neonatal risks at repeat cesarean delivery before and after 39 weeks of gestation [34–36]. In general elective repeat cesarean sections between 37 and 39 weeks are associated with a higher neonatal morbidity. Especially the rates of adverse respiratory outcomes and mechanical ventilation were increased. Neonates born before 39 weeks of gestation have significant more respiratory distress syndromes. Additionally the risks of newborn sepsis, hypoglycemia, admission to the neonatal ICU, and hospitalization are also higher in the group with a repeat cesarean section before 39 weeks [36].

Another study demonstrated increased costs through increasing adverse neonatal outcomes because of elective repeat cesarean deliveries at 37 or 38 weeks [37].

On the opposite side, the elective cesarean delivery at 39 weeks seems to be associated with better neonatal outcome in comparison to a later timing of delivery [34].

Altogether our findings suggest that from the neonatal point of view, there are benefits to waiting until 39 weeks of gestation to perform an elective repeat cesarean delivery.

To achieve the prolongation of the pregnancy until 39 weeks for the neonatal benefit, it is important to know if an elective repeat cesarean section at this time is also of benefit for the maternal outcome. The results of three studies with a total of 37,938 women show that an elective repeat cesarean delivery at 37 or 38 weeks is not associated with decreased maternal morbidity [34, 35, 38]. In comparison to the group of elective delivery at 39 weeks, there was no significant difference in uterine scar rupture, estimated blood loss, hysterectomy, or other maternal complications.

Additionally one study pointed out that elective cesarean delivery at 37 weeks had significantly higher risks of a prolonged (>5 days) maternal hospitalization [38].

Although a cesarean section before 39 weeks has a similar rate of risks for women with multiple repeated cesarean sections as the delivery after 39 weeks, the elective repeat cesarean section at 37 or 38 weeks exposes the neonate to an unnecessary increased risk of respiratory distress syndromes.

In conclusion, if there are no other medical indications for an earlier delivery, 39 weeks of gestation is apparently the optimal timing for repeat cesarean delivery yielding both the best neonatal and maternal outcome.

8. Summary

- The risks of rare but potentially serious maternal morbidities such as visceral injury, hemorrhage, abnormal placentation, hysterectomy, or severe adhesions importantly increased with the number of multiple repeat cesarean sections.
- Adverse neonatal outcome depends more on the mode and the timing of delivery than on the numbers of repeat cesarean sections.
- There is no clear absolute threshold for a safe number of previous cesarean sections, but a total of four or more cesarean deliveries was identified as the critical level for most of the major complications to be substantially increased.
- Repeat cesarean delivery is done best at 39 weeks yielding the best outcome for both the mother and baby.
- Vaginal birth after multiple cesarean deliveries remains an option for eligible women.

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