Received: 31 March 2021 | Revised: 19 May 2021 | Accepted: 1 June 2021 | First published online: 23 June 2021

DOI: 10.1002/ijgo.13775

CLINICAL ARTICLE

Obstetrics

The effect of the onset of labor on the characteristics of the cesarean scar

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Funding information
Dr. Senckenberg Foundation

Abstract

Objective: To assess the effect of cesarean section (CS) timing, elective versus unplanned, on the residual myometrial thickness (RMT) and CS scars.

Methods: This is a prospective single-blinded observational cohort study with 186 observations. Patients indicated to undergo first singleton CS were preoperatively recruited. Exclusion criteria were history of repeated CS, vertical hysterotomy, diabetes, and additional uterine surgeries. Sonographic examination was performed for assessing the RMT ratio, the presence of a niche, fibrosis, and the distance from the scar to the internal os (SO) 1 year after CS. Power analysis was performed with 0.05 α, 0.1 β, and all statistical analyses were conducted with STATA®.

Results: Wilcoxon rank-sum test for the association between CS timing, RMT ratio and SO showed Z values of −0.59 and −4.94 ($P = 0.553$ and $P < 0.001$), respectively. There was no association between CS timing and niches and fibrosis ($P > 0.99$ and $P = 0.268$, respectively). Linear regression between SO and the extent of cervical dilatation showed a −0.45 β (95% confidence interval −0.68 to −0.21) and a 10.22-mm intercept ($P < 0.001$).

Conclusion: RMT is independent of the timing of CS, but the SO distance shows a negative linear relationship with the cervical dilatation.

KEYWORDS
cesarean section, niche, residual myometrial thickness

1 | INTRODUCTION

Poidevin[1] was the first to demonstrate the wedge-shaped cesarean section (CS) scars during hysterography back in 1961. These findings represent myometrial defects at the site of hysterotomy and their sonographic depiction was named as "a niche" by Monteagudo et al.[2] A unified methodology for conducting the measurements for niches and residual myometrium thickness (RMT) did not exist until Jordans et al.[3] published Delphi-based guidelines in 2019. Despite an abundance of studies concerned with CS scars and niches, a global distribution of niche incidence and dimensions does not exist.[4]

Implantation of the gestational sac within the niche is a progenitor to placenta accreta spectrum (PAS).[5] and the presence of a niche and RMT thinning are associated with a high risk for developing PAS.[6] In addition to this, the RMT measurement has been assumed to play a role in predicting uterine rupture during the trial of

labor after CS.[7] There is emerging evidence that the risk of PAS is higher in subsequent pregnancies after elective pre-labor CS than after unplanned CS after cervical dilatation.[8] A recent study comparing the CS scars between early-labor and pre-labor CS reported a higher incidence of niches after early-labor CS without reporting RMT.[9] Moreover, the clinical implication of reporting RMT as an absolute value is debatable whereas RMT ratio represents a reproducible measurement that could be more useful for comparing patients.[10] Our work was proposed to be the first prospective study that uses the recommendations of Jordans et al.[3] for assessing RMT after CS. We hypothesize that CS timing in relation to the onset of labor affects RMT ratio, and the aim of this study is to assess the effect of CS timing, scheduled versus unplanned in labor, on the characteristics of the CS scar 1 year later.

2 | MATERIALS AND METHODS

This is a prospective observational cohort study investigating the effect of CS timing as a binomial exposure variable, whether elective pre-labor or unplanned intrapartum, on the primary outcome of RMT ratio as a continuous variable. The Ethical Committee of the Hessen Regional Medical Council (Reg. No. 2019-1138-evBO) approved the study before recruitment. All patients undergoing first singleton CS in a tertiary center were invited to participate in the study at the time of the operation, which was performed by either experienced trainees or specialized consultants. Written consent was obtained, and a follow-up examination for an interpregnancy interval 1 year postoperatively was scheduled. Patients with a history of repeated CS, vertical hysterotomy, diabetes, and additional uterine surgeries were excluded. The sonographic evaluation of the CS scar, blinded to the cohort group, was performed by experienced sonographers with 5–13 MHz micro-convex transvaginal transducers, GE RIC6-12-D (Voluson E10; GE Healthcare GmbH, Chicago, IL, USA). The RMT ratio, the presence of a niche and/or fibrosis, as well as the distance from the scar to the internal os (SO) as shown in Figure 1, were recorded. A niche is defined as "an indentation at the site of CS scar with a depth of at least 2 mm"[3] and fibrosis is defined as "a hyperechogenic dent from the serosa into the myometrium".[11]

Our null hypothesis assumes that the mean RMT ratios (primary outcome) for the two cohorts lie within half a standard deviation, which was adapted from Roberge et al.[12] The power analysis was performed with 0.05 type I error, 0.1 type II error and 23% standard deviation. The calculated two-sided sample size was 186 individuals with 93 observations for each cohort. All statistical analyses were conducted with STATA® (ver. 16.1; StataCorp., College Station, TX, USA) and the Wilcoxon rank-sum test, linear regression, and χ^2 test were utilized.

3 | RESULTS

Of the recruited eligible patients, 300 non-pregnant women attended a follow-up ultrasound examination within 12 and 24 months postoperatively. We used block randomization to select 93 patients who underwent elective CS and 93 patients who had unplanned intrapartum CS in the analysis. A summary of the characteristics for the study population along with some perioperative circumstances associated with the CS are shown in Table 1.

The collected scar measurements from this study are summarized in Table 2.

Two-sample Wilcoxon rank-sum test for RMT ratio dependence on CS timing resulted in Z value of −0.59 and a P value of 0.553, whereas CS timing showed a significant effect on SO distance (Z −4.94; $P < 0.001$). The distribution of RMT ratio as well as SO distance among the two cohorts is shown in Figure 2.

The χ^2 test showed no association between CS timing and niches or CS timing and fibrosis ($P > 0.99$ and $P = 0.268$, respectively). The relative frequencies of manifesting niches and fibrosis are shown in Figure 3.

Linear regression for SO distance as an outcome and the extent of cervical dilatation showed β of −0.45 (95% confidence interval −0.68 to −0.21, intercept 10.22 mm; $P < 0.001$). The result of this linear regression is shown in Figure 4.

4 | DISCUSSION

The main outcome of this study showed that RMT ratio was independent of CS timing. RMT is believed to be key for the risk assessment of complications facing women post CS during a subsequent pregnancy, such as PAS and uterine rupture during trial of labor.[13] Several study groups show that the anterior RMT is measurable and reproducible and RMT is measured on the sagittal plane.[3] The

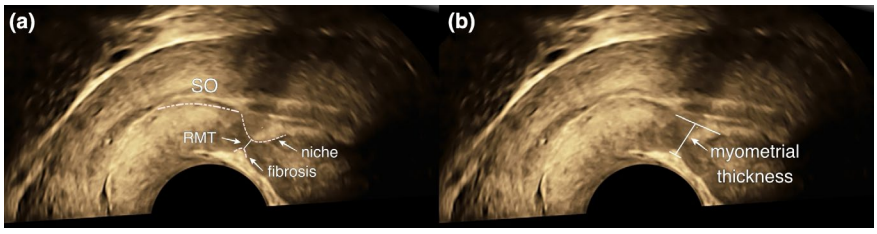

FIGURE 1 The sonographic sagittal view of the uterus showing (a) the outcome variables of the study including residual myometrial thickness, niche, fibrosis, and distance from the scar to the internal os (SO) in addition to (b) the assumed pre-cesarean myometrial thickness. RMT ratio = (RMT/myometrial thickness) × 100

TABLE 1 Demographic data of the study two cohorts with *P* value for significant difference.[a]

	Unplanned CS	Elective CS	*P* value
Gestational age at delivery, wk	38.1 ± 4.3	37.9 ± 2.5	0.704
Maternal age, y	32 ± 5.3	32.2 ± 5.7	0.622
Consultant-performed surgery	82%	74%	0.110
Cervical dilatation (cm)	4.9 ± 3.2	0 ± 0	<0.001
Antepartal infection	12.9%	0%	<0.001
Surgical indications	Fetal distress 38 (40.8) Obstructed labor 32 (34.7) Other 23 (24.5)	Breech 40 (43) Choice 15 (16.1) IUGR 11 (11.8) Other 27 (29)	—

Abbreviations: CS, cesarean section; IUGR, intrauterine growth restriction.

[a]Values are given as mean ±standard deviation, as number (percentage), or as percentage.

TABLE 2 The different outcomes of this study among the exposure cohorts.[a]

	Unplanned CS	Elective CS
Niche relative frequency	75 (80.6)	75 (80.6)
Fibrosis relative frequency	40 (43.4)	48 (51.6)
RMT ratio	54.13 ± 21.29	56.57 ± 21.41
SO, mm	7.91 ± 4.14	11.49 ± 4.94

Abbreviations: CS, cesarean section; RMT ratio, residual myometrial thickness ratio; SO, distance from the scar to the internal os.

[a]Values are given as mean ±standard deviation or as number (percentage).

reports regarding RMT and CS scar healing in relation to the onset of labor are contradictory. Some authors suggest a negative effect of unplanned CS in advanced labor on the scar healing,[14] whereas others show a positive correlation between RMT and the extent of cervical dilatation before CS.[15] Our results failed to demonstrate a difference of RMT ratios between scheduled and unplanned CS. Some of these contradictory results can be attributed to early scar assessment within as short a time-lapse as 3 months postoperatively.[9] Our cohorts were examined after at least a year and are assumed to have reached their scar healing potential, achieved after 6–9 months post CS.[16]

The RMT and the extent of niches seem to be dependent on the surgical technique with better healing and thicker RMT after double-layer uterine closure.[17] The standard surgical procedure used in our study center is double-layered unlocked, which is associated with a healing ratio of 73% ± 23% according to Roberge et al.[12] As a result, we used 23% as a standard deviation in our power analysis because of the similarity of both closure technique and reporting scar healing as a ratio.[12] The published incidence of niches varied within a broad range from 7% to 65%.[18,19] The variance in niche incidence could be partly attributed to the population demographic difference. Nevertheless, our population exhibits an exceptionally high incidence of both niches and fibrosis, and although we are unable to identify a definite clarification for this high incidence, employing high-frequency matrix transducers by experienced sonographers as well as using the latest niche assessment guidelines could have improved niche imaging and facilitated a higher detection rate of niches.[3] There are several other factors that affect RMT and CS scar healing, including obesity, infection, smoking, diabetes, and multiple CS.[20] We controlled for some factors at the level of study design by excluding patients with repeated CS or diabetes; however, not including demographic information on smoking or obesity can be considered a weakness of our study. The significant difference of peripartum infection rate between the two cohorts can be attributed to the nature of unplanned CS due to obstructed labor or fetal distress. Nevertheless, infection could have skewed the results of the RMT ratio and scar healing in our cohorts towards the null.

As far as we are aware, there has been only one recent published study that investigated the relationship between scar position and intrapartum CS timing. The investigators showed that pre-labor and early-labor CS are associated with scars within the uterine cavity and the height of the scar is inversely correlated with the cervical dilatation.[9] This negative linear relationship is in agreement with the theory of normal cervical dilatation pattern during labor, whereby the cervix is pulled superiorly after effacement.[21] Our data confirm these findings because the scar location was significantly higher within the uterus for elective CS compared with unplanned CS. The inverse linear relationship between SO distance and cervical dilatation at CS in our study reflects the work published by Kamel et al.[9] with a very similar intercept around 10.2 mm, but their slope was more extreme with a decrease of 1.39 mm instead of our 0.45 mm for each centimeter increase in cervical dilatation. The difference of the absolute values can be attributed to the population differences, and the retained similarity of the negative association confirms the validity of this finding.

In conclusion, we demonstrate that the relationship between performing the CS and the onset of labor did not affect the RMT for our study population. The height of the CS scar along the uterine length, referred to as the SO distance, is dependent on the progress of labor at the time of CS, and it shows a negative linear relationship with the measurement of cervical dilatation. Kamel et al.[9] assumed that the location of the scar could explain the predisposition to PAS and that low CS scars closer to the internal os could be considered

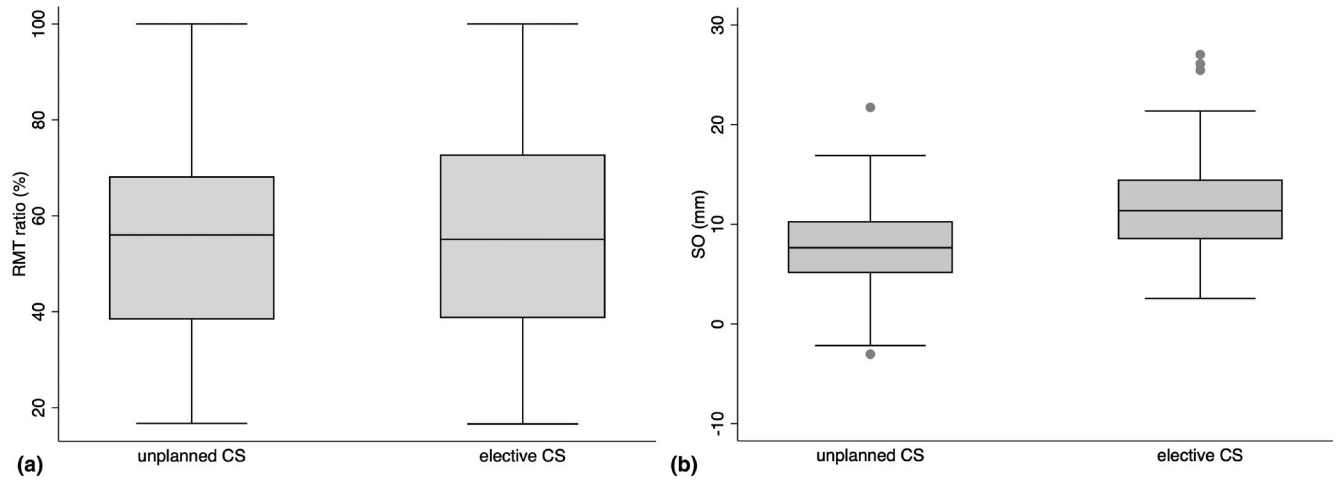

FIGURE 2 Box plots showing the distribution of (a) residual myometrial thickness ratio and (b) distance from the scar to the internal os (SO) among the two study cohorts

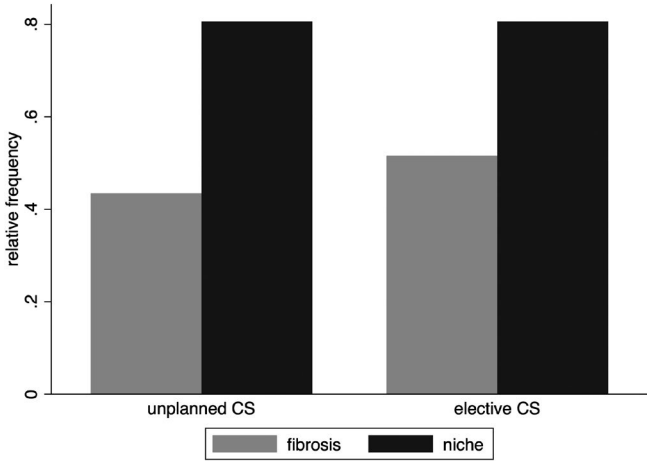

FIGURE 3 Bar plots showing the relative frequency of both niches and fibrosis among the study cohorts

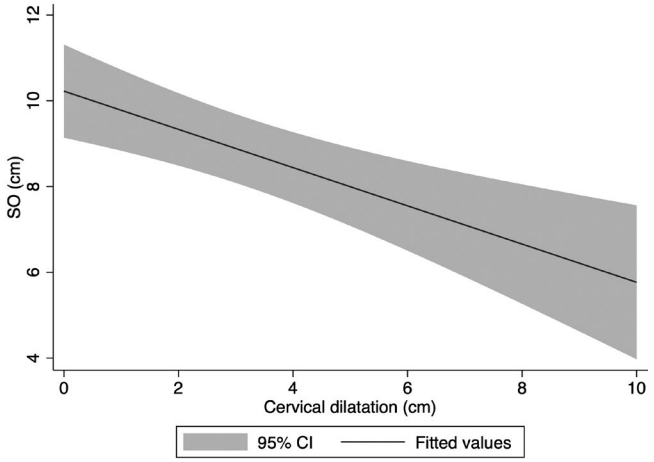

FIGURE 4 The linear regression between the distance from the scar to the internal os (SO) and the cervical width at the time of cesarean section with the fitted slope and the 95% confidence interval (CI) showing the regression formula ($y = 10.22–0.45x$)

protective. If we apply this thinking to our results then we could hypothesize that unplanned, in labor CS is associated with lower incidence of PAS, noting that this outcome was not a part of our study.

The strengths of this study are the prospective design, the statistical power analysis, the modern sonographic equipment, randomization, and blinding to exposure during outcome assessment. The association between CS timing and the location of the CS scar is a theoretical facilitator of PAS in a subsequent pregnancy, but proving the causative relationship is difficult because of the relatively low incidence of PAS. This rarity hinders the clinical implication of cohort studies such as ours for prospective investigation of the causative relationship.

ACKNOWLEDGMENTS

This study was supported by the Dr. Senckenberg Foundation, Frankfurt am Main.

CONFLICTS OF INTEREST

The authors have no conflicts of interest.

AUTHOR CONTRIBUTIONS

AAN contributed to protocol, data collection, and manuscript writing; LJ contributed to data analysis and manuscript editing; NM contributed to data management; and FL and FB contributed to project development.

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How to cite this article: Al Naimi A, Jennewein L, Mouzakiti N, Louwen F, Bahlmann F. The effect of the onset of labor on the characteristics of the cesarean scar. *Int J Gynecol Obstet*. 2022;157:322–326. https://doi.org/10.1002/ijgo.13775