Celine Kaps, Alexander Schwickert, Desislava Dimitrova, Andreas Nonnenmacher, Jan-Peter Siedentopf, Wolfgang Henrich and Thorsten Braun*

Online survey on uterotomy closure techniques in caesarean section

<https://doi.org/10.1515/jpm-2021-0118>

Received March 5, 2021; accepted May 19, 2021;

published online July 7, 2021

Abstract

Objectives: Uterine closure technique in caesarean section (CS) influences the rate of late complications in subsequent pregnancies. As no common recommendation on suture techniques exists, we developed a questionnaire to determine the techniques currently used and the frequencies of late complications.

Methods: The online questionnaire consisted of 13 questions and was sent to 648 obstetric hospitals (level I–IV) in Germany. Number of CS, rate of vaginal birth after caesarean section (VBAC), the type of uterus suturing technique and the frequency of uterine dehiscences, ruptures and placenta accreta spectrum (PAS) were queried. The answers were anonymous, and results were evaluated descriptively.

Results: The response rate was 24.7%. The mean CS rate was 27.3% (± 6.2), the repeat CS rate 33.2% (± 18.1). After CS, 46.2% (± 20.2) women delivered vaginally. To close the uterotomy, 74.4% of hospitals used single layer continuous

sutures, 16.3% single layer locked sutures, 3.8% interrupted sutures, 3.1% double layer continuous sutures and 2.5% used other suture techniques. The percentages of observed uterine dehiscences did not differ significantly between the different levels of care nor did the uterotomy suture techniques.

Conclusions: There is no uniform suturing technique in Germany. A detailed description of suture technique in surgery reports is required to evaluate complications in subsequent pregnancies. National online surveys on obstetric topics are feasible and facilitate the discussion on the need to define a standardized uterine closure technique for CS.

Keywords: abnormally invasive placenta; double layer suture; interrupted suture; long-term complications; placenta accreta spectrum; suture technique; trial of labor after caesarean section; uterine closure; uterine rupture; vaginal birth after caesarean section.

Introduction

The caesarean section (CS) is the most common operation in women [1]. The rate has doubled worldwide between 2000 and 2015 [2]. Apart from its benefits, CS (and especially repeat CS) can cause complications in subsequent pregnancies such as uterine rupture, especially at *trial of labor after caesarean section* (TOLAC), and the development of *placenta accreta spectrum* (PAS) [3, 4]. The prevalence of PAS ranges from 0.003–0.24% for nulliparous women with no previous CS to 40% after two previous CS and placenta praevia totalis [4–7]. Effective risk reduction can be achieved by reducing the number of operations on the uterus or by adequate closure technique [5, 8, 9]. Surprisingly, only 10% of the CS in Germany are performed from absolute indications [10]. Years of efforts to reduce the number of the first CSs were not successful. On contrary, there is a growing amount of CS on request without a medical indication.

One way to reduce the rising CS rates and the associated short- and long-term morbidity is to reduce the number of repeat CS and increase the number of TOLAC. This will be possible if we manage to make *vaginal birth after*

Celine Kaps and Alexander Schwickert contributed equally to this work.

***Corresponding author: PD Dr. med. Thorsten Braun**, Department of Obstetrics and Division of 'Experimental Obstetrics', Charité - Universitätsmedizin Berlin, Corporate Member of Freie Universität Berlin, Humboldt-Universität zu Berlin and Berlin Institute of Health, Klinik für Geburtsmedizin Charité, Campus Virchow-Klinikum, Augustenburger Platz 1, 13353 Berlin, Germany; and Division of 'Experimental Obstetrics', Charité - Universitätsmedizin Berlin, Corporate Member of Freie Universität Berlin, Humboldt-Universität zu Berlin and Berlin Institute of Health, Campus Virchow-Klinikum, Berlin, Germany, E-mail: thorsten.braun@charite.de. <https://orcid.org/0000-0002-1989-9920>

Celine Kaps, Alexander Schwickert, Desislava Dimitrova, Andreas Nonnenmacher, Jan-Peter Siedentopf and Wolfgang Henrich, Department of Obstetrics and Division of 'Experimental Obstetrics', Charité - Universitätsmedizin Berlin, Corporate Member of Freie Universität Berlin, Humboldt-Universität zu Berlin and Berlin Institute of Health, Campus Virchow-Klinikum, Berlin, Germany. <https://orcid.org/0000-0003-2360-6016> (A. Schwickert)

caesarean section (VBAC) safer. Although the prevalence of uterine rupture is only 0.1–1.0%, it is associated with relevant maternal and neonatal morbidity [8, 11, 12]. The low prevalence described in the literature so far is certainly due to the high rate of planned repeat CS. A strong increase of uterine ruptures can nevertheless be expected with the globally rising CS rates as a Norwegian population-based study already has documented [2, 3].

Uterine scar healing and thickness plays a significant role for scar stability and therefore for a safe TOLAC. The influence of the uterine closure technique for the stability of the uterine scar and the risk of uterine rupture has become more and more focus of studies during the last years [9, 13–18]. Although most international societies do not recommend a specific uterine closure technique, currently the most commonly used sutures are single layer continuous, single layer locked sutures, double layer continuous and interrupted sutures (Figure 1) [19]. The British Guidelines of the National Institute for Health and Care Excellence (NICE) recommend a double layer suturing technique due to uncertain data for single layer techniques [20]. With the same argumentation, the guideline on caesarean section from the German, Swiss and Austrian societies for obstetrics and gynecology does not recommend a certain suturing technique [21].

Studies which compare the impact of suture techniques on the scar stability come to differing results. Some studies conclude that double layer closure leads to a thicker uterine scar in postpartum ultrasound controls – a sign for a more stable uterine scar [13, 14, 22, 23]. However, whether a sonographically “thicker” scar significantly reduces the risk of a rupture is also the subject of debate.

A Canadian multicenter case-control study with 384 women has confirmed that the risk of rupture after single layer uterine closure is significantly higher compared to a double layer closure [24]. Conversely, a meta-analysis of nine studies with 5,810 women could not show a significant

difference between single layer and double layer uterine closure concerning the risk of rupture. However, single layer locked suture technique was significantly associated with a higher risk of rupture [15].

So far, limited data exists on the effect of interrupted sutures on uterine scar stability. When the Misgav Ladach method for CS gained worldwide popularity around the year 2000, this widely used technique was abandoned in favor of the single-layer locked technique [25]. However, the existing studies have shown some promising results such as in 30 primiparae, a significantly smaller defect of the uterine scar in transvaginal sonography and hysteroscopy 24 months after CS was shown when interrupted sutures had been used compared to single layer locked suture [26]. In another study, the uterine scar after interrupted sutures was even significantly thicker in hystero-graphic examinations three months after CS than after closure with double layer continuous sutures [27]. A retrospective study evaluated the uterine rupture rate in 1,059 pregnant women with TOLAC. Fifteen (0.8%) cases of uterine rupture were described, least likely after interrupted suture [28].

Since there is no common recommendation, we created an online questionnaire to evaluate which suture techniques are currently used in Germany and how often late complications are observed.

Materials and methods

Study protocol

A survey with 13 questions was created and related to data from 2018 (Supplement 1). Questions 1–5 covered epidemiological aspects of the interviewed hospitals as well as the frequencies of CS, repeat CS and VBAC. Questions 6–10 recorded the technique and procedure for closing the uterotomy and questions 11–13 the frequency of possible subsequent complications. The questionnaire was created using SurveyMonkey® online service and invitations were distributed via email

Figure 1: Uterine closure sutures.

Single layer continuous suture (a), single layer locked suture (b), double layer continuous suture (first suture as in (a) and above suture as in (c)), interrupted sutures (d). Adapted by permission from Springer Nature [Chirurgische Gastroenterologie by Allgöwer M., Harder F., Hollender L.F., Peiper H.J., Siewert J.R., 1981].

to 648 hospitals in Germany. Contact information was obtained from the hospital websites or by telephone request. The survey period was two months (the middle of April to the middle of June 2019). After 4 weeks of the first contact, a new electronic request was sent out as a reminder.

Statistics

Data was processed and analyzed using the statistical software SPSS® v25 (IBM®, Coppel, TX, USA). Data are reported as median and interquartile range (IQR) or mean and standard deviation (SD), as appropriate. Differences were compared using non-parametric test (Kruskal–Wallis test) when groups were independent. Categorical variables were expressed as numbers (percentage) and compared using Chi-square test. All tests were performed with a defined significance level of 0.05. Level of significance was adjusted for multiple testing.

Ethical approval

The survey was anonymous and the conducted research not related to either human or animals use, a specific ethical approval was not needed.

Results

The response rate was 24.7% (160/648 hospitals with an obstetric department). The average processing time was 4 min.

German care levels have been adapted according to the definition of the American College of Obstetricians and Gynecologists (ACOG) [29, 30]. Maternal care level IV corresponds to the German perinatal center level 1 (compare Figure 2). Mostly hospitals with maternal care level I (basic

care) participated in the survey (43.1%, 69/160), followed by maternal care level IV (regional perinatal health care centers) (26.3%, 42/160). The participation of hospitals with maternal care level II (specialty care) was 19.4% (21/160) and of maternal care level III (subspecialty care) 10.0% (16/160) (Figure 2). The mean annual number of births in 2018 was $1,328.7 \pm 813.4$ (range 235–5,400), in total 211,262 births in the participating hospitals. The mean CS rate was $27.3\% \pm 6.2$, the mean repeat CS rate was $33.2\% \pm 18.1$, and VBAC was performed in $46.2\% \pm 20.2$ (Table 1). It is not clear from the data on the frequency of a VBAC whether it refers to TOLACs or successful spontaneous deliveries after CS (VBAC).

To close the uterotomy, 74.4% (119/160) used single layer continuous sutures, 16.3% (26/160) single layer locked sutures, 3.8% (6/160) interrupted sutures, 3.1% (5/160) double layer continuous sutures and 2.5% (4/160) other techniques (n=1 Lemberg sutures (continuous inverted), n=2 first layer continuous, second layer z-sutures, n=1 first layer continuous, second layer double continuous sutures and single stitches) (Figures 1 and 3).

In 57.5% (92/160), a standardized suturing technique was defined by the hospital. For 32.5% (52/160), the surgeons explicitly included the endometrium. While 96.9% (155/158) used the same suturing technique for repeat CS. Simultaneous tubal sterilization did not affect the suturing technique (Table 1).

In total, there were 466 observed dehiscences at planned repeat CS, 944 at emergency repeat CS and 284 uterine ruptures at VBAC in the year of reporting. This corresponds to a dehiscence rate of 7.6% for repeat CS in the interviewed collective. Almost half of the participated hospitals (44%, n=70) observed more than five

Figure 2: Frequencies of care levels of the participating hospitals according to the classification of ACOG [29, 30].

Maternal care level IV = German perinatal care center level 1: preterm birth before 29+0 gestational age (GA), <1,250 g, triplets < 33+0 GA, severe fetal anomalies, severe maternal underlying disease; Maternal care level III = German perinatal care center level 2: preterm birth between 29+0 – 31+6 GA, 1,250–1,499 g, gestational diabetes with insulin therapy, pregnancy associated diseases (e.g. HELLP), intrauterine growth restriction (IUGR) Fetus (<3rd percentile); Maternal care level II = German hospital with perinatal focus (care level 3): preterm birth between 32+0 – 35+6 GA, ≥1,500 g, gestational diabetes with insulin therapy, IUGR Fetus (3rd–10th percentile); maternal care level I = German maternity hospital (care level 4): GA ≥ 36+0, no complications expected.

Table 1: Descriptive presentation of the results of the online survey.

No.	Question	Answer	Frequency in %	Mean	SD	Median	IQR	Range
1	Care level of hospital	Regional perinatal health center (care level IV)	26.3					
		Subspecialty care (care level III)	10.0					
		Specialty care (care level II)	19.4					
		Basic care (care level I)	43.2					
2	Birth rate at hospital			1,328.7	813.4	1,200.0	650–1,800	235–5,400
3	CS rate/year, %			27.3	6.2	28.0	24–30	11–50
4	Repeat CS rate/year, %			33.2	18.1	33.0	15–50	4–80
5	VBAC rate/year, %			46.2	20.2	50.0	30–60	5–90
6	Suturing technique	Single layer continuous	74.4					
		Single layer locked	16.3					
		Double layer continuous	3.1					
		Interrupted suture	3.8					
		Others	2.5					
7	Is suturing technique mandatory at hospital?, %	Yes	57.5					
		No	42.5					
8	Does suturing technique include endometrium layer?, %	Yes	32.1					
		No	67.9					
9	Does the suturing technique diverse in repeat CS?, %	Yes	1.9					
		No	98.1					
10	Does the technique diverse when performing a sterilization?, %	Yes	0.6					
		No	99.4					
11	Number of uterine dehiscence at: (per year)	Planned repeat CS		3.3	4.5	2.0	0–5	0–25
		Emergency repeat CS		6.6	10.2	3.0	2–9	0–100
12	Number of uterine rupture at VBAC/year			1.9	3.4	1.0	0–2	0–30
13	Case number of PAS/year			4.5	6.3	2.5	1–5	0–35

CS, caesarean section; VBAC, vaginal birth after caesarean section; PAS, placenta accreta spectrum; SD, standard deviation; IQR, interquartile range, range = minimum – maximum.

dehiscences per year. Due to the study design, it was unfortunately not possible to indicate the percentage rupture rate of TOLAC or VBAC.

In total, the participating hospitals treated 660 PAS in 2018. This results in an average of 4.5 ± 6.3 (range 0–35) cases per year.

Considering the data in relation to the care levels, the following results are obtained (Table 2): Hospitals with

maternal care level IV and III (German perinatal center level 1 and 2) had significantly higher birth and CS rates than level II (German hospital with perinatal focus) and I (German maternity hospital) (birth rate $p < 0.001$, CS rate $p < 0.001$). The rate of repeat CS and VBAC did not diverge between the care levels (repeat CS $p = 0.92$, VBAC $p = 0.90$). The percentages of observed uterine dehiscence did not differ significantly according to the different levels of care

Figure 3: Representation of the distribution of the applied suturing techniques.

Table 2: Overview of the results relating to the hospital care level.

Question	Answer	Maternal care level IV	Maternal care level III	Maternal care level II	Maternal care level I	Kruskal-Wallis-test (p)	Chi-square test (p)
Frequency, % (n=158)		26.3 (42/158)	10.0 (16/158)	19.4 (31/158)	43.2 (69/148)		
Birth rate ^g		1950	1,550	650	790		
CS rate, % ^g		30.0	27.8	27.0	26.8		0.00 ^a
Repeat CS rate, % ^g		30.0	38.0	33.0	34.0		0.00 ^b
VBAC, % ^g		45.0	50.0	50.0	50.0		0.92
Suturing technique, % ^g		83.3	87.5	67.7	69.6		0.91
	Single layer continuous						0.48
	Single layer locked	7.1	6.3	22.6	21.7		
	Double layer continuous	2.4	6.3	0.0	4.3		
	Interrupted suture	4.8	0.0	3.2	2.9		
	Others	2.4	0.0	6.5	0.0		
Suturing technique mandatory at hospital?, % ^g	Yes	61.9	56.3	61.3	53.6		0.81
	No	38.1	43.8	38.7	46.4		
Including endometrium?, % ^g	Yes	40.5	50.0	25.8	26.5		0.16
	No	59.5	50.0	74.2	73.5		
Dehiscence at repeat CS (per year) ^g	Planned CS	4.5	2.0	1.0	1.0		0.00 ^c
	Emergency CS	8.0	5.0	2.0	2.0		0.00 ^d
Percentual dehiscence rate at repeat CS ^g		5.7	3.6	6.8	5.8		0.52
Number of uterine rupture at VBAC/year ^g		1.8	1.0	1.0	0.8		0.00 ^e
PAS cases per year ^g		4.0	3.0	2.0	1.0		0.00 ^f

CS, caesarean section; VBAC, vaginal birth after caesarean section; PAS, placenta accreta spectrum; IQR, interquartile range. ^aThe birth rate was significant lower at care level II than in care level III ($p<0.00$) and IV ($p<0.00$), also significant lower in care level I than in care level III ($p<0.00$) and care level IV ($p<0.00$). The birth rate was neither significant different between care level I and II and care level III and IV. ^bThe CS rate was significant different between care level I and IV ($p<0.00$) and between care level II and IV ($p=0.01$). ^cA dehiscence at planned repeat CS was significant more often observed in care level IV than in care level I and care level II ($p<0.00$ and $p=0.01$). ^dA dehiscence at emergency repeat CS was significant more often observed in care level IV than in care level I and care level II ($p<0.00$ and $p<0.00$). ^eA uterine rupture at attempted VBAC was significantly more often observed in care level I and II ($p<0.00$, $p=0.01$). ^fThe number of PAS cases per year were significant higher in care level IV than in care level I and II ($p=0.02$, $p<0.00$). ^gAll results are presented as median values. Level of significance was adjusted for multiple testing.

(Table 2). Only the absolute number of observed uterine ruptures per year was significantly different between the care levels. Maternal care levels IV had significant higher rupture rates than care level I and II ($p < 0.00$, $p = 0.01$). As well as the number of documented uterine dehiscences at planned and emergency repeat CS (each $p < 0.05$). The number of PAS cases per year was significant higher in care level IV than in care level I and II ($p = 0.02$, $p < 0.00$). The suturing technique did not diverge significantly between the care levels ($p = 0.91$, $p = 0.46$).

Single layer continuous sutures were mostly applied in hospitals with a high birth rate (maternal care level IV and III). The single layer locked technique was used by hospitals with rather low birth rates. Those hospitals tend to have high repeat CS rates with 40% and low VBAC rates with 39%. The double layer continuous sutures were only used in five interviewed hospitals, but with high median birth rates. In this group, the VBAC rate was 59%. The interrupted suture technique was only applied by six of the interviewed hospitals and was mostly standardized by the respective hospital (Table 3).

Discussion

In our survey, the mean CS rate was $27.3 \pm 6.2\%$, the mean repeat CS rate was $33.2 \pm 18.1\%$, and VBAC was performed in $46.2 \pm 20.2\%$ of cases. Hospitals with maternal care level III and IV (German perinatal care center level 2 and 1) had significantly higher birth and CS rates than level II and I. The rate of repeat CS and VBAC did not diverge between the care levels.

In the literature, the CS rate in Germany is 32.0% with rates of planned repeat CS at 19.8% [31]. The rates in our survey are comparable with a trend to a higher repeat CS rate, especially in hospitals with maternal care level III and IV. These data show that the surveyed centers are representative of German maternal care hospitals.

The consequences of a disturbed uterine wound healing like uterine rupture and PAS is a feared complication in subsequent pregnancy and it is interesting that our results show that the used suture techniques diverge strongly between the obstetricians although there is increasing evidence that suture technique plays an important role [9, 13–15, 22–24, 26–28]. The single layer continuous suture technique is used the most (74.4%), although the only recommended suture technique from an obstetric society (NICE) is the double layer continuous technique [21]. Only 3.1% of the German hospitals surveyed comply with the recommendation from Great Britain.

Table 3: Association of uterotomy suture techniques at caesarean section and basic information as provided by participating hospitals.

Question	Answer	Single layer continuous	Single layer locked	Double layer continuous	Interrupted suture	Others	Wallis-test (p)	Kruskal-Wallis-test (p)	Chi-square test (p)
Frequency, % (n = 160)		74.4 (119/160)	16.4 (26/160)	3.1 (5/160)	3.8 (6/160)	2.5 (4/160)			
Birth/year ^c		1,300	600	1,464	1,000	1,075		0.00 ^a	
CS rate, % ^c		28.0	26.0	25.0	31.0	25.0		0.63	
Repeat CS rate, % ^c		31.0	40.0	30.0	32.0	20.0		0.32	
VBAC, % ^c		50.0	39.4	59.0	45.0	64.7		0.04 ^b	
Including endometrium?, %	Yes	34.7	23.1	40.0	33.3	0			0.50
	No	65.3	76.9	60.0	66.7	100.0			
Suture technique	Yes	62.2	42.3	20.0	66.7	50.0			0.15
mandatory at hospital?, % ^c	No	37.8	57.7	80.0	33.3	50.0			

CS, caesarean section; VBAC, vaginal birth after caesarean section; PAS, placenta accreta spectrum; IQR, interquartile range. ^aSingle layer continuous sutures are used significantly more often in hospitals with comparatively higher birth rates ($1,300 \pm 749$ births/year) compared to hospitals that use single layer locked sutures ($p < 0.00$). ^bVBAC rates differ significantly between hospitals according to the used uterotomy closure technique. No certain correlation of applied suture technique and VBAC success rate is possible, since we had no information if the previous CS was performed at the same hospital. ^cAll results are presented as median values.

Admittedly, several trials have not been able to detect significant differences in uterine rupture rates and myometrial thickness in postpartum ultrasound when comparing single and double layer continuous sutures [16, 18, 32].

Fewest of the participating hospitals use interrupted sutures to close the uterus during CS (3.1%). Interestingly, this technique has been shown to enhance wound healing in several small studies [26, 27, 33]. It appears that after the widespread adoption of the Misgav Ladach technique for CS around the year 2000, the technique of interrupted sutures has been buried in oblivion [25]. In times of rising CS rates and disproportionately rising uterine rupture rates, as documented in a Norwegian population-based study, it is important to find out whether interrupted sutures allow a better uterine healing and thus a safer vaginal delivery after CS and a lower risk for PAS in subsequent pregnancies [3, 9]. A Japanese case-control study with 98 pregnant women with placenta praevia investigated the effect of the suture technique at the prior CS on the frequency of PAS. The risk for PAS was significant lower when interrupted sutures were used compared to continuous sutures. The suture technique used on the inner wall made the difference and not if it was a single or double layer closure [9]. The average number of PAS in the surveyed hospitals is low with 4.5 cases per year. A CS with PAS should always be operated at a specialized center, since the operation can be very challenging and needs an interdisciplinary well-coordinated team. Prenatal screening for PAS to ensure referral of cases to specialized centers is essential.

In only two thirds (57.5%) of the surveyed hospitals the suture technique was defined. In general it is difficult to compare outcomes of surgical procedures if the surgical steps are not standardized [34].

Furthermore, current evidence supports the fact that uterine healing is improved and niche development is prevented by including the decidua into the suture [35, 36]. The survey showed that only 32.1% of hospitals do so.

The median uterine rupture rate at VBAC was with approximately 1 case per hospital and year a rare event and comparable to the data in the literature [8, 11, 12]. Hospitals with higher care levels (IV and III) have, in our survey, significantly more uterine ruptures at VBAC. Besides the higher birth rates, those hospitals take care of high risk pregnancies like women with twin pregnancies, pregnancies after myoma enucleation, insulin dependent gestational diabetes and often consecutive fetal macrosomia, which can contribute to the higher uterine rupture risk.

The percentage of uterine dehiscence at repeat CS in our survey is high with 7.6%. The definition of dehiscence is not clear and it is possible that data was influenced by different understanding of these terms [37, 38]. An

indication of this are single extreme outliers. In this study design it was not possible to correlate the risk of uterine dehiscence or rupture with the applied suture technique, because the actual suturing technique used for the previous CS is often not known, since the women were partially operated in other hospitals and the operations techniques varies even within the clinic.

As primary CS are indicated conservatively in Germany, the most effective way to reduce the CS rate seems to be a reduction of the number of repeat CS. The use of the optimal suture technique to avoid disturbance of uterine wound healing can reduce the rate of PAS and uterine ruptures and can help to restore the confidence of a safe VBAC.

This survey is the first national questionnaire on uterine closure techniques. Currently, neither a core outcome set of questionnaires on obstetric operative management exists in the database of Core outcomes in women's and newborn's health (CROWN) nor is one in development. It shows that national online surveys on obstetric topics are feasible and makes it possible to get into discussion on the need to define a standardized uterine closure technique during CS.

The fact that the survey was limited to hospitals in the Federal Republic of Germany and the response rate of 24.7% limits the generalizability of the results. However, the wide share of degrees of specialization from basic care centers (level I, 43.2%) to regional perinatal health care centers (level IV, 26.3%) increase the possibility to extrapolate to the total population.

Furthermore, due to the retrospective survey design, the results are probably also subject to recall bias and reporting bias. The terms of uterine dehiscence, uterine rupture and PAS were not defined clearly and the amount of VBAC was only asked for as a percentage, so answers may be influenced by different understandings of these terms. It was also not stated whether and how often further (hemostatic) sutures, like z-sutures, were applied. It is important to emphasize, that it is not possible to make a statement about the correlation of suture technique and frequency of complications like uterine dehiscence and rupture or PAS since we had no information, if the previous CS was performed at the same hospital and which suture technique was used.

Conclusions

Although the closure technique of the uterus during CS plays an important role for scar stability, our results show that there is no uniform suturing technique in Germany. There is increasing evidence that the risk of long-term

complications is associated with wound healing or suturing technique. A detailed surgery report with the used suture technique should be given to every patient to allow the obstetrician to plan the birth mode for the next pregnancy. The consent of the pregnant woman is a necessary requirement to a TOLAC. We would support the idea that women with previous operation on the uterus give birth (TOLAC or repeated CS) at regional centers like maternity care level III-IV to have experienced staff on site at all times in the event of complications and to be able to intervene immediately. Women with previous uterine operation should be standardized screened for PAS in the 2nd trimester ultrasound. We need a strategy to evaluate reliable the operation techniques at CS. A mandatory participation in a registry quality assurance based on the certification process for tumor centers would be an option.

Research funding: No funding.

Author contributions: All authors contributed substantially in the conception and planning of the study. CK collected the data and drafted the first manuscript with AS. Statistical analyses were performed by CK and AS. All authors contributed to the interpretation of the data. CK, AS, TB revised the manuscript together. All authors reviewed and approved the final submitted version of manuscript.

Competing interests: Authors state no conflict of interest.

Informed consent: Not applicable.

Ethical approval: Not applicable.

References

1. Statistisches Bundesamt. Publikation - Gesundheit - Operationen und Prozeduren der vollstationären Patientinnen und Patienten in Krankenhäusern; 2017.
2. Boerma T, Ronsmans C, Melesse DY, Barros AJD, Barros FC, Juan L, et al. Global epidemiology of use of and disparities in caesarean sections. *Lancet* 2018;392:1341–8.
3. Al-Zirqi I, Stray-Pedersen B, Forsén L, Daltveit A-K, Vangen S. Uterine rupture: trends over 40 years. *BJOG* 2016;123:780–7.
4. Silver RM, Landon MB, Rouse DJ, Leveno KJ, Spong CY, Thom EA, et al. Maternal morbidity associated with multiple repeat cesarean deliveries. *Obstet Gynecol* 2006;107:1226–32.
5. Thurn L, Lindqvist PG, Jakobsson M, Colmorn LB, Klungsoyr K, Bjarnadóttir RI, et al. Abnormally invasive placenta—prevalence, risk factors and antenatal suspicion: results from a large population-based pregnancy cohort study in the Nordic countries. *BJOG* 2016;123:1348–55.
6. Fitzpatrick KE, Sellers S, Spark P, Kurinczuk JJ, Brocklehurst P, Knight M. Incidence and risk factors for placenta accreta/increta/percreta in the UK: a national case-control study. *PLoS One* 2012;7:e52893.
7. Jauniaux E, Chantraine F, Silver RM, Langhoff-Ross J. FIGO consensus guidelines on placenta accreta spectrum disorders: epidemiology. *Int J Gynaecol Obstet* 2018;140:265–73.
8. Hofmeyr GJ, Say L, Gülmezoglu AM. WHO systematic review of maternal mortality and morbidity: the prevalence of uterine rupture. *BJOG* 2005;112:1221–8.
9. Sumigama S, Sugiyama C, Kotani T, Hayakawa H, Inoue A, Mano Y, et al. Uterine sutures at prior caesarean section and placenta accreta in subsequent pregnancy: a case-control study. *BJOG* 2014;121:866–74.
10. Deutsche Gesellschaft für Gynäkologie und Geburtshilfe e.V. (DGGG). Absolute und relative Indikationen zur Sectio caesarea. Leitlinien, Empfehlungen, Stellungnahmen. 2010.
11. Landon MB, Hauth JC, Leveno KJ, Spong CY, Leindecker S, Varner MW, et al. Maternal and perinatal outcomes associated with a trial of labor after prior cesarean delivery. *N Engl J Med* 2004;351:2581–9.
12. Motomura K, Ganchimeg T, Nagata C, Ota E, Vogel JP, Betran AP, et al. Incidence and outcomes of uterine rupture among women with prior caesarean section: WHO Multicountry Survey on Maternal and Newborn Health. *Sci Rep* 2017;7:1–9.
13. Bamberg C, Dudenhausen JW, Bujak V, Rodekamp E, Brauer M, Hinkson L, et al. A prospective randomized clinical trial of single vs. double layer closure of hysterotomy at the time of cesarean delivery: the effect on uterine scar thickness. *Ultraschall der Med* 2018;39:343–51.
14. Vachon-Marceau C, Demers S, Bujold E, Roberge S, Gauthier RJ, Pasquier J-C, et al. Single versus double-layer uterine closure at cesarean: impact on lower uterine segment thickness at next pregnancy. *Am J Obstet Gynecol* 2017;217:65. e1–5.
15. Roberge S, Chaillet N, Boutin A, Moore L, Jastrow N, Brassard N, et al. Single- versus double-layer closure of the hysterotomy incision during cesarean delivery and risk of uterine rupture. *Int J Gynaecol Obstet* 2011;115:5–10.
16. Roberge S, Demers S, Berghella V, Chaillet N, Moore L, Bujold E. Impact of single- vs double-layer closure on adverse outcomes and uterine scar defect: a systematic review and metaanalysis. *Am J Obstet Gynecol* 2014;211:453–60.
17. Bujold E, Bujold C, Hamilton EF, Harel F, Gauthier RJ. The impact of a single-layer or double-layer closure on uterine rupture. *Am J Obstet Gynecol* 2002;186:1326–30.
18. Di Spiezio Sardo A, Saccone G, McCurdy R, Bujold E, Bifulco G, Berghella V. Risk of cesarean scar defect following single- vs double-layer uterine closure: systematic review and meta-analysis of randomized controlled trials. *Ultrasound Obstet Gynecol* 2017;50:578–83.
19. Dahlke JD, Mendez-Figueroa H, Rouse DJ, Berghella V, Baxter JK, Chauhan SP. Evidence-based surgery for cesarean delivery: an updated systematic review. *Am J Obstet Gynecol* 2013;209:294–306.
20. National Institute for Health and Clinical Excellence (UK). Caesarean section: evidence update March 2013. A summary of selected new evidence relevant to NICE clinical guideline 132 'Caesarean section'. London 2013; 2011.
21. Deutsche Gesellschaft für Gynäkologie und Geburtshilfe (DGGG), Österreichische Gesellschaft für Gynäkologie und Geburtshilfe (OEGGG), Schweizerische Gesellschaft für Gynäkologie und Geburtshilfe (SGGG). Leitlinienprogramm Sectio caesarea; 2020.

22. Glavind J, Madsen LD, Ulldbjerg N, Dueholm M. Ultrasound evaluation of cesarean scar after single- and double-layer uterotomy closure: a cohort study. *Ultrasound Obstet Gynecol* 2013;42:207–12.
23. Sevkiet O, Ates S, Molla T, Ozkal F, Uysal O, Dansuk R. Hydrosoneographic assessment of the effects of 2 different suturing techniques on healing of the uterine scar after cesarean delivery. *Int J Gynaecol Obstet* 2014;125:219–22.
24. Bujold E, Goyet M, Marcoux S, Brassard N, Cormier B, Hamilton E, et al. The role of uterine closure in the risk of uterine rupture. *Obstet Gynecol* 2010;116:43–50.
25. Holmgren G, Sjöholm L, Stark M. The Misgav Ladach method for cesarean section: method description. *Acta Obstet Gynecol Scand* 1999;78:615–21.
26. Ceci O, Cantatore C, Scioscia M, Nardelli C, Ravi M, Vimercati A, et al. Ultrasonographic and hysteroscopic outcomes of uterine scar healing after cesarean section: comparison of two types of single-layer suture. *J Obstet Gynaecol Res* 2012;38:1302–7.
27. Lal K, Tsomo P. Comparative study of single layer and conventional closure of uterine incision in cesarean section. *Int J Gynaecol Obstet* 1988;27:349–52.
28. Sestanovic Z, Mimica M, Vulic M, Roje D, Tomic S. [Does the suture material and technique have an effect on healing of the uterotomy in cesarean section?]. *Lijec Vjesn* 2003;125:245–51.
29. American College of Obstetricians and Gynecologists (ACOG). Levels of maternal care; 2015. Internet: <https://www.acog.org/en/Programs/LOMC>.
30. Institut für Qualitätssicherung und Transparenz im Gesundheitswesen (IQTIG) Perinatalzentren; 2020 Internet: https://www.perinatalzentren.org/information.php?open=perinatalzentrum_info.
31. Institut für Qualitätssicherung im Gesundheitswesen (IQTIG). Bundesauswertung zum Erfassungsjahr 2017. Geburtshilfe; 2018.
32. Bennich G, Rudnicki M, Wilken-Jensen C, Lousen T, Lassen PD, Wøjdemann K. Impact of adding a second layer to a single unlocked closure of a Cesarean uterine incision: randomized controlled trial. *Ultrasound Obstet Gynecol* 2016;47:417–22.
33. Yasmin S, Sadaf J, Fatima N. Impact of methods for uterine incision closure on repeat caesarean section scar of lower uterine segment. *J Coll Phys Surg Pak* 2011;21:522–6.
34. Stark M, Gerli S, Di Renzo GC. The importance of analyzing and standardizing surgical methods. *J Minim Invasive Gynecol* 2009;16:122–5.
35. Stegwee SI, Jordans IPM, van der Voet LF, van de Ven PM, Ket JCF, Lambalk CB, et al. Uterine caesarean closure techniques affect ultrasound findings and maternal outcomes: a systematic review and meta-analysis. *Int J Gynaecol Obstet* 2018;125:1097–108.
36. Yazicioglu F, Gokdogan A, Kelekci S, Aygun M, Savan K. Incomplete healing of the uterine incision after caesarean section: is it preventable? *Eur J Obstet Gynecol Reprod Biol* 2006;124:32–6.
37. Baron J, Weintraub AY, Eshkoli T, Hershkovitz R, Sheiner E. The consequences of previous uterine scar dehiscence and cesarean delivery on subsequent births. *Int J Gynaecol Obstet* 2014;126:120–2.
38. Levine E. Uterine rupture vs. dehiscence. *Am J Obst Gynecol* 2016;214:415.
39. Müller C, Allgöwer M. Nahtmaterial und Nahttechnik. In: Allgöwer M, Harder F, Hollender LF, Peiper H-J, Siewert JR, editors *Chirurgische gastroenterologie*. Berlin, Heidelberg: Springer; 1981:156–69 pp.

Supplementary Material: The online version of this article offers supplementary material (<https://doi.org/10.1515/jpm-2021-0118>).