Thieme

Contrast Hysterosonographic Evaluation of Niche Prevalence Following a Standardized Suturing Technique for Caesarean Sections

Kontrasthysterosonografische Untersuchung der Nischenprävalenz nach standardisierter Sectio-Nahttechnik

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ABSTRACT

Introduction
After caesarean section a uterine niche can be detected in 42–84 % of all women and in 11–45 % large defects with a residual myometrium < 2.2 mm occur. If the niche compromises > 50 % of myometrial thickness, risk of uterine rupture during birth increases. The suturing technique might contribute substantially on pathogenesis of niches. The objective of this study is to investigate the effect of the suturing technique on niche prevalence by using a standardized two-layer surgical technique.

Methods
Women with one previous caesarean section were examined within 6–23 months after caesarean section using contrast medium-supported transvaginal sonography regarding the prevalence, sonomorphological aspect and clinical symptoms of a uterine niche. The surgical technique used was: dilatation of the cervix, interrupted suture of the first layer (excluding the endometrium), continuous closure of the visceral and parietal peritoneum.

Results
Using native vaginal sonography, no niches were visible in the whole cohort. In three cases, there was a small niche detectable with a depth between 2.3 and 3.9 mm by contrast hysterosonography. Regarding the total myometrial thickness, the niche depth compromised less than 50 %. All patients were symptom-free.

Conclusion
In our study population, there were only three cases (9.1 %) with a small uterine niche. Residual myometrium and niche percentage on myometrial thickness were excellent in all three cases. Thus, our results show that the uterotomy closure technique used in the study cohort might be superior with respect to the development of uterine niches compared with the expected prevalence.

ZUSAMMENFASSUNG

Einleitung
Nach einem Kaiserschnitt lässt sich bei 42–84 % aller Frauen eine Uterusnische nachweisen, und bei 11–45 % treten große Defekte mit einem Restmyometrium < 2,2 mm auf. Wenn die Nische > 50 % der Myometriumdicke einnimmt, steigt das Risiko einer Uterusruptur während der Geburt. Die Nahttechnik könnte wesentlich zur Pathogenese von Nischen beitragen. Ziel dieser Studie ist es, den Einfluss der Nahttechnik auf die Nischenprävalenz mithilfe einer standardisierten zweischichtigen Operationstechnik zu untersuchen.

Methoden
Frauen mit einem vorangegangenen Kaiserschnitt wurden innerhalb von 6–23 Monaten nach dem Kaiserschnitt mittels kontrastmittelgestützter transvaginaler Sonografie auf die Prävalenz, den sonomorphologischen Aspekt und die klinischen Symptome einer Uterusnische untersucht. Die angewandte Operationstechnik war: Dilatation der Zervix, Einzelknopfnaht der ersten Schicht (ohne Endometrium), kontinuierlicher Verschluss des viszeralen und parietalen Peritoneums.

Ergebnisse
Bei der nativen Vaginalsonografie waren in der gesamten Kohorte keine Nischen sichtbar. In 3 Fällen war eine kleine Nische mit einer Tiefe zwischen 2,3 und 3,9 mm in der Kontrast-Hysterosonografie nachweisbar. Bezogen auf die Gesamtdicke des Myometriums betrug die Nischentiefe weniger als 50 %. Alle Patientinnen waren symptomfrei.

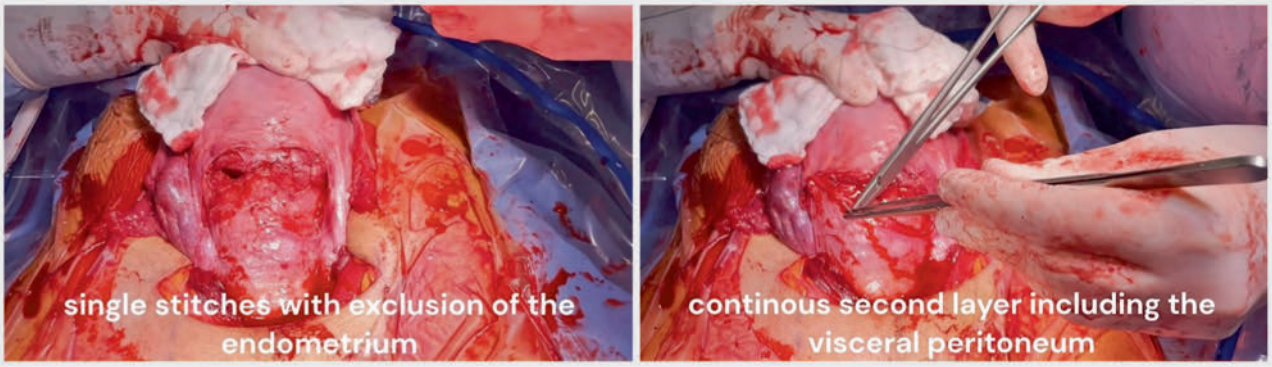
Fazit
In unserer Studienpopulation gab es nur 3 Fälle (9,1 %) mit einer kleinen uterinen Nische. Sowohl das Restmyometrium als auch der prozentuale Anteil der Nische bezogen auf die Myometriumdicke war in allen 3 Fällen ausgezeichnet. Somit zeigen unsere Ergebnisse, dass die in der Studienkohorte angewandte Uterotomie-Verschlusstechnik im Hinblick auf die Entstehung von Uterusnischen im Vergleich zur erwarteten Prävalenz überlegen sein könnte.

Introduction

Caesarean section (CS) is one of the most frequently performed surgery in the world. Awareness for the resulting consequences and complications is increasing. One of the negative effects is a defect healing of the uterotomy leading to a uterine scar defect, isthmocele or niche and associated symptoms. Recently a panel of 31 international niche experts summarized symptoms associated with a uterine niche in a modified Delphi study calling it caesarean scar disorder [1]. The term of uterine niche, exclusively observed in patients with a previous CS, was firstly introduced by Monteagudo [2]. Meanwhile there exists a precise definition for a niche. According to Jordans [3] a niche is defined as an indentation at the site of the CS scar with a depth of at least 2 mm. A niche can be subclassified as a simple niche, a simple niche with one branch or a complex niche (with more than one branch). Additionally, a large scar defect was defined when the residual myometrium thickness (RMT) was < 2.5 mm using contrast hysterosonography (HSG) or 2.2 mm using native transvaginal sonography (TVS) [4, 5]. Prevalence of a niche varies greatly depending on niche definition, symptomatology and imaging technique [6]. Various studies propose HSG as the gold standard in niche diagnostic [3, 4, 7]. As seen in various studies, using TVS without contrast agent, niche prevalence is much lower than using HSG (46.4 % vs 69.1 % [4] or 49.6 % vs. 64.5 % [8]). Within a recently published systematic review [6], prevalence detected by HSG varied between 42 % [9] and 84 % [7]. Prevalence of large defects with residual myometrium < 2.2 mm or niche depth of 50–80 % of the myometrium has been seen between 11 % [10] and 45 % [11] in a random population.

Niches result in a variety of symptoms associated with them, highlighting the importance of a correct diagnosis explaining the patient's complaints. Typical symptoms include bleeding disorders, especially postmenstrual spotting, dysmenorrhea, dyspareunia, chronic lower and abdominal/pelvic pain [6, 8, 12]. Niches can cause endometriosis, secondary infertility and complications of gynecological procedures like embryo transfer [13, 14]. Women with a uterine niche are at higher risks of obstetric complications such as scar pregnancy, uterine rupture and placenta accreta spectrum disorders [5]. The depth of the niche or the thickness of the residual myometrium appear to correlate with the risk of uterine rupture. Niche depth compromising ≥ 50 % of myometrial thickness or RMT ≤ 2.2 mm have a remarkable predictive value for real uterine rupture during birth [15].

There are various hypotheses of the pathogenesis of niches, whereas the question on the exact origin is not yet completely clarified. The most promising considerations include problems in wound healing like a (reversible) retroflexio uteri, the number of previous CS and the location of the uterotomy as summarized in [16]. Sholapurkar [17] hypothesizes ischemia and poor adaptation of uterotomy margins to be the greatest risk factor for development of a niche, along with scarring and adhesions. Thus, the suture technique for closure of the uterotomy seems to play a major role in the development of uterine niches after CS. Until now, there exists no universally accepted technique for optimal uterine closure. Trends show that double-layer closure of the uterotomy has an advantage compared to single-layer closure [18, 19, 20, 21]. Also exclusion of the decidua from the suture reduces the development of scar defects [22]. In addition to the optimal closure technique of the uterotomy, the dilatation of the cervical channel



▶ **Fig. 1** Suturing technique for closing the uterotomy at caesarean section. Left: first layer with single stitches with exclusion of the endometrium. Right: continuous second layer including visceral peritoneum.

and the location of the uterotomy cranially of the vesicouterine fold seems to have positive effects on scar integrity, wound healing and RMT [23].

In accordance with this current state of knowledge, a suture technique for closing the uterotomy during CS was established in the Department of Gynecology and Obstetrics at University Clinic St. Hedwig in Regensburg, specifically with the hypothetic goal of avoiding uterine niches. The main feature is the double-layer suture of the uterotomy excluding the endometrium. The first layer is closed by single stitches and the second layer by a continuous unlocked suture including the superficial muscle layer and the visceral peritoneum (▶ **Fig. 1**, online ▶ **Video 1**). Additionally, the parietal peritoneum is closed, and the cervix is dilatated in case of elective CS. This standardized technique during CS has been used since January 2021 in the study cohort.

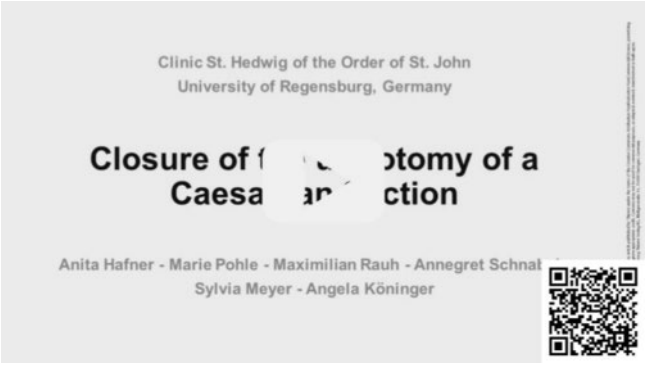
Hence, the aim of this prospective study is to investigate the healing of the uterotomy after application of the described surgical technique to evaluate the effect of the suturing technique with regard to niche prevalence. Primary outcome was the presence of a niche, measured by contrast medium supported vaginal contrast hysterosonography according to the Delphi criteria (see [3]).

Methods

Data for this prospective non-randomized cross-sectional study, conducted at the Department of Gynecology and Obstetrics at the University Clinic St. Hedwig in Regensburg, Germany, were collected between October 2022 and July 2023. Methodological procedures of this clinical study were reviewed and approved by the Ethics Committee of the University of Regensburg, Germany (22–2889–101).

Patient selection

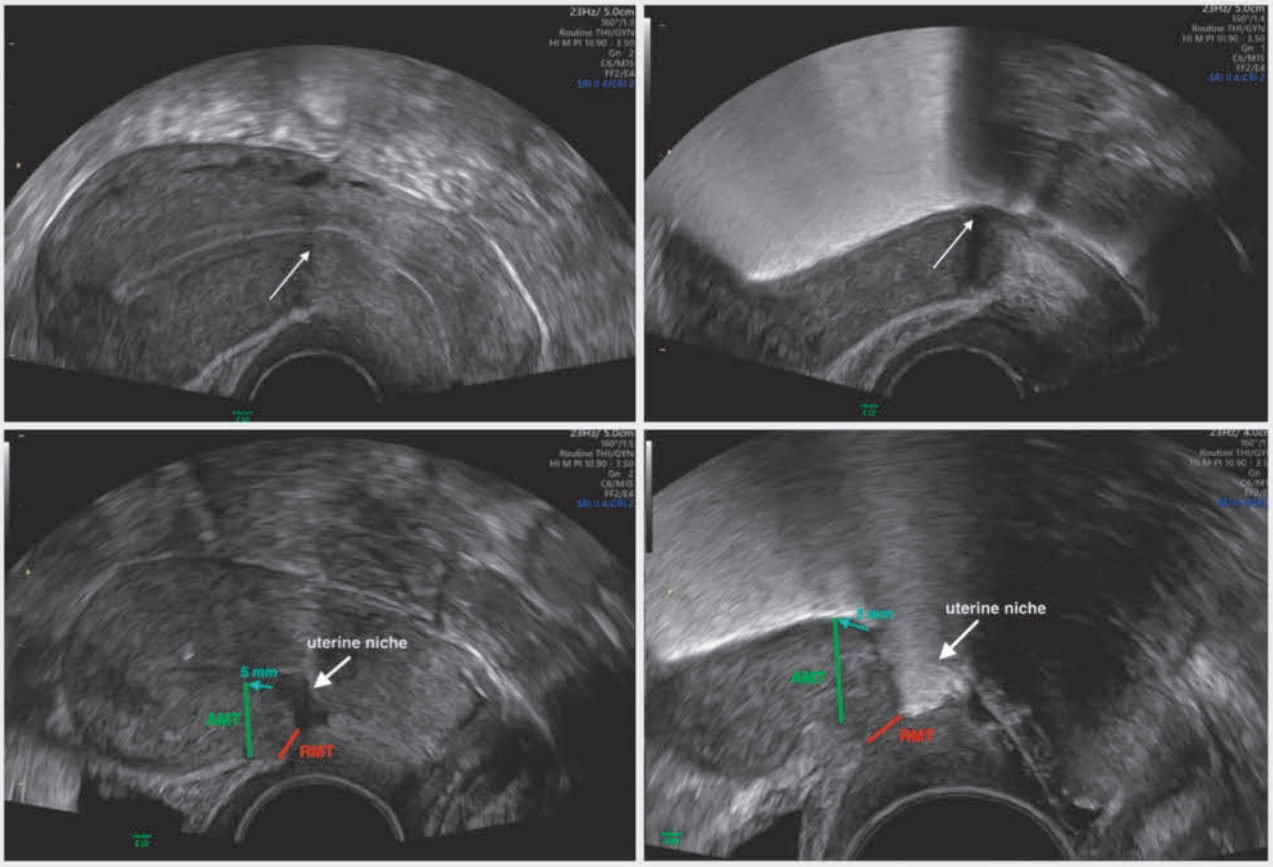
Women with exactly one previous CS performed at our clinic since 2021 were invited to participate in our study. Inclusion criteria were primary or secondary CS performed at least six months ago as well as timing for examination in the follicular phase of menstrual cycle in case of no hormonal contraceptive intake. Exclusion criteria were current pregnancy, existing or suspected urogenital infection or neoplasia or more than one CS in the past. After considering the inclusion and exclusion criteria, an appointment was made for the examination. After detailed information about objectives, procedure and possible side effects of the study, all participants gave written informed consent prior to the start of the examination.



▶ **Video 1** Closure of the uterotomy of a caesarean section.

Study design

The study protocol included a standardized medical history (age and Body-Mass-Index [BMI]) at time of patient examination, medication, pre-existing diseases, previous surgeries, symptoms associated with CS (irregularities of menstrual cycle, dysmenorrhea, hypermenorrhea, postmenstrual spotting, pelvic pain, secondary infertility). TVS was performed for exclusion of pathologies of the uterus, ovaries or other pelvic structures. To detect a niche with highest sensitivity [4, 8], contrast HSG was added for each women using a high echogenic medium (ExEm Foam). The focus was therefore on the lower uterine segment next to the uterine cavity and tube filling. All tests were carried out using an ultrasound machine with high resolution (GE [General Electrics] Voluson E10) and the software ViewPoint 6 (GE Healthcare) for collecting data. All examinations were carried out according to the four eyes principle. One of the examiners was a senior consultant with DEGUM II



▶ **Fig. 2** Above: uterus with a well healed scar after caesarean section. Bottom: uterus with a niche measuring residual myometrial thickness (RMT, red) and adjacent myometrial thickness (AMT, green) using native transvaginal sonography (left) and contrast hysterosonography (right) in each case.

qualification (Deutsche Gesellschaft für Ultraschall in der Medizin) for ultrasound in obstetrics and gynecology. In case of a niche, it was visualized in all planes under standardized guidelines and the exact size extension was measured according to Jordans criteria [3]. Hence, niche length, depth, residual myometrial thickness (RMT) and adjacent myometrial thickness (AMT) in sagittal plane as well as niche wide and RMT in transverse plane. AMT was measured 5 mm cranial to the uterine niche (▶ **Fig. 2**). In addition, the healing ratio was calculated, defined as RMT/AMT in sagittal plane using HSG.

Data analysis

Patients' demographic and ultrasonographical measured parameters were collected in an excel file. Descriptive statistics were calculated for the parameters: time after CS, age, BMI, gestational age at CS, RMT sagittal, niche depth and healing ratio. All statistical analysis were conducted with the statistic software SigmaPlot (Version 14.0, Systat Software, Inc., San Jose, California).

Results

Study cohort

34 patients were included, 33 of whom underwent TVS and HSG. In one patient, insertion of the catheter for HSG was not possible due to patient's concern of complaints, so she was excluded from calculations. On average, the examination was performed 16 months (range from 6 to 23 months) after surgery. Time of examination was during follicular phase of menstrual cycle (range from day 4 to day 12) in case of no hormonal contraception. Only in one case examination was performed on day 22 of menstrual cycle.

The mean age of all participants at time of examination was 36 years (range from 28 to 47 years) and the mean BMI 24 kg/m^2 (range from 18.4 to 46.1) (▶ **Table 1**). In medical history, seven patients had at least one curettage, one a conization and two laparoscopic myoma enucleations before CS. Six of the 33 patients used hormonal contraception (oral contraceptives or vaginal ring) at time of the examination.

▶**Table 1** Patients' demographic and sonographic characteristics at time of examination.

Parameter	n	Mean (± Standard Deviation; STD)	Median (Interquartile Range; IQR)
Time after CS [months]	33	16.17 (± 4.10)	17.0 (13.0–19.0)
Age [years]	33	36.70 (± 4,85)	36.00 (33.00–40.00)
BMI [kg/m^2]	32	24.26 (± 5.51)	23.00 (20.83–25.38)
gestational age at CS [weeks]	33	37.97 (± 2.95)	39.00 (37.00–40.00)
RMT sagittal [mm] by contrast HSG	33	10.77 (± 2.51)	10.30 (8.65–13.25)
Niche depth [mm] by contrast HSG	33	0.36 (± 1.01)	0.00 (0.00–0.00)
Healing-ratio by contrast HSG	33	0.97 (± 0.08)	1.00 (1.00–1.00)

BMI = Body Mass Index; CS = Caesarean Section; HSG = hysterosonography; RMT = Residual Myometrial Thickness

Parameters of previous CS

The gestational age at CS varied from 29 to 42 weeks with a mean value of 37.6 weeks. A total of 28 were primipara and five women of the cohort had at least one previous vaginal delivery. Of the 33 women included 19 underwent elective CS and 14 secondary CS. Complications during or after surgery included twice atony (without blood transfusion or using an intrauterine balloon tamponade) and two patients suffered from postpartum endomyometritis. At the time of the study visit, five patients complained about increased bleeding intensity after CS, three about dysmenorrhea and one described chronic lower abdominal pain with anamnestic suspicion of endometriosis. The symptoms in the last case existed already before CS.

Sonographic results

The examination revealed 20 anteverted uteri, eight retroverted uteri and four uteri in midline position. By using native TVS, in none of the cases a measurable niche was seen. Using contrast HSG, 3/33 cases showed a hinted niche with a mean depth of 3.1 mm (2.3 mm, 3.2 mm and 3.9 mm, respectively). All of them could only be visualized by HSG (▶ **Fig. 3**, ▶ **Fig. 4**). The residual myometrial thickness in these cases was 6.5 mm, 8.6 mm and 8.0 mm, respectively. Thus, the niche depth incorporated 26 %, 27 % and 33 % of the myometrial thickness (measures as AMT) with an AMT of 9.1 mm, 10.2 mm and 12.8 mm, respectively. With regard to the sonomorphology, so-called "simple" niches, i.e. niches without further branching, were seen in each case.

Considering all 33 patients the mean healing-ratio (RMT/AMT) was 0.974 with a mean RMT of 10.8 mm (Standard deviation, STD ± 2.51 mm).

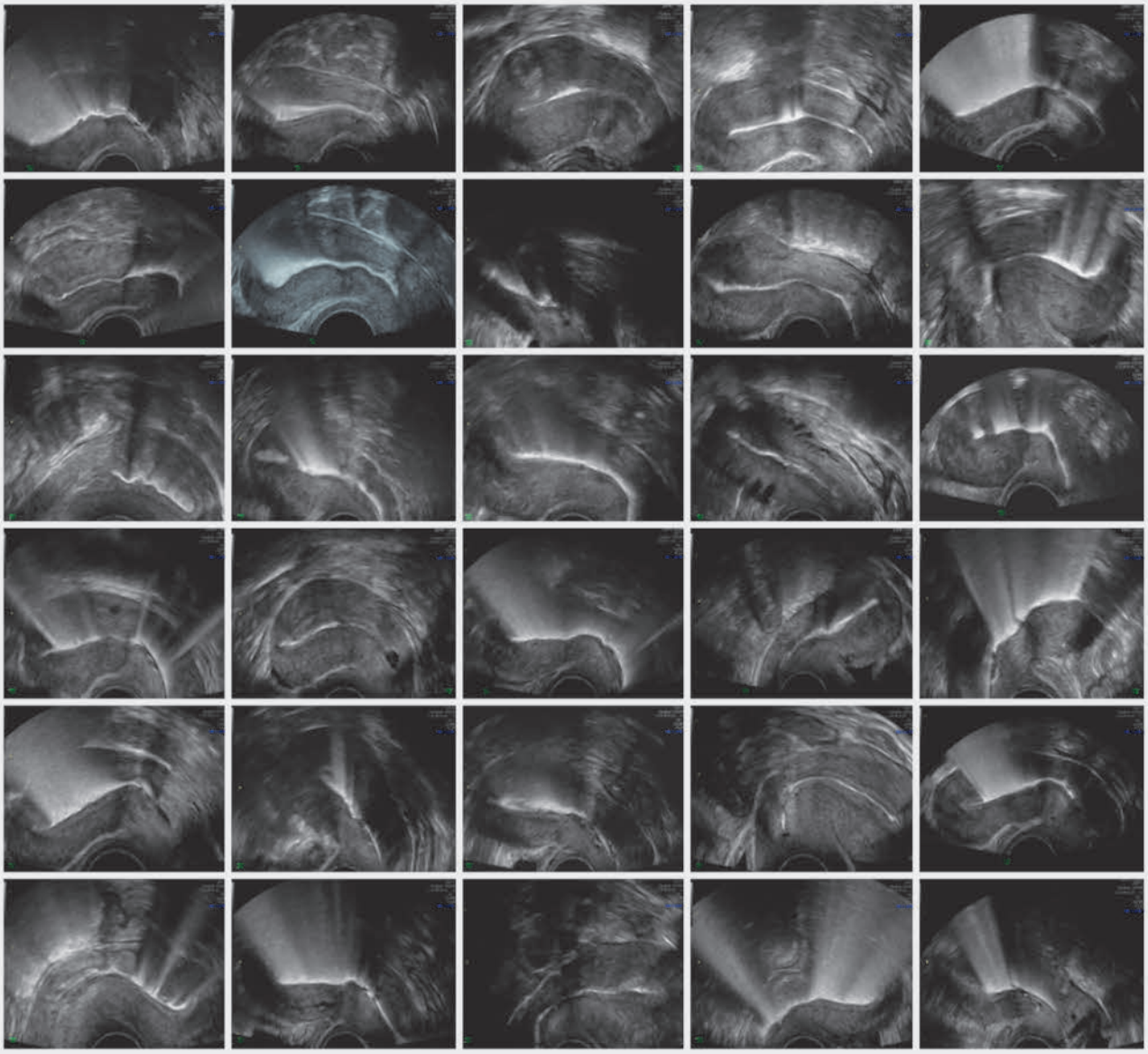
Clinical characteristics of patients with niches

All three patients were symptom-free. Timing of examination of these three patients was 18 to 19 months after CS. Each case was an elective CS. Indications for surgery were placenta previa in two cases and once maternal age (45 years). The woman with the largest niche (3.9 mm) had three curettages in her medical history. All three patients used hormonal contraception at time of examination. Position of the uterus was two times anteverted and once in midline position.

Discussion

The aim of our study was to evaluate a standardized suturing technique for uterus closure in CS, with regard to the prevalence of uterine niches. In 33 women, mainly examined in follicular phase of menstrual cycle, no one showed a niche using native TVS. Only three cases (9.1 %) showed a small niche with a mean RMT of 7.7 mm and a mean niche depth of 3.1 mm, which could only be visualized by contrast HSG. All three patients with niches had sonomorphologically only discrete defects without clinical symptoms. This is in line with further studies that have shown that niche size correlates with the severity of symptoms [12]. In summary, no patient suffered from Caesarean Scar Disorder (according to [1]) and thus all niches were clinically not relevant. In a recently published review including 19 studies, the prevalence of a niche was 13–75 %, measured by native TVS and 42–84 %, using HSG in a random population of women with a history of at least one CS [6]. Definition of a niche was identical to the protocol of this study with a depth of at least 2 mm. Thus, compared to the historical collectives, the prevalence of uterine niches in our study is markedly lower than the prevalence stated in the literature.

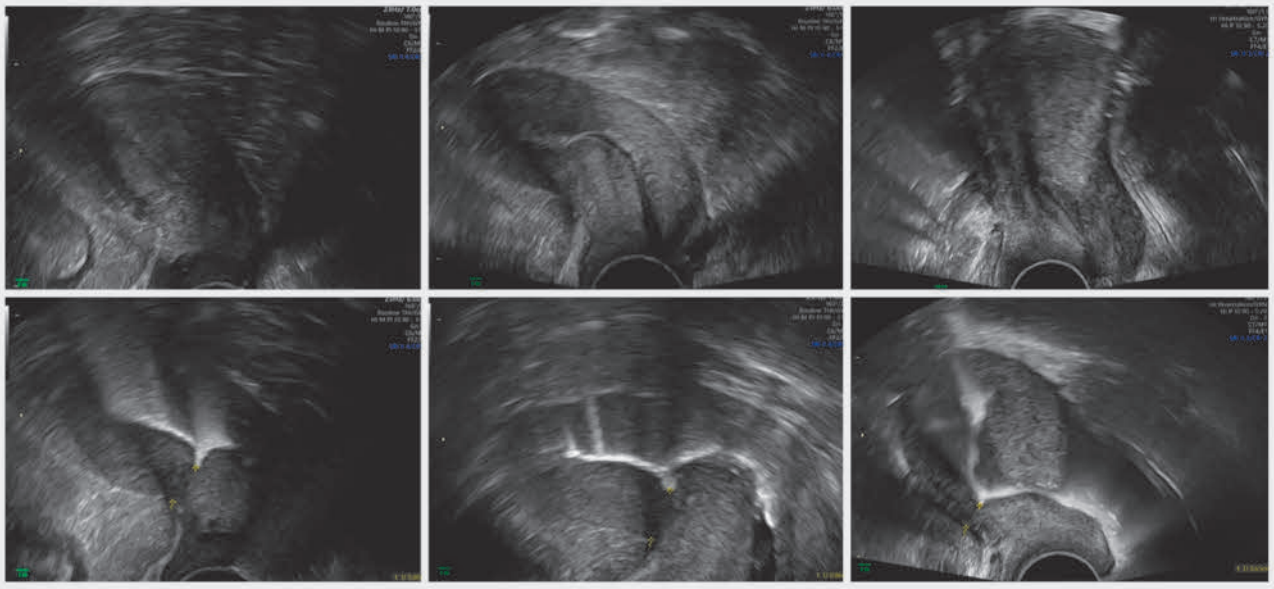
In this context, we emphasize that no niches were found by TVS but only by contrast HSG in our study. This fact makes our data even more reliable as it is known from previous studies that HSG examination results in a higher prevalence of niches, increased niche depth and significantly smaller residual myometrium in comparison with native TVS [6]. Therefore, HSG seems to be the method with the highest sensitivity in niche detection and was used for this reason in our study. One further strength of this study was the time of patient examination during follicular phase in all cases without hormonal contraceptive intake. During follicular phase, the cervical mucus is liquid and therefore niches can be seen with high precision. In many cases, niches are located partially within cervical tissue and cervical mucus directly fills in the niche cavity.



▶ **Fig. 3** Images of the 30 uteri without a niche in sagittal plane using contrast hysterosonography.

A further strength of our study is the time of wound healing after CS. The earliest timepoint of patient examination was six months post partum. We deduced from previous findings that wound healing is complete after this period [3]. We can therefore assume that our measurement timeframe is reliable. In another comparable study, there was no difference in niche prevalence, niche depth or width two months compared to 12 months after CS, but RMT, AMT and healing-ratio were significantly lower after 12 months compared to two months, examined with both, TVS and HSG [24]. In this study, the mean RMT/AMT-ratio (healing ratio) after 12 months was only 0.54 and the mean RMT 6.5 mm. In contrast, the mean healing ratio in our cohort was 0.97 and the mean RMT 10.8 mm, even after a longer follow-up period of 16 months. Hence, our low prevalence of uterine niches as well as better results of RMT and the healing ratio compared to the literature support the hypothesis that the suturing technique may be a critical causal factor for better wound healing and preventing uterine niches after CS. We can also deduce from the obviously very low number of uterine niches that our suture technique might be superior to others in prevention of uterine scar defects. The following aspects take a closer look at all relevant steps during CS.

Our core element in suture technique is the double-layer uterotomy closure as precisely explained above. A recently published multicenter double-blind randomized controlled superiority trial [25] compared a single with a double-layer suture in 2292 women. There were no significant differences in the prevalence of large niches (13.2 % vs. 11.8 %, p = 0.31), RMT (6.4 vs.



▶ **Fig. 4** Images of three uteri with a small niche measuring residual myometrial thickness using contrast hysterosonography.

6.7 mm, p = 0.108) or days of postmenstrual spotting (1.33 vs. 1.26, p = 0.81). Time of examination was nine months after CS, and only native TVS was used. Surprisingly, a significantly lower niche prevalence was shown within the single-layer closure group compared to the double-layer closure (68.9 % vs. 73.6 %, p = 0.033). However, in the double-layer suture group, the endometrium was incorporated in the suture as a standard whereas in the single-layer closure group, the endometrium was excluded optionally. A subgroup analysis of cases with exclusion of the endometrium resulted in significantly less niches (59.3 vs. 71.8 %, p = 0.001). The authors concluded that the exclusion of the endometrium may affect the results in a relevant degree. Various further studies showed a lower niche prevalence, smaller niches as well as higher RMT by excluding the endometrium compared to incorporation of the endometrium in the suture [25, 26, 27]. A recently published study postulates a six times lower prevalence of clinically significant niches by excluding the endometrium at uterine closure [22]. In summary, the exclusion of the endometrium in the suture seems to be crucial.

Supporting our hypothesis that double-layer closure has a positive effect on wound healing after CS, various studies show better results for RMT and healing ratio after a double-layer closure technique [20, 26, 28, 29, 30, 31] as well as reduced risk of scar defects [21] compared to a single-layer closure. A recently published review [32] including 19 RCTs revealed that the RMT was significantly higher with the double-layer compared with the single-layer uterine closure technique. This is in accordance with our findings showing excellent results with a RMT of 10.8 ± 2.51 mm and a healing ratio of 0.974. It can be expected that revised guidelines concerning the question of the optimal uterus closure will include the newest insights in single- versus double-layer suture in the near future. Comparing suture techniques with respect to serious side effects such as uterus rupture or dehiscence, the available literature also indicates that double-layer closure is associated with a lower incidence of such complications [33, 34].

It is difficult to assess whether the closure of the inner layer with single stitches plays a decisive role, since the majority of published studies present a variety of surgical techniques (single stitches, continuous closure, locked or unlocked) with a sparse analysis of single versus continuous stitches. One case-control study, comparing different suture techniques during CS, supports our thesis that interrupted sutures are superior to continuous sutures with regard to morbidly adherent placenta incidence in a further pregnancy. The study showed significantly lower incidences of placenta accreta cases using single stitches compared to a continuous suture (29.9 % vs. 58.1 %, p = 0.008). Placenta accreta can be considered as a clinical surrogate parameter of a scar defect. In conclusion, single stitches may play an important role in uterine wall integrity [23].

Apart from uterotomy closure, additional steps included in our surgical technique (cervical dilatation and position of the uterotomy, closure of visceral and parietal peritoneum) may also have positive effects on lower numbers of scar defects.

First, in case of elective CS, cervical dilatation was performed in our study cohort. Background of this step was to improve drainage of blood and products of conception according to the considerations and results of Dawood et al. [35]. Less scar defects were noticed in the dilatation group compared with no dilatation group (5.03 % vs. 11.04 %) and RMT was significantly thicker when the cervix was dilatated (p = 0.002) [32].

Additionally, position of the uterotomy may be critical for development of uterine niches. A caudally placed incision (lower distance to the inner cervical os) correlates with higher niche prevalence [36, 37, 38]. Vikhareva et al. [37] found in a randomized

single-blind trial a six-fold higher rate of large scar defects in the low-incision group compared with the high-incision group. An explanation for better results of higher incision could be that no or less cervical tissue with mucus-producing glands may be incorporated in the suture. Thus, incision cranially of the vesicouterine fold may be an additional positive aspect in surgical technique avoiding scar defects. This should be taken in mind especially in cases of advanced labor and the fetal head position within the dilated cervix.

A further protective factor could be labor during CS. As postulated in the literature, labor activates releasing immunological cells (a.o. granulocytes, macrophages, t-cells) as well as changes in maternal hormones which could be responsible for better wound healing and preventing of scarring [39, 40]. Various studies that examined the impact of labor on lower uterine segment thickness indicated better sonographic results in presence of labor in subsequent pregnancies [21, 41]. According to Kamel et al. [42], labor may influence positively niche formation and also abnormal placental invasion. Results show higher numbers of niche formation in prelabor or early-labor (cervical dilatation ≤ 2 cm) CS than in intrapartum CS although the incision was below the inner cervical os with advanced cervical dilatation. Hence, labor may be protective for the development of uterine niches or scar defects, compensating a low incision which is considered to be a risk factor. But since the majority of our participants had elective CS, the role of the closure technique may even overwhelm the benefit of labor.

Third, closure of parietal peritoneum may also have an impact on uterine niche formation. This topic is very controversially discussed, but in summary, non-closure of peritoneum was recommended just because of short-term outcomes such as shortening of operating time. Long-term outcomes such as pelvic pain, dyspareunia, infertility or surgical difficulty during repeated CS because of extensive adhesions obliterating uterovesical were not considered [43].

According to Sholapurkar et al. [17] two of the biggest risk factors for niche formation are ischemia and adhesions, due to increased tension between the uterine scar and the abdominal wall. A systematic review [44] as well as a prospective cohort study including 235 women [41] showed that closure of the visceral and parietal layers of the peritoneum significantly reduces formation of adhesions in subsequent pregnancies. It is further known, that in the majority of cases, a retroflexio uteri follows a CS due to the interrupted anterior uterine wall with a better contraction of the posterior site [45, 46]. As a potential consequence, post-surgical retroflexio uteri can be fixed onto the abdominal wall and result in poor adaption of the uterotomy margins [14].

Although there exist no studies that explore the effect of closure of the parietal peritoneum on niche incidence, we hypothesize that closure of the peritoneum may lower the uterine niche incidence.

In summary, our results support our thesis that suture technique is a crucial component in the pathogenesis of uterine niches.

Limitations and Strength

Factors beyond the CS performance, e.g. maternal age, BMI, week of gestation, rupture of membranes, preeclampsia, gestational diabetes or pre-existing retroflexio uteri, were not considered in our study, but could also have influence as described in several publications concerning risk factors for uterine niches [38, 41, 47, 48]. A limitation could be the small sample size of only 33 patients. Since hysterosonography is not very comfortable, only a small number of the symptom-free patients invited were willing to undergo this examination. Moreover, the lack of a control group could be a critical point of our study. But so far there is no general recommendation for uterotomy closure, so we deliberately decided against a control group and use the availability of the already published huge cohort results.

One of the strengths of our study is that we included a random sample of patients independent of stage of labor, gestational age at delivery (mature born or prematurity) or indication for CS. Second, the comparability of cases is better in contrast to other studies as only patients with a first caesarean section were included. Contrast HSG was used in all patients, being considered as gold standard of examination method for detecting a niche. Additionally, all examinations were performed in the optimal phase of menstrual cycle by two physicians with high experience in gynecological ultrasound and niche treatment.

Conclusion

Our results show that the uterotomy closure technique that includes a double-layer suture with single stitches of the first layer, exclusion of the endometrium, dilatation of the cervix and closure of the parietal peritoneum seems to be superior with respect to the development of uterine niches compared with historical cohorts. Even after using HSG, we only observed three small niches in 3/33 patients compared to up to 65 % in historical cohorts; see attached video in the supplemental material [8]. Thus, our study could provide a decision-making aid to create an optimal and easily performed new standard of suturing technique for closing the uterotomy. From our point of view, this is a further necessary step regarding increasing numbers of caesarean sections and resulting complications worldwide.

Conflict of Interest

The authors declare that they have no conflict of interest.

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