



Cesarean Scar Defect: Risk Factors and Clinical Manifestations

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Abstract

The increase in caesarean sections (CS) has resulted in an increase in women with a uterine niche. The exact aetiology of niche development has yet to be elucidated but is likely multifactorial. This study aimed to give a systematic overview of the available literature on histopathological features, risk factors and results of preventive strategies on niche development to gain more insight into the underlying mechanisms. Based on current published data histopathological findings associated with niche development were necrosis, fibrosis, inflammation, adenomyosis and insufficient approximation. Patient-related risk factors included multiple CS, BMI and smoking. Labour-related factors were CS before onset of labour, extended cervical dilatation, premature rupture of membranes and presenting part of the fetus at CS below the pelvic inlet. Preventive strategies should focus on the optimal level of incision, training of surgeons and full-thickness closure of the myometrium (single or double-layer) using non-locking sutures. Conflicting data exist concerning the effect of endometrial inclusion. Future studies without heterogeneity in population, using standardized performance of the CS after proper training and using standardized niche evaluation with a relevant core outcome set are required to allow meta-analyses and to develop evidence-based preventive strategies. These studies are needed to reduce the prevalence of niches and prevent complications in subsequent pregnancies such as caesarean scar pregnancies.

KeyWords: Niche, risk factors, caesarean section.

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Introduction.

Uterine niche is an iatrogenic pouch-like defect at the site of previous Cesarean scar due to defective tissue healing. Other terms used are uterine niche, Cesarean Scar defect, uterine dehiscence and diverticulum. The niche is defined radiologically as a triangular, hypoechoic or anechoic area at scar site (1). It has also been described as indentations at least 2 mm deep in the myometrium. There is recent surge in the literature including reviews addressing various aspects of niche (2).

Uterine niche occurs in up to 70% women with previous Cesarean Section of whom 30% are symptomatic. Reported prevalence varies: 24–70% with transvaginal sonography (TVS) and 56–84% with gel/saline instillation sonohysterography (SIS). This may be an underestimation because many women are

asymptomatic and also because clinicians may not recognize niche as a cause of symptoms due to unawareness. Prevalence of 45.6% was reported in a prospective observational study (n = 371) where sonohysterography was done six months post-Cesarean. Prevalence increases with increasing number of previous Cesareans (3).

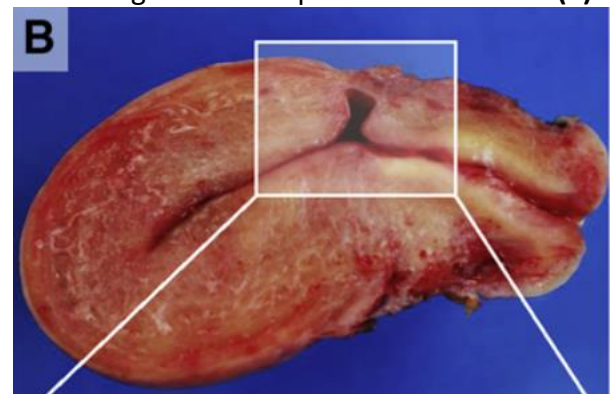


Figure 1 : Sagittal view of a frozen section from a hysterectomy specimen. A deep anterior defect covered with a thin layer of myometrium (4).



Potential Risk Factors

Niche forms due to poor healing of Cesarean scar. Risk factors may be surgery related or patient related (5).

Factors affecting lower uterine segment

- **Cervical dilatation prior to Cesarean Section**

Cervical dilatation of >5 cm, >5 hours duration of labour and advanced fetal station predispose to large niche due to thinner or lesser vascularized myometrium resulting in inadequate healing (3).

- **Level of uterine incision**

Lower uterine incision towards the cervix results in poor healing, as mucus secreted by cervical glands interferes with myometrial approximation. Mucous gradually increases the niche size also(6). Cesarean done in advanced labour after cervical effacement and also creation of uterovesical fold of peritoneum

influence the level of uterine incision (7). An incision given too high with respect to lower uterine segment may result in myometrial reconstruction and a resultant weak functional myometrium predisposing it to niche formation(8).

- **Uterine closure techniques**

Single-layer, decidual sparing closure technique predisposes to incomplete closure, compared to single full thickness closure. Almost 95% patients with niches had single-layer closure without closing peritoneum. A strong myometrial scar with proper anatomical approximation without tissue strangulation minimizes risk of niches (9).

If muscular edges are thick, they are best approximated by including deeper part in the first layer and the remaining superficial cut edges

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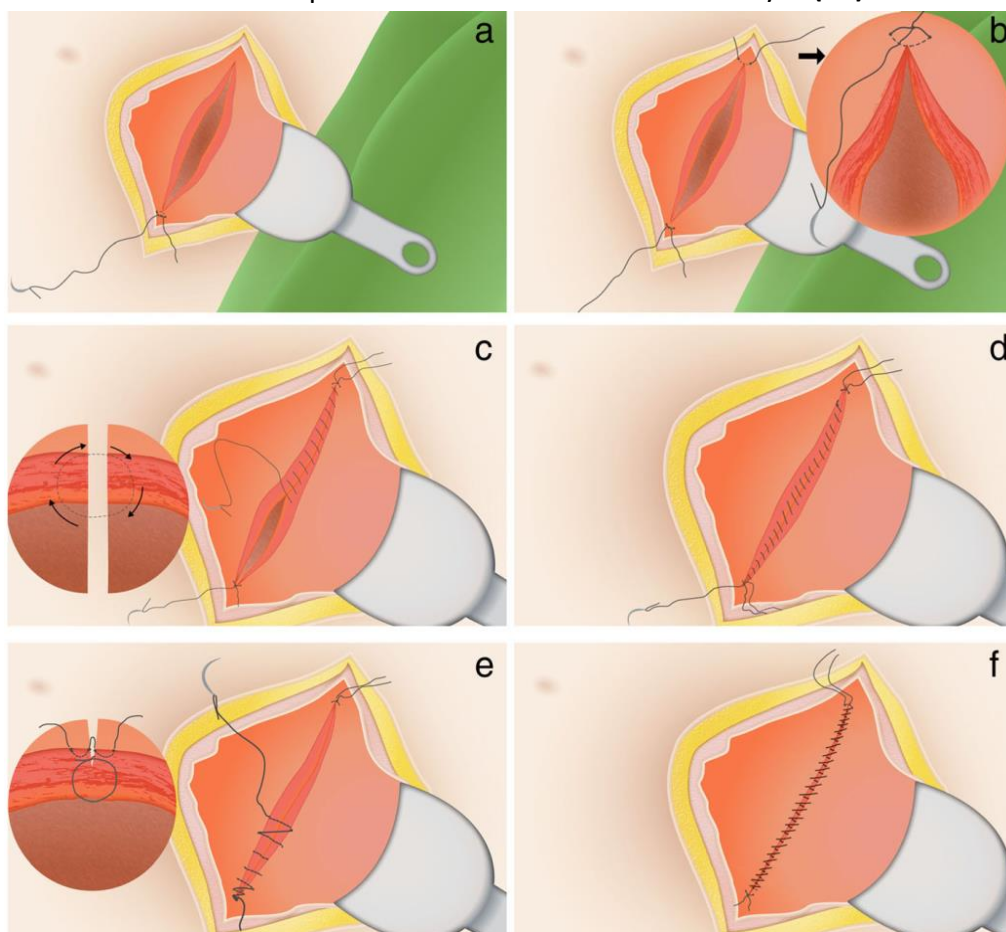


Figure 2 : Double-layer uterine closure technique. a. Step 1: lateral suture; b. Step 2: lateral suture on the other side; c. Step 3: First layer: full thickness, continuous, including large part of myometrium, including the endometrial layer; d. Step 4: End of this first layer; e. Step 5: Second layer: superficial continuous layer of serosal tissue, imbricating the first layer; f. Step 6: First and second layer should be closely connected(11).

Non-perpendicular sutures leading to an irregular myometrium closure, locking sutures or very tight second layer leading to ischemic necrosis result in poorly healed scar predisposing to niche formation (9). Thus, double-layer uterine closure using non-locking sutures is the optimal closure technique that results in thicker residual myometrium and hence potentially lower risk of niches (12).

In (13) study, they imply that synthetic multifilament suture (Vicryl) is associated with a lower niche rate than natural monofilament suture (catgut). Catgut may absorb prior to complete wound healing (14) and predispose a cesarean scar to niche formation compared to synthetic sutures. In a previous report multifilament suture (Vicryl) causes more niche formation than monofilament sutures (Monocryl). A suggested theory is that the suture remains for more than two weeks and induces an inflammatory reaction. Multifilament suture materials also have a structure that potentially has a space for bacterial needling and can impair wound healing (15).

Suboptimal surgical techniques: Inadequate haemostasis, tissue ischemia, devascularization and excessive tissue manipulation contribute to poor scar healing and adhesions, consequently forming niche (12).

- **Adhesions**

Adhesion formation with abdominal wall pulls the uterine scar towards abdominal wall, exerting counteracting force opposite to the direction of retracting uterine scar tissue and causing impaired wound healing (16).

- **Retroflexed Uterus**

Effect of gravity on uterine corpus also increases counteracting forces. Large niches are mostly found with retroflexed uterus (5).

Patient Factors

Genetic predisposition contributes to impaired healing, poor haemostasis, inflammation, or adhesion formation, post-operative infection (5). Gestational diabetes (odds ratio, 1.73), previous Cesarean Sections and advanced body mass index (OR, 1.06) are independent risk factors. Risk increases by 6% for every additional unit increase in body mass index. Longer active labour prior to emergency Cesarean also increases risk (OR, 1.06). However, there is no difference between elective and emergency Cesarean (12).

Repeated Cesarean Sections are purported to be associated with decreased perfusion of scar tissue, altered scar healing and progressive thinning of the area leading to niche formation. Literature quotes the incidence of niche as 62% after one, 68.2% two and 77.8% after three Cesarean Sections respectively (17).

Clinical Presentation

It is expected that niche related symptoms are associated to considerable direct and indirect costs, taking into account medical consultation, therapy (including hysterectomy) and absence from work (18).

In Focus Group Study done by (19) Although all niche-related outcomes could be reported, participants only prioritized themes in their top five. The overall top five was derived from the relevance scores of both FGDs "Focus Group Discussions":

1. Abnormal uterine bleeding
2. Subfertility
3. Sexual activity
4. Abdominal pain
5. Self-esteem

Other top five reported outcomes were AUB-associated odour, polyuria, energy and fatigue, personal relationships, pregnancy anxiety, psychological complaints and healthcare system features.





Figure 3 : Connection of domains and themes reported by niche patients. Size indicates relevance of the theme for Quality of Life, with larger themes being reported more frequently prioritized in the focus groups(19).

Though most women may remain asymptomatic, post-cesarean niche has been linked to following symptoms:

- **Post-menstrual Spotting**

It is defined as ≥ 2 days of intermenstrual spotting, or ≥ 2 days of brownish discharge after the end of menstruation if bleeding duration exceeds 7 days (discharge is considered normal if bleeding duration is < 7 days). Since not yet specified, it may be described as AUB-N as per FIGO-PALMCOEIN nomenclature of abnormal uterine bleeding (AUB) (20).

This is the most predominant symptom seen in 30–55% women at 6–12 months post-Cesarean due to collected menstrual blood. The anterior edge of niche obstructs flow of menstrual blood, besides, poor contractility of surrounding fibrosed muscle retains it, which is then discharged gradually (21).

When observed prospectively after 1 year of Cesarean, post-menstrual spotting was found in 20% women with niche compared to 8.3% women without niche, with 3.34 OR for large defects (3).

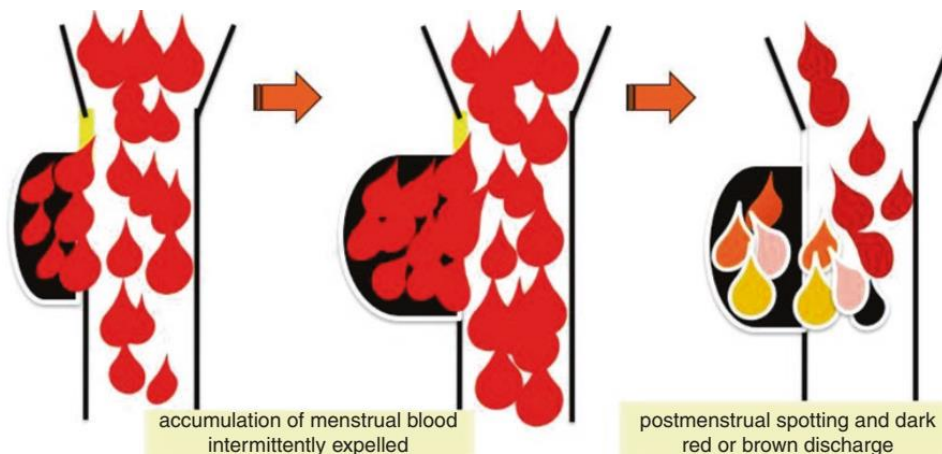


Figure 4 : Persistence and accumulation of menstrual blood in niche (22).

- **Intermittent Spotting**

In situ blood formation in the niche, evidenced by free erythrocytes in scar, leads to intermenstrual spotting.

- **Midcycle Intrauterine Fluid Accumulation**

It may be due to excess mucus formation by retained blood in approximately 45% women(7).

- **Pain**

Women with niche may present with dysmenorrhea (40–50%), chronic pelvic pain (35%), dyspareunia (18%) or suprapubic pain(23).

The etiology of niche related postmenstrual spotting and pain has not been fully elucidated. They are thought to be caused by retention of menstrual blood in a niche, which is intermittently expelled after the majority of the menstruation has ceased (24).

Blood can also accumulate, if fibrotic tissue in the myometrium at the site of the Cesarean scar may impair normal contractions and as a consequence the drainage of menstrual flow(25).

Additionally, newly formed fragile vessels in the niche may also attribute to the accumulation of blood or fluid in the niche or uterine cavity due to a constant low production of in situ leakage of blood and fluid. This is supported by the presence of free blood cells in the endometrial stroma, suggesting recent haemorrhage and

hysteroscopic evaluations where small vessels in the majority of patients are seen (26).

- **Cesarean Scar Ectopic Pregnancy**

Pregnancy may implant in the niche with risk of rupture (27).

- **Secondary Infertility**

Probable mechanisms might be chronic inflammation by residual blood or peri-ovulatory fluid accumulation interfering with sperm penetration, fertilization and implantation. A large niche may interfere with conception similar to hydrosalpinx(28).

- **Problems in IVF**

Difficult embryo transfer is encountered in 20% women with niche undergoing IVF, due to a distorted anatomy, especially in a retroflexed uterus. Also, chances of unsuccessful IVF are higher in presence of uterine niche (29).

- **Bladder Dysfunction**

Local accumulation of fluid and scarring were postulated to cause dysfunction due to proximity of niche to the bladder; however, prospective studies did not support this (30).

- **Obstetric Complications in Future Pregnancy**

There is increased risk of scar ectopic, placenta accreta, scar dehiscence and uterine rupture (19).

- **Scar Abscess**

Though rare, it has been reported even up to 6 years after Cesarean, due to residual blood and mucus that gets infected (2).

Niche Diagnosis and Classification

Uterine niche can be examined using two- or three-dimensional Transvaginal Ultrasound, as well as two- and three-dimensional sonohysterography, hysterosalpingography, hysteroscopy or magnetic resonance imaging (25). However, neither of the above diagnostic method is considered as the “gold standard”(31).

Transvaginal Ultrasound (TVS)

Transvaginal Ultrasound is the initial and least invasive diagnostic method used to evaluate the integrity of the uterus wall. The Cesarean Section scar may take the form of an isolated niche, a niche with fibrosis, an isolated fibrosis (32). In TVS, small niches may not be visible, or their parameters may be underestimated (33).

In 2007, in the study entitled “Ultrasonographic analysis of cesarean scar

features in nonpregnant uterus” for the first-time standardized ultrasound evaluation of the uterine niche was presented. In 2012, the same parameters were introduced for ultrasound examination of pregnant uterus by (34). In 2013, Tower et al. proposed a uterine niche classification based on RMT and RMT/adjacent myometrial thickness (AMT) ratio as the only ultrasound niche features (35).

In 2019, the guidelines for sonographic examination of uterine niche in non-pregnant women according to a modified Delphi procedure were introduced (36). According to these guidelines, basic niche evaluation includes the measurement of its length, depth, width, RMT, AMT, along with documentation and measurement of the present niche’s branches. RMT, length, depth of the niche should be measured in the sagittal plane, while the transverse plane is used to measure the width and identify its branches.



Figure 5 : Basic evaluation of the simple niche according to the study of Jordans IPM, et al. “Sonographic examination of uterine niche in non-pregnant women: a modified Delphi procedure” [3]; L — length; D — depth; RMT — residual myometrial thickness; AMT — adjacent myometrial thickness(31)

The assessment of the distance between the niche and the vesicovaginal fold, and between the niche and the external os of the cervix provide an extended niche assessment, which is helpful in surgical strategy planning. The use of Doppler imaging is not obligatory but can be useful in differentiating uterine niches from hematomas, adenomyomas, and fibrotic tissue. This publication also introduces the classification of niches according to their shape, with a division into simple niche, simple niche with one branch, complex niche (36).

Sonohysterography (SIS)

Sonohysterography is a diagnostic method in which Transvaginal Ultrasound of the uterus is enhanced by instillation of fluid into the uterine cavity to provide an anechoic contrast medium. It may be the sterile saline solution (SIS) or gel (GIS).



Figure 6 : 3D SIS image of the uterus showing the cesarean scar niche depth (16).

A 3D-sonohysterography evaluation of the niche should be performed between the 17–25 day of the menstrual cycle because the cervical mucous during the preovulatory phase

and blood deposits after menstruation may mix with the infused saline, which will deteriorate the quality of imaging (37).

During sonohysterography the same parameters of the cesarean scar niche as with TVS are measured, but it enables better visualization and demarcation of niche. Additionally, it has increased sensitivity and specificity for the detection of uterine niches by enhancing the niche and allowing its dynamic evaluation (31).

Compared to Transvaginal Ultrasound, it detects more niches (38) and more of them are classified as large. It is more invasive examination than TVS and carries a low risk of complications (such as infections). During this examination, the cesarean scar niche may also be overestimated (about 1–2 mm) due to its overstretching by flushed into uterine cavity fluid. The study by (39) showed that the detectability of the cesarean scar niche in SIS compared to hysteroscopy is 96%, while for intrauterine adhesions 91%, therefore SIS is a good alternative in the assessment of the uterine cavity.

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Hysterosalpingography (HSG)

Niche in HSG is visualized as a leakage of contrast from the uterine cavity into a myometrial defect. HSG also allows classification of the uterine niches in terms of its shape and location. The limitation of this diagnostic method is its inability to accurately measure RMT and other parameters of the niche. Moreover, if blood or mucus is accumulated in the niche, HSG may not clearly identify the uterine niche (40).



Figure 7 : Anteroposterior and lateral view a of hysterosalpingram of the uterus showing the uterine scar diverticulum (12).

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Magnetic Resonance Imaging (MRI)

MRI of the cesarean scar niche is not widely used due to its cost and availability. However, because it provides a comprehensive insight into the anatomy of the pelvis and its pathology, thanks to a higher tissue resolution and a wider field of view in comparison to TVS, it is particularly useful in planning surgery, especially if there are other pathological conditions of the female's reproductive organs (31).

Hysteroscopy

Diagnostic Hysteroscopy is the "gold standard" in the diagnosis of uterine abnormalities. During

this examination, the presence of the Cesarean Section scar niche can be directly visualized and confirmed (41). So far, the classification of the niches in hysteroscopic examination has not been described. The uterine niche in hysteroscopic examination is defined in various ways, e.g., a cavity with fibrotic ring, a pouch-like defect, a diverticulum with/without mucosa, a dome-shaped niche with nodules of endometrial hyperplasia/vascular hyperplasia (42).

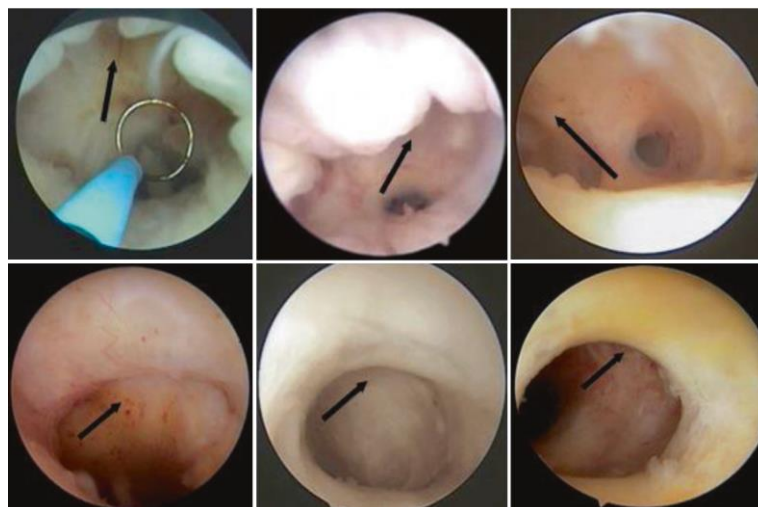


Figure 8 : Hysteroscopic appearance of niche (black arrows)(22)

There are no data in the literature on the relationship between the appearance of the uterine niche and the presence of clinical symptoms. During hysteroscopy, which was performed in a group of women with abnormal uterine bleeding after Cesarean Section, the areas of profuse vascularization or polyps in niche were present (43). Hysteroscopy can also show the invagination of the myometrium with residual blood, which may correspond to the menstrual blood accumulating in the niche or related to endometriosis (44).

Histological analysis of samples taken after hysteroscopic treatment of uterine niches showed the presence of chronic inflammatory infiltration of the endocervix, fibrosis and necrosis, adenomyosis and polyps (44).

Classification and Scoring

Some classifications are used for determination of the grade of niche. One of them is the classification of Gubbini et al., in which the surface of the defect is measured using its thickness and width. The defect is determined as *grade 1* when it is less or equal to 15 mm², *grade 2* - with a surface between 16 and 25 mm² and *grade 3* - when larger than 25 mm². In their initial report, they found that more than 55 percent of cases were of *grade 1*(45).

Table 1 : Classification of Niche (45)

Grade	Surface area
1	≤ 15 mm ²
2	16 to 25 mm ²
3	>25 mm ²

The second classification is the one of Ofili-Yebovi et al., which is based on the measurement of the endometrial thinning at the Cesarean defect; the authors defined the degree of thickness by the ratio between the myometrial thickness at the level of the defect and the thickness of the adjacent myometrium, and defined a severe defect as a ratio > 50 percent and dehiscence as a ratio equal or more than 80 percent. Other authors have defined CSD as severe when the remaining myometrium is less than 2.2 mm visualized by vaginal ultrasound or 2.5 mm in women who undergo sonohysterogram(17).

In the classification (VTS system) of Cesarean Section niches, which was proposed by A. Ludwin et al., the niche volume, RMT, presence supplementary features (niche’s branches, urinary bladder not covering the niche and suspicion of deeply infiltrating endometriosis in the niche) were assessed. Depending on the obtained total score, the niche is classified as probably clinically irrelevant or relevant (37).

Table 2: Proposed scoring system (VTS system) for classification of uterine niche according to presence of potentially clinically relevant features(37).

Feature	Score		
	0	1	2
Volume of niche*	< 0.1 cm ³	0.1–1.0 cm ³	> 1.0 cm ³
Thickness of residual myometrium	> 3 mm	1–3 mm	< 1 mm
Supplementary features‡	Absent	Present	---

Interpretation: niche with total score between 0 and 2 is probably clinically irrelevant and other specific features should be investigated; total score >2 indicates potentially clinically relevant features of uterine niche and future pregnancies should be monitored closely.
 *Estimated based on automatic calculation or manual calculation based on three diameters (length × depth × width × 0.52).
 ‡Supplementary features comprise presence of branches, urinary bladder not covering niche and suspicion of deep infiltrating endometriosis in niche.

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