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Cesarean Scar Niche: Risk Factors, Clinical Consequences, and Diagnostic Modalities - A Narrative Review

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Abstract

Cesarean scar niche is a defect of the myometrium at the site of a previous Cesarean section scar. Its reported prevalence varies widely according to the definition used, the studied population, the timing of evaluation, and the imaging modality. The condition results from impaired healing of the uterine incision and is influenced by surgical technique, intraoperative events, uterine anatomy, obstetric circumstances, and patient-related factors. Potential surgical determinants include the uterine incision site, single- or double-layer closure, locked or unlocked sutures, endometrial inclusion, suture material, uterine exteriorization, hemostatic technique, and visceral peritoneal closure. Cesarean scar niche may remain asymptomatic or may be associated with postmenstrual spotting, prolonged menstruation, dysmenorrhea, pelvic pain, dyspareunia, secondary infertility, Cesarean scar pregnancy, placenta accreta spectrum, and uterine rupture in subsequent pregnancy. Transvaginal ultrasound is the first-line diagnostic modality, saline infusion sonohysterography improves visualization and detection, and magnetic resonance imaging is reserved for complex or inconclusive cases. This narrative review summarizes the definition, epidemiology, pathophysiology, risk factors, clinical consequences, and diagnostic modalities of Cesarean scar niche, with particular attention to potentially modifiable surgical factors.

Keywords: Cesarean scar niche; isthmocele; uterine niche; scar defect; residual myometrial thickness; sonohysterography

Introduction

A Cesarean scar niche (also called isthmocele, Cesarean scar defect, or uterine niche) is defined as an indentation at the site of a previous Cesarean section scar in the lower uterine segment, typically visible on transvaginal ultrasound, saline infusion sonohysterography, or MRI [1].

The most widely accepted definition is an anechoic or hypoechoic triangular or semicircular defect with a depth of at least 2 mm in the myometrium at the site of the Cesarean scar. The defect may vary in size and shape (triangular, semicircular, droplet-shaped, or cystic) and represents incomplete healing of the uterine incision [2].

Some researchers distinguish between a simple niche (any defect ≥2 mm) and a large niche, which is often defined as one where the residual myometrial thickness (RMT) over the defect is less than 50% of the adjacent myometrium [2].

Clinical significance:

The clinical significance of a Cesarean scar niche lies in its ability to cause gynecological symptoms, reproductive difficulties, and obstetric complications. Although many niches are detected incidentally during imaging and remain asymptomatic, others can present with distressing symptoms that significantly affect a woman's quality of life [3].

The most common symptom is abnormal uterine bleeding, particularly postmenstrual spotting. This occurs because menstrual blood becomes trapped in the pouch created by the niche and is released gradually after menstruation. Some women also experience pelvic pain, dysmenorrhea, or dyspareunia, all of which are thought to be linked to blood retention, chronic inflammation, or induced myometrial contraction by chronic irritation of

retained blood. In addition, niches have been associated with seconda ry infertility, as the accumulated fluid or blood may impair sperm transport, embryo implantation, or endometrial receptivity [4].

In terms of reproductive and obstetric outcomes, Cesarean scar niches are clinically important because they may predispose women to severe complications in future pregnancies. One of the most concerning risks is Cesarean scar pregnancy, where the embryo implants directly within the defect. This condition carries a high risk of hemorrhage and uterine rupture. Similarly, abnormal placentation such as placenta previa or placenta accreta spectrum disorders can arise when the placenta implants abnormally at the scar site. In women with large defects and a thin residual myometrium, the likelihood of uterine rupture or dehiscence during pregnancy or labor is also increased [5].

Beyond the physical consequences, niches can negatively impact mental health and quality of life. Persistent spotting, infertility, or chronic pelvic pain can cause emotional distress, anxiety, and sexual dysfunction, leading to considerable psychological and relational challenges [6].

Clinically, identifying a niche is important because it helps explain unexplained bleeding or infertility in women with a history of Cesarean section. Recognition of the condition also guides management, as both medical and surgical approaches are available to improve symptoms and fertility outcomes. Thus, while a niche may initially appear as a simple imaging finding, it carries significant clinical implications that extend from daily well-being to the safety of future pregnancies [7].

Epidemiology of Cesarean Scar Niche:

Prevalence Rates:

A review [5] highlighted that the prevalence of Cesarean scar niche was highly variable ranging from about 19% up to 100%, depending on factors like definition, study design, and imaging modality.

In a cohort of 263 women just 6–12 weeks after CS, 64.5% were diagnosed via gel instillation sonography (GIS), while 50% were identified via transvaginal ultrasound (TVUS) only [5].

A comprehensive 2024 narrative review [8] confirmed similar variability, noting that niche prevalence is influenced by diagnostic method: 24–70% via TVUS, 56–84% via sonohysterography, with higher rates among symptomatic individuals.

Geographically Focused Findings:

A cross-sectional study [9] at Tanta University, Egypt involving 300 women found a 21.7% prevalence of Cesarean scar niche, with most being symptomatic and only 7.7% were asymptomatic.

A prospective study at Minia University ,Egypt women who had surgical site infection (SSI) post-CS reported an 84% niche prevalence overall 75% in superficial SSI cases and 90.1% in deep infections [10].

A retrospective study included 100 women in Bengladesh assessed via TVUS, factors like repeated CS, Single-layer uterine closure and found that Single-layer uterine closure was associated with 65% prevelance also retroflexed uterus was associated with 45% prevelance [11].

A prospective cohort study In Indonesia found a 44.3% (124/288 patients) prevalence of niche at six weeks post-CS via TVUS. Independent risk factors were included cervical dilatation over 4 cm, locking suture technique, non-closure of vesicouterine folds, and a retroflexed uterus [12].

Pathological and Post-Mortem Perspectives:

A cross-sectional study included 200 hysterectomy samples revealed that 83.5% of women had niches detected on pre-hysterectomy sonography, but 91% had niches confirmed in tissue specimens post-surgery highlighted under-detection in imaging alone(P=.008) [13].

Pathophysiology of Cesarean scar niche:

The pathophysiology of Cesarean scar niche formation is complex and multifactorial, involving impaired wound healing at the site of the uterine incision, surgical techniques, anatomical factors, and patient-related influences. A niche is essentially a localized defect in the myometrium of the lower uterine segment that develops when the healing process after Cesarean delivery is impaired [14].

Impaired Healing of the Uterine Incision:

Impaired healing of the uterine incision is the central mechanism behind niche formation and leads to several characteristic tissue changes:

- Myometrial thinning: Instead of complete regeneration of muscle fibers, the residual myometrium over the scar remains thinner than the surrounding uterine wall.
- Fibrosis and poor vascularization: Scar tissue replaces normal myometrium, with excessive collagen deposition and reduced blood supply, which weakens contractility and tissue remodeling.
- Deficient closure or incomplete tissue apposition: If myometrial edges are not properly aligned or adequately sutured, healing is impaired, leaving a pouch-like defect [8].

Surgical Factors:

Several surgical factors were shown to play a role in Cs scar niche development including low incision with cervical tissue involvement ,sigle layer uterine incision closure,excessive use of cautery and non closure of visceral peritoneum [15].

Anatomical and Uterine Factors:

Cs scar remodling was shown to be signically affected by uterine position (RVF) as retroflexed uterus applies tension to the scar, reducing proper apposition of incision edges and predisposing to defect development. Additionally, rapid postpartum uterine involution may stretch or deform the lower uterine segment, further disturbing scar integrity [16].

Patient-Related Factors:

Several maternal factors were found [17] to impair normal tissue healing and increase niche risk development, including advanced maternal age, obesity, smoking, and diabetes also Postoperative complications such as surgical site infection and /or endometritis were disrupt normal collagen deposition, angiogenesis, and myometrial repair, resulting in a defective scar formation.

Biological Mechanisms:

Histologically, niches are characterized by interrupted continuity of the myometrium, excessive fibrosis, poor vascularization, and /or reduced muscular regeneration. The pouch-like configuration of the defect leads to pool of the menstrual blood inside the niche enhancing local inflammation and subsequently more weakness. This Vicious cycle explains the persistence and progression of niche-related symptoms [18].

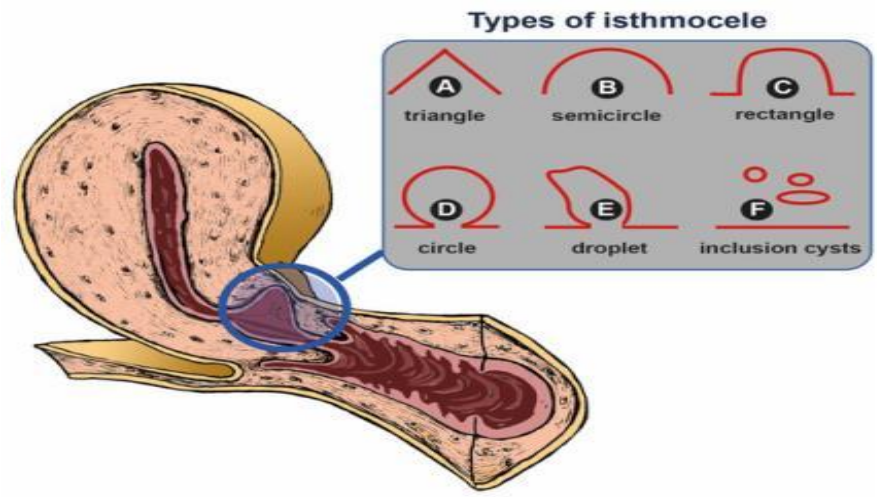

Figure (1): The picture shows a drawing of a longitudinal section of Uterus, Cervix and Vagina. In the blue circle in correspondence to the uterine isthmus, there is an enlargement (a sack or pouch) of the uterine cavity: isthmocele. On the top right of the image, there is a schematic representation of the possible different shapes of isthmocele: (A) triangle shape; (B) semicircle shape; (C) rectangle shape; (D) circle shape; (E) droplet shape; (F) inclusion cysts [19].

Risk factors of Cesarean Scar Niche

Cesarean scar niche development was strongly influenced by many interacting risk factors that negatively impact proper healing of the uterine incision. These factors was grouped into surgical technique–related, anatomical, patient-related, and obstetric/perioperative categories [5].

A. Surgical Technique–Related Risk Factors:

1. Uterine Incision Site:

The type and site of uterine incision had a major impact on niche formation.

Low transverse incision is the most common and generally preferred, but if placed too low and extending into the cervical tissue, it may impair myometrial regeneration and promote defect formation.

Low vertical incisions are less frequently used but may heal more effectively in some cases because they avoid cervical tissue; however, they are associated with higher risk of uterine rupture in subsequent pregnancies.

Classical (upper segment) incisions rarely result in niches because the upper segment is thicker and more vascularized, but they carry higher morbidity and are usually reserved for difficult obstetric cases [15].

2. Single vs. Double Layer Closure:

Single-layer closure had been associated in some studies with thinner residual myometrium and a higher risk of niche formation that was explained by inadequate reinforcement of the myometrial edges, 50 cases were evaluated by trans vaginal sonography (TVS), after 6 months of LSCS and there was observable thinning of the anterior lower uterine segment [20] in contrast double-layer closure was found to be associated with lower niche incidence that was explained by stronger tissue support, better alignment of incision edges, and less scar thinning [21].

Multicenter 2Close trial's 3-year follow-up [22] found no difference between single- and double-layer closure after a first Cesarean (≈68% vs. 71%), gynecologic symptoms were nearly equal in both groups while double-layer may improve scar morphology, it does not improve fertility or live-birth rates.

3. Locked vs. Unlocked Sutures:

Locked sutures created localized tissue ischemia, impairing vascularization leading to poor scar remodeling. While Unlocked sutures allowed more even tension distribution, that promotes better healing and thus reduce the risk of fibrotic defect formation [23].

A meta analysis [24] found that locked single-layer closure is associated with a higher risk of uterine rupture/dehiscence in a subsequent trial of labor compared with double-layer, while unlocked single-layer does not carry that higher risk.

4. Use of Endometrial-Sparing Closure:

There is ongoing debate over whether to include or exclude the endometrium during closure as including the endometrium ensures complete closure of the uterine wall but may increase the risk of intrauterine adhesions While excluding the endometrium (endometrial-sparing closure) theoretically reduces adhesions, but some studies suggest it might predispose to niche development because of incomplete apposition of tissue layers [25].

5. Type of Suture Material:

Delayed-absorbable sutures (e.g., polydioxanone, polyglactin with slower absorption) maintain tensile strength longer, supporting adequate wound healing and reducing scar thinning while rapidly absorbable sutures (e.g., Vicryl Rapide, Plain Gut) may lose support too quickly, leading to incomplete healing and higher risk of defect formation [26].

6. Exteriorization vs. In-situ Repair of Uterus:

Exteriorization of the uterus during closure allows better visualization of the incision and more precise apposition of the myometrial edges, potentially reducing niche risk In-situ repair may be technically easier but limits visibility, which could contribute to suboptimal closure and incomplete healing [27].

B. Intraoperative Factors:

1. Hemostasis Technique:

Excessive use of cautery or compression sutures may damage myometrial tissue, impair vascularization, and contribute to fibrosis and thinning at the incision site. Gentle hemostasis with minimal tissue trauma favors better scar healing [28], excessive use of diathermy at the uterine edges, aggressive devitalization, or overzealous compression sutures can damage myometrium and microvasculature and have been implicated in poorer scar healing [2].

2. Emergency vs. Elective Cesarean Section:

Emergency CS is associated with higher risk of niche formation. In emergencies, surgical conditions are often suboptimal, with less attention to meticulous closure due to urgency and dilated cervix with low incision near to cervix [29].

Elective CS generally allows controlled conditions, better incision placement, and more precise closure, resulting in improved scar healing [30].

3. Intraoperative Bleeding and Infection:

Excessive bleeding during surgery compromises visualization, which can impair closure accuracy and Large hematomas at the incision site may further interfere with wound healing also Infection (endometritis and/or wound contamination) pre and/or immediately after CS interfere with tissue regeneration, replacing healthy myometrium with poorly vascularized fibrotic tissue, thus predisposing to niche development [31].

C. Patient and Obstetric Factors:

1. Number of Prior Cesareans:

The risk of niche formation rises with increasing number of Cesarean deliveries. Each additional incision weakens the lower uterine segment by introducing new fibrotic tissue, reducing myometrial thickness, and impairing vascular supply. Repeated Cesareans also complicate surgical closure due to adhesions, which limit tissue mobility and precise apposition [32].

2. Thin Lower Uterine Segment:

A naturally thin lower uterine segment, especially in late gestation, provides less tissue bulk for suturing. This increases the chance of inadequate healing and persistent myometrial defects, which form the basis of a niche. Preoperative ultrasound measurement of residual myometrial thickness can help identify women at higher risk [33].

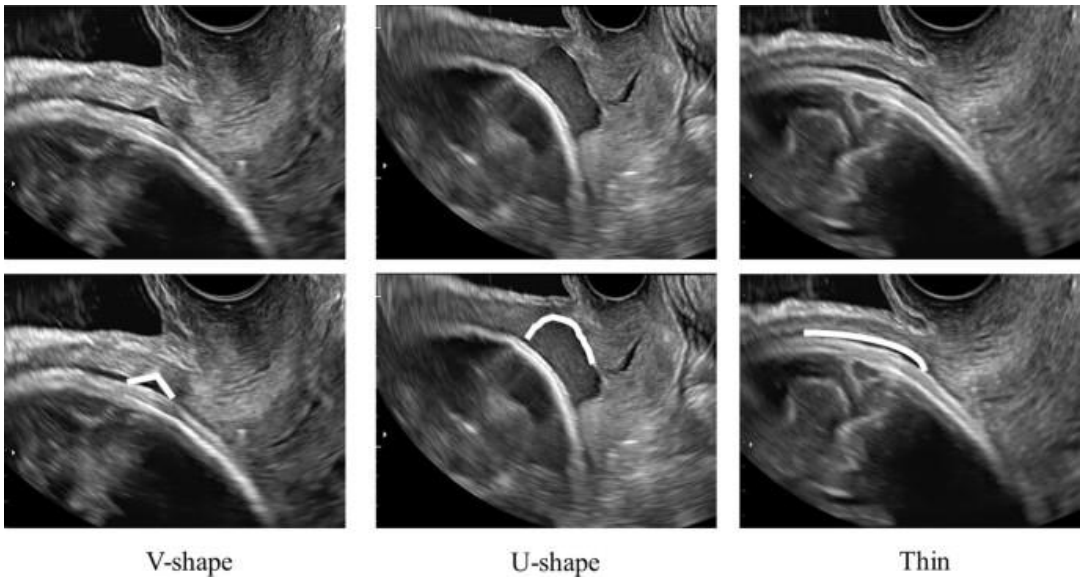

Figure (2): Classification of ultrasonographic images of the lower uterine segment [33]

3. Retroflexed Uterus:

A retroflexed uterus places continuous mechanical tension on the scar, preventing optimal edge alignment and promoting gradual separation of tissue planes during healing. This makes a residual gaps and thus enhance niche development compared with an anteflexed uterus which provide more favarabole tissue apposition [34].

4. Labor Before Cesarean Section vs Elective Cs:

Cesarean sections performed after and during active labor or in obstructed labor, are at higher risk for niche development as during labor, the lower uterine segment becomes overstretched and extremely thin, making it more difficult to achieve an adequate closure. In contrast, elective Cesarean sections performed before onset of labor generally provide better tissue conditions for incision and repair [35].

5. Maternal Comorbidities: Diabetes mellitus, Smoking, and Obesity:

Diabetes mellitus impairs angiogenesis and collagen remodeling, leading to poor tissue regeneration at the incision site also smoking reduces oxygen delivery and blood supply resulting in wound healing delay and favor fibrosis instead of muscular repair. Obesity increases surgical difficulty, prolongs operative time, favors infection, all of which negatively imact uterine healing and thus increases the risk of niche formation [36].

Clinical Consequences of Cesarean Scar Niche

A. Gynecological Consequences:

1. Abnormal Uterine Bleeding (AUB):

One of the most common clinical presentation of a niche is postmenstrual spotting or prolonged menstruation. Blood tends to collect in the defect (termed “niche reservoir”), where it is continue to releas slowly after menstruation, causing persistent dark spotting. Interfers with menstrual blood in addition to poor contractility of the fibrotic scar area. This symptom may significantly affect quality of life and push women to seek medical advice [35].

2. Dysmenorrhea:

Many women with a niche reported painful menstruation, either as primary dysmenorrhea or worsening of previously mild one. The scar defect can prevent normal uterine contractility, causing localized ischemia and pain, in addition retained blood in the niche may irritate the surrounding myometrium, enhancing cramping and discomfort during menstruation [37].

3. Secondary Infertility:

A niche may impair fertility in several ways:

Retained blood and inflammatory fluid in the defect may act as a hostile environment for sperm survival and embryo implantation also altered uterine contractility due to fibrotic tissue may interfere with sperm transport Inflammation and disturbed endometrial regeneration around the niche may reduce endometrial receptivity. As a result, women with a niche may experience delayrd conceiving , Surgical correction of a large niche (isthmoplasty) has been shown in some cases to improve fertility outcomes and The rate of spontaneous pregnancies within 6 months of niche repair was 30.4% [38].

B. Obstetric Consequences

1. Cesarean Scar Pregnancy (CSP):

A niche is a major predisposing factor for Cesarean scar pregnancy, a rare but serious complication where the gestational sac implants directly into the scar defect. The incidence of Cesarean scar pregnancy (CSP) is increasing reflecting the global increase in Cesarean section (CS) rate which has almost doubled since 2000. This occurs because the poorly vascularized fibrotic tissue provides an abnormal implantation site. CSP carries high risks of massive hemorrhage, uterine rupture, and even hysterectomy if not recognized early [39].

2. Increased Risk of Placenta Previa and Placenta Accreta Spectrum (PAS):

A Cesarean scar niche alters the endometrial and myometrial architecture, increasing the risk of abnormal placental implantation in subsequent pregnancies. Placenta previa may occur because the lower uterine segment near the scar becomes a favorable site for implantation [40].

A prospective observational research included 122 participants during the first-trimester screening. The CS scar defect was visible in 40.2% of cases. In cases after one previous CS, the placenta was low in the uterine cavity (anterior or posterior) at 77.4%, and after two or more CSs, it was at 67.9%. Comparing the two groups according to the CS scar niche, the placenta was low in 75.5% of cases in the participant group with a CS scar niche and in 75% of cases without a CS scar niche (p=0.949).

Placenta accreta spectrum (PAS) disorders (accreta, increta, percreta) are strongly linked to prior Cesarean sections and niches, as the scarred area lacks a normal decidual layer, allowing placental villi to invade abnormally deep into the myometrium or beyond. These conditions can cause life-threatening hemorrhage during delivery [41].

3. Uterine Rupture in Subsequent Pregnancy:

A significant obstetric consequence of a niche is uterine rupture during pregnancy or labor. The niche represents a structurally weakened area with thinned myometrium, which may not withstand the stress of uterine expansion or contractions. Risk increases with deeper and larger defects, multiple prior Cesareans, and labor induction. Uterine rupture is a catastrophic event, potentially leading to severe maternal hemorrhage, fetal distress, or death if not managed urgently

In a retrospective case control study from Ireland, 30 women with live Cesarean scar pregnancies managed expectantaly, two of whom had uterine rupture and hysterectomy in the second trimester [3].

Diagnostic Modalities of Cesarean Scar Niche

Accurate diagnosis of a Cesarean scar niche is essential for both symptom correlation and planning proper management. Imaging plays a critical role in detection and characterization of it. The main diagnostic modalities include transvaginal ultrasound (TVUS), saline infusion sonohysterography (SIS), and Magnetic Resonance Imaging (MRI) [3].

1. Transvaginal Ultrasound (TVUS):

TVUS is the first-line imaging modality for diagnosis of Cesarean scar niche. It is non-invasive, widely available, and cost-effective.

- Typical appearance: A triangular, anechoic or hypoechoic defect (>2 mm) at the site of the previous scar, often with thinning of the overlying myometrium (residual myometrium).
- Advantages: accurate assessment of niche depth, residual myometrial thickness, and presence of intra-niche fluid (blood or secretions). and used for initial evaluation in women with abnormal uterine bleeding or infertility

A prospective observational cohort study was carried out at Tampere University Hospital, Finland. Non-pregnant women delivered by Cesarean section (n=371) were examined with transvaginal ultrasonography and sonohysterography six months after Cesarean section.

In all, 371 women were included,The prevalence of isthmocele was 22.4% based on TVUS and 45.6% based on SHG, Sensitivity and specificity for TVUS was 49.1 and 100%, respectively, when compared with SHG, Therefore, half of the defects (50.9%) diagnosed with SHG remained undiagnosed with TVUS [42].

There were limitations due to sensitivity depends on operator expertise and uterine orientation. Small niches or those in a retroflexed uterus may be missed [43].

On ultrasound, the uterine niche can be classified as simple, simple with one branch, or complex (main niche with more than one branch). A branch is a smaller part at the serosal side with a width less than that of the main niche. For surgical planning, it is essential to estimate distances between the niche and the external os, as well as between the niche and the vesicovaginal fold (residual myometrial thickness), although not essential for basic

evaluation. Depth, width, length, residual myometrial thickness (RMT), Adjacent myometrial thickness (AMT), and distances to the external os are clinically significant measurements.

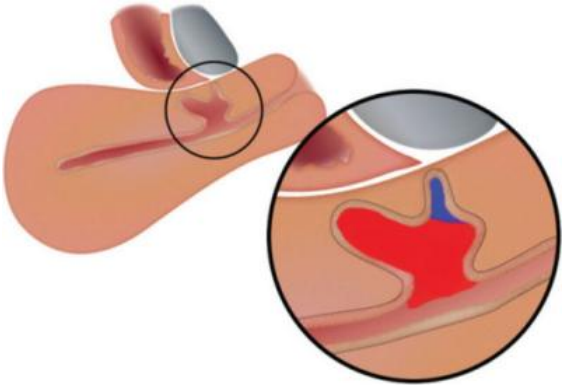

Figure (3): (diagramtic picture) Red area representing the main niche, while the blue-colored area represents the branch [8].

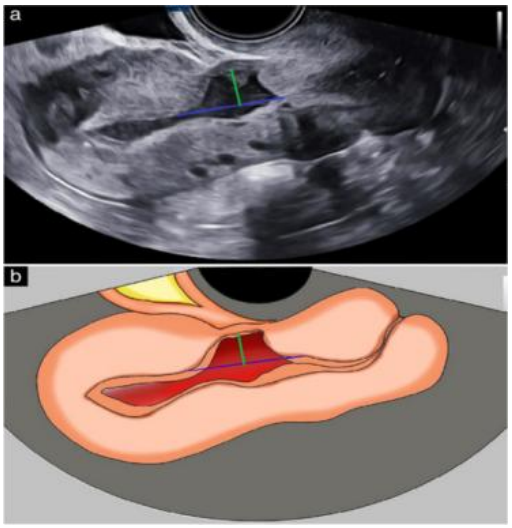

Figure (4): a- Sagittal view of uterus measuring depth and length of uterine niche b- diagramtic picture show sagittal view of uterus measuring depth and length of uterine niche [8].

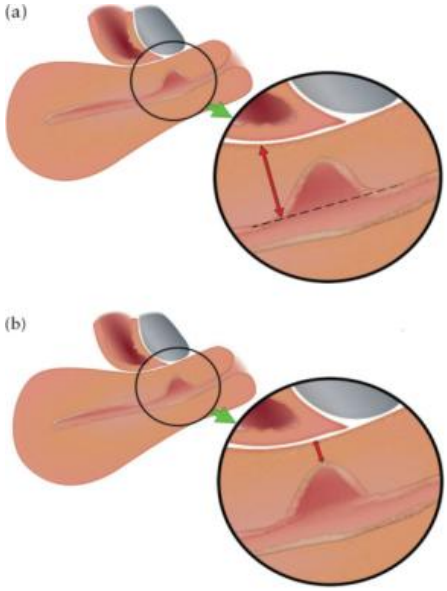

Figure (5):a,b diagrammatic picture drawn to show Sagittal view of uterus to assess RMT and AMT [8].

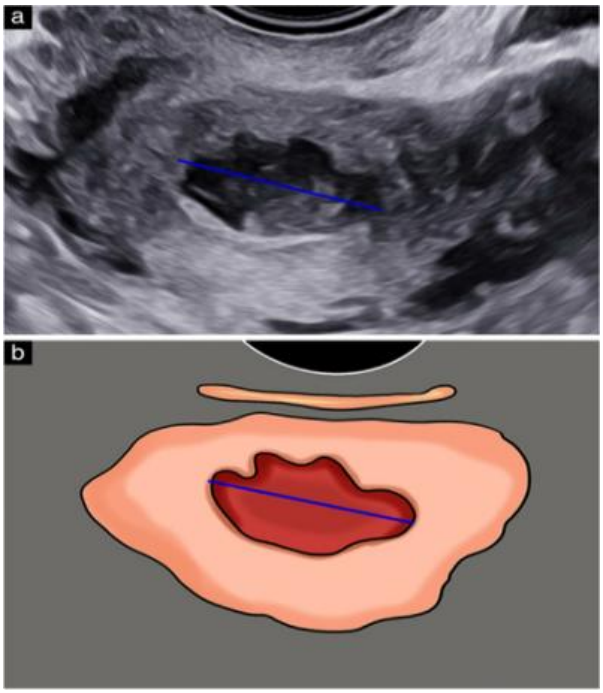

Figure (6):a- Transverse plane of niche width, b- a diagrammatic picture shows the transverse plane of niche [8].

2. Saline Infusion Sonohysterography (SIS):

SIS, also known as sonohysterography or sonohysterogram, is considered more sensitive than TVUS for detecting and characterizing niches.

- Technique: Sterile saline is infused into the uterine cavity during transvaginal ultrasound, which distends the cavity and enhances visualization of the niche.
- Advantages: delineate clearly niche size, shape, and site relative to the endometrial cavity. It also illuminate residual myometrial thickness more accurately than TVUS alone.
- Its use is valuable in women with infertility or recurrent postmenstrual spotting, where niche size and residual myometrium thickness determine treatment decisions (e.g., hysteroscopic vs. laparoscopic repair) but it is a more invasive procedure than TVUS alone and may cause mild cramping or discomfort.

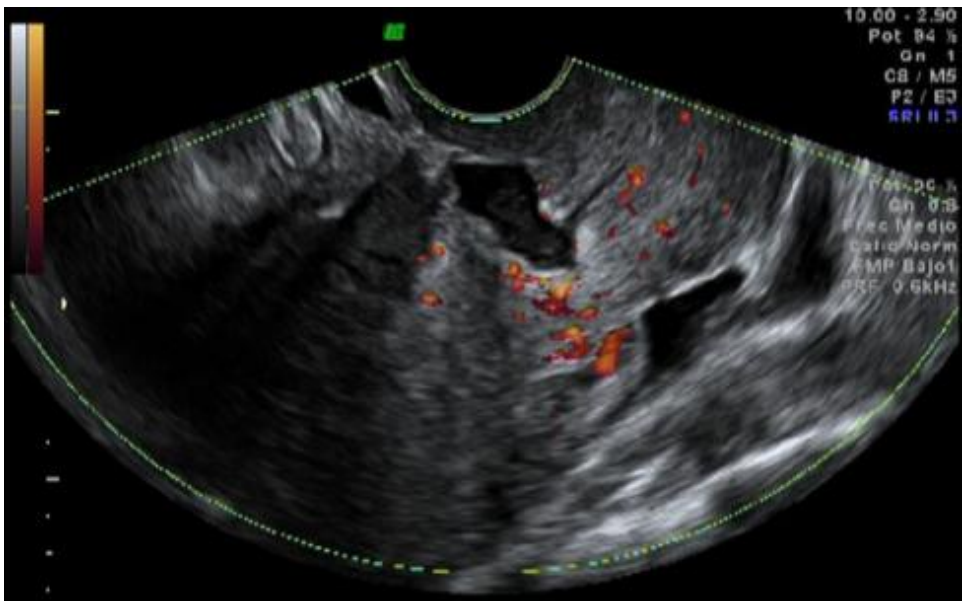

Figure (7): Transvaginal saline-contrast sonohysterography showing large niche [44]

3. Magnetic Resonance Imaging (MRI):

MRI is not routinely required but serves as an additional and secoundary imaging tool in complex cases especialy when surgical planning is needed.

Advantages:

It Provides excellent soft-tissue contrast, allowing detailed evaluation of the niche, including depth, width, and residual myometrium thickness also it can Identify associated pathologies such as adhesions, adenomyosis, or placenta accreta spectrum disorders in C.s scar pregnancy.

Clinical use: Reserved for cases where ultrasound findings are inconclusive or when complex reconstructive surgery is being considered but its higher cost, limited availability limit its use.

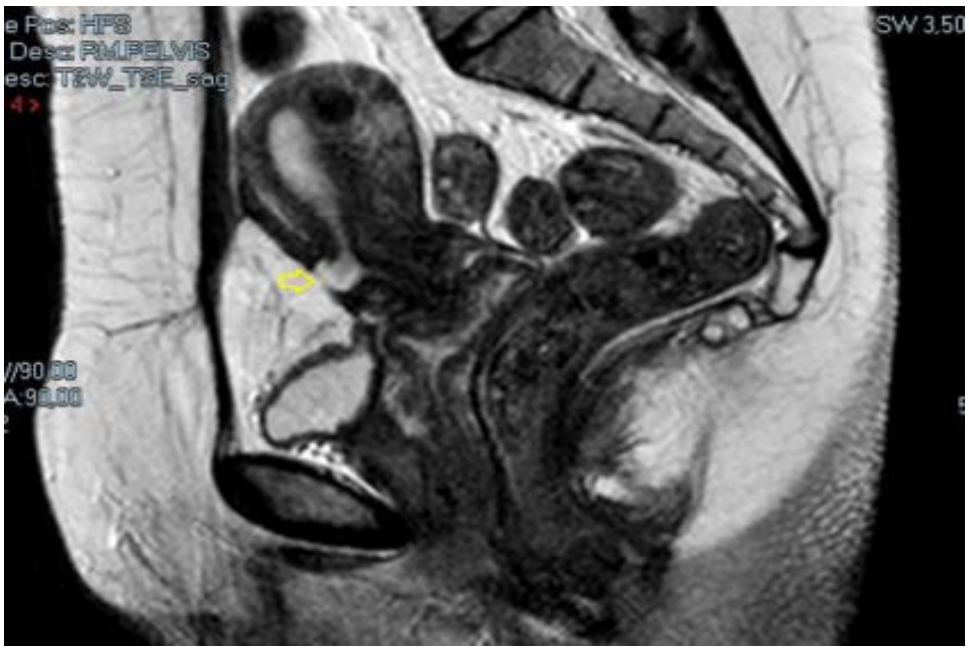

Figure (8): Isthmocele (arrow) as depicted by magnetic resonance imaging [44]

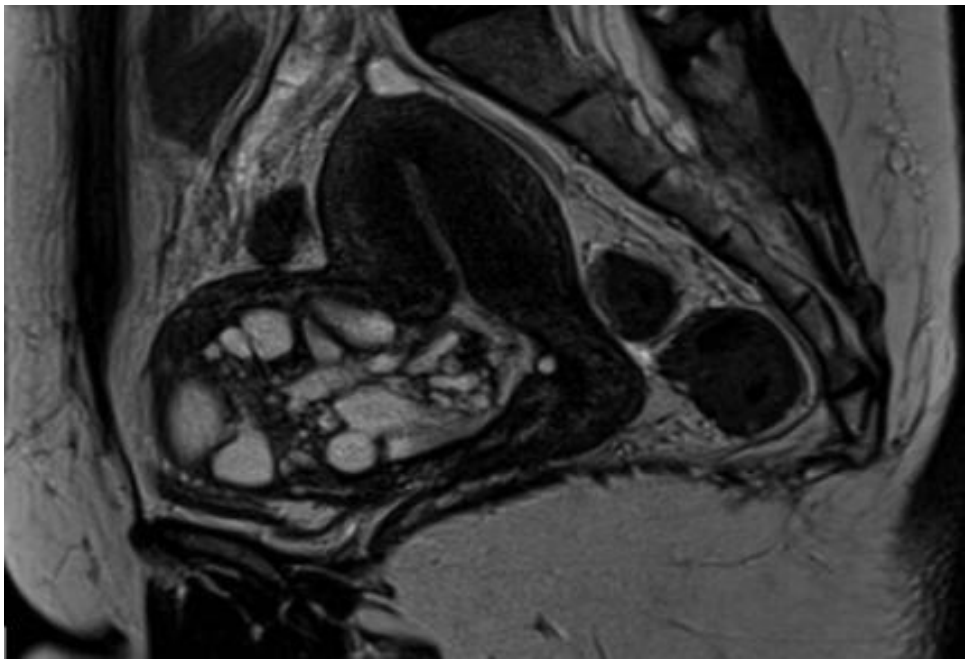

Figure (9): Magnetic Resonance Imaging (MRI) demonstrating a bulky isthmocele at Cesarean section scar with several cysts inside [45].

Conclusion

Clinically, identifying a niche is important because it helps explain unexplained bleeding or infertility in women with a history of Cesarean section. Recognition of the condition also guides management, as both medical and surgical approaches are available to improve symptoms and fertility outcomes. Thus, while a niche may initially appear as a simple imaging finding, it carries significant clinical implications that extend from daily well-being to the safety of future pregnancies [7].

Accurate diagnosis of a Cesarean scar niche is essential for both symptom correlation and planning proper management. Imaging plays a critical role in detection and characterization of it. The main diagnostic modalities include transvaginal ultrasound (TVUS), saline infusion sonohysterography (SIS), and Magnetic Resonance Imaging (MRI) [3].

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