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REPRODUCTIVE DYSFUNCTION AFTER CESAREAN SECTION: THE ROLE OF ISTHMOCELE, DIAGNOSIS, AND TREATMENT

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Abstract: Cesarean section is a life-saving mode of delivery; however, the increasing number of procedures is accompanied by a rise in long-term complications that may impair menstrual and reproductive function. One of the most clinically significant consequences is a uterine scar defect—an isthmocele. This review summarizes evidence on the prevalence, mechanisms of formation, clinical manifestations, diagnosis, and treatment of isthmocele in women of reproductive age. A scar defect may promote retention of menstrual blood, chronic inflammation, and bacterial colonization of the uterine cavity, impair sperm transport, and reduce endometrial receptivity. Clinically, isthmocele may present with postmenstrual spotting, dysmenorrhea, chronic pelvic pain, and secondary infertility. Transvaginal ultrasonography is the primary first-line diagnostic modality; saline infusion sonohysterography, hysteroscopy, and magnetic resonance imaging are used to further characterize the defect and plan surgery. Management is determined by symptom severity, niche depth, residual myometrial thickness, and reproductive plans. Hysteroscopic correction is appropriate for small defects with adequate myometrial thickness, whereas deep niches require reconstructive metroplasty. Early diagnosis and an individualized, organ-preserving approach can reduce clinical symptoms and increase the likelihood of a subsequent pregnancy.

Keywords: cesarean section, uterine scar, isthmocele, secondary infertility, abnormal uterine bleeding, chronic endometritis, metroplasty.

Introduction

Cesarean section remains one of the most important procedures in modern obstetrics and, when performed for appropriate indications, reduces the risk of maternal and perinatal morbidity and mortality. At the same time, the sustained increase in cesarean delivery rates has created a new clinical population—women of reproductive age with a uterine scar. Traditionally, follow-up of these women has focused on the risks of subsequent pregnancy and childbirth, whereas disorders occurring outside pregnancy were underestimated for many years.

In recent years, the concept of "cesarean scar syndrome" has emerged, encompassing abnormal uterine bleeding, dysmenorrhea, chronic pelvic pain, dyspareunia, and secondary infertility associated with a defect of the anterior uterine wall at the site of a previous incision. A cesarean scar niche, or isthmocele, is an indentation of the myometrium that communicates with the uterine cavity. It may remain asymptomatic; however, when accompanied by blood retention, thinning of the residual myometrium, and chronic inflammation, it becomes clinically significant in its own right [1, 2].

The relevance of this problem is determined by the high prevalence of cesarean scar niches, the diversity of their manifestations, and the absence of a single universal treatment algorithm. Selecting an appropriate strategy is particularly challenging in women planning pregnancy, because

symptoms must be relieved and the anatomy of the lower uterine segment restored without increasing the risk of complications during a subsequent gestation.

Objective of the Review

To systematize current concepts regarding the mechanisms of reproductive dysfunction after cesarean section, define the role of imaging and endoscopic methods in the diagnosis of isthmocele, and present a differentiated organ-preserving treatment approach for women planning pregnancy.

Materials and Methods

An analytical review was conducted of national and international publications included in the study literature database and devoted to the long-term consequences of cesarean section. The analysis primarily included studies published between 2013 and 2024, together with selected fundamental investigations addressing scar morphology and the pathogenesis of clinical symptoms. Evidence from cohort studies, systematic reviews, meta-analyses, and clinical guidelines on the diagnosis and correction of cesarean scar defects was evaluated.

Prevalence and Clinical Significance of Isthmocele

The detection rate of a niche depends on the examination method, the interval since surgery, the number of previous cesarean sections, and the diagnostic criteria applied. In a multicenter prospective study of 546 women examined 6 months after surgery, a scar defect was diagnosed in 44.4% of cases [2]. Saline infusion sonohysterography generally detects niches more frequently than standard transvaginal ultrasonography because distension of the uterine cavity improves visualization of the internal contour of the defect.

The presence of a niche does not always correspond to a clinical syndrome. Its dimensions, depth, width, volume, residual myometrial thickness, uterine position, fluid accumulation, and association with symptoms are of practical importance. Repeat procedures, emergency cesarean section, a low uterine incision, technical aspects of uterine closure, infectious and inflammatory complications, and impaired uterine involution are regarded as factors contributing to incomplete healing.

Outside pregnancy, a scar defect may cause abnormal uterine bleeding, pelvic pain, and infertility. During a subsequent pregnancy, it is associated with cesarean scar implantation, abnormal placentation, and a potential risk of lower uterine segment dehiscence. Isthmocele should therefore be assessed not as an isolated ultrasound finding but as an anatomic and functional condition that must be interpreted in relation to the patient's symptoms and reproductive plans.

Pathogenesis of Reproductive Dysfunction

Reduced fertility after cesarean section is multifactorial. Meta-analyses have demonstrated a longer interpregnancy interval and a lower likelihood of subsequent pregnancy after cesarean delivery [6]. In the presence of an isthmocele, additional local mechanisms may impair natural conception and the outcomes of assisted reproductive technologies.

The most widely accepted hypothesis involves retention of menstrual blood within the scar niche. Prolonged accumulation of blood and mucus sustains postmenstrual spotting and alters the intrauterine environment. Niche contents may adversely affect cervical mucus, reduce sperm motility, and impede sperm transport. Hemoglobin breakdown products and excess iron increase oxidative stress, activate macrophages, and perpetuate the inflammatory response.

Chronic inflammation represents a second key mechanism. Bacterial colonization of the defect is detected more frequently in women with secondary infertility than in those without a niche; the reported microbial spectrum includes gram-positive cocci and gram-negative bacilli [7]. In the study by Y. Nobuta et al., chronic endometritis and increased production of proinflammatory cytokines were more common in patients with cesarean scar syndrome [9]. These inflammatory changes impair endometrial receptivity, implantation, and early placentation.

A third mechanism is anatomic distortion of the uterus. A pronounced niche may alter the orientation of the cervical canal and uterine cavity, complicate embryo transfer—particularly in a retroflexed uterus—and promote fluid accumulation before transfer. A retrospective analysis of in vitro fertilization cycles after cesarean section demonstrated lower live birth rates than those observed in women with a history of vaginal delivery [8].

Finally, localized adenomyosis or endometriosis may develop in the scar region, intensifying pain and inflammation and impairing myometrial contractility. The combined effects of these mechanisms explain why the severity of reproductive dysfunction is not always directly proportional to niche size alone and why a comprehensive assessment is required.

Table 1. Principal Pathogenetic Mechanisms of Reproductive Dysfunction Associated with Isthmocele

Mechanism	Pathophysiologic significance	Potential clinical consequence
Retention of blood and secretions	Prolonged persistence of contents within the niche, with alteration of cervical mucus and the intrauterine environment.	Postmenstrual spotting and impaired sperm transport.
Chronic inflammation and dysbiosis	Bacterial colonization, activation of proinflammatory cytokines, and endometrial injury.	Chronic endometritis and reduced receptivity and implantation.
Iron overload and oxidative stress	Hemoglobin breakdown products activate macrophages, angiogenesis, and fibrosis.	Persistent inflammation and scar-associated endometriosis/adenomyosis.
Anatomic distortion	Altered orientation of the cervical canal and uterine cavity, with fluid accumulation.	Difficult embryo transfer and reduced effectiveness of assisted reproductive technologies.
Thinning of the residual myometrium	Deficiency of the muscular layer and impaired contractile function.	Pain and an increased risk of complications in a subsequent pregnancy.

Clinical Manifestations

The most typical symptom of isthmocele is postmenstrual spotting. According to systematic reviews, abnormal uterine bleeding occurs in approximately one-quarter of patients with a cesarean scar defect, and both its frequency and duration increase with larger niches [3, 4]. Blood retention within the defect prolongs menstrual bleeding, causes discomfort, and may contribute to iron deficiency.

Chronic pelvic pain and dysmenorrhea are associated with inflammation, impaired drainage of niche contents, and deformation of the lower uterine segment. Symptoms are generally more severe in women with deep defects and uterine retroflexion. Some patients also experience dyspareunia and a reduced quality of life, requiring the condition to be considered not only from the perspective of fertility but also in terms of overall gynecologic health.

Secondary infertility is the most clinically important manifestation in women seeking to achieve pregnancy. Large meta-analyses have associated cesarean delivery with a longer time to the next pregnancy, while individual studies have reported an approximately 10% lower probability of subsequent pregnancy [6]. Nevertheless, a causal role of a specific niche should be established only after other factors of infertility have been excluded.

Diagnosis

The diagnostic evaluation begins with a detailed medical history, including the number and urgency of previous cesarean sections, the postoperative course, menstrual characteristics, duration of infertility, pelvic pain, previous inflammatory disease, and pregnancy plans. Physical examination usually reveals no specific signs; therefore, imaging plays the leading role.

Transvaginal ultrasonography is the first-line diagnostic method. It is preferably performed during the early follicular phase, when a small amount of fluid may naturally outline the defect. The report should describe niche shape, depth, and width; residual myometrial thickness; total thickness of the anterior uterine wall; the presence of fluid; uterine position; and concomitant endometrial or myometrial pathology [1, 2].

Saline infusion sonohysterography increases the sensitivity for detecting small defects and provides a more accurate assessment of their internal contours. Hysteroscopy directly visualizes the niche opening, fibrotic margins, vascular pattern, and concomitant intrauterine pathology. It is particularly useful in patients with abnormal uterine bleeding and when hysteroscopic correction is being planned. Magnetic resonance imaging is used in cases of complex anatomy, suspected endometriosis, marked deformation, or when the relationship of the defect to the urinary bladder requires clarification.

A clinically significant isthmocele is diagnosed by correlating imaging findings with symptoms. The mere presence of a niche in an asymptomatic woman is not an automatic indication for surgery. Conversely, the combination of secondary infertility, intracavitary fluid, postmenstrual spotting, and thinning of the residual myometrium warrants a more detailed evaluation and discussion of organ-preserving correction.

Table 2. Diagnostic Methods for Cesarean Scar Defects

Method	Principal capabilities	Practical application

Method	Principal capabilities	Practical application
Transvaginal ultrasonography	Detection of the niche; measurement of its depth and width; assessment of residual myometrial thickness and fluid.	First-line method and follow-up assessment.
Saline infusion sonohysterography	Contrast enhancement of internal contours and detection of small or complex defects.	Refinement of morphometric assessment when standard ultrasonography is inconclusive.
Hysteroscopy	Direct assessment of the niche opening, fibrotic margins, endometrium, and source of bleeding.	Evaluation of abnormal uterine bleeding and planning of hysteroscopic correction.
Magnetic resonance imaging	Detailed assessment of the myometrium, endometriosis, deformation, and relationships with adjacent organs.	Complex cases and preparation for reconstructive surgery.

Treatment and Prevention

The goals of treatment are to relieve abnormal bleeding and pain, treat chronic inflammation when indicated, restore the anatomy of the lower uterine segment, and create conditions for a safe pregnancy. The choice of treatment depends on symptom severity, niche characteristics, residual myometrial thickness, concomitant pathology, and reproductive plans.

Conservative therapy may reduce spotting and pain but does not correct the anatomic defect. It may be considered in patients without reproductive plans, in those with mild symptoms, or when temporary contraindications to surgery are present. Confirmed chronic endometritis requires etiologically targeted treatment followed by reassessment of the endometrium; prolonged empirical antibacterial therapy in the absence of documented infection should not replace correction of a pronounced defect.

Hysteroscopic resection is intended to smooth the lower edge of the niche, improve drainage of menstrual blood, and coagulate pathologically altered tissue. It is less invasive and effective for postmenstrual spotting, but it does not restore the thickness of the anterior uterine wall. Therefore, in women planning pregnancy, this method is preferable for small defects with adequate residual myometrium; a threshold greater than 2.5–3 mm is frequently cited in the literature [10, 11].

Reconstructive metroplasty is indicated for a deep niche, marked myometrial thinning, or external deformation. A laparoscopic approach allows excision of fibrotic tissue, approximation of viable myometrial edges, and restoration of anterior uterine wall anatomy. Transvaginal repair may be used when the defect is favorably located and the surgeon has appropriate expertise [13]. Laparotomy remains relevant in the presence of extensive adhesions, major concomitant pathology, or the need for a more extensive procedure.

After surgery, scar healing should be monitored, the uterine cavity reassessed, and the timing of pregnancy planned. Most publications recommend postponing embryo transfer or attempts at natural conception for 3–6 months after reconstruction, although the interval should be individualized according to imaging findings. Preventive strategies include appropriate selection of the uterine incision level, accurate approximation of the myometrial edges, standardization of uterine closure, and prevention of postpartum infection [15]. An interpregnancy interval of at least 18 months after cesarean section is considered an important component of reducing obstetric risk [16].

Table 3. Differentiated Selection of Treatment Strategy

Clinical scenario	Preferred approach	Key conditions
Asymptomatic niche	Observation and ultrasound follow-up.	No infertility, intracavitary fluid, or marked thinning of the residual myometrium.
AUB or pain without reproductive plans	Conservative therapy or hysteroscopic correction.	Assessment of concomitant endometrial pathology and contraindications.
Small niche with adequate residual myometrium	Hysteroscopic resection or smoothing of the niche margins.	Predominantly intracavitary defect and informed discussion of a future pregnancy.
Deep defect with thin myometrium	Laparoscopic or transvaginal metroplasty.	Need for anatomic restoration of the uterine wall.
Complex concomitant pathology	Open or combined reconstruction.	Extensive adhesions, leiomyoma, adenomyosis, or another surgical indication.

Conclusion

Isthmocele is a common morphologic consequence of cesarean section that, when symptomatic, may substantially impair menstrual and reproductive function. The principal pathogenetic mechanisms of secondary infertility include blood retention within the niche, chronic inflammation and dysbiosis, reduced endometrial receptivity, anatomic distortion of the uterine cavity, and difficulty with embryo transfer.

Transvaginal ultrasonography should be an essential component of the evaluation of women with postmenstrual spotting, pelvic pain, or secondary infertility after cesarean section. Detailed morphometric assessment of the niche and residual myometrium provides a rational basis for selecting observation, hysteroscopic correction, or reconstructive metroplasty.

The optimal strategy should be individualized and organ-preserving. Surgical intervention is justified not merely by the detection of a niche but by the combination of clinical symptoms, impaired fertility, and unfavorable anatomic characteristics. Future priorities include standardization of ultrasound criteria, assessment of endometrial receptivity, and comparative studies of reproductive outcomes following different correction techniques.

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