Medical Science

To Cite:
Kasianik W, Kowalczuk D, Lazitskaya D, Sobchynskyi M, Surosz N, Turlej K, Myrny A, Milasheuskaya V, Kiełbaszewska I, Miraniuk K, Wiczkowski D. Cesarean scar defects as an underestimated cause of secondary infertility. *Medical Science* 2025; 29: e211ms3707
doi: https://doi.org/10.54905/disssi.v29i164.e211ms3707

Authors' Affiliation:
[1]Mazovian Rehabilitation Center STOCER Ltd. Saint Anna Hospital, Barska 16/20, 02-315 Warsaw, Poland
[2]Międzyleski Specialist Hospital in Warsaw, Bursztynowa 2, 04-749 Warsaw, Poland
[3]University Clinical Center of the Medical University of Warsaw, Banacha 1A, 02-097 Warsaw, Poland
[4]Wroclaw Medical University, wyb.Ludwika Pasteura 1, 50-367 Wroclaw, Poland
[5]Independent Public Healthcare Center in Hajnówka, Doc. Adama Dowgirda 9, 17-200 Hajnówka, Poland
[6]Medical University of Warsaw, Zwirki i Wigury 61, 02-091 Warsaw, Poland
[7]Independent Public Specialist Western Hospital named after St. John Paul II, Daleka 11, 05-825 Grodzisk Mazowiecki, Poland

***Corresponding author:**
Wiktoria Kasianik,
Mazovian Rehabilitation Center STOCER Ltd. Saint Anna Hospital,
Barska 16/20, 02-315 Warsaw, Poland
Email: wiktoriakasianik2@gmail.com

Contact List:

Wiktoria Kasianik	wiktoriakasianik2@gmail.com
Dmytro Kowalczuk	dmytro.kovalchuk1999@gmail.com
Darya Lazitskaya	datskayalo@gmail.com
Kamil Turlej	kturlej99@gmail.com
Mykola Sobchynskyi	sobczynski0@gmail.com
Valeryia Milasheuskaya	valeryiamilasheuskaya@gmail.com
Andrzej Myrny	andmyrnyi@gmail.com
Iga Kiełbaszewska	kielbaszewska.i@gmail.com
Natalia Surosz	natalia.surosz@gmail.com
Katsiaryna Miraniuk	mironk2711@gmail.com
Dawid Wiczkowski	dawid.wiczkowski@gmail.com

ORCID List:

Wiktoria Kasianik	0009-0004-1540-5227
Dmytro Kowalczuk	0009-0004-1433-5052
Darya Lazitskaya	0009-0007-8680-8826
Kamil Turlej	0009-0008-2919-284X
Mykola Sobchynskyi	0009-0008-1804-1114
Valeryia Milasheuskaya	0009-0006-4126-2375
Andrzej Myrny	0009-0006-5592-259X
Iga Kiełbaszewska	0009-0004-9892-4769
Natalia Surosz	0009-0005-1939-151X
Katsiaryna Miraniuk	0009-0006-1406-9756
Dawid Wiczkowski	0009-0004-7050-9598

Peer-Review History
Received: 05 May 2025
Reviewed & Revised: 03/June/2025 to 09/October/2025
Accepted: 14 October 2025
Published: 30 October 2025

Peer-review Method
External peer-review was done through double-blind method.

Medical Science
pISSN 2321–7359; eISSN 2321–7367

Cesarean scar defects as an underestimated cause of secondary infertility

Wiktoria Kasianik[1]*, Dmytro Kowalczuk[2], Darya Lazitskaya[2], Mykola Sobchynskyi[2], Natalia Surosz[2], Kamil Turlej[3], Andrzej Myrny[3], Valeryia Milasheuskaya[4], Iga Kiełbaszewska[5], Katsiaryna Miraniuk[6], Dawid Wiczkowski[7]

ABSTRACT

Cesarean scar defect (CSD, also called isthmocele or niche) has become a more common issue after cesarean deliveries. Most women with CSD don't notice symptoms, but for some, it causes problems that get in the way of pregnancy. CSD can lead to old blood lingering in the uterus, fluid collecting, chronic inflammation, changes in the endometrial lining, and weaker uterine contractions. All these factors together make it more difficult to conceive. And it doesn't end there—women with CSD often have other conditions like adenomyosis, endometriosis, or sexual dysfunction, making fertility even more challenging. However, the lack of standard criteria among various studies concerning diagnosis and inconsistencies in nomenclature make it hard to identify how frequently this defect occurs. There is an increasing body of evidence relating CSD to infertility, but most of this data was collected from research on an observational basis, meaning the cause-and-effect relationship remains unknown. Surgical repair is performed by hysteroscopic or laparoscopic approaches. The outcome of this procedure seems promising, particularly among those with marked symptoms. However, more research on a larger number of subjects is still required. More awareness, proper approaches in the diagnosis of CSD, as well as individual programs of treatment, can help increase the possibility of pregnancies among those with CSD.

Keywords: Cesarean scar defect; secondary infertility; uterine niche; hydrometra; endometriosis

1. INTRODUCTION

Cesarean section (CS) is a common surgical procedure that helps lower the mortality risks for mothers and babies. The global average rate of cesarean sections is now 21%. In the European Union, CS deliveries vary from 16.5% in Finland to 54.8% in Cyprus. Poland has one of the highest rates in Europe: in 2023, 48% of children were born there by cesarean section. This trend raises concerns about its potential long-term consequences. Cesarean delivery has many potential consequences, especially delayed complications that are the result of cutting the

uterus. One possible outcome is a cesarean scar defect (CSD), also known as an isthmocele, niche, uterine pouch, or diverticulum (Tsuji et al., 2023). CSD is a disruption of the myometrium at the site of a previous cesarean incision, usually in the anterior wall of the uterine isthmus. Such defects typically result from impaired or incomplete healing of the cesarean scar (Tower and Frishman, 2013).

CSD is an important clinical problem. Various diagnostic criteria are currently used in the literature. But in 2019, the European Niche Taskforce proposed a standardized definition, characterizing a niche as an indentation of at least 2 mm in depth at the site of the cesarean scar. Other studies have applied slightly different thresholds, suggesting that a defect may be classified as CSD when the depth exceeds 1 mm, or when a hypoechoic space—whether fluid-filled or not—measures 2 mm or more within the scar region (Jordans et al., 2019).

An alternative approach considers any indentation that represents a discontinuity of the myometrium at the previous uterine incision, provided it communicates with the endometrial or cervical canal (Bij de Vaate et al., 2014). Saline contrast sonohysterography (SHG) allows clear visualization of the niche structure and improves its delineation (Jordans et al., 2019).

The reported prevalence of cesarean scar defect varies widely, with estimates ranging from approximately 24% to 84% among women with a history of cesarean section (Tower and Frishman, 2013).

Several studies have established that the number of prior cesarean sections is the key factor in the development of scar defects. The percentage of the risk of isthmocele among females after one, two, and three cesarean sections was estimated by the survey by Antila-Långsjö et al., (2018) to be 63%, 76%, and 88%, respectively. The progressive increase suggests that each additional cesarean incision contributes cumulatively to the weakening of the uterine wall.

The uterine closure technique has an important effect on the quality of the scar. Double-layer closure methods involve the decidua and deep muscle layers, prevent locking sutures, and increase the levels of residual myometrial thickness (RMT), which also reduces the chances of CSD. Single-layer closure or the exclusion of the more important tissue layers decreases the levels of RMT, which results in the development of a niche (Qayum et al., 2021).

Variables related to labor issues also matter. The effect of cesarean sections that occur during active labor, particularly involving cervical dilation measuring more than 5 cm or prolonged labor, was seen to negatively influence scar healing (Vikhareva et al., 2019). Although some studies suggest that emergency cesarean sections may carry a higher risk of CSD than elective procedures, evidence is lacking to consistently support that this is an independent risk factor. Additional reports indicate that the station of the presenting fetal part throughout cesarean delivery may contribute to CSD development. However, clinicians find this parameter difficult to assess objectively, and it is rarely included in routine risk evaluation (McGowan et al., 2022).

Anatomical and surgical factors further influence healing outcomes. Lower incisions, especially those that extend into cervical tissue, may heal poorly (McGowan et al., 2022). The presence of adhesions in the vesicouterine pouch has been reported as an independent risk factor for CSD. The pulling caused by the uterine scar sticking to the abdominal wall or bladder can slow down normal healing (Tsuji et al., 2023). In addition, uterine retroflexion has been associated with the development of larger or wider niches (Vikhareva Osser et al., 2009).

Maternal conditions such as obesity, gestational diabetes, and preeclampsia, and also peripartum infections, are linked to impaired healing and are independent risk factors for CSD (Antila-Långsjö et al., 2018). These diseases interact with other factors and influence the formation of the scar. To improve management strategies and reduce complications after cesarean delivery, it is important to better understand this process and its underlying mechanisms.

2. MATERIALS AND METHODS

We searched PubMed and Google Scholar databases using keywords to identify studies published up to March 18, 2025. We screened titles and abstracts for relevance and conducted a detailed review of the eligible articles. The inclusion of studies was determined by their methodological rigor and significance. Given the large number of entries, only the first 300 records (sorted by relevance) were screened in detail, in accordance with previously published methodological recommendations for narrative reviews (Figure 1).

3. RESULTS

Secondary infertility means the inability to conceive after a previous birth despite regular sexual intercourse for at least one year. Although many anatomical, hormonal, and male factors may contribute to its development, recent research has explored the association between secondary infertility and cesarean scar defect (Bij de Vaate et al., 2014) (Table 1).

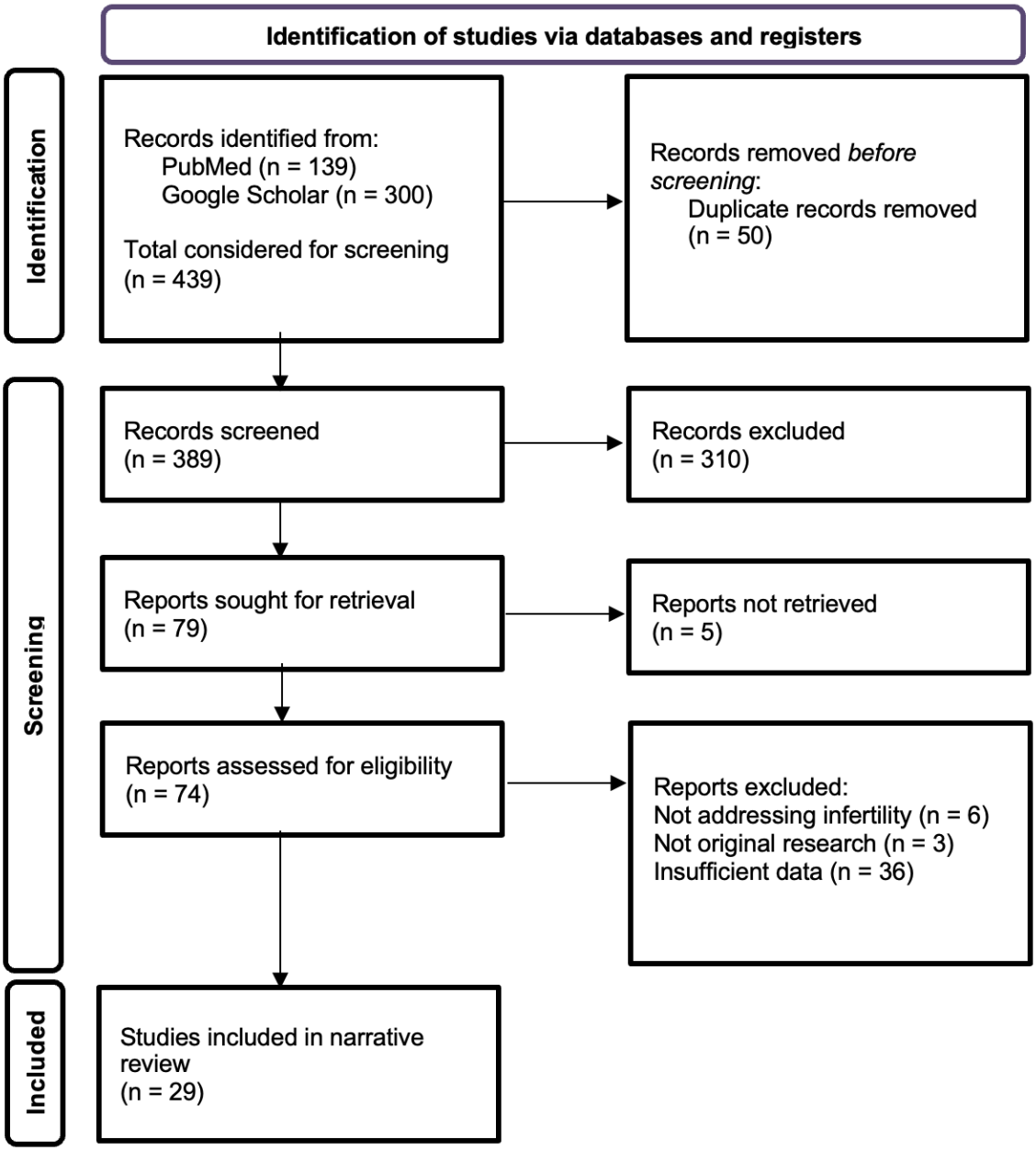

Figure 1: PRISMA flowchart

Table 1. Potential mechanisms linking cesarean scar defects (CSD) with infertility

Mechanism	**Potential impact on fertility**
Retention of menstrual blood in the niche	Toxic environment, worse sperm passage, reduced implantation.
Hydrometra	Mechanical barrier to implantation, worse IVF outcomes.
Chronic inflammation	Reduced receptivity, lower implantation rates.
Abnormal endometrium within the niche	Bad regeneration, disturbed synchrony with embryo development.
Coexisting adenomyosis and/or endometriosis	Inflammation, worse receptivity.
Sexual dysfunction	Reduced intercourse frequency, psychological stress.

Some studies suggest a link between CSD and infertility, but the evidence is limited, and a causal relationship has not been clearly demonstrated. Many of the associations reported in the literature relate more to experimental or small-scale studies than large clinical ones. However, there is evidence of fertility improvement following surgical treatment of the defect, in particular among females presenting with symptoms of the condition. Based on this, there has been a suggestion of infertility as a possible contributory factor by CSD in females (Ahamed et al., 2023).

Exact mechanisms that cause CSD to affect fertility are speculative. The presence of a uterine niche may interfere with the intrauterine environment, embryo transport, and implantation. Moreover, some authors report that the association between CSD and infertility is strongest among symptomatic women who experience abnormal uterine bleeding, pelvic pain, or intrauterine fluid accumulation (Vervoort et al., 2018; Bij de Vaate et al., 2014).

The improvement in pregnancy rates after hysteroscopic or laparoscopic repair of CSD is significant, which supports the hypothesis of a clinically relevant link. Many studies show that surgical repair of the uterine wall improves conception rates, suggesting that correcting the defect may help resolve secondary infertility (Tsuji et al., 2020).

Local Factors Affecting Fertility

Retention of Menstrual Blood Within the Niche

The most frequently discussed mechanism by which CSD impacts fertility is the uterine niche retaining menstrual blood. During menstruation, it does not empty, and it accumulates blood, mucus, and necrotic tissue (Murji et al., 2022). These substances may persist during the follicular phase of the menstrual cycle, which is crucial for endometrial regeneration and embryo implantation (Tsuji et al., 2015). Retention of blood in the uterine cavity can worsen the physiological environment and create obstacles to conception.

Another essential mechanism is impaired sperm transport. The altered consistency and composition of uterine mucus due to blood contamination interfere with sperm motility and capacitation. This reduction in sperm function decreases the likelihood of successful fertilization (Vikhareva Osser et al., 2009; Florio et al., 2012).

A toxic microenvironment is another crucial factor. Breakdown of red blood cells in the niche causes the release of iron and free radicals, which damage the endometrium and the embryo in the early stages. This process harms the viability of the embryo and disrupts implantation, making it particularly critical during the implantation window (Lousse et al., 2009).

Presence of Intrauterine Fluid (Hydrometra)

The existence of intrauterine fluid has been demonstrated to be a potentially significant factor in the pathogenesis of secondary infertility in association with CSD (Baldini et al., 2024). Fluid or menstrual retention and uterine niche morphology contribute to the backward flow of fluid into the uterus, leading to hydrometra (Ahamed et al., 2023).

Accumulation of fluid occurs in 42% of those patients having a large niche, mostly in the follicular phase of the cycle. A mechanical barrier that is created via hydrometra can act to obstruct embryo implantation. Even a thin layer of fluid upon the endometrium may block an embryo from attaching. The fluid may also disturb all the molecular processes that are needed so that implantation can succeed. Fertility treatment outcomes are often markedly reduced in effect (Akman et al., 2005).

It is important to note that hydrometra is usually reversible with surgical intervention, decreasing from 40% to 7.5% within six months postoperatively. Over 50% of previously infertile patients conceived spontaneously within two years after surgery (Vissers et al., 2020a and 2020b). Hysteroscopic resection of the niche gives good results, especially when methods for improvement of fluid drainage are combined with surface coagulation or with subglandular tissue resection (Vervoort et al., 2018).

Chronic Inflammation

Chronic inflammation is another factor affecting fertility in women with defects of the cesarean scar (Baldini et al., 2024). Histopathologic assessment of the CSD tissue reveals chronic inflammation with its outcome of fibrosis. There seems to be an increased occurrence of endometritis in those presenting with symptomatic CSD (CSDi), in comparison with the prevalent group of infertile females. Moreover, the accumulation of mucus or fluid within the niche can act as an environment that favors microorganisms. (Ben-Nagi et al., 2009; Naji et al., 2013). There could be concerns of subclinical infection, which has adverse impacts on assisted reproduction techniques like IVF.

Abnormal Endometrium

Abnormal endometrial tissue can be a barrier to successful implantation. Many analyses suggest that in women with CSD, the surface of the endometrium is often replaced by fibrotic tissue, which has reduced vascular density and altered architecture (Ben-Nagi et al., 2009).

Only 22% of women with CSDi had standard endometrial lining in the niche (compared to 62% among women without symptoms) (Tsuji et al., 2023). These changes significantly impair the endometrium's capacity to implant the embryo. Dilated vessels as well as microhemorrhages often occur. They are frequently caused by the nature of the scar itself (Vissers et al., 2020a and 2020b). Normal endometrial receptivity needs regeneration from disruption by it.

Related Conditions and Contributory Factors

Adenomyosis and Endometriosis in CSD

There has been an increasingly observed significant coexistence of adenomyosis with endometriosis in patients diagnosed with cesarean scar defects, most of whom experienced abnormal uterine bleeding, pelvic pain, or secondary infertility. Histopathological examination of the resected tissue often reveals the presence of adenomyosis, indicated by ectopic endometrial tissue or inclusion of endometrial glands within the uterine wall (Murji et al., 2022; Vissers et al., 2023a and 2023b). Recently, in a case–control study involving 204 symptomatic females undergoing sonohysterography, it was found that patients with underlying adenomyosis presented with a considerably larger defect size on cesarean scars, both in depth and width, than patients without adenomyosis. Moreover, the value of the ratio of residual myometrial thickness (RMT) to the corresponding myometrial thickness (AMT) was revealed to be much smaller in patients with adenomyosis, establishing a link between adenomyosis and more seriously compromised uterine wall anatomy (Katouli et al., 2024).

In addition, there was an impaired endometrium among those with cesarean scar syndrome (CSS). The increase in CD138 expression (indicating endometritis), together with the increase in inflammatory cytokine levels, such as IL-6, IL-1β, or TNF-α, represents an aspect of infertility.

4. DISCUSSION

Sexual well-being is an often-overlooked component of reproductive health, yet emerging evidence suggests that symptoms commonly associated with cesarean scar defects may impair sexual function and indirectly reduce fertility (Tsuji et al., 2023). The common gynecologic symptoms reported by women with CSD include abnormal uterine bleeding, dyspareunia (painful sexual intercourse), chronic pelvic pain, or postcoital spotting. The postcoital bleed was seen in 8.3% of the patients with isthmocele, as well as dyspareunia seen in 18.3% of the females (Vissers et al., 2020a and 2020b). For individuals with both bleeding episodes and spotting, there is a decreased occurrence of sexual activity among 60% of men and 54% of females (Barnhart et al., 1995). Couples are less likely to engage in intercourse during the fertile window, which may contribute to relational tension.

Also, postcoital spotting leads to increased anxiety (Vissers et al., 2020a and 2020b). This symptom causes women to delay diagnosis and management of underlying structural defects. In conclusion, while sexual dysfunction or pelvic pain is not always the underlying or predominant cause of infertility in the woman with CSD, it is an important secondary factor in conceiving. Care for both of these issues can potentially increase the quality of life of the affected individual.

Many studies show an association between cesarean scar defects and infertility. Due to particular methodological challenges, our ability to assess the impact of CSD on fertility is limited. Different studies apply various terms (such as "niche," "isthmocele," or "pouch") and adopt different diagnostic thresholds, which complicates comparison of results. Another issue is separating the impact of CSD on fertility from other coexisting factors, since many women have additional medical conditions.

There is also no clear consensus on which features of the niche are the most clinically significant. Some studies suggest that larger defects are more likely to cause symptoms and are more often associated with intrauterine fluid accumulation. Unfortunately, there is a lack of information on which treatment methods are the most effective or considered the gold standard. Nevertheless, some surgical approaches, such as hysteroscopic or laparoscopic resection of the niche, have proven their efficacy, mainly among those presenting symptoms, intrauterine fluid, or an unsuccessful IVF cycle. It should be noted that these procedures carry inherent risks, and the required recovery period may delay subsequent attempts at conception.

5. CONCLUSION

CSD is a recognized gynecological condition that has many implications for fertility. Anatomical disruption, chronic inflammation, fluid retention, and endometrial or myometrial abnormalities, as described above, reduce fertility in women. The lack of standardized diagnostic criteria, clear risk factors, and treatment strategies makes it difficult to assess the magnitude of the problem. Surgical correction of CSD improves fertility in selected cases, especially among women with symptoms and with intrauterine fluid accumulation.

Improving diagnostic procedures and individualizing therapeutic approaches are essential to reducing symptoms in women affected by this condition. Improving care for women affected by CSD-related infertility comes through the collaboration between gynecologic surgeons, endocrinologists, and imaging specialists.

Acknowledgments

The authors have no acknowledgments to disclose.

Author contributions

Conceptualization: Wiktoria Kasianik
Methodology: Iga Kiełbaszewska, Dmytro Kowalczuk, Darya Lazitskaya
Formal analysis: Kamil Turlej, Mykola Sobchynskyi, Dawid Wiczkowski
Investigation: Wiktoria Kasianik, Andrzej Myrny, Valeryia Milasheuskaya
Writing-rough preparation: Natalia Surosz, Katsiaryna Miraniuk
Writing-review and editing: Darya Lazitskaya, Dmytro Kowalczuk, Kamil Turlej
Supervision: Wiktoria Kasianik, Dmytro Kowalczuk
All authors have read and agreed with the published version of the manuscript.

Informed consent

Not applicable.

Ethical approval

Not applicable. This article does not contain any studies with human participants or animals performed by any of the authors.

Funding

This research did not receive any external funding like specific grant from funding agencies in the public, commercial, or nonprofit sectors.

Conflict of interest

The authors declare that they have no conflicts of interests, competing financial interests or personal relationships that could have influenced the work reported in this paper.

Data and materials availability

All data associated with this study will be available based on the reasonable request to corresponding author.

REFERENCES

1. Ahamed FM, Solkar S, Stevikova M, Peramo Moya B. Link between cesarean section scar defect and secondary infertility: case reports and review. JBRA Assist Reprod 2023;27(1):134-141. doi:10.5935/1518-0557.20220009.
2. Akman MA, Erden HF, Bahceci M. Endometrial fluid visualized through ultrasonography during ovarian stimulation in IVF cycles impairs the outcome in tubal factor, but not PCOS, patients. Hum Reprod 2005;20(4):906-909. doi:10.1093/humrep/deh737.
3. Antila-Långsjö RM, Mäenpää JU, Huhtala HS, Tomás EI, Staff SM. Cesarean scar defect: a prospective study on risk factors. Am J Obstet Gynecol 2018;219(5):458.e1-458.e8. doi:10.1016/j.ajog.2018.09.004.

4. Baldini GM, Lot D, Malvasi A, Di Nanni D, Laganà AS, Angelucci C, Tinelli A, Baldini D, Trojano G. Isthmocele and infertility. J Clin Med 2024 .
5. Barnhart K, Furman I, Devoto L. Attitudes and practice of couples regarding sexual relations during the menses and spotting. Contraception 1995;51:93-98.
6. Ben-Nagi J, Walker A, Jurkovic D, Yazbek J, Aplin JD. Effect of cesarean delivery on the endometrium. Int J Gynaecol Obstet 2009. doi:10.1016/j.ijgo.2009.02.019.
7. Bij de Vaate AJM, van der Voet LF, Naji O, Witmer M, Veersema S, Brölmann HAM, Bourne T, Huirne JAF. Prevalence, potential risk factors for development and symptoms related to the presence of uterine niches following cesarean section: systematic review. Ultrasound Obstet Gynecol 2014;43(4):372-382. doi:10.1002/uog.13199.
8. Florio P, Filippeschi M, Moncini I, Marra E, Franchini M, Gubbini G. Hysteroscopic treatment of the cesarean-induced isthmocele in restoring infertility. Curr Opin Obstet Gynecol 2012;24(3):180-186. doi:10.1097/GCO.0b013e3283521202.
9. Jordans IPM, de Leeuw RA, Stegwee SI, Amso NN, Barri-Soldevila PN, van den Bosch T, Bourne T, Brölmann HAM, Donnez O, Dueholm M, Hehenkamp WJK, Jastrow N, Jurkovic D, Mashiach R, Naji O, Streuli I, Timmerman D, van der Voet LF, Huirne JAF. Sonographic examination of uterine niche in non-pregnant women: a modified Delphi procedure. Ultrasound Obstet Gynecol 2019;53(1):107-115. doi:10.1002/uog.19049.
10. Katouli FS, Zebardast J, Tavoli Z, Bayan L, Azizinik F, Moradpour M, Mardani R, Meimani N, Fathi S. Evaluation of association between adenomyosis and cesarean scar defect. J Ultrasound Med 2024. doi:10.1002/jum.16388.
11. Lousse JC, Defrère S, Van Langendonckt A, González-Ramos R, Colette S, Donnez J. Iron storage is significantly increased in peritoneal macrophages of endometriosis patients and correlates with iron overload in peritoneal fluid. Fertil Steril 2009;91(5):1668-1675.
12. McGowan S, Goumalatsou C, Kent A. Fantastic niches and where to find them: the current diagnosis and management of uterine niche. Facts Views Vis Obgyn 2022;14(1):37-47. doi:10.52054/FVVO.14.1.003.
13. Murji A, Sanders AP, Monteiro I, Munro MG, Maheux-Lacroix S. Cesarean scar defects and abnormal uterine bleeding: a systematic review and meta-analysis. Fertil Steril 2022;118(4)
14. Naji O, Wynants L, Smith A, Abdallah Y, Saso S, Stalder C, Van Huffel S, Ghaem-Maghami S, Van Calster B, Timmerman D, Bourne T. Does the presence of a cesarean section scar affect implantation site and early pregnancy outcome in women attending an early pregnancy assessment unit? Hum Reprod 2013;28(6):1489-1496. doi:10.1093/humrep/det110.
15. Qayum K, Kar I, Sofi J, Panneerselvam H. Single- versus double-layer uterine closure after cesarean section delivery: a systematic review and meta-analysis. Cureus 2021;13(9):e18405. doi:10.7759/cureus.18405.
16. Tower AM, Frishman GN. Cesarean scar defects: an underrecognized cause of abnormal uterine bleeding and other gynecologic complications. J Minim Invasive Gynecol 2013;20(5):562-572. doi:10.1016/j.jmig.2013.03.008.
17. Tsuji S, Murakami T, Kimura F, Tanimura S, Kudo M, Shozu M, Narahara H, Sugino N. Management of secondary infertility following cesarean section: report from the Subcommittee of the Reproductive Endocrinology Committee of the Japan Society of Obstetrics and Gynecology. J Obstet Gynaecol Res 2015;41(9):1305-1312. doi:10.1111/jog.12750.
18. Tsuji S, Nobuta Y, Hanada T, Takebayashi A, Inatomi A, Takahashi A, Amano T, Murakami T. Prevalence, definition, and etiology of cesarean scar defect and treatment of cesarean scar disorder: a narrative review. Reprod Med Biol 2023;22(1):e12532. doi:10.1002/rmb2.12532.
19. Tsuji S, Takahashi A, Higuchi A, Yamanaka A, Amano T, Kimura F, Seko-Nitta A, Murakami T. Pregnancy outcomes after hysteroscopic surgery in women with cesarean scar syndrome. PLoS One 2020;15(12):e0243421.
20. Vervoort AJMW, van der Voet LF, Hehenkamp WJK, Thurkow AL, van Kesteren PJM, Quartero H, Kuchenbecker W, Bongers M, Geomini P, de Vleeschouwer LHM, van Hooff MHA, van Vliet H, Veersema S, Renes WB, Oude Rengerink K, Zwolsman SE, Brölmann HAM, Mol BWJ, Huirne JAF. Hysteroscopic resection of a uterine cesarean scar defect (niche) in women with postmenstrual spotting: a randomised controlled trial. BJOG 2018;125(3):326-334. doi:10.1111/1471-0528.14733.
21. Vikhareva O, Rickle GS, Lavesson T, Nedopekina E, Brandell K, Salvesen KÅ. Hysterotomy level at cesarean section and occurrence of large scar defects: a randomized single- blind trial. Ultrasound Obstet Gynecol 2019;53(4):438-442. doi:10.1002/uog.20184.
22. Vikhareva Osser O, Jokubkiene L, Valentin L. High prevalence of defects in cesarean section scars at transvaginal ultrasound examination. Ultrasound Obstet Gynecol 2009;34(1):90-97. doi:10.1002/uog.6395.
23. Vissers J, Hehenkamp W, Lambalk CB, Huirne JAF. Post-cesarean section niche-related impaired fertility: hypothetical mechanisms. Hum Reprod 2020a;35(7):1484-1494. doi:10.1093/humrep/deaa094.

24. Vissers J, Hehenkamp WJK, Brölmann HAM, Lambalk CB, Huirne JAF. Reproductive outcomes after laparoscopic resection of symptomatic niches in uterine cesarean scars: long- term follow-up on the prospective LAPNICHE study. Acta Obstet Gynecol Scand 2023a;102(12):1643-1652. doi: 10.1111/aogs.14647.
25. Vissers J, Jordans IPM, Huang Y, Mischi M, Schoot D, Huirne JAF. Increased amplitude of subendometrial contractions identified by ultrasound speckle tracking in women with a cesarean scar defect. Reprod Biomed Online 2023b;46(3):577-587. doi:10.1016/j.rbmo.2022.12.002.
26. Vissers J, Sluckin TC, Repelaer van Driel-Delprat CC, Schats R, Groot CJM, Lambalk CB, Twisk JWR, Huirne JAF. Reduced pregnancy and live birth rates after in vitro fertilization in women with previous cesarean section: a retrospective cohort study. Hum Reprod 2020b;35(3):595-604. doi:10.1093/humrep/dez295.