Journal of Infertility and Reproductive Biology
Volume 13, Issue 3, DOI 10.18502/jirb.v13i3.19528
Production and Hosting by KnE Publishing

KnE Publishing

Check for updates

Research Article

The Isthmocele: A Comprehensive Review of Anatomical Defects and Fertility Implications

Mohanad Suhail Najm[1,2] **and Hengameh Dortaj**[2]*

[1]Department of Human Anatomy, College of Medicine, University of Anbar, Anbar, Iraq
[2]Department of Anatomy and Cell Biology, School of Medicine, Mashhad University of Medical Science, Mashhad, Iran

Abstract

Isthmocele, also known as a uterine niche or cesarean scar defect, is a 1 to 2 mm defect in the anterior myometrium that appears as a hypoechoic triangle at the location of the lower segment caesarean section scar. The term is derived from the Greek words “isthmo” (uterine isthmus) and “cele” (cavity or pouch). The number of cases of isthmoceles varies significantly in the medical literature, with approximately 30% of afflicted women exhibiting symptoms. The Delphi consensus classified the disorder as Caesarean Scar Disorder (CSD), characterized as a uterine niche with at least one major symptom (postmenstrual spotting, discomfort during uterine bleeding, technical problems after embryo transfer) or two secondary symptoms (unexplained infertility and intrauterine fluid). Isthmocele is a serious iatrogenic condition of caesarean birth that might have long-term consequences for reproductive health. The pathophysiological pathways connecting isthmocele and infertility are diverse, comprising mechanical impediment, chronic inflammation, intrauterine fluid buildup, and disturbance of normal uterine contractility and receptivity. Diagnostic advances, such as upgraded ultrasonography methods and standardized criteria, have facilitated the identification and characterization of many abnormalities. Therapeutic options are evolving, with less invasive surgical procedures exhibiting excellent success in treating problems and restoring fertility. However, considerable knowledge gaps persist, and further research is needed to better understand the best surgical method for different defect shapes and long-term obstetric outcomes following surgical repair. The growing global caesarean rate ensures that isthmoceles will remain a major clinical problem in reproductive medicine.

Keywords: isthmocele, anatomical defects, fertility implications

Corresponding Author:
Hengameh Dortaj; email:
DortajH@mums.ac.ir

Received: 2 June 2025
Accepted: 21 August 2025
Published: 20 September 2025

Production and Hosting by KnE Publishing

OPEN ACCESS

1. Introduction

Isthmocele, also known as a uterine niche/cesarean scar defect, is a 1 to 2mm defect in the anterior myometrium that appears as a hypoechoic triangle at the location of the lower segment caesarean section scar. The myometrial defect may be observed connecting with the endometrial cavity [1, 2]. The location of the defect might vary depending on the position of the incision, the stage of labour, and the surgical procedure, which can lead to the accumulation of blood and fluids in the uterine cavity [3, 4]. The phrase is derived from the Greek words “isthmo” (uterine isthmus) and “cele” (cavity or pouch) [5]. Morris originally discovered this phenomenon in 1995, when he examined 51 hysterectomy specimens to determine the pathological alterations at the caesarean scar [6]. As the number of caesarean sections worldwide has significantly increased, so too has the clinical detection of this condition. Previous information The World Health Organisation reports that now 21% of deliveries are caesarean, up from 7% in 1990 [7]. Around 38 million births will occur via caesarean delivery by 2030, when the average worldwide rate of caesarean deliveries will increase to 28.5%[8]. Caesarean rates are well beyond the World Health Organization’s recommended ideal rate of 15% in certain places, such as Latin America and the Caribbean, where they surpass 40%. One of the most important late-term consequences of this surgical tendency is isthmocele, which has raised the number of both short- and long-term problems [9]. The number of cases of isthmoceles varies significantly in the medical literature, varying between 20% to 70% for women who have undergone caesarean birth, with roughly 30% of afflicted women exhibiting symptoms[10]. This vast variance in prevalence reported is caused by discrepancies in the criteria for diagnosis, imaging methods employed for identification, and research characteristics of the population. The growing acknowledgement of isthmocele as a unique clinical condition resulted in the recent Delphi consensus, which classified the disorder as Caesarean Scar Disorder (CSD)[11]. This agreement characterised CSD as a uterine niche with at least one major symptom (postmenstrual spotting, discomfort during uterine bleeding, technical problems after embryo transfer) or two secondary symptoms (unexplained infertility and intrauterine fluid) [4, 11].

2. Etiology and Pathogenesis

An isthmocele is the result of a complicated interaction between surgical conditions and characteristics of the patient that together prevent the incision in the uterus from healing properly. Abnormal tissue adhesion and repair at the location of the caesarean scar are the pathophysiology, leading to a pouch-like abnormality that can differ greatly in size and shape (Table **1**).

Table 1: Risk Factors for Isthmocele Development.

Category	Specific Factors	Proposed Mechanism
Surgical Factors	Single-layer uterine closure	Incomplete approximation of myometrial layers
	Low cervical incision	Cervical mucus interferes with healing
	Prolonged labor (>5 cm dilation)	Thinned, less vascularized lower uterine segment
	Multiple cesarean sections	Cumulative damage to the myometrium
Patient Factors	Genetic connective tissue disorders	Impaired wound healing capacity
	Obesity (high BMI)	Altered tissue perfusion and healing
	Diabetes mellitus	Microvascular compromise and reduced fibroblast activity
	Uterine retroflexion	Increased mechanical stress on the scar site
	Endometriosis	Inflammation and adhesion formation

2.1. Surgical and Technical Factors

The development of isthmocele is influenced by several factors, including the uterine incision, uterine repair method, and obstetric conditions during birth. Incisions made too low on the uterus can lead to worse healing results, as cervical gland mucus can obstruct normal myometrial approximation. Single-layer closure methods are linked to a higher likelihood of isthmocele formation, with 95% of isthmocele patients undergoing single-layer closure[10]. Technical considerations include locking sutures, extremely tight sutures, non-perpendicular sutures, and insufficient haemostasis, which can cause haematoma development. Additionally, caesarean sections done during protracted labor, especially when cervical dilation reaches 5 cm or with advanced fetal station, can lead to larger abnormalities. The risk is continuously correlated with the number of prior caesarean sections, and incidence increases significantly with each additional surgery[12].

2.2. Patient-Related Factors

Several patient characteristics influence susceptibility to isthmocele formation.

Genetic predispositions

An isthmocele is more likely to develop in women born with congenital uterine abnormalities, such as a thin uterine wall or isthmocele agenesis. There is no clear hereditary propensity for isthmocele formation after a caesarean section [2]. However, certain genetic disorders may increase the likelihood of pregnancy and delivery problems. Isthmocele onset is linked to hereditary connective tissue illnesses like Ehlers-Danlos syndrome and Marfan syndrome, which can impair the correct healing of uterine tissues. Poor connective tissues may be more prone to rupture following a caesarean operation, increasing the likelihood of isthmocele development [13]. Certain blood coagulation-related genetic abnormalities can increase the likelihood of postpartum haemorrhage, favoring the formation of isthmoceles. Mutations in Factor V Leiden (FVL) and Prothrombin (PT) genes have been linked to an increased risk of postpartum

hemorrhage and isthmoceles. Congenital hip dysplasia, a genetic condition causing hip joint abnormality, has also been linked to isthmocele [14].

Metabolic factors constitute an additional significant category. Obesity (high BMI), gestational diabetes, and chronic hypertension have all been established as distinct risk factors for the appearance of isthmocele [15]. These disorders may act through strategies such as poor tissue perfusion, decreased fibroblast activity, and a generalized disruption of wound recovery.

Uterine anatomical factors also contribute to pathogenesis. A retroflexed or retroverted uterus has a posterior angulation in relation to the bladder. This posture can be present from birth or developed as a result of uterine diseases such as fibroids, endometriosis, or pelvic adhesions [16]. A retroverted uterus does not always enhance the chance of developing an isthmocele after a caesarean procedure [17].

Endometriosis Scientific research supports a link between isthmocele and endometriosis, with some women acquiring isthmocele following a caesarean delivery. The specific process is unknown; however, speculations imply that endometrial cells may migrate to the isthmocele site during a caesarean delivery, which is aided by surgical stress and inflammation. This weakening may facilitate the implantation and growth of extrauterine endometriotic tissue. Understanding this link is critical for the successful management and treatment of this complicated illness [18, 19].

2.3. Healing Abnormalities

The last prevalent route in isthmocele development is aberrant wound healing at the incision location. This involves poor myometrial regeneration, excessive fibrotic tissue deposition, and disorganisation of the endometrial-myometrial interface. The ensuing defect usually appears as a hypocontractile region with impaired vascularity, generating a milieu susceptible to blood buildup and inflammatory alterations [4].

3. Anatomical and Functional Defects

The isthmocele, an anatomical defect, leads to significant functional abnormalities in uterine physiology, posing significant clinical implications, and understanding its therapeutic implications requires a comprehensive understanding of its structural and functional alterations [20] (Table **2**).

Table 2: Functional Consequences of Isthmocele and Their Clinical Implications.

Functional Defect	Underlying Mechanism	Clinical Manifestations
Menstrual blood retention	Loss of contractility in a niche area	Postmenstrual spotting, prolonged bleeding
Chronic inflammation	Breakdown products of retained blood	Hostile uterine environment, impaired implantation

Table 2: Continued.

Functional Defect	Underlying Mechanism	Clinical Manifestations
Junctional zone disruption	Architectural disruption of myometrial layers	Abnormal uterine peristalsis, impaired sperm transport
Intrauterine fluid accumulation	Secretion and impaired drainage from the niche	Mechanical interference with implantation, embryotoxic effects
Vascular compromise	Disorganization of normal vascular architecture	Impaired endometrial proliferation and receptivity

3.1. Morphological

Isthmoceles' morphological characters vary significantly. On imaging investigations, the abnormalities often present as triangular or semicircular anechoic spots around the caesarean scar, although round, oval, droplet-shaped, and inclusion cyst morphologies have also been recognized [12, 21]. The size can range from tiny indentations (2-3 mm deep) to large abnormalities spanning the majority of the anterior uterus. Three major morphological structures have been identified: (1) inward protrusion (internal scar surface extending towards the uterine cavity), (2) outward protrusion (external scar surface extending towards the bladder or peritoneal cavity), and (3) inward retraction (external scar surface dimpled towards the myometrium) [12, 22].

The residual myometrial thickness (RMT), or the vertical distance between the uterine serosa and the damaged peak, is an essential anatomical measurement with therapeutic implications. An RMT of <2.2-3.0 mm indicates serious problems, including elevated levels of symptoms and reproductive effects [3]. In severe cases, the myometrium might be absent, leading to a total deficit [23].

3.2. Functional Consequences

Isthmocele, an anatomical alteration in the uterus, causes significant functional disturbances. Menstrual blood retention occurs due to the defective area's lack of normal contractile function, creating a reservoir where blood pools and drains over time. It leads to postmenstrual recognition, which is a frequent symptom in afflicted women [24]. The specialized environment also affects local uterine biochemistry, causing hemolysis and inflammatory mediators, which may compromise the receptivity of the endometrium and implantation processes [25]. The abnormality also affects the uterine junctional zone, which is essential for coordinating uterine peristalsis during sperm transport and implantation. Unusual contraction patterns are being found in women having isthmoceles, which may contribute to infertility and poor obstetric outcomes [26]. Furthermore, intrauterine fluid buildup, which occurs in 45% of women with isthmocele, may mechanically inhibit implantation and cause embryotoxic consequences like hydrosalpinx [27].

4. The Isthmocele-Infertility

Isthmocele and infertility are caused by an intricate combination of anatomical, metabolic, and immunological variables, requiring the development of tailored therapy techniques [28] (Figure **1**).

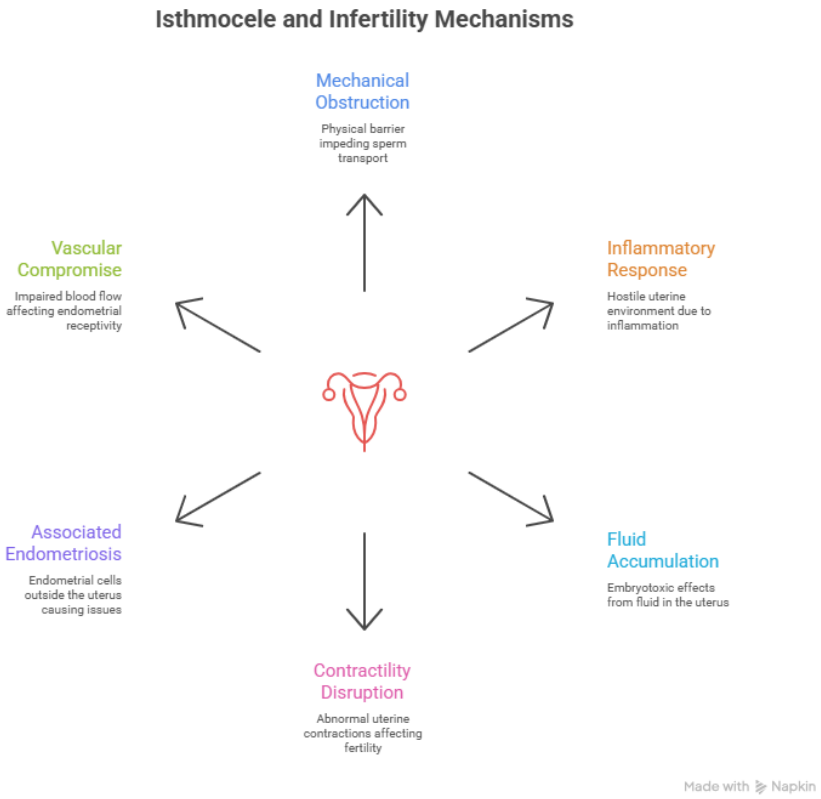

Figure 1: Pathophysiological Mechanisms Linking Isthmocele to Infertility.

4.1. Mechanical and physical limitations

There is substantial proof that physical barriers cause isthmocele-related infertility. A large lesion may physically impede sperm migration into the fallopian tubes, particularly when the uterus is retroflexed.[29]. Additionally, the deformed uterine architecture poses technical challenges during ART (assisted reproductive technology) procedures; approximately twenty percent of women having an isthmocele who undergo IVF 2 have had abnormal embryo transfers. The blood and mucus accumulation in niche 7 may establish a chemical barrier that illnesses spermatozoa or restricts their movement and capacitation.[30].

4.2. The Inflammatory and Immunological Environment

Chronic inflammation in the isthmocele is a significant cause of infertility. Retained menstrual blood products activate macrophages and produce pro-inflammatory cytokines, which can impair sperm function, embryo development, and implantation [31]. This environment also alters the native uterine microbiome, reducing endometrial receptivity. The accumulation of intrauterine fluid (ICF) in the position is especially important since accumulation inside the periovulatory phase decreases implantation and pregnancy rates in both natural cycles and ART treatments. The fluid could have direct embryotoxic consequences [10].

4.3. Vascular and Structural Impairment

The isthmocele lesion disorders natural uterine circulation, resulting in hypoperfusion and inadequate oxygen and nutrient supply to the neighboring endometrium. This deficiency may induce insufficient endometrial growth and maturation, resulting in a “thin endometrium” appropriate for implantation. The fibrosis and architectural disruption impact uterine peristalsis coordination, which may interfere with sperm transport and embryo implantation.[32].

4.4. Endometriosis Association

Endometriosis, which affects women with isthmocele, is usually linked to infertility [32]. This association is caused by the iatrogenic dispersion of endometrial cells during caesarean surgery, which produces a conducive environment for endometriotic implantation, as well as shared risk factors. Endometriosis causes infertility by inflammation, anatomic distortion, and poor implantation, affecting the overall fertility burden.[33].

4.5. Quantitative Effect on Fertility Outcomes

The cumulative impact of these pathophysiological mechanisms on fertility is significant. According to meta-analytic statistics, women having isthmocele have reduced live birth rates than women who have had normal vaginal deliveries or caesarean sections. In ART settings, isthmocele has been associated with considerably decreased clinical pregnancy and implantation rates, with the unfavourable effects as most obvious in situations of simultaneous intrauterine fluid accumulation [34].

5. Diagnostic

Isthmocele diagnosis mainly includes ultrasound examination, which visualizes the defect in the uterine wall (Figure **2**). Advanced diagnostic techniques like magnetic resonance imaging may be needed for detailed evaluation. Hysterosalpingography or SIS can identify a cavity or deformity, while hysteroscopy may be necessary. MRI confirms the isthmocele's presence and size [35] (Table **3**).

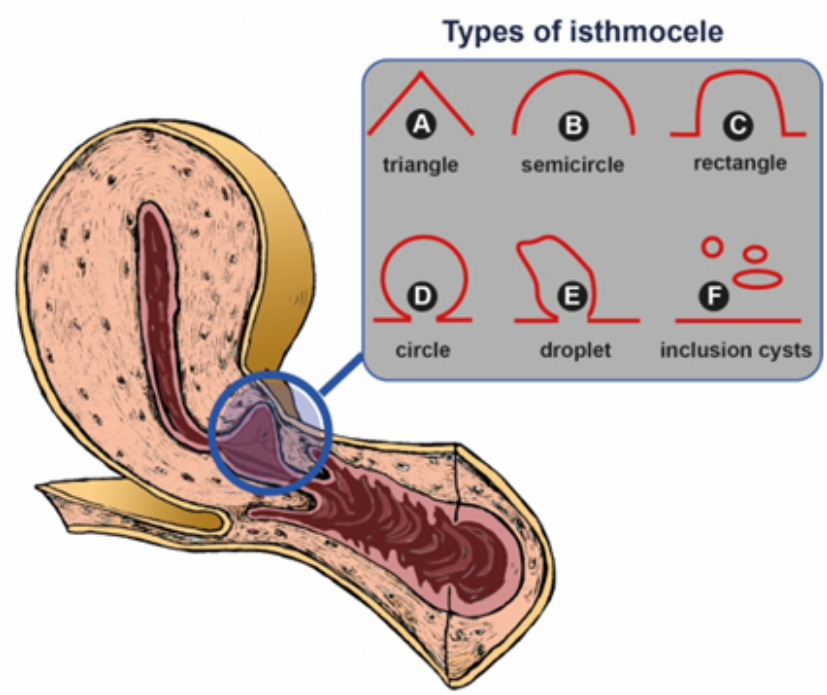

Figure 2: The image depicts a longitudinal section of the Uterus, Cervix, and Vagina, with a blue circle representing the uterine isthmus and an enlargement called an isthmocele. A schematic representation of different shapes of isthmocele is shown on the top right, including (A) triangle, (B) semicircle,(C) rectangle,(D) circle, (E) droplet, and (F) inclusion cysts[10].

Table 3: Diagnostic *Modalities for Isthmocele Evaluation.*

Modality	Key Features	Advantages	Limitations
Transvaginal Ultrasound	First-line imaging: assesses niche dimensions and RMT	Readily available, non-invasive, cost-effective	Lower sensitivity for small defects
Saline Infusion Sonohysterography	Fluid-enhanced cavity distension	Superior detection rate, precise RMT measurement	Invasive, requires technical expertise
Hysteroscopy	Direct visual inspection of the cavity	Allows simultaneous therapeutic intervention and assesses endometrial quality	Invasive, cannot assess external contour
Magnetic Resonance Imaging	Excellent soft tissue characterization	Detailed anatomical relationships, tissue characterization	Cost, availability, and no dynamic assessment
3D Ultrasound	Multiplanar reconstruction	Volumetric assessment, improved measurement consistency	Operator dependence, limited availability

5.1. Transvaginal Ultrasound Examination

Isthmoceles may be identified and measured via ultrasound imaging, which shows up as a hollow cavity or sac-like region in the uterine wall. The size and method may differ, but they are usually visible. Ultrasound parameters can be used to determine the dimensions of an isthmocele, such as length, breadth, and depth. Jordans et al. presented ultrasonographic diagnostic and classification criteria in 2019, modifying the Delphi process. Isthmoceles are described as a depression with a depth greater than 2 mm at the location of the Cesarian scar. They can be simple, with one branch, or complicated. Small isthmoceles are less than 1 cm long and less than 1.5 cm wide [36].

5.2. Saline Infusion Sonohysterography

Saline infusion sonohysterography improves its diagnostic reliability over standard TVUS. SIS dilates the uterine cavity with fluid, making it easier to delineate niche morphology and accurately quantify RMT. It can detect up to twice the amount of isthmoceles as TVUS, including clinically important and minor anomalies. The therapy includes inserting a catheter into the cervix, giving sterile saline under ultrasound guidance, and scanning the anterior uterine wall [37].

5.3. Hysteroscopy

Isthomecele is a cavity on the anterior side of the isthmus that may be seen using a hysteroscope. The hysteroscopic method can also reveal hypervascularized regions and dendritic arteries with haemorrhage or polyps, which could indicate bleeding from the defect; it can also distinguish endometriotic diseases at this spot [38].

5.4. Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging (MRI) is an effective method for analyzing soft tissue and determining the relationship between the isthmocele and its surroundings, mainly the bladder. It is especially useful in cases with significant defects or indistinct distinctions between deep position and uterine wall problems. The higher tissue quality of MRI allows for the distinction between fibrotic tissue, normal myometrium, and inflammatory changes. Nevertheless, downsides include greater costs, limited accessibility, and a lack of ability to conduct dynamic evaluations [39].

5.5. Three-Dimensional Ultrasound

Three-dimensional ultrasound reconstruction techniques enable multiplanar assessment of niches and niche volume computation, with coronal plane imaging particularly useful for investigating transverse anomalies and their relationship to the uterine cavity and cervical canal. This technique also enables more precise RMT measurement and improves consistency among measurements and operators [10].

6. Therapeutic Strategies

Management of symptomatic isthmocele, especially in women seeking fertility, involves careful consideration of defect characteristics, symptom profile, and reproductive goals, with treatment strategies ranging from expectant management to surgical correction [23] (Figure **3**).

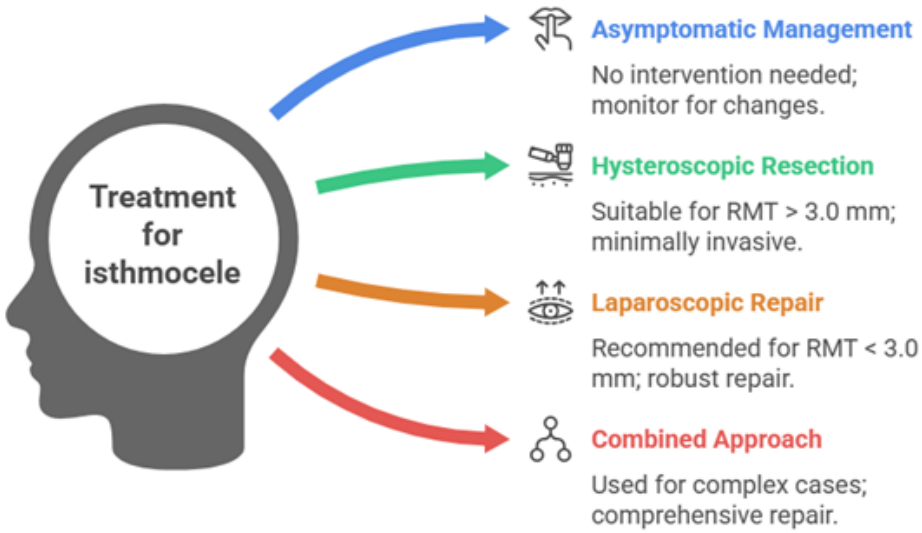

Figure 3: Treatment options for Isthmocele.

6.1. Hysteroscopic Repair

Isthmocele is best treated by hysteroscopy, which allows for direct evaluation and therapy. It entails excision of the higher and lower margins, as well as cavity ablation, which relieves of symptomatic ladies their symptoms. Hysteroscopic reshaping flattens endometrial tissue, preventing blood or menstrual residue buildup. Hysteroscopy is a minimally invasive procedure, although laparoscopic correction is suggested for women with residual myometrial thickness (RMT) less than 2.5 mm and future pregnancies. For proper identification, a combination of hysteroscopy and transillumination is recommended. Hysteroscopic resection may be the best option for women who are unsure about their

future demands. Laparoscopic isthmoplasty is recommended for individuals with a history of infertility, ectopic pregnancy, more severe isthmocele, lower parity, and fewer caesarean sections [40].

6.2. Laparoscopic Repair

Laparoscopic surgery is often recommended for isthmoceles with reduced myometrial thickness, as it allows the surgeon to access the isthmocele and reinforce the anterior wall of the uterus. This method is preferred for larger defects to avoid complications like uterine rupture. A two-layer repair without passage inside the uterine cavity can reduce symptoms in 77% of patients, restore fertility in 73%, and reduce time to conception in 73%. Hysteroscopy without perfusion in operative laparoscopy allows for observation of the uterine lumen without backflow of fluid. Intraoperative monitoring by hysteroscope and laparoscope allows visualization of the lesion site during resection, allowing precise identification of the lesion area, complete removal of lesions, and prevention of excessive resections [41]. Fluorescence-guided laparoscopic niche detection is a new approach that may help prevent bladder injuries and unnecessary tissue preparation [42].

6.3. Combined Laparoscopic-Hysteroscopic Approach

The rendezvous technique, which combines radiology, endoscopy, and surgery, is particularly useful in complex cases or those near the bladder, avoiding potential iatrogenic injury [43].

6.4. Robotic-Assisted and Novel Techniques

Robotic-assisted laparoscopic repair improves surgical accuracy through three-dimensional magnification, tremor filtering, and better tool manoeuvrability. Case studies demonstrate good outcomes in complex situations, providing advantages in difficult surgical circumstances [44].

7. Conclusion and Future Directions

Isthmocele is a serious iatrogenic condition of caesarean birth that might have long-term consequences for reproductive health [45]. Our awareness of this issue has grown significantly, from recognizing it as a basic physical abnormality to realizing its intricate functional implications for uterine biology and fertility [46]. The pathophysiological pathways connecting isthmocele and infertility are diverse, comprising mechanical impediment, chronic inflammation, intrauterine fluid buildup, and disturbance of normal uterine contractility and receptivity [10].

Diagnostic advances, notably upgraded ultrasonography methods and standardized criteria, have facilitated the identification and characterization of many abnormalities [47]. Therapeutic options are

evolving, with less invasive surgical procedures exhibiting excellent success in treating problems and restoring fertility. Current research suggests that laparoscopic isthmocele surgery results in roughly 72% of live births in infertile women, which is a significant improvement over expectant care [5].

Despite these advancements, considerable knowledge gaps persist. Comparative studies are needed to better understand the best surgical method for different defect shapes. Long-term obstetric outcomes following surgical repair, including the risks of uterine rupture in subsequent pregnancies, warrant further research [48]. Perhaps most significantly, well-designed randomized controlled studies are needed to establish definite criteria for surgical intervention vs expectant care in asymptomatic women with infertility [10, 48]. The growing global caesarean rate assures that isthmoceles will remain a major clinical problem in reproductive medicine. Clinicians can best address this illness and its repercussions by conducting ongoing research and refining diagnostic and treatment techniques, eventually improving reproductive results for the expanding group of women who have had previous caesarean births [49].

Conflict of Interest

Each author has no conflict of interest related to the presented review article. Artificial intelligence (AI) has not been used, and data from our own research is provided.

References

[1] Rupa R, Kushvaha S, Venkatesh K. Uterine isthmocele—a frequently overlooked complication of cesarean sections. Indian J Radiol Imaging. 2021;31(03):601-604.

[2] Tulandi T, Cohen A. Emerging manifestations of cesarean scar defect in reproductive-aged women. J Minim Invasive Gynecol. 2016;23(6):893-902.

[3] Gubbini G, Casadio P, Marra E. Resectoscopic correction of the “isthmocele” in women with postmenstrual abnormal uterine bleeding and secondary infertility. J Minim Invasive Gynecol. 2008;15(2):172-175.

[4] Tsuji S, Nobuta Y, Hanada T, Takebayashi A, Inatomi A, Takahashi A, et al. Prevalence, definition, and etiology of cesarean scar defect and treatment of cesarean scar disorder: A narrative review. Reprod Med Biol. 2023;22(1):e12532.

[5] Vidal A, Geiger J, Vinayahalingam V, Pape J, Gulz M, Karrer T, et al. High live birth rates after laparoscopic isthmocele repair in infertility: a systematic review and meta-analysis. Front Endocrinol (Lausanne). 2025;16:1507482.

[6] Morris H. Surgical pathology of the lower uterine segment caesarean section scar: is the scar a source of clinical symptoms? Int J Gynecol Pathol. 1995;14(1):16-20.

[7] Angolile CM, Max BL, Mushemba J, Mashauri HL. Global increased cesarean section rates and public health implications: A call to action. Health Sci Rep. 2023;6(5):e1274.

[8] Betran AP, Ye J, Moller A-B, Souza JP, Zhang J. Trends and projections of caesarean section rates: global and regional estimates. BMJ Glob Health. 2021;6(6):e005671.

[9] Fakhr MS, Mozafari M, Rezvanfar K, Amini Z, Amiri K, Hosseini RS, et al. Investigating the risk factors for isthmocele development after cesarean delivery. AJOG Glob Rep. 2024;4(2):100299.

[10] Baldini GM, Lot D, Malvasi A, Di Nanni D, Laganà AS, Angelucci C, et al. Isthmocele and infertility. J Clin Med. 2024;13(8):2192.

[11] Stout A, Dicks-Ilori L, Elghobashy A. Isthmocele: A Case Report and Review of an Increasingly Common Gynecological Hurdle. Cureus. 2024;16(10)1-19.

[12] Wu Z, Liu S, Huang F, Ke Y. The Diagnosis and Treatment of Caesarean Scar Defect: Progress and Controversies. Clin Exp Obstet Gynecol. 2023;50(6):116-121.

[13] Kjellberg U, van Rooijen M, Bremme K, Hellgren M. Factor V Leiden mutation and pregnancy-related complications. Am J Obstet Gynecol. 2010;203(5):469-468.

[14] Goland S, Elkayam U. Pregnancy and Marfan syndrome. Ann Cardiothorac Surg. 2017;6(6):642-500.

[15] Gupta T, Singal K, Gupta N, Kohli S, Kanyal M. Comparative Study of USG and MRI in Evaluation of Isthmocele. J Obstet Gynaecol India. 2021;71(3):292-296.

[16] Haylen BT. The retroverted uterus: ignored to date but core to prolapse. Int Urogynecol J. 2006;17(6):555-558.

[17] Fiaschetti V, Massaccesi M, Fornari M, Nezzo M, Da Ros V, Sorrenti G, et al. Isthmocele in a retroflexed uterus: a report of an unrecognized case. Clin Exp Obstet Gynecol. 2015;42(5):705-707.

[18] Lerman OZ, Galiano RD, Armour M, Levine JP, Gurtner GC. Cellular dysfunction in the diabetic fibroblast: impairment in migration, vascular endothelial growth factor production, and response to hypoxia. Am J Pathol. 2003;162(1):303-312.

[19] Gornet ME, Abhari S, Christianson MS. Isthmocele endometriosis: When two is definitely not better than one. Fertil Steril. 2022;117(6):1337-1338.

[20] 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.

[21] van der Voet L, Bij de Vaate A, Veersema S, Brölmann H, Huirne J. Long-term complications of caesarean section. The niche in the scar: a prospective cohort study on niche prevalence and its relation to abnormal uterine bleeding. BJOG. 2014;121(2):236-244.

[22] Abacjew-Chmylko A, Wydra DG, Olszewska H. Hysteroscopy in the treatment of uterine cesarean section scar diverticulum: a systematic review. Adv Med Sci. 2017;62(2):230-239.

[23] Marotta M-L, Donnez J, Squifflet J, Jadoul P, Darii N, Donnez O. Laparoscopic repair of post-cesarean section uterine scar defects diagnosed in nonpregnant women. J Minim Invasive Gynecol. 2013;20(3):386-391.

[24] Donnez O, Jadoul P, Squifflet J, Donnez J. Laparoscopic repair of wide and deep uterine scar dehiscence after cesarean section. Fertil Steril. 2008;89(4):974-980.

[25] Raimondo G, Grifone G, Raimondo D, Seracchioli R, Scambia G, Masciullo V. Hysteroscopic treatment of symptomatic cesarean-induced isthmocele: a prospective study. J Minim Invasive Gynecol. 2015;22(2):297-301.

[26] Li C, Guo Y, Liu Y, Cheng J, Zhang W. Hysteroscopic and laparoscopic management of uterine defects on previous cesarean delivery scars. J Perinat Med. 2014;42(3):363-370.

[27] Zhou J, Yao M, Wang H, Tan W, Chen P, Wang X. Vaginal repair of cesarean section scar diverticula that resulted in improved postoperative menstruation. J Minim Invasive Gynecol. 2016;23(6):969-978.

[28] Api M, Boza A, Gorgen H, Api O. Should cesarean scar defect be treated laparoscopically? A case report and review of the literature. J Minim Invasive Gynecol. 2015;22(7):1145-1152.

[29] Chen Y, Chang Y, Yao S. Transvaginal management of cesarean scar section diverticulum: a novel surgical treatment. Med Sci Monit. 2014;20:1395.

[30] Zhang Y. A comparative study of transvaginal repair and laparoscopic repair in the management of patients with previous cesarean scar defect. J Minim Invasive Gynecol. 2016;23(4):535-341.

[31] Vitale SG, Ludwin A, Vilos GA, Török P, Tesarik J, Vitagliano A, et al. From hysteroscopy to laparoendoscopic surgery: what is the best surgical approach for symptomatic isthmocele? A systematic review and meta-analysis. Arch Gynecol Obstet. 2020;301(1):33-52.

[32] Klein Meuleman SJ, Post B, Vissers J, de Leeuw RA, Post Uiterweer ED, Huirne JA. Presence of intrauterine fluid in women with a large niche is not associated with a difference in endometrial thickness. Fertil Steril. 2023;119(2):322-325.

[33] Ahamed FM, Solkar S, Stevikova M, Moya BP. Link between cesarean section scar defect and secondary infertility: Case reports and review. JBRA Assist Reprod. 2023;27(1):134-141.

[34] Harjee R, Khinda J, Bedaiwy MA. Reproductive outcomes following surgical management for isthmoceles: a systematic review. J Minim Invasive Gynecol. 2021;28(7):1291-1302.

[35] Zhang H, Huang J, Wu X, Fan H, Li H, Gao T. Clinical classification and treatment of cesarean scar pregnancy. J Obstet Gynaecol Res. 2017;43(4):653-661.

[36] Jordans I, De Leeuw R, Stegwee S, Amso N, Barri-Soldevila P, Van Den Bosch T, et al. Sonographic examination of uterine niche in non-pregnant women: a modified Delphi procedure. Ultrasound Obstet Gynecol. 2019;53(1):107-115.

[37] Baldini D, Beck R, Negro F, De Viti D. Assisted reproductive technologies and metabolic syndrome complications: medico-legal reappraisal. Clin Ter. 2019;170(5):364-367.

[38] Chen Y-Y, Tsai C-C, Kung F-T, Lan K-C, Ou Y-C. Association between hysteroscopic findings of previous cesarean delivery scar defects and abnormal uterine bleeding. Taiwan J Obstet Gynecol. 2019;58(4):541-544.

[39] Donnez O. Cesarean scar defects: management of an iatrogenic pathology whose prevalence has dramatically increased. Fertil Steril. 2020;113(4):704-716.

[40] Huang C-C, Chiu S-C, Pan C-M, Huang C-C, Chang CY-Y, Chao S-C, et al. New efficient method for hysteroscopic isthmoplasty: four simple steps lead to a significant improvement in bleeding status. J Clin Med. 2022;11(21):1-19.

[41] Karampelas S, Engels S, Birbarah C, Nisolle M. Laparoscopic approach for a cesarean scar pregnancy. Fertil Steril. 2022;117(5):1099-1101.

[42] Krentel H, Lauterbach L-K, Mavrogiannis G, De Wilde RL. Laparoscopic Fluorescence Guided Detection of Uterine Niche—The Next Step in Surgical Diagnosis and Treatment. J Clin Med. 2022;11(9):2657-2600.

[43] Iwashita T, Uemura S, Tezuka R, Senju A, Iwata S, Ohashi Y, et al. Endoscopic ultrasound-guided rendezvous techniques for difficult biliary cannulation: Technical review. Dig Endosc. 2025;37(1):68-76.

[44] Katsimperis S, Tzelves L, Feretzakis G, Bellos T, Tsikopoulos I, Kostakopoulos N, et al. Innovations in Robot-Assisted Surgery for Genitourinary Cancers: Emerging Technologies and Clinical Applications. Appl Sci. 2025;15(11):6118-1002.

[45] Shutak M, Ostrovska K, Makarchuk O, Ostrovska O. P-748 Reproductive impact of isthmocele. Hum Reprod. 2025;40(Supplement_1):deaf097.1053.

[46] Ioannou D, Tempest HG. The genetic basis of male and female infertility. Syst Biol Reprod Med. 2025;71(1):143-169.

[47] Yan L, Li Q, Fu K, Zhou X, Zhang K. Progress in the application of artificial intelligence in ultrasound-assisted medical diagnosis. Bioengineering. 2025;12(3):288-279.

[48] Dokras A, Somigliana E, Donnez O, Humphries LA, Shah DK, Christianson MS, et al. Isthmocele—fix it or observe, an ongoing dilemma. Fertil Steril. 2025;123(6):981-988.

[49] Harjee R, Devji J, Barrett-Chan EK, Khinda J, Bedaiwy MA. Surgical management of caesarean scar disorder using different techniques: a scoping review and case series. Middle East Fertil Soc J. 2024;29(1):25.