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Advanced repair of recurrent and low-large hysterotomy defects using a myometrial glide flap

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ABSTRACT

Background: The resolution of factors linked to the recurrence of cesarean section defects can be accomplished through a comprehensive technique that effectively addresses the dehiscent area, eliminates associated intraluminal fibrosis, and establishes a vascularized anterior wall by creating a sliding myometrial flap.

Objective: Propose a comprehensive surgical repair for recurrent and large low hysterotomy defects in women seeking pregnancy or recurrent spotting.

Study design: A retrospective cohort analysis included 54 patients aged 25–41 with recurrent large cesarean scar defects treated at Otamendi, CEMIC, and Valle de Lili hospitals. Comprehensive surgical repair was performed by suprapubic laparotomy, involving a wide opening of the vesicouterine space, removal of the dehiscent cesarean scar and all intrauterine abnormal fibrous tissues, using a glide myometrial flap, and intramyometrial injection of autologous platelet-rich plasma. Qualitative variables were determined, and descriptive statistics were employed to analyze the data in absolute frequencies or percentages. The data obtained were processed using the Infostat™ statistic program.

Results: Following the repair, all women experienced normal menstrual cycles and demonstrated an adequate lower uterine segment thickness, with no evidence of healing defects. All patients experienced early ambulation and were discharged within 24 h. Uterine hemostasis was achieved at specific points, minimizing the use of electrocautery. The standard duration of the procedure was 60 min (skin-to-skin), and the average bleeding was 80–100 ml. No perioperative complications were recorded. A control T2-weighted MRI was performed six months after surgery. All patients displayed a clean, unobstructed endometrial cavity with a thick anterior wall (Median: 14.98 mm, IQR 13–17). Twelve patients became pregnant again, all delivered by cesarean between 36.1 and 38.0 weeks, with a mean of 37.17 weeks. The thickness of the uterine segment before cesarean ranged between 3 and 7 mm, with a mean of 3.91 mm. No cases of placenta previa, dehiscence, placenta accreta spectrum (PAS), or postpartum hemorrhage were reported.

Conclusions: The comprehensive repair of recurrent low-large defects offers a holistic solution for addressing recurrent hysterotomy defects. Innovative repair concepts effectively address the wound defect and associated fibrosis, ensuring an appropriate myometrial thickness through a gliding myometrial flap.

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Hysterotomy defects; recurrence; advanced repair; myometrial flap; platelets-rich plasma

Introduction

Cesarean scar defects (CSD) are associated with various obstetric concerns. The incidence of post-cesarean defects is variable, although the CSD incidence is estimated at 61% after one cesarean (CS), increasing to 81% after two CS and even 100% after three procedures [1]. However, this value depends on multiple factors, such as the measurement method and the numerical value, which are not considered normal. While existing research has identified potential etiological factors, definitive solutions and universal approaches necessitate extensive collaborative research. Risk factors for CSD include cesarean sections, uterine position, labor before cesarean section, and possibly hysterotomy closure techniques [2,3].

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Nevertheless, despite decades of research exploring variations in cesarean suture methods, no clear conclusion has been reached. However, two contemporary randomized controlled trials have shown no differences among closure methods [4,5]. Cesarean Scar Pregnancy (CSP) and the Placenta Accreta Spectrum (PAS) are challenging complications linked to cesarean scar defects [6–12]. These complications raise questions about the etiological factors associated with dehiscent cesarean scars. Cesarean Scar Defects (CSD) are associated with fertility problems [3,13,14], such as fluid and blood retention [15], which can promote the release of inflammatory cytokines [16]. Menstrual or inflammatory liquid tends to accumulate inside the CSD and thus contaminates quality cervical mucus, stopping normal sperm movement and egg implantation that might lead to reduced fecundity [17] (CSD). Besides, continual effusion off the diverticulum stands out as one of the major factors responsible for developing the acute condition called cervical dysbiosis by bacteria within us. When exposed under such circumstances as these, harmful new cells with their waste products even result in changes on the endometrium surface, making it impossible for embryos to stay implanted, forestalling any possibility of having children born [18]. CSD, especially large hysterotomy defects, is related to PAS [6,7], particularly when associated with certain fertility techniques [19].

Various methods, including laparotomy, laparoscopy, hysteroscopy, and vaginal approaches, can be used to repair CSD. However, there is conflicting evidence regarding the optimal recommended repair route [14]. Proving this comparison can be challenging, as outcomes that do not meet expectations, similar to other medical procedures, are not often published [20].

While CSD recurrence, cesarean scar pregnancy, or uterine rupture after CSD repair appears rare [21], patients may report these complications in clinical practice. To our knowledge, no formal papers admit its existence regarding recurrence occurrence after cesarean scar repair; therefore, it is uncertain. Some patients may undergo a second repair attempt [22]. During medical consultations, some patients have shared that they accepted their condition, attributing it to the lack of alternatives following the failure of the initial repair procedure. Many repair techniques focus on suturing [23], ensuring proper drainage of the endometrial cavity [24], or closing the uterine defect [25] without addressing why the primary cesarean healing failed. Two surgical techniques using uterine flaps have been described. One was described in the surgical treatment of adenomyosis [26], and the other uses the uterus as a biological tamponade in complex hernias or eventrations [27]. In gynecological surgery, the use of a vaginal flap to repair a vesicovaginal fistula has been described. The interposition of tissue serves the purpose of a mechanical barrier to fistula recurrence and as a source of reperfusion of previously poorly vascularized tissue [28]. Therefore, it must be highly vascular and easily mobilized with its blood supply.

Comprehensive repair of a large or recurrent CSD involves not only the removal of the defective scar and all fibrotic tissues to restore the permeability of the endometrial cavity but also the creation of a thick anterior wall with an adequate vascular bed to promote proper healing, a vascularized myometrial flap results in a thick, smooth anterior wall, free from residual scars. Additionally, highly concentrated platelet-rich plasma enhances healing by releasing growth and vascular factors [29].

Materials and methods

Population

Fifty-four patients with cesarean scar defects had one or two previous repair procedures. Twenty-three patients had undergone a previous surgical repair by laparoscopy (resection and suture), nine through laparoscopy-assisted hysteroscopy, 15 defect borders were corrected by resective hysteroscopy [30] or 360-degree technique [31], and 15 patients were refused for any surgical procedure due a large defect and or to myometrial thinning less than 2–3 mm [14,32]. Fifty patients exhibited intrauterine fluid retention, eleven experienced prolonged menstrual bleeding, two were occasional social smokers (no more than two cigarettes a week), and fifty-two were experiencing infertility and expressed a desire for future pregnancy. Other demographic variables include GE: Median 32.18, Interquartile Range (IQR) 75th percentile: 37.25; parity: Median 1.44, IQR 75th percentile: 1; BMI (Body Mass Index): Median 21.58; IQR 75th percentile: 23.2, number of previous cesarean sections: Median 1.07, IQR 75th percentile: 1. Maternal background and cesarean scar defect (niche) measurement variables are included in Table 1.

Study design

A retrospective cohort analysis included fifty-four patients aged 25 to 41 with lower large hysterotomy defects who underwent surgery at Otamendi, CEMIC, and Valle de Lili hospitals. Inclusion criteria comprised patients with large Cesarean Scar Defects (CSD), which is defined as a width greater than 2.5 mm or a low

Table 1. Maternal background-cesarean scar defect measurement.

P		P		P		P		P	
1	33 Y; 2 CS, 1 D&C Niche: RM: 1 MM, DP: 2 MM; WD: 4 MM	12	38 Y, 2 CS Niche: RM: 1 MM, DP: 2.7 MM; WD: 4.1 MM	23	28 Y, 1 Preg stopped AT 19 W, D&C Niche: RM: UN, DP: FTD; WD: 4.5 MM	34	25 Y, CS by demand niche: RM: 1 MM, DP: 3 MM; WD: 4.2 MM	45	25 Y, 1 CS by induction failure Niche: RM: 1.4 MM, DP: 3.6 MM; WD: 5.3 MM
2	29 Y, 2 CS. 1 CS Long Labor 39 W Niche: RM: UN, DP:FTD, WD: 4 MM	13	24 Y, 1 CS at 41 W Niche: RM: 3 MM, DP: 1.5 MM; WD: 4.5 MM	24	25 Y, 1 ABO, 1 CS niche: RM: 2.2 MM, DP: 3 MM; WD: 2.9 MM	35	32 Y, 1 ABO, 1 CS niche: RM: 1.6 MM, DP: 2.7 MM; WD: 4.4 MM	46	34 Y, 1 CS, 1 D&C niche: RM: UN, DP: FTD WD: 3.8 MM
3	31 Y, D&C Niche: RM: 2 MM, DP: FTD; WD: 5,5 MM	14	30 Y, 1 CS MAR niche: RM: 2 MM, DP: 3 MM; WD: 4.9 MM	25	30 Y, 2 CS Niche: RM: 2 MM, DP: 3,3 MM; WD: 3.5 MM	36	36 Y, CS by niche: RM: UN MM, DP: FTD WD: 4.7 MM	47	27 Y, CS at demand Niche: RM: UN MM, DP: FMD; WD: 2.5 MM
4	26 Y, 1 CS AT 41 W Niche: RM: 1 MM, DP: FTD; WD: 4 MM	15	29 Y, 1 ABO, 1 CS Niche: RM: 1 MM, DP: 4 MM; WD: 4.6 MM	26	41 Y, 1 CS AT 39.5 W Niche: RM: 1 MM, DP: 4.2 MM; WD: 3.7 MM	37	39 Y, 1 CS Niche: RM: UN, DP:FTD, WD: 3.4 MM	48	40 Y CS by maternal age Niche: RM: 1.5 MM, DP: 3 MM; WD: 3.2 MM
5	41 Y, 1 CS, D&C Niche: RM: UN, DP: 2 MM; WD: 3.7 MM	16	29 Y, 1 CS, 1 VBAC Niche: RM: UN, DP: FTD; WD: 3.8 MM	27	29 Y, 1 CS Niche: RM: UN, DP:FTD, WD: 24 MM	38	24 Y, 1 CS after labor failure Niche: RM: UN, DP:FTD, WD: 3.7 MM	49	39 Y, CS by induction failure niche: RM: UN, DP: FMD; WD: 11.4 MM
6	39, 1CS Niche: RM: UN DP: FTD; WD: 15 MM	17	37 Y, abortion niche: RM: 1.5 MM, DP: 3 MM; WD: 4.3 MM	28	41 Y, 1 CS, 1 VBAC niche: RM: 1 MM, DP: 2.5 MM; WD: 3.6 MM	39	26 Y 1 CS, MAR niche: RM: 0 MM, DP: FTD; WD: 11 MM	50	29 1 CS, 1 CSP niche: RM: 1 MM, DP: 3 MM; WD: 4.8 MM
7	34, 1 CS NICHE: RM: 2 MM, DP: 3 MM; WD: 2.9 MM	18	29 Y, 1 vaginal birth and manual extraction niche: RM: 2 MM, DP: 2 MM; WD: 4.8 MM	29	35 Y, 1 CS, 1 Miscarriage niche: RM: 2 MM, DP: 2.6 MM; WD: 3.5 MM	40	32 Y, CS AT 38 W niche: RM: UN DP: FTD; WD: 4.3 MM	51	25 Y, CS (unknown indication) niche: RM: 1 MM, DP:2 MM; WD: 2,3 MM
8	27 Y, 1 CS MAR niche: RM: 1.5 MM, DP: 3 MM; WD: 3 MM	18	30 Y, 2 CS niche: RM: 2 MM, DP: 3 MM; WD: 4,4 MM	30	26 Y, CS by twins niche: RM: UN, DP:FTD; WD: 4.2 MM	41	29 Y, CS by podalic niche: RM: 1 MM, DP: 2 MM; WD: 9.5 MM	54	36 Y, 2 ABO Niche: RM: 1.5 MM, DP: 3 MM; WD: 4.3 MM NICHE: RM: 1.5 MM, DP: 3 MM; WD: 4.3 MM
9	33 Y, 1 CS, D&C niche: RM: UN, DP: FTD; WD: 4,6 MM	20	25 Y, 1 CS niche: RM: 2 MM, DP: 2 MM; WD: 3.4 MM	31	40 Y CS by age and high weight. niche: RM: 1 MM, DP: 3 MM; WD: 2.7 MM	42	40 Y, 1 CS by lack of induction niche: RM: UN, DP: FTD; WD: 5.7 MM	53	37 Y 1 CS Niche: RM: 1 MM, DP: 2.7 MM; WD: 4.7 MM
10	40 Y, 1 CS niche: RM: 2 MM, DP: 2 MM; WD: 3.5 MM	21	39 Y 1 CS niche: RM: UN, DP: FMD; WD: 4.5 MM	32	32 Y, 1 Miscarriage, 1 CS NICHE: RM:1.6 MM, DP: 3.4 MM; WD: 6 MM	43	42 Y, CS by maternal age niche: RM:1.1 MM, DP: 3.4 MM; WD: 3.9 MM	54	32 Y, CS by demand Niche: RM: UN, DP:FTD, WD: 4,5 MM
11	32 Y, 1 CS, long labor niche: RM: 2 MM, DP: 3 MM; WD: 4,5 MM	22	25 Y, 1 Miscariage and D&C niche: RM: 1 MM, DP: 2 MM; WD: 3,8 MM	33	26 y, CS by opp niche: RM: 2 MM, DP: 3 MM; WD: 3.5 MM	44	27 Y, CS by fetal suffering niche: RM: UN, DP: FTD; WD: 7.1 MM		

CS: cesarean section; RM: residual myometrium; DP: depth; WD: width; UN: undetectable; FTD: full thickness defect; D&C: dilation and curettage; MAR: medically assisted reproduction; W: weeks; Y: years; OPP: occiput posterior position.

location less than 2 cm from the internal cervical area based on ultrasound or MRI. Potential contraindications of the procedure included severe adherent processes of the peritoneum or pelvic organs, as well as suspicion of gynecological neoplastic pathology. Transvaginal ultrasound (TVUS) or T2 MRI diagnosed and characterized the defect and fluid retention (Supplemental File 1, Figures 1–4). Patients underwent suprapubic laparotomy under spinal anesthesia. After opening the abdomen, the uterus was held with forceps, and bladder traction with Allis clamps improved access to the vesicouterine space. The vesicouterine fold was dissected using Vicryl 0 (Polyglactin 910, Ethicon™ USA) ligatures, and in cases with strong adhesions, tissues were incised with a scalpel blade number 15, proximal to the uterine side to avoid detrusor damage (see Supplementary File 1, Figure 7). Two stitches were placed in the lateral defect border for traction, and defective scar resection was facilitated with a scalpel blade number 23–24. Fibrous tissue obstructing access to the upper endometrial cavity was resected, and intracavitary fibrous tissue was removed using a modified 90-degree angle scalpel through a parallel cut to the myometrial line. Two additional cuts were performed 1 cm away from the lateral uterine borders to remove the entire fibrous tissue, creating the bed for the myometrial flap. The surgeon removed all additional intraluminal fibrotic tissues with a cold scalpel and the assistance of an Allis clamp.

Subsequently, the surgeon inserted an index finger into the uterine cavity to check for any tissue abnormalities, ensuring a smooth myometrium from hysterotomy to the uterine fundus. Over the anterior cervical surface, the surgeon removed a square tissue measuring 3 × 3 cm and 1 mm thick with a cold scalpel to promote abrasive and microvascular connections with the upper flap. This maneuver typically

induced some points of bleeding, controlled by electrocautery. Three U stitches of Monocryl 0 (Poliglecaprone Ethicon™ USA) were used to join the upper part of the flap with the flap bed. An assistant manipulated the upper edge to the lower area before the surgeon secured the stitches to reduce tension and minimize cutting damage.

After setting the internal flap, a continuous suture of Vicryl 2/0 was performed on the lower edge of the upper flap on one side and the cervix on the other. Upon completion of the repair steps, 16 ml of platelet-rich plasma (PRP) was injected into the upper and lower sutured borders. The PRP was obtained from the patient's blood using RegenKit A-CP-Kit 3™ by Regen Lab SA Switzerland in the surgical room and then separated using low-speed centrifugation. The procedural steps are illustrated in Supplementary File 2, Pictures 1–10. Following the repair, a continuous suture of 000 Vicryl achieved immediate hemostasis of peritoneal borders. The omentum was placed over the repaired area to prevent further adhesion. The laparotomy was closed in layers, including the peritoneum, muscular fascia, subcutaneous fat, and skin with intradermal absorbable sutures.

The thickness of the uterine segment before cesarean ranged between 3 and 7 mm, with a mean of 3.91 mm. All deliveries were performed by elective cesarean section at 37 weeks and by indication of the obstetrician in charge. The authors attended all the cesarean sections, which were performed at about 5 cm from the vesicouterine fold in order not to damage the repaired area.

The initial ultrasonographic healing control evaluation occurred six weeks after surgery, utilizing both abdominal and transvaginal ultrasound (TVUS) examinations to observe the initial healing process (Supplementary File 2, Picture 11). The conclusive assessment was conducted using a semi-filled bladder with T2-weighted magnetic resonance imaging between days 20 and 23 of the menstrual cycle (Supplementary File 2, Picture 12). Morphological analysis included evaluating the permeability of the endometrial cavity, the presence of fibrous tissue, and measuring the thickness of the anterior wall at the lower uterus.

A statistician performed a descriptive statistical analysis. Qualitative variables were determined, and descriptive statistics were employed to analyze the data in absolute frequencies or percentages. The data obtained were processed using the Infostat statistic program.

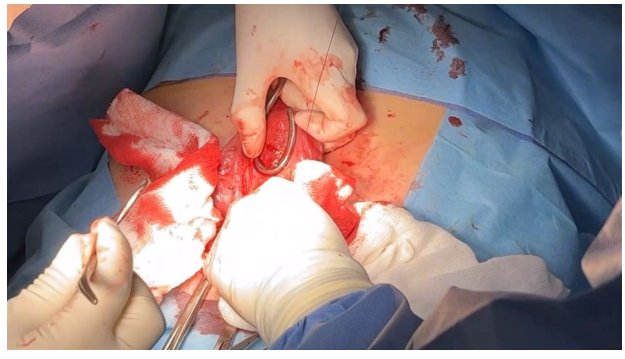
This study was conducted according to the Declaration of Helsinki for Medical Research Involving Human Subjects. Informed consent was not required due to the retrospective nature of the study. The project was approved by the research ethics committee of CEMIC Hospital in Buenos Aires, Argentina, IRB protocol number 10829.

Results

The fifty-four women who underwent repair experienced normal menstrual cycles and demonstrated an adequate lower uterine segment thickness without any evidence of healing defects. No perioperative complications were recorded. All patients achieved early ambulation and were discharged within 24 h. Estimated bleeding ranged from 80 to 100 ml, primarily corresponding to the opening of the abdominal wall. Uterine hemostasis was successfully achieved at specific points, minimizing the use of electrocautery. The average duration of the procedure, from skin to skin, was 60 min. Video 1.

After a six-month T2 weighted MRI, the control displayed a clean, unobstructed endometrial cavity with a thick anterior wall measuring between 12 and 19 mm, with a median of 14.98 mm and an interquartile range (IQR) of 13–17. Subsequent ultrasound and MRI control images revealed no evidence of fibrous tissue adhering to the uterine walls or causing endometrial occlusion. None of the women exhibited spotting, bleeding, recurrence of cesarean scar dehiscence, or fluid retention afterward.

Twelve patients became pregnant again, all delivered by cesarean between 36.1 and 38.0 weeks, with a mean of 37.17 weeks. The thickness of the uterine segment before cesarean ranged between 3 and 7 mm, with a mean of 3.91 mm. No cases of placenta previa, uterine segment dehiscence, placenta accreta spectrum (PAS), or postpartum hemorrhage were reported. Other characteristics of subsequent pregnancies can be found in Table 2.



Video 1. Uterine glide flap.Video is located in: https://drive.google.com/drive/folders/1gY4p1hYo9ICNztP26bh_xMHJd1Lgb1Rb?usp=sharing.

Table 2. Pregnancies after comprehensive repair.

	1	2	3	4	5	6	7	8	9	10	11	12	Media
Age	38	34	32	28	35	33	27	27	28	32	26	41	31,75
Parity	3	2-MAR	2	3	2-MAR	2	3	4	2	2	2	2-MAR	2,416
GA	37	36.3	37.4	37.1	38	36.1	38.2	37.3	36.6	37.4	37.1	37.6	37,175
Uterine segment thickness (mm)	5	7	4	3	3	5	4	3	3	3	4	3	3,91666667
Placenta	Fundal posterior	Anterior placenta	Fundal-Anterior	Fundal	Posterior lateral-left	Fundal	Fundal	Fundal-posterior	Posterior	Fundal-anterior	Anterior	Fundal posterior	–
Birth weight (g)	2990	2780	3050	2586	3100	2700	3100	3000	2800	2950	2890	3020	2913,83333
Apgar	9/10	8/10	9/10	8/10	9/10	8/10	9/10	9/10	8/10	9/10	8/10	9/10	–
Neonatal care unit	No	No	No	No	No	No	No	No	No	No	No	No	None

GA: gestational age; MAR: medically assisted reproduction.

Discussion

The advanced repair of recurrent hysterotomy defects using a myometrial sliding flap was successful in all treated patients, with no myometrial defects observed at the six-month follow-up (Median residual myometrium: 14.98 mm, IQR: 13–17 mm). This surgical technique effectively addressed recurrent spotting secondary to cesarean scar defects, removed all intracavitary fibrous tissue, and restored normal uterine thickness.

The comprehensive removal of fibrous tissues is decisive, as they can obstruct the endometrial space at multiple points (Supplementary File 1, Figures 5 and 6), leading to fluid retention, secondary infertility [33], delayed and unsuccessful embryo transfer, or endometritis [34]. In women with a niche, sub-endometrial wave patterns are disturbed during all phases of the menstrual cycle, which could lead to spotting due to suboptimal menstrual outflow and lower implantation rates. Inflammation in association with the presence of a niche induces a higher amplitude [35]. It has also been postulated that pro-inflammatory factors (like Interleukin(IL)-1b, IL-8, and cyclooxygenase-2) may induce uterine contractions and secondary infertility associated with chronic endometritis, endometriosis, and chronic inflammation in the uterine cavity [16].

The fibrotic tissue is firm, displaying a light grayish-white color in contrast to the soft, dark pink myometrium. Removal is achieved using a cold scalpel with a number 15 blade. The distinctive hardness and color facilitate its complete removal without difficulty.

Experimental results demonstrate that inflammation-mediated vasodilation (cytokines) is a critical source of additional blood flow before revascularization begins. However, an intact vascular network following injury is a prerequisite for normal healing [36,37]. The uterine segment is irrigated by a terminal blood supply, with very few anastomoses from the vaginal vessels. If the main vessels are cut during the cesarean section, a reduction in blood flow supply ensues, causing low oxygen delivery and disrupting the normal healing process.

Due to this pattern of blood supply, surgical interventions on the uterine segment may lead to delayed wound healing and spontaneous rupture or defect [38]. Although the mechanism is unclear, it is proposed that abnormal wound healing of the previous cesarean section scar predisposes to impaired pregnancy development [2].

Platelet-rich plasma (PRP) accelerates the repair processes by directly delivering a high concentration of platelet-derived growth factors and other cytokines to the affected area [38]. As a fraction of blood plasma with concentrated platelets, PRP contains over 300 biologically active elements that can be released upon

activation [36]. PRP is freshly prepared autologous platelet preparations. Activation methods such as thrombin activation were not preferred because a slow and coordinated release of growth factors is needed for complete angiogenesis [36]. *Revascularization strategies stimulate the regeneration of vascular networks to achieve a successful clinical outcome for* an implanted cell construct [38].

Platelet-rich plasma (PRP) provides an autologous substrate that enhances the creation of neovascularization between the two surfaces of the sliding flap. Additionally, it stimulates healing and reorganizes collagen and elastin fibers. Platelet granules contain proteins that play a significant role in wound healing, including platelet-derived growth factor (PDGF). Platelet activation (degranulation) causes the granules to fuze with the platelet cell membrane, activating intracellular signaling proteins [39]. This, in turn, leads to a genetic expression that directs collagen proliferation, among other elements. Platelets actively secrete these proteins within the first 10 min following clot formation, completing the secretion of more than 95% of the pre-synthesized growth factors within 1 h [39].

The uterine body and cervix possess a rich vascular network; consequently, *sliding myometrial tissues provide a repaired area with good perfusion from two vascular components (uterine and cervical)*. Constructing the myometrial flap, therefore, fulfills the prerequisite of platelet stimulation to establish a healthy vascular network (which may have been damaged by the cesarean).

While a normal endometrial cavity without blood or fluid retention is a crucial factor during the evaluation and treatment of infertility [40], it's essential to consider that restoring the anterior uterine thickness minimizes the risk of cesarean scar pregnancy, placenta accreta spectrum, or uterine rupture. Hence, the sliding myometrial flap offers two advantages: improved blood supply and a thick anterior wall free of remaining scars.

Current repair methods may not always address all the issues associated with cesarean scar defects. Additionally, hysteroscopic surgery may not be viable for patients with a myometrial thickness of less than 2 mm surrounding the scar defect, as defects cannot be sutured hysteroscopically [41]. Although both hysteroscopic and laparoscopic corrections are highly effective in treating cesarean section scar defects, they may not eliminate recurrence and further complications [42].

Cesarean scar pregnancy accounts for 6% of all ectopic pregnancies in women with at least one prior cesarean delivery [43,44] and is associated with cesarean scar defects. Cesarean scar pregnancy is a precursor to morbidly adherent placenta [9], and thus, cesarean scar defects are a significant risk factor. Scar defects or microscopic dehiscence in the scar result from fibrosis and poor vascularization, leading to compromised wound healing [43,45].

In the case of the advanced repair described in this paper, all aspects of fertility and subsequent pregnancy are thoroughly considered.

Clinical implications

A quick analysis of the factors influencing wound healing indicates that a poor oxygen supply is a leading candidate to explain the etiology of cesarean scar defects. It is plausible that the presence of segmental and terminal irrigation in the uterine segment, with very few anastomoses, is essential in developing cesarean scar defects.

The conversion of procollagen (fragile) to mature tensile collagen (firm with tensile strength) necessitates oxygen. The development of myofibroblasts, augmented by PRP, enhances this process following the myometrial glide flap. Myofibroblasts play a crucial role in wound contraction during the proliferation phase and are considered one of the key events in wound healing [46]. When myofibroblasts fail to develop, the wound may spontaneously open, as seen in cesarean scar defects.

At the end of pregnancy, the uterine segment can be divided into three areas: the lower one concerning the posterior lower bladder, the middle one about the upper lower bladder, and the upper one near the uterine body. Traditionally, obstetricians perform cesarean sections in the middle or lower area, characterized by limited blood supply [47,48] and poor collateral vascularization from the vaginal pedicles.

In contrast, the upper segment area is 100% anastomosed with the uterine arteries [49]. Therefore, performing the cesarean at this level ensures an accurate vascular network, appropriate oxygen delivery, and precise healing. The upper limit of the uterine segment is easily identifiable by fixed anatomical landmarks and remains unaffected by any stage of labor [50], preventing inadvertent vaginal cesarean [51]. In 2019, Dr. Vikareva-Osser conducted a randomized, single-blind trial [52] demonstrating that a low cesarean hysterotomy level in women in advanced labor was associated with a higher incidence of large scar defects. Although the rational basis for this correlation was not established, there is a perfect alignment between clinical results and the local features of the uterine segment blood supply.

Implications in research

The blood flow in the middle portion of the uterine segment exhibits certain unique characteristics; it is

terminal and has limited supplementary connections. An updated anatomical study encompassing the ovary, uterine, and vaginal pedicle is necessary to precisely identify the optimal area for performing a cesarean. Wound healing in regions with poor blood supply is compromised, with its reduction resulting in low oxygen delivery and disruption of normal healing [53,54]. Due to this blood supply pattern, surgical interventions at the level of the uterine segment may lead to delayed wound healing and spontaneous rupture or defect.

Proper healing implies fewer cesarean scar defects associated with the genesis of placenta accreta spectrum cases, cesarean scar pregnancy, and other problems [47]. To our knowledge, this is the first time that the local peculiarities in the uterine segment blood supply are associated with the healing process to explain the basis of cesarean scar defects.

Conducting electron microscopy and molecular analysis of samples from the dehiscent healing area may provide a rational source for understanding the primary healing defect, thereby eliminating or significantly reducing this iatrogenic problem.

Strengths and limitations

The study was limited by its retrospective design, potentially constraining the generalizability of the findings. However, comprehensive repair of recurrent cesarean scar defects has demonstrated apparent advantages over other therapeutic options.

The surgical technique involves the elimination of the dehiscent scar and removing the entire intracavitary fibrous tissue. It restores myometrial thickness with healthy and well-perfused tissues using a sliding myometrial flap and intramyometrial PRP injection.

While the results are promising, experimental design studies must confirm the advantages over other surgical options. Conducting such studies can be challenging, and the results presented in this study provide an intriguing option for a group of patients with limited additional therapeutic choices following initial failure.

Conclusions

The comprehensive repair of recurrent low-large defects provides an integral solution for recurring cesarean scar defects. This approach entails repairing the defect and removing all intracavitary fibrotic tissue, considering the myometrial vascular blood supply, and addressing the thickness of the anteroinferior uterine wall. Innovative concepts enable us to tackle the root causes of wound healing problems.

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Author contributions

JMPJ generated the research idea, designed the reported surgical technique, conducted the study, analyzed the data, and prepared the manuscript. NAB and AJNC participated in the execution of the study, data analysis, and manuscript preparation.

Disclosure statement

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author, JMPJ. The data are not publicly available due to their containing information that could compromise the privacy of research participants.

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