SINGLE-LAYER VERSUS DOUBLE-LAYER UTERINE CLOSURE TECHNIQUE IN NICHE DEVELOPMENT AMONG WOMEN WITH FULL-TERM PRIMARY C-SECTIONS: A RANDOMIZED CLINICAL TRIAL

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This study aims to compare niche incidence between single- and double-layer uterine closure techniques and describe related factors among women with full-term primary C-section. From May 2022 to March 2023 at Hanoi Obstetrics and Gynecology Hospital, a double-blind, randomized controlled trial was performed on 116 participants (64 in single- and 52 women in double-layer group). The uterine scar was evaluated by transvaginal ultrasound at 12 months postoperatively. The overall niche was 43.1%. There was no difference in niche incidence and residual myometrial thickness between single - and double group (48.4% versus 36.5%; 4.4mm versus 4.6mm, respectively). The healing ratio was better in the latter group (0.60 vs. 0.66, p<0.05). The mean volume of niche was 64mm3. All women were in the mild niche, with a VTS score ≤ 2. The retroverted uterus among women with niche was 56%, higher significantly than women without niche (34.8%). In conclusion, on the hand of well-trained surgeons, there were no difference in niche incidence and RMT between single- and double-layer uterine closure techniques. Retroverted uterus was the main factor contributed to development of niche. Further studies are needed to evaluate the progress of the niche in a longer span and to prevent retroverted uterus.

Keywords: Single-layer, double-layer, uterine closure technique, niche, healing ration, VTS score, related factors.

I. INTRODUCTION

Caesarean scar defect or niche was first described in 1995 by Morris.[1] Niche is supposed to relate to gynecological symptoms and increasing in the risk of subsequent pregnancy.[2] Because there is little knowledge about the healing of the uterus after Caesarean delivery, the niche formation mechanism is unclear. Possible factors could play a role in niche development and uterine closure techniques are supposed to be the most important.[3]

Many studies have been performed to determine which uterine closure technique is better.[3-5] However, there is lack of strong evidence about niche development between single-layer and double-layer closures. In 2021, a meta-analysis of 19 RCTs revealed that double-layer uterine closure is better than single-layer uterine closure in residual myometrial thickness (RMT) and dysmenorrhea.[2] But, in the 2Close study in 32 hospitals in the Netherlands, niche prevalence was 4.7% higher (95% CI 0.7–8.7%, P = 0.022) after double-layer closure.[6] This heterogeneous result was blamed on the heterogeneous participants (preterm and full-term pregnancy, first or repeat C-sections),

timing of evaluation niche on ultrasound (6 weeks to years) and types of imaging diagnosis (transvaginal ultrasound, hysterosonography).

Therefore, this study was conducted to compare the incidence of niche and residual myometrial thickness between single-layer versus double-layer uterine closure techniques and to describe some related factors that affected niche development at 12 months postoperative among women with full-term primary C-sections.

II. MATERIALS AND METHODS

A double-blind, randomized controlled trial was performed from May 2022 to March 2023 at Hanoi Obstetrics and Gynecology Hospital.

This study was approved by the Institutional Review Board for Ethics in Biomedical Research – Hanoi Medical University (IRB-VN01.001/ IRB00003121/FWA 00004148).

1. Participants

We enrolled all full-term (gestational age ≥ 37 0/7 weeks) pregnant women aged 18 years or older who underwent a primary caesarean delivery (emergency or elective). The exclude criteria included previous major uterine surgery, abnormal menstrual bleeding, dysmenorrhea, dyspareunia, suprapubic pain before pregnancy, and abnormal placenta (placenta previa, placenta accreta spectrum) in the current pregnancy.

2. Procedure

Potential eligible pregnancies at term were fully consulted information related to this study upon admission. Written consent was obtained from each eligible pregnant woman before caesarean delivery. After signing the consent form, eligible women were randomly assigned in a 1:1 ratio to receive either single-layer closure or double-layer closure, using block randomization with a variable block size of 4,

6. The computer-generated random list was prepared by an independent statistician who has no other involvement in the study. To ensure allocation concealment, opaque and sealed envelopes were prepared and controlled by two administrative staff in the Clinical Trial Unit who have no involvement in clinical work. Whenever there is an eligible participant, these two staff will hand over the envelope in sequence to the clinician. As the result, surgeons will not be blinded, but participants and sonographers will be unaware of closure techniques. Apart from randomization, patients will be managed and followed up according to local protocol.

The caesarean section with two uterine scar closure techniques will be performed by well-trained obstetricians. In both study groups, women underwent a CD following a standard way with respect to mode of hysterotomy, non-closure of the peritoneum. In the intervention group, double-layer closure of the uterus will be performed using unlocked multifilament continuous running sutures for both layers and the endometrial layer will be included in the first layer. The second layer is a continuous running suture that imbricates the first layer. The control group will receive a single-layer closure using unlocked continuous running multifilament sutures and the endometrial layer will be included.

3. Follow-up

Participants were contacted via telephone to notify about follow-up visits within 10 days of the first day of every menstrual cycle at 12 months postoperatively (give or take 2 weeks). A structural assessment of the uterine scar, including the detection and measurement of a niche (depth, length and branches), RMT, Adjacent myometrial thickness (AMT), distance between uterine scar and vesicovaginal fold, distance between uterine scar and external os,

uterine position, was performed according to the niche measurements guideline, endorsed by ISUOG experts in 2019[7] (Figure 1).

Addition, the niche width was measure in axial plane. A niche volume was calculated by formula: depth (mm) x width (mm) x length (mm) x 0.52. Niche was classified according to VTS score system, based on: volume of niche (V); thickness of scar myometrium (T); and supplementary features (S), proposed by ISUOG in 2019 (Figure 2), as mild (≤2 points) and severe (> 2 points).[8]
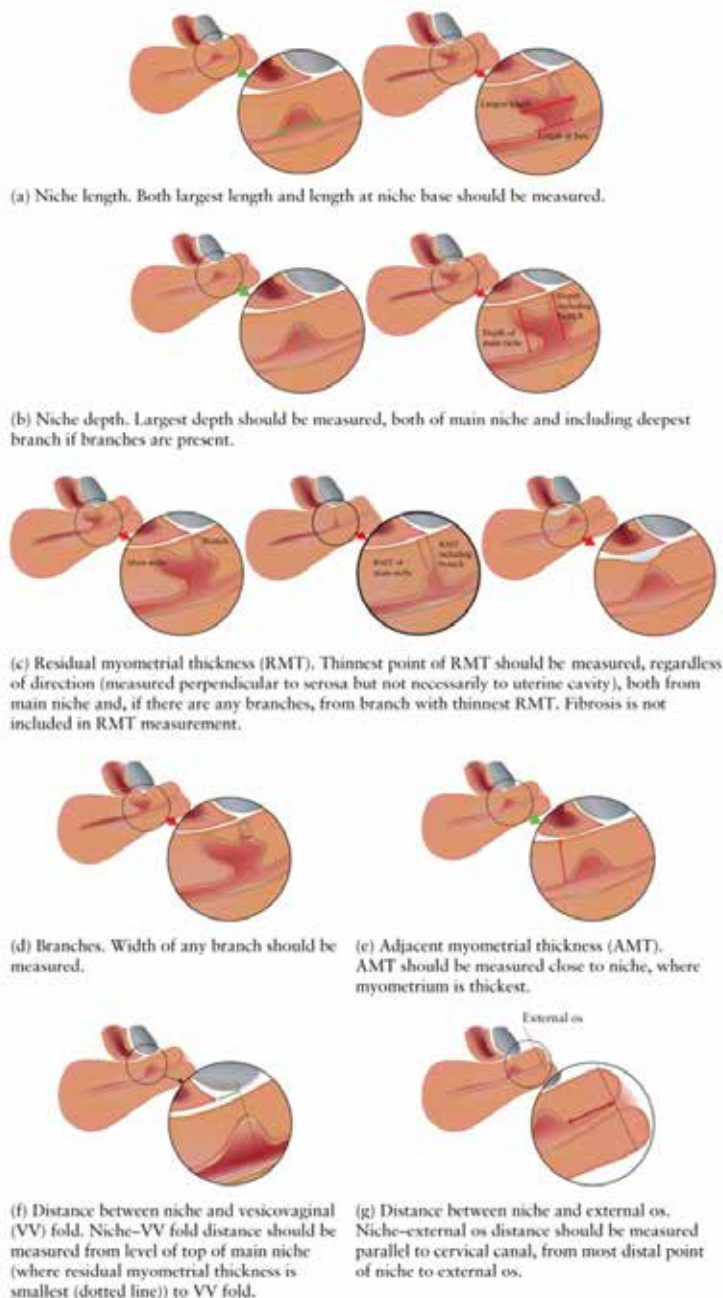

(a) Niche length. Both largest length and length at niche base should be measured.

(b) Niche depth. Largest depth should be measured, both of main niche and including deepest branch if branches are present.

(c) Residual myometrial thickness (RMT). Thinnest point of RMT should be measured, regardless of direction (measured perpendicular to serosa but not necessarily to uterine cavity), both from main niche and, if there are any branches, from branch with thinnest RMT. Fibrosis is not included in RMT measurement.

(d) Branches. Width of any branch should be measured.

(e) Adjacent myometrial thickness (AMT). AMT should be measured close to niche, where myometrium is thickest.

(f) Distance between niche and vesicovaginal (VV) fold. Niche–VV fold distance should be measured from level of top of main niche (where residual myometrial thickness is smallest (dotted line)) to VV fold.

(g) Distance between niche and external os. Niche–external os distance should be measured parallel to cervical canal, from most distal point of niche to external os.

Figure 1. Measurements of uterine niche in the sagittal plane (ISUOG expert 2019)[7]

Feature	Score		
	0	1	2
Volume of niche [*]	$< 0.1 \text{ cm}^3$	$0.1–1.0 \text{ cm}^3$	$> 1.0 \text{ cm}^3$
Thickness of residual myometrium [†]	$> 3 \text{ mm}$	$1–3 \text{ mm}$	$< 1 \text{ mm}$
Supplementary features [‡]	Absent	Present	—

Figure 2. VTS system for classification of uterine niche according to presence of potentially clinically relevant features[8]

4. Outcomes

The primary outcome was proportion of niche and the residual myometrial thickness at twelve months postoperative of the two groups. The secondary outcomes were evaluating some potential factors contributing to niche development.

5. Statistical analysis

All statistical analyses were performed using SPSS 20.0 software (SPSS Inc., Chicago, IL, USA). Qualitative and continuous variables were described as percentages and medians. Quantitative variables were compared using the Independent T-Test, Mann–Whitney U test, Fisher Exact Test, Chi-square Test. P-values < 0.05 were considered significant.

III. RESULTS

Between May 2022 and February 2023,

we enrolled 225 women randomized to two groups, 113 in single-layer group and 112 in double-layer group. However, because of the refusal of re-examination due to long distance (54), pregnancy (23), and loss of contact (32), there were 116 participants in the final analysis.

The mean age of participants was 27 years. Almost all women were nulliparous, living in urban areas, had spontaneous conception, had no medical history, and underwent elective cesarean sections at 39 weeks of gestation. There were no complication related to surgery, such as postpartum hemorrhage, postpartum infections, damage to internal organs, or admission to the ICU. The baseline characteristics of the two groups were comparable with p at each variable > 0.05 as a result of efficient randomization (Table 1).

Table 1. Baseline characteristics of participants

Variables	Total (n=116)	Single-layer (n=64)	Double-layer (n=52)	p
Age (years)	27.3±3.14	27.3±3.27	27.2±3.00	0.660[b*]
BMI	25.8±2.5	26.1±2.28	25.6±2.76	0.487[b]
Accommodation				
Urban	86	46(71.9)	40(76.9)	0.670[a]
Rural	30	18(28.1)	12(23.1)	

Variables	Total (n=116)	Single-layer (n=64)	Double-layer (n=52)	p
Ethinicity				
Kinh	113	62(96.9)	51(98.1)	1.000[a]
Others	3	2(3.1)	1(1.9)	
Number of delivery				
0	109	58(90.6)	51(98.1)	
1	6	5(7.8)	1(1.9)	0.222[b]
2	1	1(1.6)	0	
Number of abortion				
0	103	55(85.9)	48(92.2)	
1	8	6(9.4)	2(3.8)	
2	4	3(4.7)	1(1.9)	0.332[b]
3	1	0	1(1.9)	
Conception method				
Spontaneous	110	61(95.3)	49(94.2)	1.000[b]
IVF	6	3(4.7)	3(5.8)	
Maternal condition				
Normal	103	56(87.5)	47(90.4)	0.770[a]
Hypertension	3	1(1.6)	2(3.8)	0.586[b]
Diabetes	7	5(7.8)	2(3.8)	0.457[b]
Anaemia	4	3(4.7)	1(1.9)	0.627[b]
C-section Indications				
Macrosomia	12	7(10.9)	5(9.6)	1.000[a]
Multiple gestations	5	2(3.1)	3(5.8)	0.656[b]
Malpresentation	10	6(9.4)	4(7.7)	1.000[a]
Pre-eclampsia	1	1(1.6)	0	1.000[b]
Maternal/Fetal indications	14	7(1.09)	7(13.5)	0.777[a]
Obstetrics indications	24	17(26.6)	7(13.5)	0.108[a]
Labor arrest	8	4(6.3)	4(7.7)	1.000[b]
Non-reassuring FHR tracings	20	10(15.6)	10(19.2)	0.630[a]
Maternal request	24	12(18.8)	12(23.1)	0.647[a]

Variables	Total (n=116)	Single-layer (n=64)	Double-layer (n=52)	p
Membrane rupture before CD				0.663[a]
Yes	28	14(21.9)	14(26.9)	1.000[b]
<6h	21	10(71.4)	11(78.6)	1.000[b]
≥6h	7	4(28.6)		
No	88	50(78.1)	38(73.1)	1.000[a]
Timing of CD				
Elective	81	45(70.3)	36(69.2)	0.700[b]
Emergency	35	19(29.7)	16(30.8)	
Cervical dilation <6cm	26	15(78.9)	11(68.8)	0.197[c]
Cervical dilation ≥6cm	9	4(21.1)	5(31.3)	0.508[a]
Blood loss (ml)	319±41.9	323.3±41.25	315.4±42.63	0.197[c]
Additional hemostasis suture				0.305[c]
No	89	51(79.9)	38(73.1)	0.695[c]
Yes	27	13(20.3)	14(26.9)	1.000[a]
Gestational age (weeks)	39.2±0.85	39.1±0.77	39.2±0.957	1.000[b]
New-born weight (gram)	3097±404.9	3085±391.8	3111±423.8	0.777[a]
Time of menstruation	6.0±3.70	5.8±3.78	6.4±3.60	0.001[c]
Menstruation				
Regular	97(83.6)	54(84.4)	43(82.7)	1.000[a]
Irregular	19(16.4)	10(15.6)	9(17.3)	

Values are given as no. (%); mean±standard deviation.

[a] Chi square test [b] Fisher Exact Test. [c] Mann Whitney U Test

In terms of characteristics of uterine scar, there were no difference between the two groups regarding residual myometrial thickness (4.4mm versus 4.6mm, respectively) and adjacent myometrial thickness (7.3mm versus 7.0 mm, respectively). However, the lower uterine segment tended to heal better among women in the double-layer group compared to the single-layer group, with the healing ratio (RMT/AMT) significantly higher in the former group (0.66 vs. 0.60, p<0.05).

Table 2. Comparison the characteristics of uterine scar and gynecological symptoms between single-layer and double-layer groups at 12 months postoperative

Variable	Total	Single-layer (n=64)	Double-layer (n=52)	p
Characteristics of uterine scar (n=116)				
RMT (mm)	4.5±1.29 (2.0-7.8)	4.4±1.39 (2.0-7.8)	4.6±1.16 (2.7-7.4)	0.273[d]
AMT (mm)	7.1±1.47 (4-10.8)	7.3±1.71 (4-10.8)	7.0±1.08 (4.1-9.2)	0.577[c]
RMT/AMT (mm)	0.63±0.146 (0.3-1)	0.60±0.157 (0.3-1)	0.66±0.125 (0.4-0.9)	**0.024[c]**
Niche (n=50)	50 (43.1)	31 (48.4)	19 (36.5)	0.258[a]
Depth (mm)	3.2±1.06 (2.0-6.6)	3.4±1.19 (2.0-6.6)	2.9±0.74 (2-4.2)	0.203[c]
Length (mm)	5.2±2.15 (2.0-11.9)	5.5±2.45 (2.0-11.9)	4.7±1.50 (2.5-8.0)	0.395[c]
Width (mm)	5.8±3.11 (2-18.2)	5.9±3.43 (2-18.2)	5.6±2.6 (2-12)	0.944[c]
Volume of niche (mm³)	62.1±105.3 (7.6-746)	76.7±131.8 (8-746)	38.3±16.48 (7.6-65.9)	0.484[c]
Niche score (VTS system)	0.42±0.538	0.55±0.568	0.21±0.419	**0.031[c]**
0	30 (60)	15 (48.4)	15 (78.9)	
1	19 (38)	15 (48.4)	4 (21.1)	0.092[b]
2	1 (2)	1 (3.2)	0	

Values are given as no. (%); mean±standard deviation(min-max).

[a] Chi-square Test [b] Fisher Exact Test. [c] Mann Whitney U Test [d] Independent T-Test

The overall incidence of niche after primary C-sections among full-term pregnant women was 43.1%. This rate was similar in the single-layer group (48.4%) compared to the double-layer group (36.5%) with p> 0.05. All niches were simple without branches and triangular shape. In the single-layer group, the depth of the niche tended to be larger, and the volume of the niche was approximately twice that of the double-layer group, though the differences were not significant (Table 2). Using VTS score, all women was in the mild niche, with VTS score ≤2. However, the mean VTS score among women in single-layer group was significantly higher compared to double-layer group (0.55 versus 0.21) (Table 2).

Among many factors regarding maternal conditions, characteristics of labor and

operation, relation of uterus and uterine scar, only uterine position has affected to the development of niche. In niche group, the percentage of retroverted uterus was 56%, while this proportion among women without niche was 34.8%, and the difference has significant (p< 0.05) (Table 3).

Table 3. Potential factors related to niche development

Variables	Total (n=116)	Niche (n=50)	No Niche (n=66)	p
Maternal age	27.3±3.14	27.3±3.32	27.3±3.02	0.944[c]
BMI	25.8±2.5	25.6±2.71	26.0±2.35	0.361[c]
Conception method				
Spontaneous	110(94.8)	47(94)	63(95.5)	1.000[b]
IVF	6(5.2)	3(6)	3(4.5)	
Rupture membrane before C-sections				
Yes	28(24.1)	13(26)	15(22.7)	0.827[a]
No	88(75.9)	37(74)	51(77.3)	
Timing of C-sections				
Elective	81(69.8)	33(66)	48(72.7)	0.281[a]
Emergency	35(30.2)	17(34)	18(27.3)	
Additional hemostasis suture				
Yes	27(23.3)	10(20)	17(25.8)	0.513[a]
No	89(76.7)	40(80)	49(74.2)	
Uterine position				
Anteverted	65(56)	22(44)	43(65.2)	**0.025[a]**
Retroverted	51(44)	28(56)	23(34.8)	
Distance between uterine scar and vesicovaginal fold	8.4±4.59	10.1±5.67	7.2±3.04	0.001[c]
Distance between uterine scar and external os	27.1±5.17	27.3±4.90	26.8±5.38	0.563[d]

Values are given as no. (%); mean±standard deviation.

[a] Chi square test [b] Fisher Exact Test [c] Mann Whitney U Test

IV. DISCUSSION

Obviously, defects in uterine healing have a major gynecological and obstetric impact. The main results of this double-blind, randomized controlled trial indicate that although the

incidence of niche and RMT at 12 months postoperative among women who underwent primary cesarean sections were not different between the two uterine closure techniques, the healing ratio (RMT/AMT) was higher and the niche score according to VTS system was lower in the double-layer group. There was only uterine position related to formation of niche after C-sections.

As a result of efficient randomizations, the baseline characteristics of two groups were comparable. This helped to eliminate the bias factors to the primary outcome. The niche incidence and RMT was not difference between two groups. These results were similar with Stegwee et al's study. However, from a meta-analysis, double-layer had advantage in better RMT. The main reason was that in other studies in the meta-analysis, there were numerous heterogeneity in surgeon's experiences, C-section techniques, types of suture. According to Sholapurkar, the crucial factor in the development of niche were the finer details of the component surgical techniques.[9] In our study, all three surgeons were trained to do similar surgeries in terms of step-by-step C-sections techniques (except in uterine closure technique), types of sutures, prophylactic antibiotic. This homogeneity could limit the effect of other surgical factors on niche formation. In addition, this study revealed that the healing ratio (RMT/AMT) was better in double-layer group compared to single-layer group (0.66 vs. 0.60, p<0.05, respectively). Despite numerous studies regarding the healing ratio, there is a lack of solid evidence in terms of its value in clinical practice.[10]

On the other hand, using the diagnosis criteria of ISUOG 2019, the niche incidence in the present study was relatively high, at 43.1%. This proportion in other studies was even higher, approximately 70% in the study of Stegwee[11] or 80% in the study of Hanacek[4] et al. However, only 30% to 50% of women with niche have clinical symptoms, and a few of them needs treatment.[5,12] Obviously, a change in a threshold value or criteria diagnosis for a medical condition could lead to overdiagnosis and overtreatment.[13] Therefore, according to an eDelphi study conducted in 2024, this condition was proposed to be named as the cesarean scar disorder, defined as a uterine niche in combination with at least one primary or two secondary symptoms.[14]

The volume of niche has been proven correlated to clinical symptoms[7]. The mean niche volume of participants was 62mm3. This number in the 2Close study[6] was 24mm^3. The significant difference was the timing of niche evaluation postoperatively; our study was 12 months, while Stegwee[6] et al. did it in 3 months. From this result, we proposed that the niche volume could increase over time, which could explain why many women develop clinical symptoms several years after C-section. According to VTS system proposed by ISUOG 2019, the niche scores were less than 2 points in almost all women in this study (49/50). This result indicated that the niche in these women was probably clinically irrelevant. It is clear that although niche prevalence among women with primary C-sections is so high, it rarely impacts their clinical symptoms. This could be triggered by re-menstruation after deliveries. Therefore, the observation of the niche and its related symptoms in a longer span is needed.

In attempt to prevent niche formation after C-section, many study has been conducted to determine related potential factors. In a systematic review from 21 study, probable risk factors of niche development are single-layer myometrium closure, multiple CSs and uterine

retroflexion[3]. Some recent study showed that premature rupture of membrane[15] or elective cesarean sections[16] could be blame on this uterine defect. Our results supposed that retroverted uterus was the only factor contributed to the development of uterine niche, similar to most other studies. Beside the question of what was first, a retroflected uterus which caused the scar to heal improperly or was the retroflection the result of the niche itself, due to the lack of support of the corpus by the incomplete closure of the uterine wall;[17] another question is that how to control uterine position during and after surgery to avoid retroverted uterus.

The major strengths of our study are homogeneous participants, homogeneous surgeons in operation, and homogeneous sonographers in the evaluation of uterine scars. This resulted in the limitation of bias factors. In addition, we chose the 12 months postoperative, when most women had re-menstruation after delivery, resulted in revealing all niche on ultrasound. Our study also has some limitations. Firstly, the limited number of participants may have caused the results not to be statistically different. Secondly, we used transvaginal ultrasound instead of hysterosonography in the evaluation niche, leading to misdiagnosing in some cases in which the niche was small and could not be visible in transvaginal ultrasound. However, overdiagnosis could be a major issue for women with small niches.

V. CONCLUSION

In conclusion, on the hand of well-trained surgeons, there were no difference in niche incidence and RMT between single- and double-layer uterine closure techniques. Retroverted uterus was the main factor contributed to development of niche. Further studies are needed to evaluate the progress of the niche in a longer span and to prevent retroverted uterus.

DECLARATIONS

REFERENCES

1. Morris H. Surgical pathology of the lower uterine segment caesarean section scar: is the scar a source of clinical symptoms? *Int J Gynecol Pathol*. Jan 1995; 14(1): 16-20. doi:10.1097/00004347-199501000-00004.

2. 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*. Sep 2021; 13(9): e18405. doi:10.7759/cureus.18405.

3. Bij de Vaate AJ, van der Voet LF, Naji O, et al. Prevalence, potential risk factors for development and symptoms related to the presence of uterine niches following Cesarean section: systematic review. *Ultrasound Obstet Gynecol*. Apr 2014; 43(4): 372-82. doi:10.1002/uog.13199.

4. Hanacek J, Vojtech J, Urbankova I, et al. Ultrasound cesarean scar assessment one year postpartum in relation to one- or two-layer uterine suture closure. *Acta Obstet Gynecol Scand*. Jan 2020; 99(1): 69-78. doi:10.1111/aogs.13714.

5. Zhou X, Zhang T, Qiao H, Zhang Y, Wang X. Evaluation of uterine scar healing by transvaginal ultrasound in 607 nonpregnant women with a history of cesarean section. *BMC Womens Health*. May 13 2021; 21(1): 199. doi:10.1186/s12905-021-01337-x.

6. Verberkt C, Stegwee SI, Van der Voet LF, et al. Single-layer vs double-layer uterine closure during cesarean delivery: 3-year follow-up of a randomized controlled trial (2Close

study). *Am J Obstet Gynecol*. Dec 26 2023; doi:10.1016/j.ajog.2023.12.032.

7. Jordans IPM, de Leeuw RA, Stegwee SI, et al. Sonographic examination of uterine niche in non-pregnant women: a modified Delphi procedure. *Ultrasound Obstet Gynecol*. Jan 2019; 53(1): 107-115. doi:10.1002/uog.19049.

8. Ludwin A, Martins WP, Ludwin I. Evaluation of uterine niche by three-dimensional sonohysterography and volumetric quantification: techniques and scoring classification system. *Ultrasound Obstet Gynecol*. Jan 2019; 53(1): 139-143. doi:10.1002/uog.19181.

9. Sholapurkar SL. Etiology of Cesarean Uterine Scar Defect (Niche): Detailed Critical Analysis of Hypotheses and Prevention Strategies and Peritoneal Closure Debate. *J Clin Med Res*. Mar 2018; 10(3): 166-173. doi:10.14740/jocmr3271w.

10. Backer S, Khanna D, Sadr S, Khatibi A. Intra-operative Guidelines for the Prevention of Uterine Niche Formation in Cesarean Sections: A Review. *Cureus*. Sep 2023; 15(9): e44521. doi:10.7759/cureus.44521.

11. Stegwee SI, van der Voet LF, Ben AJ, et al. Effect of single- versus double-layer uterine closure during caesarean section on postmenstrual spotting (2Close): multicentre, double-blind, randomised controlled superiority trial. *BJOG*. Apr 2021; 128(5): 866-878. doi:10.1111/1471-0528.16472.

12. Bij de Vaate AJ, Brolmann HA, van der Voet LF, van der Slikke JW, Veersema S, Huirne JA. Ultrasound evaluation of the Cesarean scar: relation between a niche and postmenstrual spotting. *Ultrasound Obstet Gynecol*. Jan 2011; 37(1): 93-9. doi:10.1002/uog.8864.

13. Dominguez JA, Pacheco LA, Moratalla E, et al. Diagnosis and management of isthmocele (Cesarean scar defect): a SWOT analysis. *Ultrasound Obstet Gynecol*. Sep 2023; 62(3): 336-344. doi:10.1002/uog.26171.

14. Klein Meuleman SJM, Murji A, van den Bosch T, et al. Definition and Criteria for Diagnosing Cesarean Scar Disorder. *JAMA Netw Open*. Mar 1 2023; 6(3): e235321. doi:10.1001/jamanetworkopen.2023.5321.

15. Park IY, Kim MR, Lee HN, Gen Y, Kim MJ. Risk factors for Korean women to develop an isthmocele after a cesarean section. *BMC Pregnancy Childbirth*. May 15 2018; 18(1): 162. doi:10.1186/s12884-018-1821-2.

16. Liu S, Chen L, Zhu G, et al. Analysis of risk factors for cesarean scar diverticulum: A STROBE-compliant case-control study. *Medicine (Baltimore)*. Apr 30 2021; 100(17):e25757. doi:10.1097/MD.0000000000025757.

17. Vervoort AJ, Uittenbogaard LB, Hehenkamp WJ, Brolmann HA, Mol BW, Huirne JA. Why do niches develop in Caesarean uterine scars? Hypotheses on the aetiology of niche development. *Hum Reprod*. Dec 2015; 30(12): 2695-702. doi:10.1093/humrep/dev240.