Single-port laparoscopy-assisted vaginal repair of a cesarean scar defect: a single-center retrospective study

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Abstract

Background: The incidence of uterine cesarean scar defect (niche) is high, and some patients require surgery. Single-port laparoscopy can reduce post-operative pain, and provide better cosmetic effects. This study was performed to evaluate the safety and superiority of single-port laparoscopy-assisted vaginal repair of uterine cesarean scar defect (niche) in women after cesarean section.

Methods: This study included 74 patients who were diagnosed with uterine cesarean niche at the Shanghai First Maternity and Infant Hospital from January 2013 to June 2015. Thirty-seven patients underwent single-port laparoscopy-assisted vaginal surgery as the case group, and the remaining patients underwent vaginal repair surgery as the control group. We collected data from the inpatient and follow-up medical records. The clinical characteristics of these two groups were compared. The odds ratios and 95% confidential intervals were calculated for each variable by univariate and multivariate analyses.

Results: Patients who underwent single-port laparoscopy-assisted vaginal repair had a significantly longer operation time (2.3 [2.0–2.7] *vs.* 2.0 [1.6–2.3] h, $P = 0.015$), shorter gas passage time (1.2 [1.0–1.5] *vs.* 1.7 [1.0–2.0] days, $P = 0.012$), shorter hospital stay (3.1 [3.0–4.0] *vs.* 4.5 [4.0–6.0] days, $P = 0.019$), and fewer complications (0 *vs.* 4 cases). Univariate analysis showed that depth of the niche ($P = 0.021$) the mild adhesiolysis score ($P = 0.035$) and moderate adhesiolysis score ($P = 0.013$) were associated with the bladder injury. Multivariate analysis showed that the moderate adhesiolysis score ($P = 0.029$; 95% confidence interval, 1.318–3.526) was the strongest independent predictor of bladder injury.

Conclusion: This study confirmed the safety and superiority of single-port laparoscopy-assisted vaginal repair of uterine cesarean scars.

Keywords: Single-port laparoscopy; Uterine cesarean scar defect (niche); Adhesion

Introduction

The incidence rate of cesarean section (CS) should not exceed 15% of all deliveries as recommended by the World Health Organization.[1] In recent years, however, this incidence rate has continued to rise. From 2008 to 2009 in Poland, the incidence rate of CS increased from 30.5% to 33.2%.[2] From 1985 to 2010, the highest CS rate was reported in Latin America and the Caribbean region (40.5%), followed by North America (32.3%), Oceania (31.1%), Europe (25.0%), and Asia (19.2%).[3] Notably, in China, the CS rate has risen from 2% to 36%–58%.[4]

The increased CS rate has led to long-term complications with clinical symptoms such as dysmenorrhea (53.1%), post-menstrual spotting (34.0%), chronic pelvic pain (36.9%), and dyspareunia (18.3%).[5] Thurmond *et al*[6] first reported in 1999 that the niche (a defect in the cesarean scar) caused abnormal bleeding; the authors postulated that the niche collected menstrual blood and caused abnormal bleeding. More recent studies have indicated that the niche may be associated with complications in late pregnancy such as scar dehiscence, uterine rupture, and an abnormally adherent placenta.[7,8]

A cohort study of 225 women from October 2007 to May 2009 showed that the prevalence of a niche was 24.0% as evaluated by transvaginal sonography (TVS) and 56.0% as evaluated by gel instillation sonohysterography.[9] Another prospective cohort study showed that the prevalence of a niche was 49.6% by evaluation with TVS and 64.5% with gel instillation sonohysterography.[5] In the most recent report, the incidence rate was 22.4% with TVS and 45.6% with sonohysterography.[10] The high prevalence of a niche indicates that this is an urgent problem to be solved as soon as possible.

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Ultrasound allows for visualization of the uterus and any scar; however, a generally accepted definition of a niche has not yet been established.[11] In general, a myometrial thickness of ≥1 mm is defined as a niche,[9] and a myometrial thickness of <2.2 mm is defined as a large niche.[12]

Several therapies can be used to treat symptoms related to the niche, such as hysteroscopic niche resection, laparoscopic repair, and vaginal repair.[13] Hysteroscopic surgery, including resection of the edge and superficial cauterization of the niche, cannot repair the myometrial defect, the presence of which introduces a potential risk of dehiscence or rupture in subsequent pregnancies.[14] Additionally, the residual myometrium is thicker after hysteroscopic surgery.[15] Patients without fertility requirements may be candidates for hysterectomy. However, patients who desire future fertility, especially those with a <3 cm myometrial thickness at the niche, should undergo laparoscopic resection.[16]

A meta-analysis showed that 67 patients developed fertility problems after hysteroscopic surgery, four after laparoscopic repair, and one after vaginal repair.[13] A transvaginal intervention is feasible for management of a niche.[17] However, a higher incidence of complications or adverse effects, such as bladder injury, has been reported after vaginal repair than after hysteroscopic resection or laparoscopic repair.[13]

With the progress in minimally invasive surgery, the single-port laparoscope has been successfully applied, resulting in less post-operative pain and a shorter recovery time.[18] We performed a retrospective study to evaluate the safety of single-port laparoscope-assisted vaginal repair of a niche and its advantages over vaginal repair. We hypothesized single-port surgery both reduced complications and produced superior cosmetic outcomes.

Methods

Ethical approval

This study was approved by the Ethics Committee of the Medical Faculty at Shanghai First Maternity and Infant Hospital (No. KS1978). All patients provided written informed consent.

Patients

In total, 132 patients were diagnosed with a niche and underwent surgical treatment at the Shanghai First Maternity and Infant Hospital from January 1, 2013 to June 30, 2015. The patients were examined at the follicular stage of their period, and an anechoic area at the site of the cesarean scar with a depth of ≥1 mm was defined as a niche. The inclusion criteria for this study were as follows: age of ≥18 years with stable menstruation, pregnancy requirement, diagnosis of a niche after CS, no abnormal vaginal bleeding before CS, no history of infertility, and a complete follow-up medical record. We also collected the clinical characteristics of the patients who met the inclusion criteria, such as age, parity, gravidity, and the size of the niche. The exclusion criteria were an age of >35 years and a niche measuring >25 mm or <10 mm.

The patients who underwent single-port laparoscopy-assisted vaginal repair of a niche comprised the study group, and those who underwent surgical vaginal repair of a niche comprised the control group.

Operative procedures and follow-up

An experienced surgeon performed the laparoscopic surgery via a single port. After a vertical skin incision of about 1.0 to 1.2 cm was made at the superior margin of the umbilicus, a port was placed in the correct position. Two assistants were needed; the first assistant handled the 30° laparoscope while standing on the right side of the patient, and the second assistant handled the uterine manipulator while sitting between the legs of the patient. The surgeon used the laparoscopic instruments while standing on the left side of the patient. Conventional surgical vaginal repair of a niche was performed as previously described.[19]

First, the adhesion between the uterine and bladder was separated using the single-site laparoendoscope. The severity of the adhesion was assessed with the adhesion score proposed by the Australian Adhesion Score Group.[20] Hysteroscopic guidance and transillumination helped to reveal the edges of the niche. Second, the bladder was pushed down along the cervix to the edge of the external os of the cervix. The vaginal surgery was then performed.

Vaginal surgery involved excision of the scar and the surrounding tissue until the whitish scar tissue disappeared and the reddish healthy myometrium was visualized. The last step was placement of a single layer of sutures to reduce tissue ischemia. Two experienced sonographers in our hospital performed TVS and magnetic resonance imaging evaluations, respectively.

The other data collected from the medical records of the included patients were the body mass index, gestational age at the time of CS, age at first CS, birth weight, elective CS, interval between the first CS and surgery, clinical presentation and physical signs, and clinical characteristics of the two different surgeries.

The patients were instructed to use contraception for 2 years after the surgery (supplementary video; http://links.lww.com/CM9/A172). The clinical characteristics of the case and control groups, including ongoing pregnancies and term pregnancies, were also collected.

If patients had an intra-uterine pregnancy, they were defined as having an ongoing pregnancy as verified by ultrasound evidence of fetal cardiac activity or occurrence of a live birth. If the patient was not pregnant, follow-up ended at the last inquiry.

Follow-up was performed on an outpatient basis and included various examinations such as pelvic examinations, TVS, and magnetic resonance imaging 1 month after surgery. We checked the outpatient medical records and telephone inquiries for the ongoing pregnancy outcomes until June 30th, 2019.

Statistical analysis

We used SPSS version 17.0 (SPSS Inc., Chicago, IL, USA) for all statistical analyses. Shapiro-Wilk test was used to assess data normality. We evaluated the distribution of events by Student's *t* test (continuous data) and the χ^2 test (categorical data). Medians were compared using the Mann-Whitney *U* test. A univariate analysis was used to screen the variables, and variables with a *P* value of <0.05 were included in the multivariate analysis. We used a Cox proportional hazards model to perform the multivariate analysis. Values were considered significant at $P < 0.05$ (two-sided).

Results

In total, 74 patients diagnosed with a cesarean scar niche were included in the study. Of these, 37 patients underwent single-port laparoscopy-assisted vaginal repair surgery and comprised the case group, and 37 underwent vaginal repair surgery and comprised the control group.

The patients' average age at the time of surgery was 32.6 years (range, 25–35 years) in the case group and 33.2 years (range, 27–35 years) in the control group, with no significant difference between the two groups ($P = 0.372$).

The clinical characteristics were not significantly different between the two groups. Details regarding gravidity, parity, body mass index, gestational age at the time of CS, age at first CS, birthweight, elective CS, and interval between the first CS and surgery are shown in Table 1.

The bleeding characteristics were not significantly different between the case and control groups, including the duration of bleeding complaints ($P = 0.425$), total days of spotting ($P = 0.671$), spotting at the end of menstruation ($P = 0.319$), and inter-menstrual spotting ($P = 0.519$). We also evaluated the spotting-associated discomfort scores, which were 8.1 in the case group, and 8.2 in the control group with no significant differences ($P = 0.368$).

Quality of life was also evaluated in this study. The 36-item short-form health survey physical component summary score ($P = 0.421$) and mental component summary score ($P = 0.219$) were not significantly different between the two groups. The EuroQoL score was 0.81 in the case group and 0.80 in the control group with no significant differences ($P = 0.363$), including the female sexual function index total score [Table 2].

The ultrasound findings are shown in Table 2. No significant differences were found in residual myometrium ($P = 0.389$), niche depth ($P = 0.635$), or intra-uterine fluid ($P = 0.572$) between the two groups. Additionally, no difference was found in the difficulty of surgery between the two groups.

Single-port laparoscopy-assisted vaginal repair had a longer operation time ($P = 0.015$), but the blood loss between the two groups was not significantly different ($P = 0.572$). In the case group, 11 patients had mild adhesiolysis ($P = 0.619$) and 13 had moderate adhesiolysis ($P = 0.632$). In the control group, 13 and 15 patients had mild and moderate adhesiolysis, respectively. The scores in the two groups were 3.5 and 3.6 ($P = 0.819$) and 7.2 and 7.0 ($P = 0.837$), respectively [Table 3].

The time to flatus ($P = 0.012$), hospital stay ($P = 0.019$), and complications ($P = 0.039$) were significantly different between the two groups. Four cases of intra-operative complications occurred, all of which were bladder injury [Table 3].

No patients in this study were lost to follow-up. The rates of ongoing pregnancy, spontaneous pregnancy, assisted reproduction, ongoing term pregnancy, natural labor, CS, and repeat ectopic pregnancy were not significantly different between the two groups [Table 4].

All patients' clinical presentations and physical signs were evaluated 2 years after the surgery. Spotting at the end of menstruation, inter-menstrual spotting, and discomfort from spotting were all improved compared with pre-operatively, and there were no differences between the two

Table 1: Biodemographic characteristics of patients with uterine cesarean scar niche.

Characteristics	Case group ($n = 37$)	Control group ($n = 37$)	*P* value
Mean age (years)	32.6 ± 1.2	33.2 ± 1.7	0.372
Gravidity			0.469
0-1	12	15	
2 and above	25	22	
Parity			0.940
1	7	9	
2 and above	9	11	
BMI (kg/m^2)	23.9 ± 2.1	24.3 ± 2.3	0.635
Gestational age at cesarean section (weeks)	37.1 ± 1.8	37.8 ± 2.1	0.676
Age at first cesarean section (years)	33.7 ± 0.6	34.4 ± 0.5	0.524
Birth weight of the child (g)	3101 ± 518	3035 ± 425	0.573
Elective cesarean section, *n* (%)	5 (31.3)	6 (30.0)	0.744
Interval between the first cesarean section and surgery (years)	2.9 ± 0.3	2.8 ± 0.5	0.831

Values are given as mean ± standard deviation, or number (percentage), unless indicated otherwise. BMI: Body mass index.

Table 2: Clinical presentation and physical signs of patients with uterine cesarean scar niche.

Characteristics	Case group ($n = 37$)	Control group ($n = 37$)	*P* value
Bleeding characteristics			
Duration of bleeding complaints (months)	38.9 (19–50)	39.1 (16–51)	0.425
Total days of spotting*	6 (4–9)	7 (6–10)	0.671
Spotting at the end of the menstruation	6 (3–9)	5 (4–11)	0.319
Inter-menstrual spotting	3 (0–4)	2 (0–5)	0.519
Discomfort from spotting (0–10)	8.1 (5.1–8.6)	8.2 (5.2–9.0)	0.368
Daily pain during micturition	1 (2.7)	2 (5.4)	0.556
Bleeding characteristics 2 years after surgery			
Spotting at the end of the menstruation	0.5 (0–1)	0.6 (0–1)	0.385
Inter-menstrual spotting	1.1 (0–1)	1.3 (0–1)	0.149
Discomfort from spotting (0–10)	0.3 (0–2.1)	0.4 (0–1.8)	0.361
Quality of life and sexual function			
SF-36 physical component summary score	51.6 (46.2–56.4)	51.9 (42.1–55.3)	0.421
SF-36 mental component summary score	50.5 (41.9–56.3)	49.1 (38.2–54.3)	0.219
EuroQol total score	0.81 (0.73–0.09)	0.80 (0.69–0.82)	0.363
FSFI total score	0.80 (0.75–0.97)	0.81 (0.68–0.81)	0.710
Quality of life and sexual function 2 years after operation			
SF-36 physical component summary score	71.7 (63.8–73.9)	70.7 (61.3–73.2)	0.841
SF-36 mental component summary score	58.7 (52.1–60.6)	57.9 (49.8–61.5)	0.762
EuroQol total score	0.87 (0.78–0.93)	0.84 (0.78–0.91)	0.472
FSFI total score	0.86 (0.81–0.89)	0.85 (0.73–0.90)	0.462
Ultrasound findings			
Residual myometrium (mm)	2.4 (2.0–4.5)	2.6 (2.3–4.9)	0.389
Niche depth (mm)	12 (10–23)	11.3 (10–22)	0.635
Intra-uterine fluid	7 (18.9)	9 (24.3)	0.572

Values are given as median (Interquartile range), or number (percentage), unless indicated otherwise. *Total days of spotting = the sum of the number of days spotting at the end of the menstruation and the number of days of inter-menstrual spotting (post-menstrual spotting). EuroQol total score = Europe Quality of Life; FSFI total score = female sexual function index.

Table 3: Clinical characteristics of single-port laparoscopy-assisted vaginal surgery and vaginal repair surgery.

Characteristics	Case group ($n = 37$)	Control group ($n = 37$)	*P* value
Intra-operative			
Operation (h)	2.3 (2.0–2.7)	2.0 (1.6–2.3)	0.015
blood loss (mL)	49 (30–70)	52 (30–80)	0.572
Pelvic adhesiolysis			
Mild adhesiolysis			
Case	11	13	0.619
Score	3.5 (2.0–5.0)	3.6 (2.0–5.0)	0.819
Moderate adhesiolysis			
Case	13	15	0.632
Score	7.2 (6–9)	7.0 (6–9)	0.837
Post-operative			
Time to flatus (days)	1.2 (1.0–1.5)	1.7 (1.0–2.0)	0.032
Hospital stay (days)	3.1 (3.0–4.0)	4.5 (4.0–6.0)	0.019
Complications	0	4 (10.8)	0.039

Values are given as *n*, median (interquartile range), or number (percentage), unless indicated otherwise.

groups. Quality of life and sexual function were also evaluated. The scores of these parameters were higher than those pre-operatively, and there were no significant differences between the two groups [Table 2].

Univariate analysis showed that the niche depth, mild adhesiolysis score, and moderate adhesiolysis score were associated with bladder injury. Multivariate analysis (Cox regression) of these three factors with bladder injury as the endpoint showed that the strongest independent predictor was the moderate adhesiolysis score ($P < 0.05$) [Table 5].

Discussion

In this study, we evaluated a new method by which to manage CS scars. We compared the clinical surgery data and the prognostic data between the two groups (single-

Table 4: Infertility follow-up after caesarean scar nich therapy.

Groups	Ongoing pregnancy	Ongoing term pregnancy	Ongoing short-term pregnancy	Ectopic pregnancy	Abortion
Case group ($N = 37$)	18 (48.6)	12	2	2	2
Control group ($N = 37$)	19 (51.3)	11	3	3	2

Values are given as *n*, number (percentage).

Table 5: Univariate and multivariate survival analyses evaluating the factors associated with bladder injury.

Variables	Univariate analysis	Multivariate analysis		
		P	HR	95% CI
Age	0.592	–	–	–
Gravidity	0.672	–	–	–
Parity	0.478	–	–	–
Duration of bleeding complaints	0.137	–	–	–
Total days of spotting	0.527	–	–	–
Niche depth	0.021	0.367	0.967	0.753–1.976
Mild adhesiolysis score	0.035	0.537	0.653	0.803–2.125
Moderate adhesiolysis score	0.013	0.029	1.817	1.318–3.526

A gestational age was calculated as the period from the date of last menstrual period to the date of surgery. HR: Hazard ratio; CI: Confidence interval.

port laparoscopy-assisted vaginal repair group and vaginal repair group). The results showed that single-port laparoscopy-assisted vaginal repair had a quicker recovery rate with a shorter time to gas passage and a shorter hospital stay, and it was more viable with less complications. The strongest independent predictor of bladder injury was moderate adhesiolysis. Our new surgery method has no negative effects on subsequent conception.

The adhesion of the CS scar was recognized laparoscopically. The tissue damage caused by the CS procedure leads to ischemia and impaired perfusion; the scar healing process is thus insufficient, resulting in adhesion formation.[21] A previous study showed that the adhesion was located in the vesicouterine pouch, and dense adhesions were visualized in 37.5% of patients.[22]

Large uterine niches are likely to lead to uterine dehiscence,[16] and the myometrial reinforcement method may be more suitable for patients with a pregnancy requirement. The vaginal repair method can increase the residual myometrium in patients with a CS defect and relieve their clinical symptoms.[23] The most suitable interval between vaginal repair surgery and cesarean birth is 2.5 years.[24]

Large CS defects and those located far away from the cervical midline may be considered "complicated" or "complex"; however, no consensus has yet been reached on these definitions. Compared with laparoscopic repair, vaginal repair has its own advantages, such as a lower recurrence rate.[25]

The vaginal pathway is safe and applicable for specimen retrieval after operative laparoscopy,[26] and the incision in the posterior vaginal wall is also feasible.[27] A recent study showed that the incision in the vaginal wall did not decrease patients' sexual satisfaction after surgery.[28]

In the present study, vaginal repair was performed to detect the boundary of the CS defect with hegar, according to palpation of the thickness of the muscular wall, the obvious frontier of the filmy muscular was the boundary. The excision and suture under direct vision resulted in a precise repair effect. Hysteroscopy after the repair helped to verify the result of the vaginal surgery.

However, about 40% of patients still have no symptoms of remission after vaginal repair.[23] A recent case report described single-incision laparoscopic repair of a CS scar. The size of the CS defect was 1.08 cm × 0.71 cm, and the myometrial thickness was 1.5 mm. The operative time was 50 min, and the blood loss was 50 mL.[29]

Some recent studies have shown that single-port laparoscopic surgery might have the benefits of a shorter hospital stay and better cosmetic outcome.[30] The optimal laparoscopic port entry remains unclear, and the safest access has not been determined.[31] The decreased number of ports in single-port laparoscopic surgery may reduce the risk.

In the present study, we used single-port laparoscopic surgery to separate the adhesion. This separation was performed more easily and decreased the risk of bladder injury. Bladder injuries only occurred in the control group, and dense adhesions were the primary cause.

The patients' post-operative quality of life was better in the case than control group, but there was no significant difference. The most obvious difference was in the post-operative complications, which more frequently occurred

in the control group. This verifies the advantage of laparoscopic surgery.

The CS scar not only influences the patient's quality of life but also increases the risk associated with the next pregnancy. The risk of secondary sterility is also problematic.[32] The pregnancy rates in the present study were 48.6% and 51.3%, which are slightly higher than those in another study.[33] However, the ectopic pregnancy rates were 11.1% and 15.8% in the two groups, which are slightly higher than those previously reported.[34]

Our method of single-port laparoscopy to separate the adhesion between the uterus and bladder using a vaginal pathway to repair the uterine scar is an improvement over previous methods. The association of these two techniques has the advantages of separating the adhesion under direct vision, avoiding the weakness of vaginal surgery, and more effectively palpating the tissues to excise the scar thoroughly. This new method not only has the advantages of a lower infection risk, faster recovery, and less operative pain but is also associated with fewer complications. Thus, it is worth extension to primary hospitals.

However, this was a single-center study, a multi-center study is needed to support and extend our findings. As surgeons became more highly skilled, the operation time may be shortened, and the statistical differences between the two groups may no longer be significant.

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Conflicts of interest

None.

References

1. Betran AP, Torloni MR, Zhang JJ, Gulmezoglu AM. WHO Working Group on Caesarean Section. . WHO statement on caesarean section rates. BJOG 2016;123:667–670. doi: 10.1111/1471-0528.13526.
2. Futyma K, Galczynski K, Romanek K, Filipczak A, Rechberger T. When and how should we treat cesarean scar defect-isthmocoele? Ginekol Pol 2016;87:664–668. doi: 10.5603/GP.2016.0063.
3. Betran AP, Ye J, Moller AB, Zhang J, Gulmezoglu AM, Torloni MR. The increasing trend in caesarean section rates: global, regional and national estimates: 1990–2014. Plos One 2016;11:e0148343. doi: 10.1371/journal.pone.0148343.
4. Deng W, Klemetti R, Long Q, Wu Z, Duan C, Zhang WH, *et al*. Cesarean section in Shanghai: women's or healthcare provider's preferences? BMC Pregnancy Childbirth 2014;14:285. doi: 10.1186/1471-2393-14-285.
5. Van der Voet LF, Bij de Vaate AM, Veersema S, Brolmann HA, Huirne JA. 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;121:236–244. doi: 10.1111/1471-0528.12542.
6. Thurmond AS, Harvey WJ, Smith SA. Cesarean section scar as a cause of abnormal vaginal bleeding: diagnosis by sonohysterography. J Ultrasound Med 1999;18:13–16. doi: 10.7863/jum.1999.18.1.13.
7. Naji O, Daemen A, Smith A, Abdallah Y, Saso S, Stalder C, *et al*. Changes in Cesarean section scar dimensions during pregnancy: a prospective longitudinal study. Ultrasound Obstet Gynecol 2013;41:556–562. doi: 10.1002/uog.12334.
8. Silver RM. Delivery after previous cesarean: long-term maternal outcomes. Semin Perinatol 2010;34:258–266. doi: 10.1053/j.semperi.2010.03.006.
9. 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 2011;37:93–99. doi: 10.1002/uog.8864.
10. Antila-Langsjo R, Maenpaa JU, Huhtala H, Tomas E, Staff S. Comparison of transvaginal ultrasound and saline contrast sonohysterography in evaluation of cesarean scar defect: a prospective cohort study. Acta Obstet Gynocl Scand 2018;97:12. doi: 10.1111/aogs.13367.
11. Naji O, Abdallah Y, Bij De Vaate AJ, Smith A, Pexsters A, Stalder C, *et al*. Standardized approach for imaging and measuring cesarean section scars using ultrasonography. Ultrasound Obstet Gynecol 2012;39:252–259. doi: 10.1002/uog.10077.
12. Bij de Vaate AJ, van der Voet LF, Naji O, Witmer M, Veersema S, Brolmann HA, *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 2014;43:372–382. doi: 10.1002/uog.13199.
13. Van der Voet LF, Vervoort AJ, Veersema S, BijdeVaate AJ, Brolmann HA, Huirne JA. Minimally invasive therapy for gynaecological symptoms related to a niche in the caesarean scar: a systematic review. BJOG 2014;121:145–156. doi: 10.1111/1471-0528.12537.
14. 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;22:1145–1152. doi: 10.1016/j.jmig.2015.06.013.
15. Tsuji S, Kimura F, Yamanaka A, Hanada T, Hirata K, Takebayashi A, *et al*. Impact of hysteroscopic surgery for isthmocele associated with cesarean scar syndrome. J Obstet Gynaecol Res 2018;44:43–48. doi: 10.1111/jog.13464.
16. Brown K, Tkacz Z. Hysteroscopic and laparoscopic management of caesarean scar (niche) defects in symptomatic patients. J Obstet Gynaecol 2018;38:730. doi: 10.1080/01443615.2018.1444394.
17. Chen Y, Chang Y, Yao S. Transvaginal management of cesarean scar section diverticulum: a novel surgical treatment. Med Sci Monit 2014;20:1395–1399. doi: 10.12659/MSM.890642.
18. Kang SH, Lee Y, Park YS, Ahn SH, Park DJ, Kim HH. Solo single-incision laparoscopic resectional Roux-en-Y gastric bypass for morbid obesity with metabolic syndrome. Obes Surg 2017;27:3314–3319. doi: 10.1007/s11695-017-2934-9.
19. Luo L, Niu G, Wang Q, Xie HZ, Yao SZ. Vaginal repair of cesarean section scar diverticula. J Minim Invasive Gynecol 2012;19:454–458. doi: 10.1016/j.jmig.2012.03.012.
20. Yip WL. Influence of oxygen on wound healing. Int Wound J 2015;12:620–624. doi: 10.1111/iwj.12324.
21. Operative Laparoscope Study Group. . Postoperative adhesion development after operative laparoscope: evaluation at early second-look procedures. Fertil Steril 1991;55:700–704. doi: 10.1016/s0015-0282(16)54233-2.
22. Dosedla E, Calda P. Outcomes of laparoscopic treatment in women with cesarean scar syndrome. Med Sci Monit 2017;23:4061–4066. doi: 10.12659/msm.902720.
23. Chen H, Wang H, Zhou J, Xiong Y, Wang X. Vaginal repair of cesarean section scar diverticula diagnosed in non-pregnant women. J Minim Invasive Gynecol 2019;26:526–534. doi: 10.1016/j.jmig.2018.06.012.
24. 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;23:969–978. doi: 10.1016/j.jmig.2016.06.013.
25. Tatar B, Oksay T, Selcen Cebe F, Soyupek S, Erdemoglu E. Management of vesicovaginal fistulas after gynecologic surgery. Turk J Obstet Gynecol 2017;14:45–51. doi: 10.4274/tjod.46656.
26. Uccella S, Cromi A, Bogani G, Casarin J, Serati M, Ghezzi F. Transvaginal specimen extraction at laparoscopy without concomitant hysterectomy: our experience and systematic review of the literature. J Minim Invasive Gynecol 2013;20:583–590. doi: 10.1016/j.jmig.2013.02.022.

27. Laganà AS, Vitale SG, Palmara V, Ban Frangež H, Triolo O. Transvaginal specimen removal in minimally invasive surgery: feasibility and possible complications during the incision of the posterior vaginal wall. World J Urol 2017;35:1155–1156. doi: 10.1007/s00345-016-1955-7.
28. Butticè S, Sener TE, Lucan VC, Lunelli L, Laganà AS, Vitale SG, *et al*. Hybrid transvaginal NOTES nephrectomy: postoperative sexual outcomes. A three-center matched study. Urology 2017;99:131–135. doi: 10.1016/j.urology.2016.09.023.
29. Ma Y, Kohn J, Zhang Y, Guan Z, Zhou T, Guan X. Single-incision laparoscopic repair of a cesarean scar defect. Fertil Steril 2019;111:607–608. doi: 10.1016/j.fertnstert.2018.11.039.
30. Maeda K, Nagahara H, Shibutani M, Fukuoka T, Inoue T, Ohira M. A review of reports on single-incision laparoscopic surgery for Crohn's disease. Surg Today 2019;49:361–368. doi: 10.1007/s00595-018-1732-x.
31. Tinelli A, Gasbarro N, Lupo P, Malvasi A, Tsin DA, Davila F, *et al*. Safe introduction of ancillary trocars. JSLS 2012;16:276–279. doi: 10.4293/108680812x13427982376464.
32. Melo-Cerda I. Cesarean scar defect. Ginecol Obstet Mex 2014;82:530–534.
33. Donnez O, Donnez J, Orellana R, Dolmans MM. Gynecological and obstetrical outcomes after laparoscopic repair of a cesarean scar defect in a series of 38 women. Fertil Steril 2017;107:289–296. doi: 10.1016/j.fertnstert.2016.09.033.
34. Chang J, Elam-Evans LD, Berg CJ, Herndon J, Flowers L, Seed KA, *et al*. Pregnancy-related mortality surveillance–United States, 1991-1999. MMWR Surveill Summ 2003;52:1–8.

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