Article

Comparative Efficacy of Uterine Suturing Techniques on Postoperative Recovery Following Repeat Caesarean Section: A Retrospective Cohort Study in Patients With Scarred Uteri

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AIM: The optimal uterine suturing technique for repeat caesarean section in women with a scarred uterus remains controversial, and evidence comparing novel techniques, such as the breakwater suture, with conventional methods in terms of comprehensive recovery is limited. The objective of this study is to investigate the combined effects of single-layer suturing, double-layer suturing, and breakwater suture techniques on postoperative recovery in patients with scarred uteri undergoing repeat caesarean section.

METHODS: In this retrospective cohort study, 300 pregnant women with scarred uteri undergoing repeat caesarean section at The Maternal and Child Health Care Hospital of Tong Xiang between January 2022 and December 2024 were included. The sample was divided into three groups based on the type of suture used: single-layer suture group (n = 108), double-layer suture group (n = 103), and breakwater suture group (n = 89). Primary outcomes comprised postoperative recovery time, complications, uterine healing status, psychological state, and sleep quality.

RESULTS: There were no significant differences in baseline characteristics among the three groups ($p > 0.05$). Regarding postoperative recovery, the breakwater suture group demonstrated significantly shorter time to anal flatus, time to first ambulation, and postoperative hospital stay compared with both the single-layer and the double-layer suture groups ($p < 0.05$). Postoperative ultrasound revealed significantly greater uterine segment myometrial thickness in the breakwater suture group compared to the other two groups ($p < 0.001$). At six months postoperatively, the incidence of uterine diverticulum in the breakwater suture group (4.5%) was significantly lower than that in the single-layer suture group (15.7%); the overall difference among the three groups was statistically significant ($p = 0.041$). Furthermore, patients in the breakwater suture group demonstrated significantly better postoperative outcomes on the Self-Rating Anxiety Scale (SAS), Self-Rating Depression Scale (SDS), Edinburgh Postnatal Depression Scale (EPDS), and Pittsburgh Sleep Quality Index (PSQI) compared with the other groups ($p < 0.001$).

CONCLUSIONS: In repeat caesarean sections in women with scarred uteri, the breakwater suture technique comprehensively promotes postoperative recovery and may be recommended as a suturing method.

Keywords: scarred uterus; repeat caesarean section; uterine suturing technique

Introduction

Caesarean section is one of the most common surgical procedures globally, and its incidence has steadily increased, making it a significant public health concern [1]. Concurrently, increasing rates of primary caesarean section and evolving global fertility policies have substantially elevated the proportion of women with a history of caesarean section undergoing subsequent pregnancies. Consequently, the management of repeat caesarean section on a scarred uterus has emerged as a central challenge in the realm of contemporary obstetrics [2,3].

Repeat caesarean section is associated with a range of increased maternal risks. Technical challenges include pelvic adhesions, heightened risk of bladder injury, and prolonged operative time [4]. Furthermore, short-term postoperative complications such as surgical site infection and postpartum haemorrhage are more prevalent [5]. With respect to long-term outcomes, the quality of uterine incision healing is paramount. Inadequate healing following caesarean section may result in the development of a caesarean scar defect, also referred to as a uterine diverticulum [6]. Uterine diverticulum is associated with a range of long-term sequelae, including abnormal uterine bleeding, chronic pelvic pain, secondary infertility, and an increased risk of uterine rupture in subsequent pregnancies [6–8].

Uterine suturing techniques are considered a key modifiable factor influencing the quality of caesarean section scar healing and long-term complications [9]. Traditional uterine suturing methods primarily comprise single-layer and double-layer suturing. The single-layer continuous suturing technique is operationally straightforward, potentially

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reducing operative time and blood loss. However, a study indicates that compared to double-layer suturing, it may result in a thinner myometrial layer in the lower uterine segment and potentially increase the risk of uterine diverticulum formation [10]. Evidence regarding the optimal suturing technique remains conflicting, and the efficacy of either technique in addressing short-term complications or uterine diverticulum incidence remains controversial, highlighting the importance of technical standardisation [11,12].

In recent years, a refined suturing concept—often referred to as the "breakwater suture technique"—has been proposed to improve anatomical apposition and healing of the uterine incision by reducing tissue tension and enhancing local blood supply [13]. Preliminary single-center studies suggest that refined suturing practices consistent with this concept (e.g., non-locking stitches and precise myometrial layer re-approximation) may help increase the residual myometrial thickness in the lower uterine segment after surgery and potentially lower the risk of cesarean scar defect (i.e., uterine diverticulum) [13,14]. However, existing evidence remains limited, with most studies primarily focusing on anatomical outcomes such as ultrasound-assessed myometrial thickness.

Currently, a significant paucity of studies exists that comprehensively evaluate the impact of this novel suturing technique on patients' overall recovery outcomes. Beyond anatomical healing, postoperative recovery is a multidimensional process encompassing physiological function restoration (e.g., bowel function, mobility), psychological well-being, and sleep quality. These factors collectively determine maternal perinatal quality of life and recovery rate, yet they are seldom collectively examined in existing literature on uterine suturing techniques.

Therefore, this retrospective cohort study aims to systematically compare the efficacy of single-layer suturing, double-layer suturing, and breakwater suture techniques on postoperative recovery in patients with scarred uteri undergoing repeat caesarean section. Our assessment metrics encompass not only conventional postoperative recovery time, complications, and uterine healing, but also incorporate assessments of multidimensional patient-reported outcomes, including pain levels, psychological state (anxiety and depression), and sleep quality. This approach aims to provide more comprehensive evidence for clinical practice.

Methods

Study Population

Medical records of pregnant women with scarred uteri undergoing repeat caesarean section in the Department of Obstetrics of The Maternal and Child Health Care Hospital of Tong Xiang between January 2022 and December 2024 were retrieved via the hospital's electronic medical record system.

Inclusion criteria are as follows: (1) a history of one prior lower-segment caesarean section; (2) a current singleton pregnancy with cephalic presentation; (3) gestational age ≥37 weeks; (4) clearly documented surgical records specifying the uterine suturing technique; and (5) complete medical records, including comprehensive intraoperative notes and postoperative follow-up data.

Exclusion criteria are as follows: (1) a history of two or more previous caesarean sections; (2) comorbidities including placenta praevia or placenta accreta; (3) severe concomitant medical conditions; (4) multiple gestation; and (5) incomplete data or loss to follow-up.

A total of 300 patients were ultimately included. The sample was divided into three groups based on the suturing technique employed, as indicated in the surgical records: single-layer suture group (n = 108), double-layer suture group (n = 103), and breakwater suture group (n = 89). The choice of suturing technique was primarily determined by the surgeon's preference and intraoperative conditions, such as uterine wall thickness and bleeding status, rather than random assignment.

This investigation was conducted as a single-centre, retrospective, observational cohort study. The study was conducted in accordance with the principles outlined in the Declaration of Helsinki. The study was approved by the Ethics Committee of The Maternal and Child Health Care Hospital of Tong Xiang (approval number: 202507). Informed consent was waived because all data were anonymised and contained no personally identifiable information.

Surgical Methods and Suturing Techniques

All procedures were performed by senior obstetricians adhering to standard protocols. A transverse incision was made in the lower uterine segment for all caesarean sections. Oxytocin was routinely administered following foetal delivery. Suturing techniques were strictly categorised according to surgical records:

(1) Single-layer suturing: a single continuous suture was applied exclusively to the full thickness of the uterine myometrium, without separate closure of the serosal layer, allowing the serosa to naturally overlie the apposed myometrial edges. When necessary, intermittent reinforcement stitches were placed between continuous stitches, with reinforcement stitches also penetrating the entire thickness of the myometrium. The technique included either single-layer continuous suturing or continuous lockstitch suturing. Typically, the suture enters the serosal layer at one end of the incision, traverses the entire thickness of the myometrium to the mucosal layer, and exits from the opposite mucosal layer to the serosa. Continuous suturing is then performed along the incision to the opposite end before the knot is tied.

(2) Double-layer suturing: this technique involves two stages of suturing: the first stage entails suturing the deep layer, which is composed of mucosal layer and inner side of myometrium, whereas the second stage targets the superfi-

cial layer, namely the outer side of myometrium and serosa. The first stage suturing of the deep layer involves continuous or continuous lockstitch closure of the inner two-thirds of the uterine myometrium. The second-stage suturing of the superficial layer utilizes continuous or interrupted mattress suturing of the superficial myometrium and serosa, enveloping the outer one-third of the myometrium.

(3) Breakwater suturing: this technique begins with continuous lockstitch suturing of the first layer. The needle is inserted at the inner side of the right upper corner of the incision (mucosal layer), passes through the deep layer of the myometrium (approximately half the myometrial thickness), and exits through the mucosal layer at the corresponding position on the left side of the incision. Continuous lockstitch suturing then proceeds leftward, ensuring precise apposition of the mucosal layers (stitch spacing approximately 0.5–0.8 cm, margin approximately 0.8–1.0 cm) until the left apex is reached. A backstitch is performed at the endpoint, and the suture is tied, resulting in a smooth uterine cavity surface with no exposed mucosa or indentations. The second layer employs continuous mattress suturing. The suture is inserted at the outer aspect of the right upper corner of the incision (serosal layer), passes through the superficial myometrium (avoiding the first layer sutures to prevent overlap and compression of blood supply), and exits through the serosal layer at the corresponding point on the left side of the incision. During suturing, the superficial myometrial layer should envelop the edges of the first layer suture, creating a "covering" apposition, analogous to a "breakwater" or water-barrier effect. Stitch spacing and margin distance should correspond to those of the first layer, ensuring complete closure of the muscle layer without gaps. Upon reaching the left apex, the suture should be staggered relative to the first layer knot to avoid excessive tension at a single point. After tightening, the suture is tied to form a "double-layered reinforcement" within the myometrium. For the third layer, if the lower uterine segment myometrium is extremely thin ($<$1 mm) or at risk of minor tearing, a supplementary serosal continuous suture may be added. This suture passes only through the serosa and a minimal portion of the superficial myometrium, completely covering the second layer stitch pattern. This technique ensures a smooth lower uterine segment surface and further minimizes the risk of intra-abdominal adhesions.

Data Collection

Postoperative recovery outcomes comprised time to first flatus, time to initial ambulation, and length of hospital stay. Postoperative complications included incisional infection, postpartum haemorrhage, and urinary retention. Uterine healing was assessed via transvaginal ultrasound at 5–7 days postoperatively, with the thinnest point of the lower anterior uterine wall myometrium measured. The incidence of uterine diverticulum—defined as a muscular defect at the lower uterine segment incision site forming a diverticulum-like recess communicating with the uterine cavity—was assessed using transvaginal ultrasound at 6 months postoperatively. Psychological state and sleep quality were assessed at 48 hours postoperatively using the Self-Rating Anxiety Scale (SAS) [15], Self-Rating Depression Scale (SDS) [16], Edinburgh Postnatal Depression Scale (EPDS) [17], and Pittsburgh Sleep Quality Index (PSQI) [18]. The SDS was used to assess general depressive symptoms, whereas the EPDS was specifically designed for screening for postpartum depression. The EPDS and PSQI were utilized for early postoperative screening, however, given the brevity of the assessment window, their results should be interpreted with caution.

Statistical analysis

Statistical analysis was conducted using R software (version 4.2.0, R Core Team). Continuous variables were assessed for normality using the Shapiro–Wilk test and for homogeneity of variance using Levene's test. Normally distributed quantitative data are expressed as mean $\pm$ standard deviation, with comparisons between multiple groups conducted using one-way analysis of variance (ANOVA). Welch's ANOVA was used when variances were unequal. Quantitative data that did not conform to the normal distribution are expressed as median with interquartile range [M (Q_1, Q_3)], with Kruskal–Wallis rank sum test employed for multi-group comparisons. Categorical variables are presented as counts and percentages. Group comparisons were conducted using the chi-square test or Fisher's exact test as appropriate. Fisher's exact test was applied when the expected frequency in any cell was $<$5 or the sample size was small; otherwise, the chi-square test was used. When overall intergroup comparisons are statistically significant, post-hoc pairwise comparisons are conducted: Tukey's HSD test following ANOVA, Games-Howell test following Welch's ANOVA, and Bonferroni-corrected Dunn's test following Kruskal–Wallis test. $p < 0.05$ denotes statistical significance.

Results

Comparison of Baseline Characteristics

As shown in Table 1, comparisons of baseline characteristics—including age, parity, gestational age, body mass index (BMI), haemoglobin, neonatal weight, and comorbidities—among the three groups revealed no statistically significant differences ($p > 0.05$), indicating comparability.

Comparison of Postoperative Recovery Time

As shown in Table 2, the breakwater suture group exhibited significantly shorter time to anal flatus, time to first ambulation, and postoperative hospital stay compared with both the single-layer suture and the double-layer suture groups ($p < 0.05$).

Table 1. Comparison of baseline characteristics among the three groups.

Indicator	Single-layer suture group (n = 108)	Double-layer suture group (n = 103)	Breakwater suture group (n = 89)	Statistical value	p-value
Age (years), M (Q_1, Q_3)	31.50 (30.00, 34.00)	32.00 (30.00, 34.00)	32.00 (29.00, 34.00)	0.029	0.986
Parity (times), M (Q_1, Q_3)	1 (1, 2)	2 (1, 2)	2 (1, 2)	3.303	0.192
Gestational age (weeks), M (Q_1, Q_3)	39 (38, 40)	39 (38, 40)	39 (38, 40)	1.584	0.453
BMI (kg/m^2), M (Q_1, Q_3)	27.05 (25.30, 28.50)	26.80 (25.25, 28.70)	27.80 (25.40, 28.90)	1.382	0.501
Haemoglobin (g/L), mean ± SD	112.35 ± 11.67	113.60 ± 12.28	114.32 ± 13.85	0.628	0.534
Newborn weight (g), mean ± SD	3233.80 ± 411.07	3245.48 ± 392.43	3278.58 ± 431.22	0.304	0.738
Gestational diabetes, n (%)				1.053	0.591
Yes	9 (8.3%)	13 (12.6%)	9 (10.1%)		
No	99 (91.7%)	90 (87.4%)	80 (89.9%)		
Gestational hypertension, n (%)				0.285	0.867
Yes	8 (7.4%)	9 (8.7%)	6 (6.7%)		
No	100 (92.6%)	94 (91.3%)	83 (93.3%)		

Abbreviation: BMI, body mass index.

Table 2. Comparison of postoperative recovery times among the three groups.

Indicator	Single-layer suture group (n = 108)	Double-layer suture group (n = 103)	Breakwater suture group (n = 89)	Statistical value	p-value
Time to first anal flatus (h), mean ± SD	22.87 ± 3.84	21.39 ± 4.33	18.70 ± 3.50^{a,b}	32.389	<0.001
Time to first ambulation (h), mean ± SD	26.29 ± 5.63	24.49 ± 5.21	21.31 ± 3.82^{a,b}	29.572	<0.001
Postoperative hospital stay (days), M (Q_1, Q_3)	5 (5, 6)	5 (4, 6)	5 (4, 5)^{a,b}	13.167	0.001

Notes: ^{a} $p < 0.05$ compared with the single-layer suture group; ^{b} $p < 0.05$ compared with the double-layer suture group.

Comparison of Uterine Healing and Complications

There were no significant differences in the incidence of postoperative complications, such as incisional infection, postpartum haemorrhage, and urinary retention, among the three groups ($p > 0.05$) (Table 3).

Ultrasound examination at 5–7 days postoperatively revealed significantly greater myometrial thickness in the lower uterine segment of the breakwater suture group compared with the other two groups ($p < 0.001$) (Table 3). At the 6-month follow-up, the incidence of uterine diverticulum was significantly lower in the breakwater suture group than in the single-layer suture group ($p < 0.05$) (Table 3).

Comparison of Postoperative Psychological Status and Sleep Quality

At 48 hours postoperatively, the breakwater suture group demonstrated significantly lower scores on the SAS, SDS, EPDS, and PSQI scales compared with both the single-layer suture and the double-layer suture groups ($p < 0.001$) (Table 4).

Discussion

This retrospective cohort study comprehensively evaluated the efficacy of three uterine suturing techniques on postoperative recovery in patients with scarred uteri undergoing repeat caesarean section. Our findings demonstrate that the breakwater suturing technique exhibits significant overall advantages over traditional single-layer or double-layer suturing in promoting postoperative physiological recovery, improving uterine healing quality, reducing the risk of complications, and enhancing psychological well-being.

This study found that patients in the breakwater suture group exhibited significantly shorter time to first anal flatus, time to first ambulation, and postoperative hospital stay. This outcome transcends the scope of simple anatomical approximation, revealing the potential impact of suturing techniques on the restoration of systemic physiological function. We hypothesise that the mechanism may be multifaceted: firstly, the breakwater suturing technique achieves superior tissue apposition through meticulous multilayer alignment, particularly the tight closure of the mucosal layer. This reduces the risk of dead space and haematoma formation, potentially mitigating local inflammatory responses and tissue oedema [8]. This milder local trauma response may positively influence autonomic nervous system function and gastrointestinal hormone secretion by modulating systemic inflammatory levels, thereby promoting earlier recovery of intestinal motility [19]. Secondly, the more stable uterine structure achieved with this technique may indirectly alleviate pain by reducing tension-related discomfort during uterine contractions, thereby promoting earlier ambulation. This aligns closely with the principles of the Enhanced Recovery After Surgery (ERAS), which aims to optimise perioperative care to reduce surgical stress and accelerate patient recovery [20]. Study demonstrates that implementing ERAS pathways in caesarean sections

Table 3. Comparison of uterine healing and complications among the three groups.

Indicator	Single-layer suture group (n = 108)	Double-layer suture group (n = 103)	Breakwater suture group (n = 89)	Statistical value	p-value
Incision infection, n (%)	1 (0.9%)	3 (2.9%)	1 (1.1%)		0.537
Postpartum haemorrhage, n (%)	2 (1.9%)	0 (0.0%)	0 (0.0%)		0.329
Urinary retention, n (%)	4 (3.7%)	5 (4.9%)	3 (3.4%)		0.876
Postoperative thickness of muscle layer (mm), M (Q_1, Q_3)	6.70 (5.50, 7.93)	7.50 (6.50, 8.50)	8.30 (7.50, 9.00)^{a,b}	49.560	<0.001
Uterine diverticulum, n (%)	17 (15.7%)	13 (12.6%)	4 (4.5%)^{a}	6.400	0.041

Note: ^{a} $p < 0.05$ compared with the single-layer suture group; ^{b} $p < 0.05$ compared with the double-layer suture group.

Table 4. Comparison of postoperative psychological status and sleep quality scores among the three groups.

Indicator	Single-layer suture group (n = 108)	Double-layer suture group (n = 103)	Breakwater suture group (n = 89)	Statistical value	p-value
SAS (scores), mean ± SD	53.73 ± 7.32	49.56 ± 6.64	45.39 ± 4.39^{a,b}	50.978	<0.001
SDS (scores), M (Q_1, Q_3)	57.00 (51.75, 61.00)	52.00 (48.00, 57.00)	50.00 (45.00, 53.00)^{a,b}	50.742	<0.001
EPDS (scores), M (Q_1, Q_3)	13.00 (11.00, 15.00)	11.00 (9.50, 13.00)	9.00 (8.00, 11.00)^{a,b}	74.361	<0.001
PSQI (scores), M (Q_1, Q_3)	12.00 (11.00, 13.00)	11.00 (9.00, 12.50)	9.00 (8.00, 10.00)^{a,b}	69.607	<0.001

Note: ^{a} $p < 0.05$ compared with the single-layer suture group; ^{b} $p < 0.05$ compared with the double-layer suture group. SAS, Self-Rating Anxiety Scale; SDS, Self-Rating Depression Scale; EPDS, Edinburgh Postnatal Depression Scale; PSQI, Pittsburgh Sleep Quality Index.

effectively shortens hospital stays without increasing readmission risks [21]. Taken together, our study provides a novel, ERAS-compliant technique for obstetric surgery.

The current study also provides compelling evidence for the uterine healing capacity of the breakwater suturing technique. Short-term postoperative ultrasound revealed significantly greater myometrial thickness in the lower uterine segment in patients of the breakwater suture group. This clearly indicates that, through its unique "reinforced" structure, this suturing technique creates a more favourable biological environment for uterine incision healing. It not only provides superior mechanical support but also allows greater blood supply to the incision site by preventing excessive suture overlap and emphasising staggered layering. Adequate haemoperfusion is fundamental to tissue regeneration and collagen synthesis. This superior short-term healing quality directly translates into clinically significant long-term benefits—a markedly reduced incidence of uterine diverticulum. Uterine diverticulum or caesarean scar defects represent a core issue affecting women's long-term reproductive health, closely associated with abnormal uterine bleeding, chronic pelvic pain, secondary infertility, and increased risk of uterine rupture during subsequent pregnancies [8]. A systematic review indicates that poor healing of the uterine incision is the primary aetiological factor of diverticulum formation, with suturing technique being a crucial modifiable factor [7]. The breakwater suture technique appears to mitigate the anatomical conditions associated with scar defect formation by promoting a smoother uterine cavity surface with fewer indentations and irregularities. Furthermore, an existing study has confirmed that residual muscular layer thickness is a significant predictor of diverticulum formation and its severity [22]. Although this study did not specifically analyze predictive factors, the relevant results lend support to the aforementioned conclusion to a certain extent.

A notable contribution of this study lies in its first systematic demonstration of the significant impact of uterine suturing techniques on maternal psychological state and sleep quality in the immediate postpartum period. The breakwater suture group exhibited significantly superior scores for anxiety, depression (SDS, EPDS), and sleep quality at 48 hours postoperatively. This finding substantially broadens our perspective on evaluating surgical technique outcomes. Postpartum psychological disorders and sleep deprivation constitute interrelated serious issues, potentially leading to long-term cognitive and behavioural consequences [23,24]. We propose that the psychological benefits of the breakwater suturing arise from multiple interacting factors. Physiologically, accelerated recovery and reduced pain directly lower the body's stress load; psychologically, positive perceptions of surgical success and personal recovery pace bolster patients' self-efficacy and sense of control. Prospectively, for mothers aware of long-term risks like uterine prolapse, a well-healed uterus fosters confidence in future reproductive health, alleviating potential 'fertility anxiety'. Improved sleep quality likely stems from the combined effects of pain reduction and psychological stress relief, while quality sleep in turn further accelerates both physical and mental recovery. This underscores the necessity of incorporating patient-reported outcomes into surgical evaluations, as the efficacy of techniques should ultimately be reflected in enhanced overall quality of life [25]. Perinatal anxiety and depression correlate with elevated inflammatory markers, and superior surgical techniques may provide a biological basis for improved psychological states by mitigating inflammatory responses [26]. Notably, no significant differences in short-term complications, such as incisional infection or postpartum haemorrhage, were observed among the three groups. This indicates that the comprehensive benefits of the breakwater suturing technique are not achieved at the expense of increased immediate surgical risks, demonstrating safety comparable to traditional suturing methods—a critical factor for its clinical adoption.

Certain limitations of this study should be acknowledged. Firstly, its retrospective observational design introduces the potential for selection bias, as the assignment to suturing technique groups was based on surgeon preference rather than randomisation. Although baseline characteristics were comparable, unmeasured confounding factors (e.g., subtle differences in surgical indications or variations in surgeon's skill) cannot be fully excluded. Secondly, the relative complexity of the breakwater suturing technique, its learning curve, and the proficiency required of surgeons may somewhat limit its universal applicability. Its long-term efficacy, particularly regarding subsequent pregnancy outcomes, necessitates extended follow-up. Future research should prioritize rigorous multicentre, prospective randomised controlled trials to generate higher-level evidence. Furthermore, the underlying molecular mechanisms of this technique warrant investigation, including its effects on local cytokine expression profiles and angiogenesis.

Conclusions

The breakwater suturing technique outperforms the traditional single-layer or double-layer suturing methods in promoting postoperative recovery across multiple domains—physiological function, pain management, psychological well-being, and anatomical integrity—in patients with scarred uteri undergoing repeat caesarean section. Therefore, this technique holds considerable value for broad clinical adoption on the grounds of its advantages in enhancing maternal perinatal quality of life and reducing long-term risk of uterine diverticulum formation.

Availability of Data and Materials

The data analyzed are available from the corresponding author upon reasonable request.

Author Contributions

JFL and XYC designed the research study. JFL performed the research. XYC analyzed the data. JFL drafted the article. Both authors have been involved in revising the manuscript critically for important intellectual content. Both authors gave final approval of the version to be published. Both authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

The study was approved by the Ethics Committee of The Maternal and Child Health Care Hospital of Tong Xiang (approval number: 202507), and all procedures followed the principles outlined in the Declaration of Helsinki. Informed consent was waived because all data were anonymised and contained no personally identifiable information.

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Conflict of Interest

The authors declare no conflict of interest.

References

[1] Betrán AP, Ye J, Moller AB, Zhang J, Gülmezoglu AM, Torloni MR. The Increasing Trend in Caesarean Section Rates: Global, Regional and National Estimates: 1990-2014. PloS One. 2016; 11: e0148343. https://doi.org/10.1371/journal.pone.0148343.

[2] Wells JC, Wibaek R, Poullas M. Global epidemiology of use of and disparities in caesarean sections. Lancet (London, England). 2019; 394: 24–25. https://doi.org/10.1016/S0140-6736(19)30715-9.

[3] Keag OE, Norman JE, Stock SJ. Long-term risks and benefits associated with cesarean delivery for mother, baby, and subsequent pregnancies: Systematic review and meta-analysis. PLoS Medicine. 2018; 15: e1002494. https://doi.org/10.1371/journal.pmed.1002494.

[4] Tulandi T, Agdi M, Zarei A, Miner L, Sikirica V. Adhesion development and morbidity after repeat cesarean delivery. American Journal of Obstetrics and Gynecology. 2009; 201: 56.e1–56.e6. https://doi.org/10.1016/j.ajog.2009.04.039.

[5] Mackeen AD, Packard RE, Ota E, Berghella V, Baxter JK. Timing of intravenous prophylactic antibiotics for preventing postpartum infectious morbidity in women undergoing cesarean delivery. The Cochrane Database of Systematic Reviews. 2014; 2014: CD009516. https://doi.org/10.1002/14651858.CD009516.pub2.

[6] Donnez O. Cesarean scar defects: management of an iatrogenic pathology whose prevalence has dramatically increased. Fertility and Sterility. 2020; 113: 704–716. https://doi.org/10.1016/j.fertnstert.2020.01.037.

[7] Bij de Vaate AJM, van der Voet LF, Naji O, Witmer M, Veersema S, Brölmann HAM, *et al*. Prevalence, potential risk factors for development and symptoms related to the presence of uterine niches following Cesarean section: systematic review. Ultrasound in Obstetrics & Gynecology: the Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology. 2014; 43: 372–382. https://doi.org/10.1002/uog.13199.

[8] Tower AM, Frishman GN. Cesarean scar defects: an underrecognized cause of abnormal uterine bleeding and other gynecologic complications. Journal of Minimally Invasive Gynecology. 2013; 20: 562–572. https://doi.org/10.1016/j.jmig.2013.03.008.

[9] Bujold E, Goyet M, Marcoux S, Brassard N, Cormier B, Hamilton E, *et al*. The role of uterine closure in the risk of uterine rupture. Obstetrics and Gynecology. 2010; 116: 43–50. https://doi.org/10.1097/AOG.0b013e3181e41be3.

[10] Roberge S, Demers S, Girard M, Vikhareva O, Markey S, Chaillet N, *et al*. Impact of uterine closure on residual myometrial thickness

after cesarean: a randomized controlled trial. American Journal of Obstetrics and Gynecology. 2016; 214: 507.e1–507.e6. https://doi.org/10.1016/j.ajog.2015.10.916.

[11] CAESAR study collaborative group. Caesarean section surgical techniques: a randomised factorial trial (CAESAR). BJOG: an International Journal of Obstetrics and Gynaecology. 2010; 117: 1366–1376. https://doi.org/10.1111/j.1471-0528.2010.02686.x.

[12] Dodd JM, Anderson ER, Gates S, Grivell RM. Surgical techniques for uterine incision and uterine closure at the time of caesarean section. The Cochrane Database of Systematic Reviews. 2014; 2014: CD004732. https://doi.org/10.1002/14651858.CD004732.pub3.

[13] Zhao Y, Zhu JW, Wu D, Wang QH, Lu SS, Liu XX, *et al*. Application of uterine lower part breakwater-like suture operation in placenta previa. Zhonghua Fu Chan Ke Za Zhi. 2018; 53: 234–238. https://doi.org/10.3760/cma.j.issn.0529-567x.2018.04.005.

[14] Jelsema RD, Wittingen JA, Vander Kolk KJ. Continuous, nonlocking, single-layer repair of the low transverse uterine incision. The Journal of Reproductive Medicine. 1993; 38: 393–396.

[15] Zung WW. A rating instrument for anxiety disorders. Psychosomatics. 1971; 12: 371–379. https://doi.org/10.1016/S0033-3182(71)71479-0.

[16] Jegede RO. Psychometric properties of the Self-Rating Depression Scale (SDS). The Journal of Psychology. 1976; 93: 27–30. https://doi.org/10.1080/00223980.1976.9921370.

[17] Cox J, Holden J. Perinatal mental health: A guide to the edinburgh postnatal depression scale (EPDS). Royal College of Psychiatrists: London. 2003.

[18] Smyth C. The Pittsburgh sleep quality index (PSQI). Journal of Gerontological Nursing. 1999; 25: 10.

[19] Watt DG, Horgan PG, McMillan DC. Routine clinical markers of the magnitude of the systemic inflammatory response after elective operation: a systematic review. Surgery. 2015; 157: 362–380. https://doi.org/10.1016/j.surg.2014.09.009.

[20] Wrench IJ, Allison A, Galimberti A, Radley S, Wilson MJ. Introduction of enhanced recovery for elective caesarean section enabling next day discharge: a tertiary centre experience. International Journal of Obstetric Anesthesia. 2015; 24: 124–130. https://doi.org/10.1016/j.ijoa.2015.01.003.

[21] Pinho B, Costa A. Impact of enhanced recovery after surgery (ERAS) guidelines implementation in cesarean delivery: A systematic review and meta-analysis. European Journal of Obstetrics, Gynecology, and Reproductive Biology. 2024; 292: 201–209. https://doi.org/10.1016/j.ejogrb.2023.11.028.

[22] Özler MR, Al RA. A prospective comparative study of single-layer versus double-layer uterine closure techniques on cesarean scar formation. BMC Pregnancy and Childbirth. 2025; 25: 868. https://doi.org/10.1186/s12884-025-08010-3.

[23] Park EM, Meltzer-Brody S, Stickgold R. Poor sleep maintenance and subjective sleep quality are associated with postpartum maternal depression symptom severity. Archives of Women's Mental Health. 2013; 16: 539–547. https://doi.org/10.1007/s00737-013-0356-9.

[24] Hyndych A, El-Abassi R, Mader EC, Jr. The Role of Sleep and the Effects of Sleep Loss on Cognitive, Affective, and Behavioral Processes. Cureus. 2025; 17: e84232. https://doi.org/10.7759/cureus.84232.

[25] Bennett AV, Jensen RE, Basch E. Electronic patient-reported outcome systems in oncology clinical practice. CA: a Cancer Journal for Clinicians. 2012; 62: 337–347. https://doi.org/10.3322/caac.21150.

[26] Liu H, Zhu K, Yang C. The Intersection between Tryptophan-Kynurenine Pathway Metabolites and Immune Inflammation, Hormones, and Gut Microbiota in Perinatal Depression. Actas Espanolas De Psiquiatria. 2024; 52: 733–740. https://doi.org/10.62641/aep.v52i5.1748.