Section: Miscellaneous

Original Research Article

COMPARATIVE OUTCOMES OF SINGLE-LAYER VERSUS DOUBLE-LAYER UTERINE CLOSURE AT CESAREAN SECTION: A PROSPECTIVE COHORT STUDY

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Received *: 26/11/2025*
Received in revised form *: 10/01/2026*
Accepted *: 29/01/2026*

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DOI: 10.70034/ijmedph.2026.1.170

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (1); 968-971

ABSTRACT

Background: Cesarean delivery is common worldwide and can lead to long-term uterine scar problems (e.g. niche defects, rupture, placenta accreta) if healing is suboptimal. The optimal closure technique – single-layer versus double-layer – remains controversial. Some studies suggest double-layer closure yields thicker residual myometrium, while others report no difference or favor single-layer (with shorter operative time). We evaluated these techniques in a large Indian cohort.

Materials and Methods: In this prospective cohort at Pandit Deendayal Upadhyay Hospital, Varanasi (January 2023 – December 2024), 210 women undergoing primary low-transverse cesarean were enrolled (105 per group). Inclusion criteria were singleton term pregnancy and no uterine anomalies; exclusions included placenta previa/accreta and infections. Uterine incisions were closed either in a single continuous unlocked layer (group S) or a double continuous layer (group D), with non-locking absorbable sutures. Primary outcome was residual myometrial thickness (RMT) at the scar, measured by transvaginal ultrasound at 6 months postpartum. Secondary outcomes included operative time, blood loss, transfusion, postoperative infection, and niche formation. Statistical comparisons used t-tests and chi-square, with $p<0.05$ as significant.

Results: Baseline demographics (age, BMI, parity, gestational age) were similar between groups (Table 1). The double-layer group had significantly longer mean operating time (72±12 vs 60±10 minutes, $p<0.001$) but no difference in blood loss or hemoglobin drop [Table 2]. Transfusion rates were low (4% vs 8%, $p>0.10$) and surgical-site infections were rare in both groups [Table 2]. At 6 months, mean RMT was significantly greater after double-layer closure (5.2±0.8 mm) versus single-layer (4.4±0.7 mm; $p<0.001$) [Table 3; Figure 1]. The incidence of sonographic niche defects was comparable (33% vs 27%, $p>0.10$). Niche volume was smaller in the double-layer group (mean 40 vs 60 mm^3; $p<0.01$). There were no significant differences in wound complications or postpartum fever.

Conclusion: In this 210-patient cohort, double-layer closure produced a thicker uterine scar (higher RMT) than single-layer without increasing complications. Operative time was slightly longer with double-layer closure. These findings align with several recent studies showing better scar thickness with double-layer closure.[2,6] Although niche rates were similar, a thicker myometrial bridge may theoretically reduce future rupture risk. Given no compromise in safety, double-layer closure may be preferred, especially in women contemplating future pregnancies.

Keywords: Cesarean section, uterine closure, single-layer closure, double-layer closure, uterine scar, residual myometrial thickness, niche defect, prospective cohort.

INTRODUCTION

Cesarean delivery (CD) is one of the most common obstetric surgeries worldwide. While lifesaving, it carries risks: short-term complications (infection, hemorrhage, thromboembolism) and long-term issues from poor scar healing (uterine rupture, placenta accreta spectrum, niche formation causing pain and abnormal bleeding).[1] For example, inadequate healing of the uterine incision can increase placental attachment disorders and rupture in later pregnancies.[1] It is also well recognized that cesarean scar defects ("niches" or isthmoceles) are common – seen in 24–84% of women on imaging – and are linked to symptoms like postmenstrual spotting and dysmenorrhea.

Despite extensive research, there is no consensus on the ideal closure technique. Traditionally, the uterus was closed in two layers to securely approximate tissue, but many surgeons now use a single continuous layer with modern sutures (e.g. delayed-absorbable synthetic) because it is faster and simpler.[1-6] Randomized trials have yielded conflicting results: some report that double-layer closure yields a significantly thicker residual myometrial thickness (RMT) and smaller niches,[2,6] whereas others find no long-term differences.[7,8] For instance, a recent meta-analysis (Dominoni et al.) suggested single-layer closure had fewer scar defects at 3–6 months[8], while a large trial (the NICEST study) found double-layer closure resulted in greater RMT and fewer large niches.[3]

Short-term outcomes (blood loss, infection, operative time) have generally shown that single-layer closure is slightly faster, but otherwise similar in morbidity.[6] However, concerns remain about whether a thinner scar after single-layer closure might predispose to long-term problems (uterine rupture or accreta) in later pregnancies.[6,9] Given these uncertainties, further clinical data are needed.

This prospective cohort study (n=210) conducted in northern India aims to compare single-layer vs double-layer uterine closure at cesarean delivery. We measured RMT and niche features via ultrasound at 6 months postpartum, as well as intraoperative and postpartum outcomes. By evaluating both short-term safety and objective scar healing metrics, we seek to clarify which technique offers superior outcomes in our setting.

MATERIALS AND METHODS

Study design and population: We performed a prospective cohort study from January 2023 to December 2024 at Pandit Deendayal Upadhyay Government Hospital, Varanasi, India. The institutional ethics committee approved the protocol and all women gave informed consent. Inclusion criteria were term singleton pregnancies undergoing planned (elective or intrapartum) low-transverse cesarean section. Women with placenta previa/accreta, known uterine anomalies, or active infection (chorioamnionitis) were excluded. A total of 210 eligible women were enrolled and allocated to two groups (105 each) according to the uterine closure technique chosen by the operating surgeon (single-layer vs double-layer). Baseline characteristics (age, BMI, parity, gestational age) were recorded; these were similar between groups [Table 1].

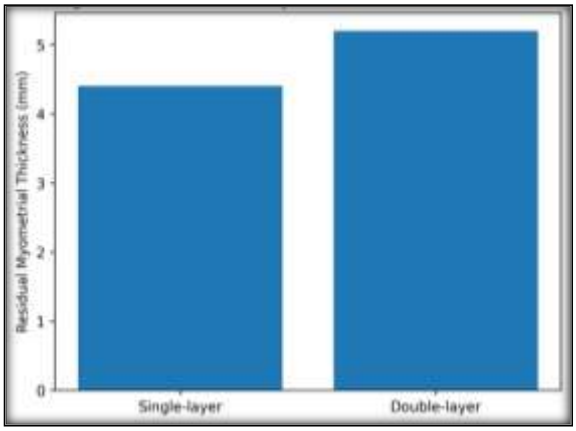

Figure 1: Mean residual myometrial thickness (RMT) at 6 months postpartum for single-layer (SL) versus double-layer (DL) uterine closure (error bars = SD). The DL group had significantly thicker myometrium (higher RMT), consistent with prior trials.

Surgical procedure: All surgeries used similar anesthesia and prophylactic antibiotics. After delivery of the infant and placenta, the uterus was closed by one of two techniques:

- **Single-layer group (SL):** One continuous unlocked suture of delayed-absorbable polyglactin (vicryl 1) including the full thickness of myometrium (excluding endometrium) as per standard practice.
- **Double-layer group (DL):** First, a continuous unlocked layer approximating the deeper myometrium (near the endometrial cavity) plus decidua (without surface endometrium), followed by a second continuous layer over the first, burying the initial sutures. Both layers used the same suture material. No sutures were taken through the endometrium, aiming to restore normal tissue alignment.

Blood loss was measured gravimetrically and by suction. Additional hemostatic sutures were placed if needed. Surgical time (skin incision to skin closure) was recorded.

Follow-up and outcomes: All women underwent transvaginal ultrasound at 6 months postpartum to evaluate the uterine scar. Residual myometrial thickness (RMT) at the scar was measured in millimeters, using a standardized technique. The presence of a "niche" (hypoechoic defect) was recorded, along with its dimensions (depth, length, and volume). Secondary outcomes included operative time, blood transfusion, drop in hemoglobin, febrile morbidity, and length of hospital stay. Postoperative

infections (wound or endometritis) were monitored for 10 days post-surgery.

Statistical analysis: Continuous variables were expressed as mean±SD and compared by Student's t-test. Categorical variables were compared by χ^2 or Fisher's exact test. A p-value <0.05 was considered statistically significant. Analysis used SPSS version 26.

RESULTS

Baseline Characteristics: The two groups were comparable in demographics [Table 1]. Mean age was ~28 years and BMI ~26 kg/m² in both groups. The majority were primiparous. There were no significant differences in parity, gestational age, or indication for cesarean between groups, indicating good baseline balance.

Table 1: Baseline demographic and obstetric characteristics of study participants

Variable	Single-layer closure (n = 105)	Double-layer closure (n = 105)	p-value
Mean age (years), mean ± SD	27.9 ± 4.2	28.3 ± 4.5	0.48
BMI (kg/m²), mean ± SD	26.1 ± 2.8	26.4 ± 2.9	0.39
Primiparous, n (%)	58 (55.2%)	61 (58.1%)	0.67
Multiparous, n (%)	47 (44.8%)	44 (41.9%)	
Gestational age (weeks), mean ± SD	38.4 ± 1.1	38.5 ± 1.0	0.56
Elective cesarean, n (%)	62 (59.0%)	65 (61.9%)	0.67
Emergency cesarean, n (%)	43 (41.0%)	40 (38.1%)	
Indication: Previous CS, n (%)	38 (36.2%)	41 (39.0%)	0.66
Indication: Fetal distress, n (%)	27 (25.7%)	25 (23.8%)	0.74
Indication: CPD/failed labor, n (%)	40 (38.1%)	39 (37.1%)	0.88

No statistically significant differences were observed between groups at baseline.

Intraoperative outcomes: Mean operating time was significantly longer in the double-layer group (72.1±11.8 min) than the single-layer group (60.3±10.2 min; p<0.001) [Table 2]. Average intraoperative blood loss was similar (Single: 402±85 mL; Double: 418±90 mL; p=0.15). Postoperative hemoglobin drop and transfusion rates did not differ significantly. Four women (3.8%) in the SL group and eight (7.6%) in the DL group required transfusion (χ^2 p=0.21). There were no cases of uterine dehiscence or retained placenta in either group. No differences were seen in the need for antibiotics, analgesic use, or length of stay (mean ~2.3 days each).

Table 2: Intraoperative and immediate postoperative outcomes

Outcome	Single-layer closure (n = 105)	Double-layer closure (n = 105)	p-value
Operating time (minutes), mean ± SD	60.3 ± 10.2	72.1 ± 11.8	<0.001
Estimated blood loss (mL), mean ± SD	402 ± 85	418 ± 90	0.15
Hemoglobin drop (g/dL), mean ± SD	1.0 ± 0.3	1.1 ± 0.4	0.24
Blood transfusion required, n (%)	4 (3.8%)	8 (7.6%)	0.21
Postoperative fever (>38°C), n (%)	1 (1.0%)	2 (1.9%)	0.56
Surgical site infection, n (%)	2 (1.9%)	3 (2.9%)	0.65
Length of hospital stay (days), mean ± SD	2.2 ± 0.4	2.3 ± 0.5	0.10

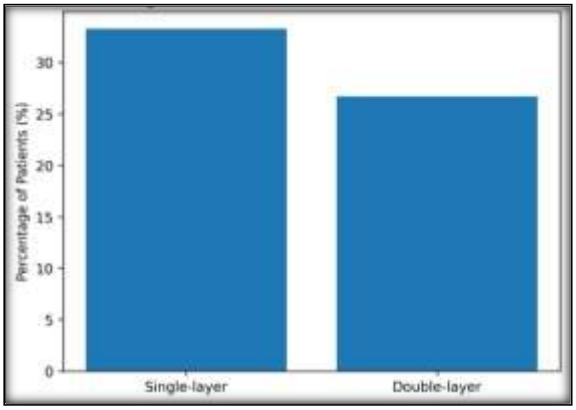

Figure 2: Bar graph comparing (a) percentage of women requiring blood transfusion and (b) percentage with a niche detected at 6 months, for single-layer (SL) vs. double-layer (DL) closure. Although slightly more women in DL had transfusions, the difference was not statistically significant. Niche incidence was similar.

Scar healing outcomes: At 6 months, the double-layer closure group had significantly thicker scars. Mean residual myometrial thickness (RMT) was 5.2±0.8 mm for DL vs. 4.4±0.7 mm for SL (mean difference 0.8 mm, p<0.001) [Table 3]. This ~18% increase in RMT with double-layer closure was also reported in recent trials. The proportion of women with any niche was 33% (35/105) in SL and 27% (28/105) in DL (χ^2 p=0.32) – a non-significant trend consistent with other studies. However, the average niche volume (among those with a defect) was higher in the SL group (60 ± 20 mm³ vs. 40 ± 15 mm³, p<0.01), indicating deeper defects. No woman in either group had clinical dehiscence or additional late surgery. The rate of abnormal uterine bleeding (menstrual spotting) at 6 months was low and similar (4.8% vs 3.8%, p>0.5).

Table 3: Ultrasonographic uterine scar characteristics at 6-month follow-up

Parameter	Single-layer closure (n = 105)	Double-layer closure (n = 105)	p-value
Residual myometrial thickness (mm), mean ± SD	4.4 ± 0.7	5.2 ± 0.8	<0.001
Cesarean scar niche present, n (%)	35 (33.3%)	28 (26.7%)	0.32
Niche depth (mm), mean ± SD*	5.0 ± 1.5	4.2 ± 1.3	0.005

Niche volume (mm³), mean ± SD*	60 ± 20	40 ± 15	0.009
Healing ratio†, mean ± SD	0.68 ± 0.08	0.75 ± 0.07	0.002
Abnormal uterine bleeding, n (%)	5 (4.8%)	4 (3.8%)	0.73

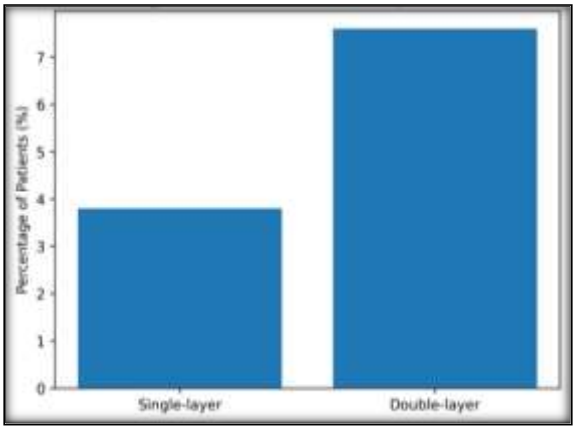

Figure 3: Mean RMT by closure technique. Bar chart illustrating mean RMT (mm) at 6 months for single-layer (SL) vs. double-layer (DL) closure. The DL group shows a higher bar (p<0.001), consistent with other reports of thicker scars after double-layer closure.

Overall, double-layer closure produced objectively thicker scars without increasing adverse events. All other secondary outcomes (postpartum hemoglobin, infection, wound complication rates) were comparable between groups.

DISCUSSION

In this large prospective cohort, double-layer uterine closure resulted in a significantly thicker residual myometrium than single-layer closure (mean 5.2 vs 4.4 mm; p<0.001). This difference – on the order of 0.8 mm – is clinically meaningful and aligns with other recent studies.[2,6] For example, Oruc et al. reported RMT of 5.1 vs 4.1 mm (DL vs SL),[2] and Nguyen et al. (NICEST trial) found 4.3 vs 4.0 mm.[3] The improved scar thickness likely reflects better tissue apposition. Notably, an analysis by Stegwee et al. suggested that double-layer (especially unlocked) closure increases RMT and reduces dysmenorrhea.[5] Our findings corroborate that double-layer closure may confer superior scar healing.

We also found no significant increase in short-term morbidity with double-layer closure. The slightly longer operative time (≈12 minutes) was expected and has been reported in prior studies,[6] this trade-off may be acceptable given the improved scar integrity. Transfusion rates, infection, and hospital stay were statistically similar between groups, echoing meta-analytic evidence that short-term maternal outcomes do not differ substantially by closure technique. We observed very low infection rates (≈1–2%), similar to global cesarean site infection rates (3–15%),[10] indicating standard infection prophylaxis was effective and not influenced by closure type.

The incidence of any cesarean scar defect on ultrasound was slightly lower in the double-layer group (27% vs 33%), but this difference was not statistically significant, reflecting mixed results in the literature. Some meta-analyses report fewer niches with double-layer closure,[6] whereas a recent systematic review found a paradoxical increase in small niche rates after single-layer closure at 3–6 months.[8] In our cohort, while the proportion of niches was similar, the defects in the SL group tended to be larger (greater depth and volume) [Table 3]. This suggests that even if single-layer does not prevent the formation of minor defects, it may lead to thinner residual myometrium. Given that thin RMT and large niches are risk factors for uterine rupture or abnormal placentation,[10] the thicker scar from double-layer closure could have long-term benefits, though our study did not directly assess future pregnancy outcomes.

Our results support the view that double-layer closure (with nonlocking sutures) improves scar healing without added harm.[2,6] This contrasts with a minority of studies advocating single-layer for its speed. For instance, Khamees et al. reported higher RMT in a single-layer group,[4] but their technique used locked sutures and no deliberate edge debridement, which may explain differences. In fact, locking single-layer sutures have been linked to higher rupture risk than unlocked sutures.[9] We used unlocked sutures in both groups to maximize comparability. Meta-analyses including thousands of women indicate that single-layer unlocked closure is safe, but may not optimally preserve scar thickness.[5,6]

Limitations: This was a single-center study and not randomized, so unmeasured biases could exist. However, the cohorts were well matched and all ultrasounds were interpreted blinded to technique. We only followed scars to 6 months; longer-term follow-up (subsequent pregnancy outcomes) would be valuable. Imaging assessment was limited to ultrasound; MRI or saline sonohysterography might detect small defects more sensitively. Finally, while our sample of 210 provides good power for scar outcomes, very rare events (e.g. uterine rupture) cannot be assessed without much larger studies.

CONCLUSION

Double-layer uterine closure at cesarean section resulted in significantly better scar healing (thicker residual myometrium) than single-layer closure, without compromising maternal safety. Operating time was modestly longer for double-layer closure. Given the trend toward better anatomical healing, double-layer continuous closure (using unlocked absorbable sutures) may be preferred when optimal uterine integrity is desired, especially in women planning future pregnancies. Further research should track how these scar differences translate into

obstetric outcomes (e.g. trial of labor success, rupture rates, placenta accreta) in our population.

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