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Original Research Article

Effect of Single- and Double-Layer Cesarean Section Closure on Residual Myometrial Thickness and Isthmocele: A Prospective Observational Study

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Abstract:

Background: Cesarean section rates are increasing worldwide, leading to growing concern regarding long-term uterine scar integrity and associated complications. Incomplete healing of the uterine incision may result in reduced residual myometrial thickness and formation of an isthmocele, which have been linked to abnormal uterine bleeding and adverse outcomes in subsequent pregnancies. The optimal uterine closure technique at cesarean section remains a subject of debate.

Objectives To compare the effect of single-layer and double-layer uterine closure at cesarean section on residual myometrial thickness and the incidence of isthmocele.

Methods: This prospective observational study was conducted in a tertiary care hospital and included 150 women undergoing lower segment cesarean section. Participants were divided into two groups based on the uterine closure technique: single-layer closure (n = 75) and double-layer closure (n = 75). Postoperative assessment was performed using transvaginal ultrasonography at approximately six weeks. Residual myometrial thickness was measured in millimeters, and the presence of isthmocele was recorded. Data were analyzed using appropriate statistical tests, with $p < 0.05$ considered statistically significant.

Results: Baseline demographic and obstetric characteristics were comparable between the two groups. The mean residual myometrial thickness was significantly greater in the double-layer closure group compared to the single-layer group (4.2 ± 0.9 mm vs 3.4 ± 0.8 mm; $p < 0.001$). Isthmocele was observed in 32.0% of women in the single-layer group and 25.3% in the double-layer group; however, this difference was not statistically significant ($p = 0.36$). Women with isthmocele demonstrated significantly lower residual myometrial thickness irrespective of closure technique ($p < 0.001$).

Conclusion: Double-layer uterine closure at cesarean section is associated with significantly greater residual myometrial thickness, suggesting improved uterine scar healing. However, the incidence of isthmocele does not differ significantly between closure techniques, indicating a multifactorial etiology. Further long-term studies are required to assess the impact of these findings on future pregnancy outcomes.

Keywords: Cesarean section, Isthmocele, Myometrial Thickness.

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Introduction

Cesarean section (CS) is one of the world's most widely performed surgical procedures, and its prevalence has been continuously increasing in both developed and developing countries. Studies from tertiary care settings and global data sets have shown a remarkable rise in the rates of cesarean delivery in the past few decades, which is based on changing obstetric practices, maternal preferences, and medico-legal considerations [1,2]. While the use of cesarean delivery is often lifesaving, the long-term sequelae of cesarean delivery on the integrity of the uterus and reproductive health has become a focus of growing clinical concern.

One of the important late complications of cesarean delivery is faulty healing of the uterine incision with the formation of a cesarean scar niche or isthmocele. A niche is defined as a depression at the site of the previous cesarean scar, which is incomplete myometrial healing. The development of uterine niches has been linked to abnormal uterine bleeding, postmenstrual spotting, pelvic pain, infertility and

difficulties in future pregnancies, such as scar pregnancy and uterine rupture [3-5]. Several hypotheses have been postulated to explain the formation of the niche including poor vascularization, low incision placement, infection, and surgical technique used for uterine closure [3].

Advances in transvaginal ultrasonography have allowed standardized and reliable assessment of cesarean scars so that scar dimension, depth of the niche, and RMT can be objectively assessed [4-8]. Residual myometrial thickness has become an important parameter reflecting the quality of myometrial healing with thinner RMT related to increased risk of uterine dehiscence, rupture and adverse gynecological symptoms [9-11]. Longitudinal studies have further shown that cesarean scar dimensions may change with time and subsequent pregnancies, and highlight the clinical relevance of optimal uterine repair at index surgery [7,12].

Among the various surgical factors that can be modified, one factor that has been widely debated is the closure of the uterus, i.e., single layer versus double layer closure. Several randomized controlled trials and observational studies have investigated the effect of closure technique on the healing of the uterine scar and RMT with conflicting outcome [12-18]. While some studies show that double-layer closure may lead to increased residual myometrial thickness and less scar defect, others state that there is no significant difference between the two techniques [13-19]. Systematic reviews and meta-analyses have tried to synthesize available evidence but heterogeneity in study design, imaging protocols and outcome measures have limited definitive conclusions [12,17-20].

Recent high quality meta-analyses based solely on randomized trials have rekindled interest on this subject, highlighting the importance of further well-designed studies examining the association between the method of uterine closure, residual myometrial thickness and isthmocele formation [20,21]. In this context, this present study seeks to assess the impact of single layer versus double layer cesarean section closure on residual myometrial thickness and isthmocele creation, to add to the growing evidence base to guide best surgical practice in cesarean delivery.

Materials and Method

This prospective observational study was carried out at a tertiary care teaching hospital to assess the impact of the single-layer and double-layer management of uterine closure on residual myometrial thickness and formation of the isthmocele after cesarean section. The study population was women who had lower segment cesarean delivery during the study period if they met the predefined inclusion criteria. Consecutive eligible participants were enrolled with an informed consent and subsequently followed prospectively from the time of surgery to a postoperative assessment.

A total sample size of 150 participants was included with 75 women in each group. Group allocation was determined by the method of closure used on the uterus at the time of the cesarean section performed as determined by the operating surgeon following routine clinical practice. One group was women who underwent the single-layer uterine closure while the other was the group that underwent the double-layer uterine closure. As this was an observational study, no intervention or randomization was done by the investigators. Baseline demographic and obstetric data were collected at enrollment; reports of age, parity, gestational age at delivery, indication for cesarean section and history of prior cesarean delivery.

All cesarean sections were done by a standard lower segment transverse uterine incision. In the single layer group, the uterine incision was closed using a single layer continuous suture technique and in the double layer group, the uterus was closed using a continuous first layer followed by imbricating or continuous second layer as per institutional practice. Other aspects of surgical technique and postoperative care were as uniform as possible to reduce the amount of confounding.

Postoperative assessment of the cesarean scar was done with transvaginal ultrasonography at a fixed time after delivery, preferably around six weeks after delivery. Ultrasonographic assessment was centered on the determination of the presence of an isthmocele and the residual myometrial thickness at the site of the cesarean scar, using standardized protocols of imaging described in previous studies. Residual myometrial thickness in millimeter was measured at the thinnest part of scar in the sagittal plane. An isthmocele was defined as a hypoechoic or anechoic defect in the location of the uterine scar.

Data were inputted in a structured proforma and analysed with appropriate statistical methods. Continuous variables were represented as mean and standard deviation, and categorical variables were represented as frequencies and percentages. Comparisons between the two groups were done to compare the difference in residual myometrial thickness and prevalence of isthmocele. Ethical approval was obtained from the institutional ethics committee before the study was initiated and confidentiality of study data was maintained throughout the study period.

Observation and Results

A total of 150 women undergoing lower segment cesarean section were included in the study, of

which 75 women belonged to the single-layer uterine closure group and 75 women to the double-layer uterine closure group. Both groups were similar with regard to baseline demographic and obstetric characteristics. The average age of the participants in the single-layer group was found to be 28.9 ±4.6 years; in the double-layer group it was found to be 29.2 ±4.8 years. There was no statistically significant difference found. The majority of women in both groups were multiparous and distribution of parity was similar in two groups. Gestational age at delivery was comparable with mean of 38.6 ±1.4 weeks in the single layer and 38.8 ±1.3 weeks in the double layer group. (Table 1)

Table 1: Baseline Demographic and Obstetric Characteristics of Study Participants

Parameter	Single-layer closure (n = 75)	Double-layer closure (n = 75)	p value
Mean age (years)	28.9 ± 4.6	29.2 ± 4.8	0.68
Multiparous women, n (%)	48 (64.0)	51 (68.0)	0.61
Gestational age at delivery (weeks)	38.6 ± 1.4	38.8 ± 1.3	0.42
Previous cesarean section, n (%)	41 (54.7)	44 (58.7)	0.62
Emergency cesarean section, n (%)	46 (61.3)	43 (57.3)	0.64

Indications for cesarean section were evenly distributed in the two groups, with previous cesarean delivery being the most common indication followed by non-progress of labor and fetal distress. There was no statistically significant difference in the two groups in terms of indication for surgery, and therefore, appears to be adequate baseline comparability. (Table 1)

Postoperative transvaginal ultrasonographic assessment was successfully performed in all the participants at the scheduled follow-up visit, approximately 6 weeks after delivery. Residual myometrial thickness was measured at the thinnest portion of uterine scar in all cases. The mean residual myometrial thickness in single-layer closure group was 3.4 ±0.8 mm, and in double-layer closure closure group it was 4.2 ±0.9 mm. This difference was statistically significant, as the double layer closure group had a greater residual myometrial thickness than the single layer group ($p < 0.001$). (Table 2)

Table 2: Residual Myometrial Thickness (RMT) at 6-week Follow-up

RMT parameter	Single-layer closure (n = 75)	Double-layer closure (n = 75)	p value
Mean RMT (mm)	3.4 ± 0.8	4.2 ± 0.9	<0.001*
RMT < 3 mm, n (%)	26 (34.7)	11 (14.7)	0.004*
RMT 3–3.9 mm, n (%)	27 (36.0)	23 (30.6)	0.47
RMT ≥ 4 mm, n (%)	22 (29.3)	41 (54.7)	0.002*

When the residual myometrial thickness was classified, less than 3 mm of residual myometrial thickness was found in 26 women (34.7%) of the single layer group compared to 11 women (14.7%) of the double layer group. In contrast, the residual myometrial thickness of 4 mm or greater was observed in 22 (29.3%) and 41 (54.7%) women in the single and double layer groups, respectively. The distribution of residual myometrial thickness categories was found to be significantly different between the two groups ($p < 0.01$), indicating a better result for scar thickness following double layer uterine closure.

The presence of isthmocele was assessed in ultrasonographic assessment. Isthmocele was observed in 24 women (32.0%) in the single layer closure group and 19 women (25.3%) in the double layer closure groups. Although the incidence of isthmocele was numerically higher in the single layer group, the difference did not reach statistical significance ($p = 0.36$). (Table 3)

Table 3: Incidence of Isthmocele on Transvaginal Ultrasonography

Parameter	Single-layer closure (n = 75)	Double-layer closure (n = 75)	p value
Isthmocele present, n (%)	24 (32.0)	19 (25.3)	0.36
Isthmocele absent, n (%)	51 (68.0)	56 (74.7)	

Table 4: Association Between Residual Myometrial Thickness and Isthmocele Formation (Overall Study Population)

Parameter	Isthmocele present (n = 43)	Isthmocele absent (n = 107)	p value
Mean RMT (mm)	3.1 ± 0.7	4.1 ± 0.9	<0.001*
RMT < 3 mm, n (%)	21 (48.8)	16 (15.0)	<0.001*
RMT ≥ 4 mm, n (%)	7 (16.3)	56 (52.3)	<0.001*

Further analysis showed that there was a significant link between residual myometrial thickness and isthmocele formation. Women with an isthmocele had a significantly lower mean residual myometrial thickness (3.1 ±0.7 mm) than women without an isthmocele (4.1 ±0.9 mm), regardless of closure technique ($p < 0.001$). (Table 4)

Table 5: Comparison of Residual Myometrial Thickness According to Closure Technique and Isthmocele Status

Group	Mean RMT (mm)	p value
Single-layer with isthmocele (n = 24)	3.0 ± 0.6	0.002*
Single-layer without isthmocele (n = 51)	3.7 ± 0.8	
Double-layer with isthmocele (n = 19)	3.5 ± 0.7	<0.001*
Double-layer without isthmocele (n = 56)	4.5 ± 0.8	

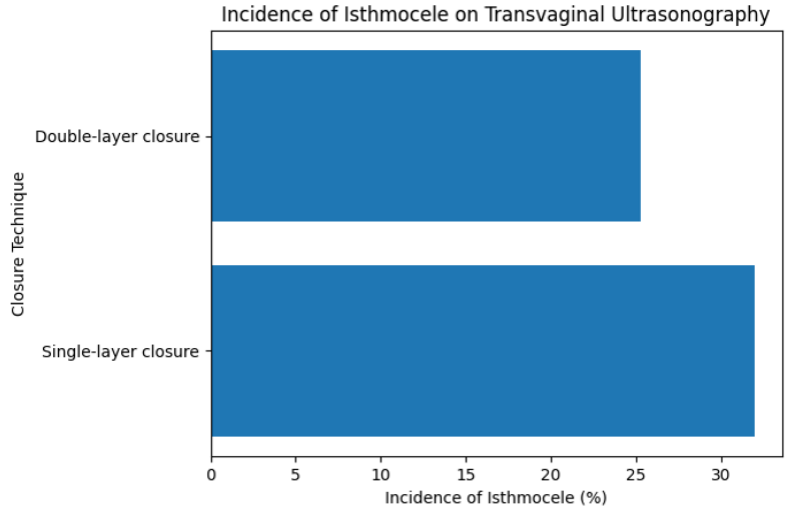

Figure 1: Incidence of Isthmocele on Transvaginal Ultrasonography

In the single layer closure group, women with isthmocele had a mean residual myometrial thickness of 3.0+-0.6 mm and those without isthmocele had a residual myometrial thickness of 3.7+-0.8 mm, a statistically significant difference ($p=0.002$). Similarly, in the double layer group, the mean residual myometrial thickness in the women with isthmocele was 3.5 ±0.7 mm versus 4.5 ±0.8 mm in the women without isthmocele ($p < 0.001$). (Table 5)

Discussion

The present prospective observational study evaluated the effect of single-layer vs. double-layer uterine closure at cesarean section on residual myometrial thickness and isthmocele formation. With an equal distribution of participants in both groups, baseline demographic and obstetric characteristics were similar, so the observed differences in scar outcomes would reasonably be explained by the uterine closure technique and not by confounding factors. These findings acquire relevance in the context of the worldwide increasing rate of cesarean sections reflected in both the regional and international data, which emphasize on the importance of optimizing the surgical techniques in order to minimize the long-term uterine morbidity [1,2].

In the current study, residual myometrial thickness of the double-layer uterine closure was significantly greater than with the single-layer closure at 6 weeks after surgery. This finding is consistent with pathophysiological hypotheses proposed by Vervoort et al. who suggested that inadequate approximation of myometrial edges and impaired healing play a role in thinning at the scar site [3]. Several ultrasonographic studies have highlighted residual myometrial thickness as a reliable marker of the integrity of the uterine scar in favor of its use as a primary outcome measure of cesarean scar assessment [4-8]. Our results further support the clinical significance of residual myometrial thickness as a surrogate marker for quality of healing for the uterus.

The mean residual myometrial thickness shown in the double-layer group in this study was significantly higher than in the single-layer group, which is concordant with past cohort studies and randomized trials that showed better scar thickness with double-layer closure [11-14]. Long term observational data have shown that low residual

myometrial thickness has been associated with an increased risk of scar-related complications including uterine dehiscence and rupture in subsequent pregnancies [9-11]. Although the present study did not assess future pregnancy outcomes, the apparent difference in scar thickness would suggest a possible long-term benefit of double-layer closure in maintaining the integrity of the uterus.

With respect to the formation of isthmocele, the present study showed an increased incidence of numerical results in the single layer closure group as compared with the double layer group; however, this difference was not statistically significant. This finding is in agreement with several previous studies that reported that there was no consistent difference in prevalence of isthmocele between closure techniques despite differences in residual myometrial thickness [12-16]. Van der Voet et al. and Naji et al. have stressed that isthmocele formation is multifactorial in nature and may be affected by various factors other than closure technique only, such as incision location, duration of labor, presence of infection and individual healing response [5,7].

An important finding in this study was the significant inverse relationship between residual myometrial thickness and isthmocele formation for either closure method. Women with isthmocele had significantly thinner scars than did those without isthmocele in both study groups. This finding supports the hypothesis that decreased residual myometrial thickness indicates impaired healing and predisposes to niche formation as hypothesized in previous ultrasonographic and prospective studies [8-11]. Similar associations have been reported by Pomorski et al and other investigators, who demonstrated that thinner scars were more often associated with uterine defects and abnormal scar morphology [10,11].

The absence of a statistically significant result in the incidence of isthmocele in the two groups in the present study is similar to the results of several systematic reviews and meta-analyses. Roberge et al. reported that while double-layer closure was linked to an improvement in residual myometrial thickness, this was not consistently linked to a reduction in the prevalence of uterine scar defects [17]. Likewise, multiple randomized controlled trials have shown better scar thickness with double layer closure without corresponding reduction of niche formation [18-20]. These results indicate that although closure technique has an impact on myometrial thickness, it may not be the only determinant in isthmocele development.

Recent good quality evidence has helped clarify this relationship further. The systematic review and meta-analysis by Marchand et al. showed that double layer closure was associated with significantly higher residual myometrial thickness at both short term and intermediate follow-up without significant difference in incidence of isthmoceles between closure techniques [20]. More recently, Dominoni et al. conducted a meta-analysis restricted to randomised trials and came to a similar conclusion that double-layer closure does improve scar thickness but not significantly reduce risk of uterine niche formation [21]. The results of the current study are consistent with these meta-analyses, thus increasing the external validity of the present study results.

The lack of significant differences of short-term postoperative complications between both groups in the current study further favors the safety of both closure techniques. Previous studies have demonstrated similar rates of infection, hemorrhage and postoperative morbidity with single- and double-layer closure, suggesting that closure technique choice does not adversely influence immediate results of surgery [17-19]. Therefore, the determination of which uterine closure technique is used may be justified in prioritizing long-term scar quality over short-term morbidity.

The present study has certain limitations which should be considered. Being a single-center prospective observational study, results may be of limited generalizability for other settings in which surgical practices may differ. Allocation to single-layer or double-layer uterine closure was driven by surgeon preference rather than randomization, which is likely to have introduced some selection bias despite showing similar baseline characteristics between groups. The follow-up period was restricted to early postoperative assessment and long-term results such as uterine rupture, abnormal placentation, and reproductive performance in subsequent pregnancies could not be assessed. Additionally, factors such as exact suture material, experience of the surgeon and labor-related variables before cesarean delivery were not analyzed independently, which may affect scar healing and isthmocele formation.

Conclusion

This prospective observational study shows that double-layer uterine closure during cesarean section is associated with significantly more residual myometrial thickness compared to single-layer closure; thus, it shows better healing of the uterine scar. However, the incidence of isthmocele did not differ significantly between the two closure techniques and this suggests that niche formation is multifactorial and not solely dependent on closure method. The results support the preferential use of double-layer closure in the case of optimizing scar thickness, and the need for further long-term, randomized studies to establish the clinical

consequences of residual myometrial thickness and isthmocele on future pregnancy outcomes.

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