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Laparoscopic repair of caesarean scar defect (CSD): does it improve the fertility outcome?

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ABSTRACT

Objective. The rising rate of caesarean sections has been linked to potential complications that could impact subsequent pregnancies, including caesarean scar defects (CSDs). Subfertility is a common issue among women diagnosed with CSD. Various theories have been proposed to explain the connection between CSDs and secondary infertility. Several interventions have shown promise in enhancing fertility outcomes following caesarean sections, potentially reducing the reliance on assisted reproductive technology (ART) interventions. This study aimed to investigate the impact of laparoscopic repair of CSDs on fertility results.

Materials and Methods. The retrospective cohort study was conducted at the infertility and endoscopy unit at Zagazig University Hospitals between June 2020 and February 2023. All patients enrolled in the study reported subfertility and underwent transvaginal ultrasound (TVUS) with saline infusion sonography (SHG) before the laparoscopic repair procedure. Following the imaging assessments, laparoscopic repair of CSDs was performed within a few days. Subsequently, all patients were followed up for at least 24 months.

Results. In this study, twenty cases were included. Post-menstrual spotting was observed in eighteen cases (90%), while continuous bleeding occurred in two cases (10%). Among the cases, fourteen patients (70%) achieved spontaneous pregnancy within 24 months. Out of these, two patients (14.28%) experienced a miscarriage, one patient (7.14%) had an ectopic pregnancy, one patient (7.14%) delivered prematurely at 32 weeks, and ten patients (71.43%) had a term delivery.

Conclusions. Laparoscopic repair of CSDs may be a promising intervention for women with secondary infertility, leading to enhanced chances of achieving pregnancy.

INTRODUCTION

Since the last decade, the rate of caesarean sections (CS) has continued to grow worldwide. In the Netherlands, the CS rate increased from 7.4 to 15.8% during the period from 1990-2008, and in the U.S.A., it increased from 21.2 to 32.8% from 1990 to 2011 [1]. Disappointingly, Egypt occupies the top of Africa in CS deliveries, as it represents approximately 51.8% of the year's deliveries [2].

Additionally, Emergency primary CS is associated with a higher incidence of CS scar defects, with less healing process [3].
The increased CS rate is associated with certain complications that may affect future pregnancies, such as placental abnormalities, uterine rupture, and CS scar defects (CSDs) [4]. Moreover, the relationship between subfertility and CS has been recorded, where subfertility may be a consequence of CS [5].
A recent meta-analysis including 750,407 women reported an increased time to conceive and risk of subfertility among women with a history of caesarean delivery when compared to women who delivered vaginally [6].
Recent studies have indicated that subfertility is a prominent symptom in women diagnosed with CSD [7]. The appearance of CSDs has attracted great attention in the last two decades [8].
The term CSDs is used to describe all abnormalities characterized by a defect within the myometrium (more than 2 mm) at the site of a previous CS, as mentioned in modified Delphi criteria using vaginal ultrasound, a pouch at the anterior uterine wall, or adhesions at the site of a CS incision by hysteroscopic examination due to defective healing [9].
Several hypotheses have tried to clarify the association between CSDs and secondary infertility [10], including detrimental environments for sperm penetration and implantation (such as the presence of intrauterine fluid, blood, and mucous, which can affect embryo implantation physically, and/or abnormal uterine contractility) [11].
Various interventions have been developed aiming to improve the gynaecological symptoms of CSDs, including hysteroscopic niche resection (HNR) [12], vaginal niche resection (VNR), laparoscopic niche resection (LSNR), and laparotomic niche resection (LTNR) [13]. The Treatment plan should be individualized depending on the presenting symptoms, like secondary infertility, the size of the defect, and future conception plans. The small defects can be repaired by hysteroscopy, and larger defects are managed by laparoscopy, vaginal approach, and combined hysteroscopy and laparoscopy [14].
However, the effect of these interventions on fertility outcomes remains unclear [15, 16].
Laparoscopic repair of caesarean scar defects (CSD) offers several unique advantages over traditional surgical methods: Symptom Improvement: Approximately 77% of patients experienced relief from symptoms such as abnormal uterine bleeding and pelvic pain following laparoscopic niche repair and Fertility Restoration. The procedure restored fertility in about 73% of patients, with a reduced time to conception post-surgery [17].
This may be achieved by Anatomical Restoration as Laparoscopic repair effectively restores the thickness of the myometrium, enhancing uterine integrity.
Comprehensive Pelvic Assessment thorough exploration of the pelvic cavity, enabling the identification and treatment of additional pathologies [18].
Moreover, laparoscopic repair without scar resection is considered a feasible, safe, and straightforward approach to treating CSD [19].
It was hypothesized that all interventions used to treat CSD can help in improving the fertility outcomes after CS and may decrease the burden of assisted reproductive technology (ART) needs [13].
Unfortunately, the evidence needed to justify the implementation of these surgical interventions on the reproductive outcome is still deficient [20].
Thus, this study was designed to provide an overview of the effect of laparoscopic repair of CSDs on fertility outcomes in women suffering from delayed conception.

MATERIALS AND METHODS

This was a retrospective cohort study conducted at the endoscopy and infertility unit of Zagazig University Hospitals between June 2020 and February 2023.

Patients

Data from all women enrolled in laparoscopic repair of CSDs reporting subfertility (failure to conceive for at least 12 months) with at least one of the following (post/intermenstrual spotting, pelvic pain, or dyspareunia) were included in this study. Women who had a previous hysterotomy (less than 28 weeks), a history of placenta previa, and/or morbidly adherent placenta in a previous CS delivery, patients with hydrosalpinx, poor ovarian reserve and those with male factors of infertility were excluded from the study.

Ultrasonic review

Transvaginal ultrasound (TVUS) with saline infusion sonography (SHG) (**Figure 1**) was scheduled before laparoscopy, and the CSD was measured using modified Delphi criteria. CSD is formally defined as a ≥ 2 mm indentation of the uterine myometrium at the site of the caesarean scar assessed by transvaginal ultrasound. Moreover, the shape of

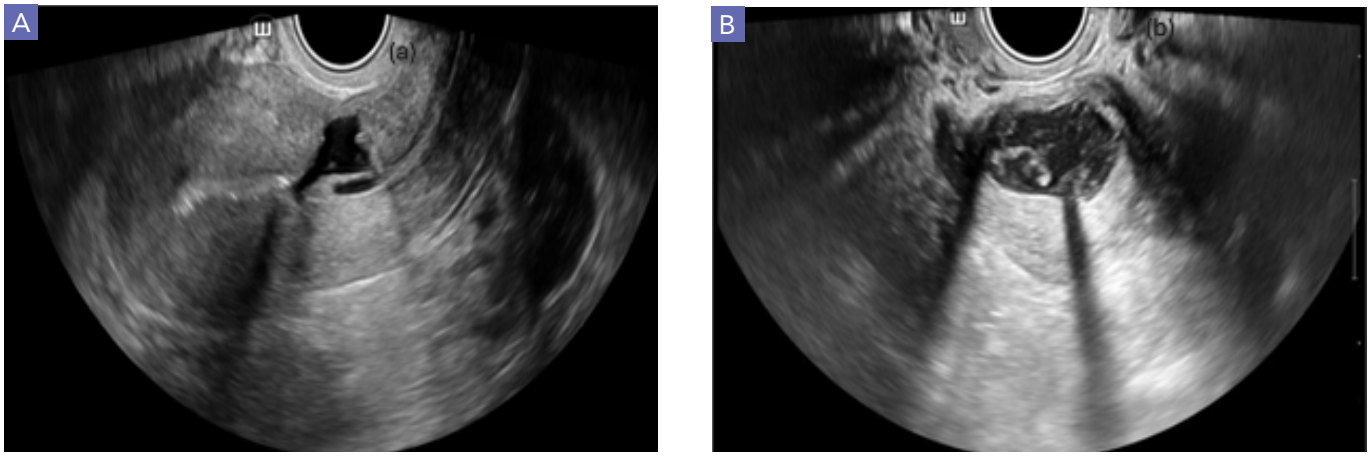

Figure 1. *Sonographic planes needed for caesarean scar niche measurement.*
(A) The sagittal plane; **(B)** The transverse plane.

the CSD was registered as triangular, semicircular, rectangular, circular, droplet, or inclusion cysts [8].

Laparoscopic repair

Laparoscopic repair of CSDs was conducted a few days later; primary laparoscopic entry was done through the Lee Huang point, followed by three secondary ports (two lateral ports and one suprapubic). Mobilization of the bladder was performed, then cervical dilatation was done vaginally up to Haegar No. 10. The CSD was identified using intentional sound perforation. Opening the assumed CS scar and trimming the edges were performed to obtain healthy bleeding edges. Finally, the defect was sealed using a 0/0 Vicryl suture in an interrupted single-layer manner. (**Figure 2**).

Pregnancy follow-up and outcomes

Sexual abstinence was advised for the 3 months following the surgery. Thereafter, normal sexual life was regained. All patients were followed up for a maximum of 24 months.

Statistical analysis

Statistical analysis was done by SPSS v26 (IBM Inc., Armonk, NY, USA). The Shapiro-Wilks test and histograms were used to evaluate the normality of the distribution of the data. Quantitative parametric data were presented as mean and standard deviation (SD). Quantitative non-parametric data were presented as the median and interquartile range (IQR). Qualitative variables were presented as frequency and percentage (%). A paired sample t-test was used to compare the population means of two correlated samples. A two-tailed P-value < 0.05 was considered statistically significant.

RESULTS

Twenty cases were enrolled in this study. The mean age was 27.6 ± 3.89 years, while the mean BMI was 25.5 ± 3.4 kg/m^2. Thirteen (65%) patients had one previous CS, 6 (30%) had two previous CS, and 1

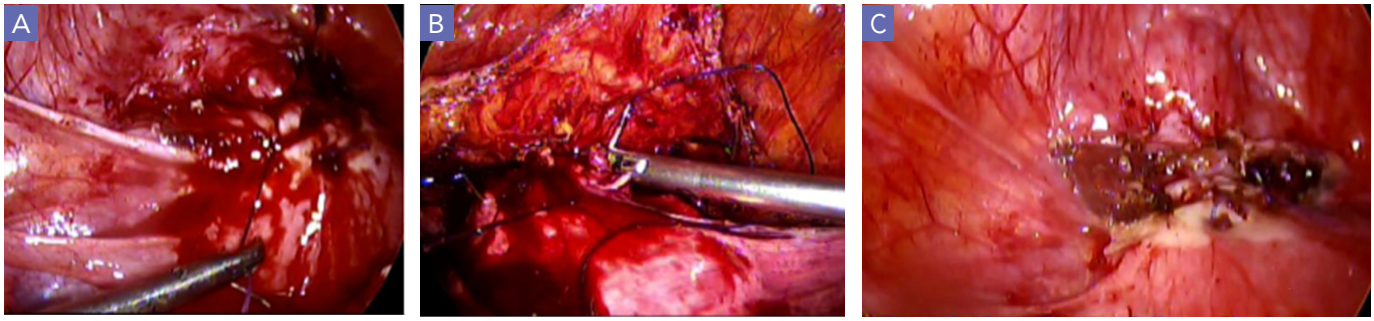

Figure 2. *(**A, B**) Suturing the edges using 2/0 polygalactin 910 sutures in an interrupted manner using the intracorporeal suture technique. We used a single-layer technique and didn't close the visceral peritoneum; (**C**) Final view of the repair.*
Number of sutures according to the size of the niche, ranging 3-5.

Table 1. *Demographic data regarding the fertility.*

	n = 20
Age (years)	27.6 ± 3.89
BMI (kg/m²)	25.5 ± 3.4
Number of CS	
One	13 (65%)
Two	6 (30%)
Three	1 (5%)
Time since last CS (months)	30.8 ± 10.4

Data are presented as mean ± SD or frequency (%); BMI: body mass index; CS: caesarean section.

Table 2. *Bleeding pattern and position of uterus.*

		n = 20
Bleeding pattern	Post menstrual spotting	18 (90%)
	Continuous	2 (10%)
Position of uterus	AVF	16 (80%)
	RVF	4 (20%)

Data are presented as frequency (%); AVF: anteverted anteflexed, RVF: retroverted retroflexed.

Table 3. *Intraoperative data.*

	n = 20
Operative time (min)	86.7 ± 20.6
Tube	
Normal	18 (90%)
Unilateral block	2 (10%)
Adhesion	
Massive	2 (10%)
Mild	8 (40%)
No	10 (50%)

Data are presented as frequency (%).

Table 4. *Menstrual characteristics and visual analogue scale before and after CSD repair.*

	Baseline	After	P-value
Menstrual characteristics			
Number of days with spotting	6 (4.75-7.25)	0 (0-0)	< 0.001*
Dysmenorrhoea (VAS)	2 (1-2)	1 (1-1)	0.006*
Dyspareunia (VAS)	3 (2-3)	1 (0-1)	< 0.001*
Chronic pelvic pain (VAS)	2 (1.75-2)	0 (0-1)	< 0.001*

Data are presented as median (IQR); VAS: visual analogue scale; *statistically significant as P-value < 0.05.

(5%) had three previous CS. The mean time since the last CS was 30.8 ± 10.4 months. No medical or surgical comorbidities could be reported (**Table 1**).

Eighteen (90%) patients had post-menstrual spotting while 2 (10%) had continuous bleeding. The position of the uterus was AVF in 16 (80%) patients, while RVF was found in 4 (20%) patients (**Table 2**). The tubal patency test revealed that 18 (90%) patients were found to have normal tubes, whereas 2 (10%) patients had unilateral blocks. Regarding pelvic adhesion, 8 (40%) patients had mild adhesion, while 2 (10%) of them had massive adhesion. The mean operative time was 86.7 ± 20.6 min (**Table 3**). The days of post-menstrual spotting, dysmenorrhea, dyspareunia, and chronic pelvic pain using (VAS) were significantly reduced after repair compared to baseline ($p < 0.05$) (**Table 4**).

Regarding fertility, 14 (70%) patients got pregnant spontaneously within 24 months 2 patients (14.28%) had a miscarriage, 1 (7.14%) patient had an ectopic pregnancy, 1 (7.14%) patient had preterm delivery at 32 weeks, and 10 (71.43%) patients had term delivery (**Tables 5, 6**).

DISCUSSION

A global increase in the rate of CSs has led to a greater need for awareness regarding the complications that can arise following a CS [21]. CSDs are recognized as long-term complications that can arise following CS [22]. The association between CS and secondary infertility is hypothesized to be mediated by the presence of CSDs [10].

There have been numerous interventions developed and widely used to treat the gynaecological symptoms associated with CSDs. These interventions have been suggested as potential alternatives or additions to ARTs. However, there is a lack of evidence supporting the use of these surgical interventions for reproductive purposes [23].

This study aimed to follow up on the reproductive outcomes after laparoscopic CSD repair.

In patients suffering from secondary infertility. Our results confirmed that 70% of patients regained their spontaneous ability to conceive within 24 months following laparoscopic repair. Out of them, 71.4% had term delivery. In addition, 7.1% of patients had preterm delivery at 32 weeks, 14.2% of patients had miscarriage and 7.1% of patients had an ectopic pregnancy.

In a recent study including 15 patients desiring fertility, 11 patients (73%) got pregnant after laparoscopic CSD repair with 9 patients (60%) having live birth while there were two miscarriages. Nine

Table 5. *Niche characteristics of the patients studied before and after CSD repair.*

	Baseline	After	P-value
Length (mm)	12.29 ± 4.03	5.08 ± 1.48	< 0.001*
Depth (mm)	6.79 ± 1.71	2.95 ± 0.83	< 0.001*
Width (mm)	15.55 ± 4.9	7.95 ± 1.99	< 0.001*
Shape			0.015*
Triangular	9 (45%)	15 (75%)	
Semicircular	1 (5%)	5 (25%)	
Rectangular	5 (25%)	0 (0%)	
Isthmocele	2 (10%)	0 (0%)	
W-shape	2 (10%)	0 (0%)	
Droplet	1 (5%)	0 (0%)	
RMT (mm)	2.38 ± 1.12	6.88 ± 1.46	< 0.001*
AMT (mm)	11.4 ± 2.9	11.78 ± 1.88	0.638

Data are presented as mean ± SD or frequency (%); RMT: residual myometrial thickness; AMT: adjacent myometrial thickness; *statistically significant as P-value < 0.05.

Table 6. *Pregnancy outcome after CSD repair.*

	n = 14
Pregnancy outcome	
Aborted	2 (14.28%)
Preterm 32w	1 (7.14%)
Term	10 (71.43%)
Tubal ectopic	1 (7.14%)

Data are presented as frequency (%).

conceived spontaneously and two conceived via ART. No serious complications were reported, including caesarean scar pregnancy or uterine rupture, following the laparoscopic repair [17].

Additionally, Tanimura *et al*. mentioned comparable results as they found that 10 out of 18 (55.6%) patients who underwent laparoscopic CSD repair could achieve pregnancy within 9 months as a medium period. Five patients delivered at term, 3 had a preterm delivery, and 2 had a miscarriage [24].

Lv *et al*. stated that 8 (61.5%) out of 13 patients who wished to conceive were able to achieve pregnancy; 2 had term delivery, 3 had preterm delivery and 3 had a miscarriage [25].

Moreover, Karampelas *et al*. reported that out of 31 patients who underwent laparoscopic repair of the CSD, 10 out of 12 people with secondary infertility conceived spontaneously following surgery. These findings support the high incidence of fertility restoration after laparoscopic CSD excision. Only one patient had placenta previa, and none of them had uterine dehiscence or rupture [26].

Additionally, in a case series done to evaluate the fertility outcomes after laparoscopic CSD repair including 18 women with infertility, 8 (44%) patients became pregnant and delivered healthy babies by caesarean section at 38-39 weeks of gestation [27].

In contrast to earlier findings, Vervoort *et al*. studied 101 cases complaining of CSD-related symptoms, and they reported only 2 cases getting pregnant with no other data in their study regarding infertility and pregnancy outcomes [12]. Wu *et al*., who used combined laparoscopy and hysteroscopy techniques, found that only one case out of 25 cases got pregnant after CSD repair despite a 1-year follow-up [28].

Unfortunately, all the trials were not RCT. However, Vissers *et al*. submitted their LAPRES trial protocol investigating the effects of laparoscopic repair of CSD on reproductive outcomes in an RCT manner under registry no. NL6350. This is an ongoing study, and the results have not yet been published [29].

It is of note that in most of the studies examining the impact of CS scar repair on fertility outcomes, hysteroscopic repair was the preferred method. This is due to being a minimally invasive procedure, shorter hospital stays, and the familiarity among surgeons, as opposed to laparoscopy which requires a certain level of expertise.

Gubbin *et al*., in 2011, reported comparable results as they mentioned that all patients regain their ability to conceive spontaneously within 24 months after hysteroscopic repair of CSD, but they did not mention their pregnancy outcome [30].

Another study done on a small number of patients confirmed similar results as they observed that spontaneous pregnancy was seen in 10 out of 12 (83.3%) participants presenting initially with secondary infertility [26].

Moreover, in an RCT, done to compare the effect of hysteroscopic repair and expectant management on fertility outcomes, they found that pregnancy was significantly higher in the repair group (75%) when compared to the expectant management group (32.1%, p = 0.001). Among the cases who got pregnant in the repair group, 19.05% had spontaneous miscarriages, and (80.95%) were delivered by caesarean section. Rupture of uterine scars did not occur in any of those treated patients [31]. Additionally, Cohen *et al.* in 2020 confirmed that hysteroscopic resection of CSD may improve fertility outcomes as 58.4% of their patients had conceived spontaneously as well as 13.2% after IVF [32].

When comparing the fertility outcomes following different methods of intervention (hysteroscopic, vaginal, and laparotomy repair), Vissers *et al*. reported that 11 out of 12 (92%) patients got pregnant. There was no significant difference between the three surgical procedures regarding the time to conception (14 months on average), type of conception (spontaneous or by ART), or mode of delivery [33]. Nezhat *et al*. observed that the laparoscopic repair of caesarean scar defects (CSD) resulted in significant symptom improvement in 77% of patients and restored fertility in 73% of patients [17].

Comparatively, other studies have reported varying outcomes:

- A novel laparoscopic technique without scar resection demonstrated a significant increase in residual myometrial thickness and alleviation of postmenstrual bleeding, suggesting its effectiveness in treating CSD [19].
- Single-incision laparoscopic repair is a feasible approach, offering excellent cosmetic results and potentially reducing surgical invasiveness [34].

These comparisons indicate that our outcomes are consistent with existing literature, supporting the efficacy of laparoscopic CSD repair in symptom relief and fertility restoration.

Our findings show a significant reduction in all caesarean scar (CS) niche dimensions (length, width, and depth) after the procedure, along with a remarkable increase in residual myometrial thickness (RMT) from 2.38 ± 1.12 mm to 6.88 ± 1.46 mm ($p < 0.001$). This improvement is more than just a number, it reflects better healing of the uterine wall, which is crucial for women planning future pregnancies. A thinner or weakened lower uterine segment, often seen after a caesarean section, due to reduced RMT and persistent CS defects are a major risk factor for abnormal placentation (*e.g*., placenta accreta spectrum disorders) [35]. This improvement in uterine integrity may play a crucial role in enhancing post-CS uterine healing, reducing the likelihood of abnormally invasive placentation in future pregnancies, potentially lowering the risk of severe obstetric complications, including life-threatening haemorrhage and hysterectomy.

By restoring uterine integrity, this procedure may reduce the chances of these life-threatening complications, providing not only symptom relief, but also a safer environment for future pregnancies. This highlights the importance of proactively addressing CS scar defects, not just for immediate symptom control, but for long-term reproductive health.

Limitations

While this study provides valuable insights into the impact of laparoscopic repair of CSDs on fertility outcomes, several limitations should be acknowledged:

- Small Sample Size: the study included only 20 patients, which limits the generalizability of the findings. Larger, multi-centre studies are needed to confirm these results.
- Retrospective Study Design: as a retrospective cohort study, the analysis is subject to potential selection bias and recall bias, which may affect the accuracy of reported outcomes.
- Lack of a Comparative Control Group: the absence of a control group (*e.g*., patients who did not undergo laparoscopic CSD repair) makes it difficult to determine whether the observed improvements in fertility outcomes were directly attributable to the intervention.
- Limited Follow-Up Data**:** although patients were followed for a maximum of 24 months, long-term data on subsequent deliveries, uterine health, and potential complications (*e.g*., uterine rupture, placenta previa) remain unavailable.

Future prospective studies with larger cohorts, longer follow-up durations, and comparative control groups are recommended to further evaluate the effectiveness and safety of laparoscopic CSD repair in improving fertility outcomes.

CONCLUSIONS

In conclusion, it is possible to hypothesize that the repair of CSD is followed by an increased pregnancy rate regardless of the method of repair and most patients can regain their spontaneous ability to conceive within 18-24 months following CSD repair.

In addition, patients who had failed ART trials before CSD repair also appeared to have a better outcome after repair. The pregnancy outcomes and mode of delivery after CSD repair look unaffected by the method of repair used in different studies. Uterine rupture appeared to be an uncommon complication following CSD repair regardless of the method of intervention.

Regarding CSD repair, particularly in patients with secondary infertility, laparoscopic repair may be a good option as it provides additional benefits for infertility management such as adhesiolysis and testing tubal patency.

COMPLIANCE WITH ETHICAL STANDARDS

Authors' contribution
M.I.K., D.O.E.: Conceptualization, resources. A.A.A., M.A.I.: Methodology, data curation, software. M.A.H., A.A.A.: Investigation. M.A.I., M.I.K.: Validation, formal analysis. D.O.E., M.A.H.: Supervision, project administration. M.A.H., S.A.S.: Writing – original draft, visualization, Writing –review & editing.

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Study registration
N/A.

Disclosure of interests
The authors declare that they have no conflict of interests.

Ethical approval
The study was approved by the Institutional Research Review Board of Zagazig Faculty of Medicine (IRB) under reference number (ZU- IRB# 384/26-May-2024) and by Zagazig Hospitals Administration. All experiments were performed by relevant guidelines and regulations and participants were not exposed to any harm or unintended effect. The study followed the ethical principles of the Declaration of Helsinki.

Informed consent
Informed consent to participate in the study was taken from all the participants after explaining the study objectives, and measures, and ensuring confidentiality.

Data sharing
Data are available under reasonable request to the corresponding author.

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