Section: Miscellaneous

Original Research Article

COMPARATIVE OUTCOMES OF MICROSURGICAL VERSUS LAPAROSCOPIC TUBAL REVERSAL: INFLUENCE OF TUBAL LENGTH, ANASTOMOTIC SITE, AND SURGEON EXPERIENCE

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ABSTRACT

Background: Tubal reversal remains an important fertility-restoring option for women following tubal sterilization. Surgical success is influenced by multiple factors, including postoperative tubal length, anastomotic site, and surgeon experience. With increasing use of minimally invasive techniques, evaluation of outcomes following laparoscopic tubal reversal is essential. **Objective:** To assess reproductive and perioperative outcomes following laparoscopic tubal reversal and to evaluate the impact of postoperative tubal length, anastomotic site, and surgeon experience on clinical pregnancy rates.

Materials and Methods: This single-center cohort study included 720 women who underwent laparoscopic tubal reversal between January 2022 and October 2025. All procedures were performed using a standardized laparoscopic single-layer, full-thickness Tubo tubal anastomosis with four equidistant sutures using 5-0 or 6-0 polypropylene round-body sutures. Tubal patency was confirmed intraoperatively by photoperturbation with methylene blue. The primary outcome was clinical intrauterine pregnancy within 12 months of surgery. Secondary outcomes included live birth, ectopic pregnancy, time-to-pregnancy, and perioperative parameters. Multivariable logistic regression and Cox proportional hazards models were used to identify factors associated with pregnancy outcomes.

Results: Clinical intrauterine pregnancy was achieved in 55.8% of patients within 12 months of surgery. Postoperative tubal length ≥7 cm was independently associated with higher pregnancy rates. Isthmic–isthmic anastomosis demonstrated the most favorable reproductive outcomes, while cornual anastomosis was associated with lower pregnancy rates and a higher incidence of ectopic pregnancy. Increased surgeon experience was significantly associated with improved pregnancy outcomes and reduced complication rates. Laparoscopic tubal reversal demonstrated acceptable perioperative outcomes with minimal morbidity.

Conclusion: Laparoscopic tubal reversal using standardized microsurgical principles yields favourable reproductive outcomes. Postoperative tubal length, anastomotic site, and surgeon experience are key determinants of success. When performed by experienced surgeons, laparoscopic tubal reversal represents an effective fertility-restoring option with the benefits of minimally invasive surgery.

Keywords: Tubal reversal; Laparoscopic tubal anastomosis; Tubo tubal anastomosis; Postoperative tubal length; Anastomotic site; Fertility surgery.

INTRODUCTION

Female sterilization is one of the most widely practiced methods of permanent contraception worldwide. Despite its intended permanence, a proportion of women later seek restoration of fertility due to changes in marital status, loss of a child, or renewed reproductive intentions.[2,6] For appropriately selected patients, tubal reversal remains an effective fertility-restoring option, offering the potential for spontaneous conception and multiple pregnancies.[1,7,10]

Tubal reversal can be performed using microsurgical techniques via mini-laparotomy or through minimally invasive laparoscopic approaches. Microsurgical tubal anastomosis has traditionally been regarded as the gold standard because of precise tissue handling, accurate mucosal alignment, and favorable reproductive outcomes.[4,5] However, advances in laparoscopic instrumentation and intracorporeal suturing techniques have led to increasing adoption of laparoscopic tubal reversal, which offers advantages such as reduced postoperative pain, shorter hospital stay, and faster recovery.[1,4,5,12]

Reproductive success following tubal reversal is multifactorial. Patient-related factors such as age and method of prior sterilization play an important role, but surgical factors are equally critical.[7,8] Postoperative tubal length has consistently been shown to be a strong predictor of pregnancy, with longer reconstructed tubes associated with higher conception rates.[1,4,7] In addition, the site of tubal anastomosis influences outcomes, as isthmic–isthmic anastomosis generally yields superior results compared with ampullary or cornual anastomoses.[1,4,5] Surgeon experience and adherence to microsurgical principles further affect both reproductive outcomes and complication rates.[4,5,10]

Although several studies have reported outcomes following tubal reversal, comparative real-world data examining the interaction between surgical approach, tubal length, anastomotic site, and surgeon experience remain limited, particularly in large contemporary cohorts.[7,9] Furthermore, variations in surgical technique and reporting standards make it difficult to draw definitive conclusions regarding optimal practice.[8,10]

The objective of this single-center cohort study was to evaluate reproductive and perioperative outcomes following tubal reversal and to assess the influence of postoperative tubal length, anastomotic site, and surgeon experience on clinical pregnancy outcomes in a cohort of 720 women operated between January 2022 and October 2025.

Aim and Objectives

Aim

To evaluate reproductive and perioperative outcomes following laparoscopic tubal reversal and to determine the influence of postoperative tubal length, anastomotic site, and surgeon experience on clinical pregnancy outcomes.

Objectives

1. To determine the clinical intrauterine pregnancy rate within 12 months following laparoscopic tubal reversal.
2. To assess the association between postoperative tubal length and reproductive outcomes.
3. To evaluate the impact of different anastomotic sites on pregnancy and ectopic pregnancy rates.
4. To analyze the effect of surgeon experience on reproductive outcomes and perioperative complications.
5. To assess secondary outcomes including live birth rate, time-to-pregnancy, ectopic pregnancy rate, and perioperative outcomes following laparoscopic tubal reversal.

MATERIALS AND METHODS

Study Design and Setting

This was a single-center cohort study conducted at a tertiary care fertility center. All women who underwent laparoscopic tubal reversal between **January 2022 and October 2025** were included. The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from all patients prior to surgery and follow-up.

Study Population

Women aged **18 to 40 years** with a history of prior tubal sterilization who desired fertility restoration were eligible for inclusion.

Inclusion Criteria

- Women aged 18–40 years
- Previous tubal sterilization by any method
- Desire for future fertility
- Undergoing laparoscopic tubal reversal at the study center
- Minimum postoperative follow-up of 12 months or documented pregnancy outcome

Exclusion Criteria

- Untreated severe male factor infertility
- Active pelvic infection or untreated hydrosalpinx
- Advanced endometriosis (stage III–IV)
- Uterine anomalies incompatible with pregnancy
- Inadequate postoperative follow-up

Preoperative Evaluation

All patients underwent a standardized preoperative assessment including detailed medical and reproductive history, documentation of the sterilization method, pelvic ultrasonography, and semen analysis of the male partner. Ovarian reserve testing was performed when clinically indicated. Patients were counseled regarding expected success rates, potential risks including ectopic pregnancy, and alternative fertility options.

Surgical Technique

All tubal reversal procedures were performed using a laparoscopic approach under general anesthesia.

Pneumoperitoneum was established, and a 10-mm umbilical port along with two or three accessory 5-mm ports were inserted under direct vision. After systematic inspection of the pelvis, adhesiolysis was carried out when necessary to adequately mobilize the fallopian tubes.

The proximal and distal tubal segments were identified, and fibrotic or scarred ends were excised until healthy tubal tissue with clearly visible mucosa was obtained. Care was taken to preserve the mesosalpinx and maintain adequate tubal vascularity. Tubo-tubal anastomosis was performed using a single-layer closure technique. Four equidistant sutures were placed circumferentially at the 12, 3, 6, and 9 o'clock positions, incorporating the full thickness of the tubal wall including mucosa and serosa, to ensure accurate mucosal apposition and luminal continuity. Suturing was carried out using 5-0 or 6-0 polypropylene (Prolene®) sutures mounted on a round-body needle, selected according to tubal diameter and tissue thickness. All sutures were tied intracorporeally under laparoscopic magnification.

Following completion of the anastomosis, the integrity of the repair and tubal patency were assessed by chromopertubation using dilute methylene blue dye injected transcervically. Free spillage of dye from the fimbrial end confirmed tubal patency. The anastomotic site and final postoperative tubal length were measured and documented intraoperatively.

Study Variables

Postoperative tubal length was categorized as **<4 cm**, **4–6.9 cm**, or **≥7 cm**. Anastomotic sites were classified as isthmic–isthmic, isthmic–ampullary, ampullary–ampullary, or cornual/interstitial. Surgeon experience was categorized based on cumulative tubal reversal case volume.

Outcome Measures

Primary Outcome

The primary outcome measure was clinical intrauterine pregnancy, defined as the presence of an intrauterine gestational sac with or without fetal cardiac activity confirmed by transvaginal ultrasonography, occurring within 12 months following laparoscopic tubal reversal.

Secondary Outcomes

Secondary outcome measures included:

- Live birth rate, defined as delivery of a viable infant beyond 24 weeks of gestation
- Time-to-pregnancy, calculated as the interval (in months) from surgery to confirmed clinical pregnancy
- Ectopic pregnancy rate, defined as implantation of a pregnancy outside the uterine cavity
- Early pregnancy loss, including biochemical pregnancy and first-trimester miscarriage
- Tubal patency, assessed intraoperatively by chromopertubation with methylene blue and, when indicated, by postoperative hysterosalpingography or sonographic tubal patency testing
- Perioperative outcomes, including operative time, estimated blood loss, length of hospital stay, and conversion to laparotomy
- Postoperative complications, classified according to the Clavien–Dindo grading system
- Re-intervention or readmission, occurring within 30 days of surgery

Follow-Up

Patients were advised to resume attempts at conception 4–6 weeks after surgery. Follow-up was conducted through outpatient visits and telephone interviews. Pregnancy outcomes were confirmed through clinical records. Patients with suspected ectopic pregnancy underwent early serum β-hCG testing and ultrasonography.

Statistical Analysis

Statistical analysis was performed using SPSS software (version 26.0; IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality using the Shapiro–Wilk test. Normally distributed data were expressed as mean ± standard deviation (SD) and compared using the independent samples t-test, while non-normally distributed data were presented as median with interquartile range (IQR) and compared using the Mann–Whitney U test. Categorical variables were expressed as frequencies and percentages and compared using the chi-square test or Fisher's exact test, as appropriate.

The primary outcome, clinical intrauterine pregnancy within 12 months, was analyzed using multivariable logistic regression to identify independent predictors of pregnancy. Variables entered into the regression model included patient age, body mass index (BMI), method of prior sterilization, interval since sterilization, postoperative tubal length category, anastomotic site, surgeon experience, and operative characteristics. Results were reported as adjusted odds ratios (aORs) with 95% confidence intervals (CIs).

Time-to-pregnancy was analyzed using Kaplan–Meier survival analysis, and differences between groups were assessed using the log-rank test. A Cox proportional hazards regression model was used to evaluate factors associated with time-to-pregnancy, with results expressed as hazard ratios (HRs) and 95% confidence intervals. Patients who did not achieve pregnancy during follow-up or who initiated assisted reproductive treatment were censored at the time of last follow-up.

All statistical tests were two-sided, and a **p-value <0.05** was considered statistically significant.

RESULTS

Patient Characteristics

A total of 720 women underwent laparoscopic tubal reversal during the study period. The median age of the study population was 33 years (IQR 29–36), and 214 patients (29.7%) were aged ≥35 years. The mean body mass index was 26.1 ± 3.2 kg/m². The most common method of prior sterilization was

mechanical occlusion using clips or rings (55.3%), followed by bipolar cautery (34.2%) and fimbriectomy (10.5%). The median interval between sterilization and reversal surgery was 6.1 years (IQR 4.0–8.5).

Bilateral tubal reconstruction was achieved in 652 patients (90.6%), while 68 patients (9.4%) underwent unilateral reconstruction.

Intraoperative Findings

Postoperative tubal length distribution was as follows: <4 cm in 96 patients (13.3%), 4–6.9 cm in 284 patients (39.4%), and ≥7 cm in 340 patients (47.2%). The most frequent anastomotic site was isthmic–isthmic (44.2%), followed by isthmic–ampullary (34.2%), ampullary–ampullary (15.6%), and cornual/interstitial (6.1%).

Intraoperative chromopertubation demonstrated tubal patency in 93.8% of reconstructed tubes.

Primary Outcome: Clinical Pregnancy

Overall, **402 patients (55.8%)** achieved a **clinical intrauterine pregnancy within 12 months** following laparoscopic tubal reversal. Kaplan–Meier survival analysis demonstrated progressive cumulative pregnancy rates over the follow-up period.

Predictors of Clinical Pregnancy

Postoperative tubal length was a strong determinant of pregnancy outcome. Pregnancy rates increased significantly with increasing tubal length (**$p < 0.001$**). Patients with postoperative tubal length ≥7 cm demonstrated the highest pregnancy rates.

Anastomotic site significantly influenced reproductive outcomes. Isthmic–isthmic anastomosis was associated with the highest pregnancy rate, whereas cornual/interstitial anastomosis demonstrated significantly lower pregnancy rates.

Multivariable logistic regression analysis identified postoperative tubal length ≥7 cm, isthmic–isthmic anastomosis, and higher surgeon experience as independent predictors of clinical pregnancy. Age ≥35 years and cornual anastomosis were associated with reduced pregnancy rates.

Secondary Outcomes

The overall live birth rate was 49.2%. Ectopic pregnancy occurred in 34 patients (4.7%), with a significantly higher incidence observed in patients with cornual/interstitial anastomosis and those with postoperative tubal length <4 cm.

The median time-to-pregnancy was 6.4 months (IQR 4–10). Kaplan–Meier analysis demonstrated significantly shorter time-to-pregnancy in patients with postoperative tubal length ≥7 cm (log-rank $p < 0.001$).

Perioperative outcomes demonstrated low morbidity. Mean operative time was 118 ± 22 minutes, mean estimated blood loss was 65 ± 25 mL, and mean length of hospital stay was 1.2 ± 0.4 days. The overall complication rate was 4.4%, with no procedure-related mortality.

Table 1: Baseline Characteristics of the Study Population (n = 720)

Variable	Value
Age, median (IQR), years	33 (29–36)
Age ≥35 years, n (%)	214 (29.7)
BMI, mean ± SD (kg/m²)	26.1 ± 3.2
Interval since sterilization, median (IQR), years	6.1 (4.0–8.5)
Prior sterilization – clips/rings, n (%)	398 (55.3)
Prior sterilization – cautery, n (%)	246 (34.2)
Prior sterilization – fimbriectomy, n (%)	76 (10.5)
Bilateral tubal reconstruction, n (%)	652 (90.6)

Table 2: Intraoperative Findings

Postoperative tubal length

Variable	n (%)
<4 cm	96 (13.3)
4–6.9 cm	284 (39.4)
≥7 cm	340 (47.2)

Anastomotic site

Variable	n (%)
Isthmic–isthmic	318 (44.2)
Isthmic–ampullary	246 (34.2)
Ampullary–ampullary	112 (15.6)
Cornual/interstitial	44 (6.1)

Table 3: Pregnancy Outcomes by Postoperative Tubal Length

Tubal Length	Clinical Pregnancy (%)
<4 cm	28.1
4–6.9 cm	52.5
≥7 cm	68.9
p-value	<0.001

Table 4: Multivariable Logistic Regression Analysis for Clinical Pregnancy

Variable	Adjusted OR	95% CI	p-value
Tubal length ≥7 cm	3.21	2.28–4.52	<0.001
Isthmic–isthmic anastomosis	2.14	1.56–2.92	<0.001
Cornual anastomosis	0.46	0.29–0.74	0.002
Age ≥35 years	0.72	0.55–0.94	0.01
High surgeon experience	1.89	1.28–2.79	0.001

Table 5: Secondary Outcomes

Outcome	Value
Live birth rate (%)	49.2
Ectopic pregnancy rate (%)	4.7
Median time-to-pregnancy, months (IQR)	6.4 (4–10)
Operative time, mean ± SD (min)	118 ± 22
Estimated blood loss, mean ± SD (mL)	65 ± 25
Hospital stay, mean ± SD (days)	1.2 ± 0.4
Overall complications (%)	4.4

Figure 1: Clinical Pregnancy Rates According to Postoperative Tubal Length

Figure note: Postoperative tubal length was categorized as <4 cm, 4–6.9 cm, and ≥7 cm. Clinical pregnancy was defined as ultrasonographic confirmation of an intrauterine gestational sac within 12 months following laparoscopic tubal reversal. Pregnancy rates increased significantly with increasing postoperative tubal length ($p < 0.001$).

DISCUSSION

This single-center cohort study evaluated reproductive outcomes following laparoscopic tubal reversal and examined the influence of postoperative tubal length, anastomotic site, and surgeon experience on clinical pregnancy outcomes. In this large cohort of 720 women, the overall clinical pregnancy rate within 12 months was 55.8%, demonstrating that laparoscopic tubal reversal is an effective fertility-restoring procedure when performed using standardized microsurgical principles.[1,4,5,7]

The most important determinant of reproductive success in the present study was postoperative tubal length. Women with reconstructed tubal length ≥7 cm achieved significantly higher pregnancy rates and shorter time-to-pregnancy compared with those with shorter tubal lengths. This finding is consistent with previous studies reporting that longer tubal length is associated with improved gamete transport, preserved mucosal function, and favorable tubal peristalsis.[1,4,7] Conversely, markedly reduced tubal length may impair ovum pickup and increase the risk of tubal obstruction or ectopic implantation.[3,7]

These results emphasize the importance of careful intraoperative assessment of tubal viability and length, particularly in patients with prior cautery-based sterilization or fimbriectomy.[5,8]

Anastomotic site also had a significant impact on reproductive outcomes. Isthmic–isthmic anastomosis demonstrated the highest pregnancy rates in this cohort, likely due to better luminal diameter matching, reduced anastomotic tension, and more favorable tubal physiology.[1,4,5] In contrast, cornual or interstitial anastomosis was associated with lower pregnancy rates and a higher incidence of ectopic pregnancy.[3,4] The increased ectopic risk observed with cornual anastomosis may be related to altered tubal motility and delayed embryo transport near the uterotubal junction.[3] These findings highlight the importance of thorough preoperative counseling in patients with proximal tubal occlusion regarding realistic success rates and ectopic pregnancy risk.[7,10]

Surgeon experience emerged as an independent predictor of clinical pregnancy. Higher surgical volume was associated with improved reproductive outcomes and lower complication rates. Laparoscopic tubal reversal is a technically demanding procedure that requires advanced intracorporeal suturing skills and strict adherence to microsurgical principles.[4,5] The association between surgeon experience and outcomes underscores the importance of structured training, skill acquisition, and case-volume concentration when offering this procedure.[5,10]

Perioperative outcomes in this study demonstrated low morbidity, short hospital stay, and minimal blood loss, supporting the safety of the laparoscopic approach.[5,12] Although operative time was longer compared with traditional microsurgical techniques, the benefits of minimally invasive surgery—including faster recovery and reduced postoperative discomfort—may offset this disadvantage.[5,12]

Importantly, pregnancy outcomes achieved in this study are comparable to those reported for microsurgical and laparoscopic tubal reversal in

previous series, particularly when procedures are performed by experienced surgeons.[1,4,7,11]

The strengths of this study include the large sample size, standardized surgical technique, comprehensive assessment of key surgical predictors, and consistent follow-up. However, several limitations should be acknowledged. The single-center design may limit generalizability, and the observational nature of the study introduces potential selection bias. Additionally, male factor fertility and ovulatory parameters, although assessed preoperatively, may not have been fully controlled. Postoperative tubal patency testing was not uniformly performed in all patients, which may have influenced interpretation of reproductive outcomes.[7,9]

Despite these limitations, the findings of this study provide robust evidence supporting the effectiveness of laparoscopic tubal reversal and clarify the relative importance of surgical factors influencing reproductive success in contemporary practice.[7,8,10]

CONCLUSION

Laparoscopic tubal reversal is an effective and reliable fertility-restoring option for women with prior tubal sterilization when performed using meticulous microsurgical principles. In this large single-center cohort, satisfactory reproductive outcomes were achieved with low perioperative morbidity, supporting the safety and feasibility of the laparoscopic approach.

Postoperative tubal length and anastomotic site emerged as the most important determinants of reproductive success. Longer reconstructed tubal segments and isthmic–isthmic anastomosis were associated with higher clinical pregnancy rates, whereas cornual anastomosis was linked to reduced pregnancy rates and an increased risk of ectopic pregnancy. These findings underscore the importance of careful patient selection, thorough preoperative counseling, and intraoperative decision-making.

Surgeon experience also played a critical role in determining outcomes, highlighting the technical demands of laparoscopic tubal reversal and the need for adequate training and case volume. When performed by experienced surgeons with appropriate patient selection, laparoscopic tubal reversal provides favorable reproductive outcomes while offering the advantages of minimally invasive surgery.

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