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The Impact of Postoperative Intra-Abdominal Adhesions on Female Infertility

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Objective: To evaluate the impact of postoperative intra-abdominal adhesions resulting from prior abdominal and gynecologic surgeries on female infertility. **Methods:** A retrospective case-control study was conducted among 764 fertile and 506 infertile women in Ulaanbaatar, Mongolia. Data were collected on prior abdominal and gynecological surgeries, including surgical approach (open vs. laparoscopic) and frequency. Baseline characteristics were compared with Chi-square test and Fisher's exact test. Logistic regression was used to calculate adjusted odds ratios (ORs), 95% confidence intervals (CIs), and P-values. **Results:** Infertile women were older (32.1 ± 4.5 vs 30.8 ± 3.9 years, P= 0.02), had higher BMI (25.1 ± 3.3 vs 23.5 ± 2.8 kg m^2, P= 0.03) and were more likely to report a previous sexually transmitted disease (19.5 % vs 8 %, P< 0.001). Prior surgeries such as salpingectomy (OR = 16.5), ovarian cystectomy (OR = 7.3), and ectopic pregnancy surgery (OR = 4.67) were significantly associated with infertility. Open surgical approach was associated with a higher risk (OR = 2.8, P= 0.015), while laparoscopy was protective (OR = 0.45, P= 0.021). The risk increased further with multiple open surgeries (OR = 2.96, P= 0.029). In multivariable analysis, the strongest predictors of infertility were salpingectomy (OR = 13.2, 95 % CI 2.2–78.5, P= 0.005), ≥ 2 open abdominal surgeries (OR = 2.96, 1.11–7.91, P= 0.029). The model showed acceptable fit (Hosmer–Lemeshow P= 0.48; AUC = 0.78; Nagelkerke R^2 = 0.23). **Conclusion:** Postoperative intra-abdominal adhesions, particularly following open gynecologic and abdominal surgeries, significantly contribute to female infertility. Minimally invasive surgical techniques and adhesion prevention strategies may reduce this risk.

Keywords: Infertility; Peritoneal Adhesions; Gynecologic Surgical Procedures; Laparotomy; Risk Factors

Introduction

Infertility is a global public health concern, affecting approximately 8–12% of couples of reproductive ages.[1] Among women, one of the leading causes of infertility is tubal factor infertility, often resulting from intra-abdominal adhesions.[2,3] Adhesions may develop as a result of both surgical interventions and non-surgical inflammatory conditions. Non-operative causes include various inflammatory diseases such as pelvic inflammatory disease, peritonitis, cholecystitis, and diverticulitis. Additionally, endometriosis, infections, and complications from intrauterine devices can also trigger inflammation, contributing to the formation of pelvic adhesions. Although determining the exact contribution of each cause remains challenging, it is widely accepted that most adhesions are formed following surgical procedures.[4,5]

These adhesions are bands of fibrous tissue that form between abdominal organs and tissues, frequently resulting from postoperative healing following gynecologic or general abdominal surgery.[6]

Adhesions develop in approximately 67–93% of cases following general abdominal surgery, with rates reaching as high as 97% after open pelvic surgeries in gynecology.[4] Adhesions linked to infertility can develop on the uterine walls, supporting ligaments, or within the cervix, obstructing sperm movement toward the uterus and fallopian tubes. These adhesions may also contribute to increased uterine spasms, implantation difficulties, and miscarriage, thereby impairing conception.[7,8] When adhesions form near the end of the fallopian tube, they can interfere with the fimbriae's ability to capture the ovum, raising the chance that the egg may be lost in the abdominal cavity. Suppose adhesions develop along the inner or outer surface of the fallopian tube. In that case, they may cause partial or complete blockage, thereby reduce the likelihood of fertilization and increase the risk of ectopic pregnancy. Additionally, adhesions can obstruct access to the ovary during oocyte retrieval.[9]

Conversely, laparoscopy may reduce postoperative adhesion formation relative to laparotomy. However, laparoscopy does not appear to eliminate adhesions completely.[10]

Studies highlight that access to laparoscopic surgery remains limited in low—and middle-income countries (LMICs), including Mongolia. A systematic review by Wilkinson et al. (2021) identified several barriers to implementing laparoscopic surgery in LMICs, such as insufficient funding, lack of equipment and maintenance, limited access to experienced trainers, and inadequate training curricula.[11]

As a result, numerous women of reproductive age still have open abdominal or pelvic surgeries, which might elevate their risk of becoming infertile. Nevertheless, only a limited number of studies have thoroughly measured the effect of postoperative adhesions on infertility in these circumstances using solid epidemiological techniques. Consequently, many women of childbearing age still undergo open surgeries in the abdomen or pelvis, which could heighten their likelihood of infertility. However, there are only a small number of studies that have thoroughly evaluated the impact of postoperative adhesions on infertility in these situations using reliable epidemiological methods. As a result, numerous reproductive-age women continue to have open abdominal or pelvic surgeries, possibly increasing their risk of infertility. Yet, very few studies have systematically assessed the effect of postoperative adhesions on infertility in these contexts using strong epidemiologic techniques.

Therefore, the present study aimed to assess the association between prior abdominal and gynecological surgeries and the risk of female infertility due to postoperative intra-abdominal adhesions in a Mongolian population. The findings of this study inform surgical best practices and fertility-preserving strategies in similar healthcare contexts.

Materials and Methods

Study Design and Subjects

This retrospective case-control study was conducted between January 2022 and December 2024 at the Infertility Centre of Unimed International Hospital in Ulaanbaatar, Mongolia.

Case group (infertile women): Women in the case group were recruited from couples who sought infertility evaluation and treatment at the Unimed International Hospital. Inclusion criteria were as follows: (1) female partner aged between 22 and 44 years; (2) infertility diagnosed according to the World Health Organization (WHO) definition (failure to conceive after 12 months of regular unprotected intercourse); and (3) both partners voluntarily agreed to participate in the study. Exclusion criteria included: (1) confirmed male factor infertility and (2) refusal to participate.

Control group (fertile women): The control group consisted of women who were evaluated at the same hospital for routine preventive care and women who had delivered or were preparing to give birth at two major maternity hospitals in Ulaanbaatar Khuree Maternity Hospital and Urgoo Maternity Hospital. Controls were selected based on the following criteria: (1) no clinical history of infertility, (2) relatively healthy status, and (3) history of one or more live births.

Sample Size and Sampling Method

To investigate the structure and causes of infertility, we initially collected clinical data from 1,095 patients who had presented with infertility at Unimed International Hospital between 2022 and 2024. These patients underwent diagnostic evaluation and/or laparoscopy-based surgical procedures as part of their infertility work-up.

The minimum required sample size was calculated based on the infertility prevalence estimate and national demographic data. According to the 2020 Household and Family Survey conducted by the National Statistics Office of Mongolia, there were approximately 761251 family units in the country, including both registered and unregistered unions, among women aged 20–44. Using the global infertility prevalence estimate of 10–15%, we projected approximately 114000 couples to be infertile in Mongolia. Based on this population, with a 95% confidence level and a 5% margin of error, the minimum representative sample size required was estimated to be 383 infertile couples. As our dataset included 1095 couples with infertility, the study sample exceeded the calculated minimum and was deemed statistically adequate for robust analysis.

To examine female-specific risk factors of infertility, we selected a final sample of 506 women with confirmed female-factor infertility for the case group and 764 fertile women for the control group. To reduce confounding, the control group was matched to the case group by age strata. Age-matching was performed in five-year intervals across the reproductive age range.

Data Collection

Data on infertile couples were collected through structured chart reviews and pre-designed questionnaires. For each participant in the case group, detailed clinical information was extracted from hospital records, including laboratory test results, imaging reports, inpatient treatment histories, surgical records, operative notes, and histopathological findings where applicable.

Two specialized data collection tools were developed and utilized for this study. Survey Form No.1, comprising nine sections and 81 items, was designed to assess the primary causes of infertility. Survey Form No.2, consisting of 6 sections and 68 items, was used to evaluate specific risk factors related to female infertility.

The forms included questions about previous abdominal or pelvic surgeries. For surgical history, detailed information was collected regarding the type of procedure performed, surgical approach (open vs. laparoscopic), and postoperative complications, if any. All collected data were documented in standardized case report forms and subsequently entered into a digital database for analysis.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were calculated for both continuous and categorical variables. The mean, median, minimum, and maximum values were reported for continuous variables. Frequencies and percentages were presented for categorical variables, along with the standard deviation where applicable. Binary logistic regression analysis was employed to identify factors associated with female infertility. Variables that showed statistical significance in univariate analysis were included in the multivariate logistic regression model to calculate adjusted odds ratios (ORs) with 95% confidence intervals (CIs). The relationship between continuous variables was assessed using Pearson's correlation coefficient. A P-value of less than 0.05 was considered statistically significant.

Ethical Statement

The study protocol (№2022/3-07) was approved by the Research Ethics Committee at Mongolian National University of Medical Sciences on Jun 22, 2022. All participants were informed about the study and provided written informed consent.

Results

Infertility Types and Causes

A total of 1,095 couples with infertility were included in the study. Among them, male factor infertility was identified in 392 cases (35.8%), female factor infertility in 506 cases (46.2%), combined male and female factors in 91 cases (8.3%), and unexplained infertility in 106 cases (9.7%).

Among the 506 women with confirmed female-factor infertility, 158 (31.2%) were diagnosed with primary infertility, and 348 (68.8%) with secondary infertility. The duration of infertility ranged from 1 to 22 years, with a mean duration of 5.95 ± 3.92 years.

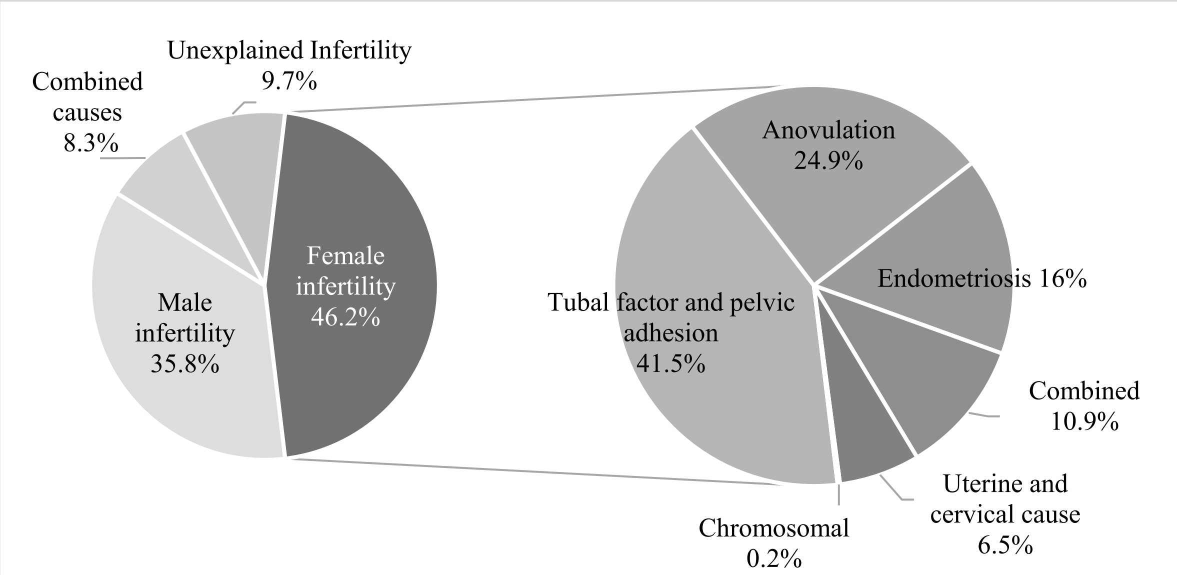

Figure 1. Infertility causes

An analysis of the underlying causes of female infertility revealed the following distribution (Figure 1). Among 506 infertile women, 47.6% had tubal or pelvic adhesion-related infertility. Of these, 53.3% had a history of either STI or open surgery. Infertile women were significantly older (mean age 32.1 ± 4.5 vs 30.8 ± 3.9 years, P= 0.02) and had a higher mean BMI (25.1 ± 3.3 vs 23.5 ± 2.8 kg/m^2, P= 0.03) compared to fertile women (Table 1).

Table 1. General characteristics of the study population

Variables	Control group (n=764)	Case group (n=506)	P-value
Women's age (year)	35.0±5.1	34.5±5.1	0.075
BMI (kg/m2)	24.2±3.8	24.9±4.3	0.002**
Education			
High school or below	119 (15.6%)	93 (18.4%)	0.19
College or above	645 (84.4%)	413 (81.6%)	
Smoking (yes)	74 (9.7%)	62 (12.2%)	0.088
History of STD's	61 (8%)	99 (19.5%)	<0.001**

The prevalence of previous sexually transmitted diseases was more than twice as high in the infertile group (19.5% vs 8.0%, P< 0.001).

Infertility and General Abdominal Surgery

The impact of previous general abdominal surgeries on female infertility was assessed in this study. The results revealed that a history of appendectomy significantly increased the risk of infertility by approximately 2-fold (OR = 2.23, 95% CI: 1.53–3.25, P< 0.001; χ^2 = 26.1, P< 0.001). No statistically significant difference was observed for intestinal surgery (0.99% vs. 0.3%), although a trend toward increased risk was noted (OR=3.80, 95% CI: 0.46–19.9, P= 0.16; Fisher's exact test, P= 0.09). Similarly, hernia repair was rare in both groups (0.4% vs. 0.13%), with no meaningful association detected (OR=3.03, 95% CI: 0.40–23.1, Fisher's P= 0.35). (Table 2).

Table 2. General Abdominal Surgeries and Their Association with Infertility

Surgical variables	Control group (n=764)	Case group (n=506)	OR	95% CI	P-value	P (χ^2 test)	Fisher's exact test
Appendectomy	82 (10.7%)	107 (21.1%)	2.23	1.53 – 3.25	<0.001**	χ^2=26.1 <0.001**	-
Intestinal surgery	2 (0.3%)	5 (0.99%)	3.80	0.46 – 19.9	0.160	-	0.09
Abdominal TBC	0 (0.0%)	4 (0.8%)	-	-	-	-	-
Hernia repair	1 (0.13%)	2 (0.4%)	3.03	0.4 – 23.1	0.240	-	0.35
Total	764 (100%)	506 (100%)					

Abdominal tuberculosis surgery was reported only in the case group (0.8% vs. 0.0%), precluding statistical comparison; odds ratios and p-values were therefore not estimable.

When a surgical approach was considered, women who underwent open surgery were found to have a 6-fold higher risk of infertility compared to those who underwent laparoscopic procedures (OR = 5.90, 95% CI: 1.22–28.5, P= 0.019).

Table 3. General Abdominal Surgical Approach

Surgical approach	Control group	Case group	OR	95% CI	P-value
Open surgery	76 (90.5%)	112 (98.2%)	5.90	1.22 – 28.5	0.019*
Laparoscopic surgery	8 (9.5%)	2 (1.8%)			
Total	84 (100%)	114 (100%)			

OR = Odds Ratio; CI = Confidence Interval; p < 0.05 considered statistically significant.
**Statistically significant*

This association was strongly supported by the Fisher's exact test (P< 0.001), indicating a highly significant difference in surgical modality distribution between the case and control groups (Table 3). This finding highlights the potential impact of surgical invasiveness on postoperative pelvic adhesions and tubal damage.

Infertility and Gynecologic Surgeries

We examined the association between prior gynecologic surgeries and female infertility. Approximately one in three women in the case group had a documented history of gynecologic surgery. The results showed that specific surgical procedures significantly increased the risk of infertility. Surgical procedures that demonstrated a statistically significant association with increased infertility risk included: Salpingectomy (tubal removal): 16.5-fold increase in infertility risk (OR = 16.5, 95% CI: 3.77–71.3, P< 0.001), ovarian cystectomy: 7.3-fold increase (OR = 7.30, 95% CI: 3.12–17.1, P< 0.001; χ^2 = 29.9, P< 0.001), surgery for ectopic pregnancy: 4.67-fold increase (OR = 4.67, 95% CI: 2.74–7.95, P< 0.001; χ^2 = 40.9, P< 0.001), myomectomy (leiomyoma removal): 3.71-fold increase (OR = 3.71, 95% CI: 1.82–7.57, P< 0.001; χ^2 = 14.7, P< 0.001) (Table 4).

Apoplexy surgery was infrequent in both groups (0.8% vs. 0.1%) and did not reach statistical significance (OR=6.08, 95% CI: 0.7–54.5, P= 0.09).

Hysterectomy and oophorectomy were reported only among cases (0.8% and 1.8%, respectively), which precluded meaningful statistical analysis.

Table 4. Gynecologic Surgeries and Their Association with Infertility

Surgical variables	Control group (n=764)	Case group (n=506)	OR	95% CI	P-value	P (χ^2 test)	Fisher's exact test
Myomectomy	11 (1.4%)	26 (5.1%)	3.71	1.8– 7.6	<0.001**	χ^2=14.7 <0.001**	-
Ovarian cystectomy	7 (0.9%)	32 (7.9%)	7.30	3.1– 17.1	0.001**	χ^2=29.9 <0.001**	-
Apoplexy surgery	1 (0.1%)	4 (0.8%)	6.08	0.7–54.5	0.085	-	0.09
Ectopic pregnancy	21 (2.7%)	59 (11.7%)	4.67	2.7–7.9	<0.001**	χ^2=40.9 <0.001**	-
Salpingectomy (hydrosalpinx, pyosalpinx etc)	2 (0.3%)	21 (4.2%)	16.5	3.8–71.3	<0.001**	-	<0.001**
Hysterectomy	0 (0.0%)	4 (0.8%)	-	-	-	-	-
Oophorectomy	0 (0.0%)	9 (1.8%)	-	-	-	-	-

When surgical approaches were compared, open surgery was associated with a nearly 3-fold increased risk of infertility compared to laparoscopic procedures (OR = 2.8, P= 0.015, χ^2 = 26.1, P < 0.001), further emphasizing the potential impact of surgical invasiveness on reproductive outcomes (Table 5).

Table 5. Gynecological Surgical Approach

Surgical approach	Control group	Case group	OR	95% CI	P-value	P (χ^2 test)
Open surgery	25 (90.5%)	133 (86.6%)	2.80	1.17 – 6.73	0.015*	χ^2=160.1 <0.001**
Laparoscopic surgery	10 (9.5%)	19 (13.4%)				
Total	35 (100%)	152 (100%)				

*OR = Odds Ratio; CI = Confidence Interval. * Statistically significant at P < 0.05.*

Frequency of Surgery and Infertility

In addition to the type and approach of surgery, we also assessed whether the frequency of surgical interventions was associated with infertility. Among women who had undergone a single open abdominal or pelvic surgery, no statistically significant difference in infertility risk was observed between the case and control groups (P> 0.05). However, women who had undergone two or more open surgeries exhibited a 2.96-fold increase in the risk of infertility, which was statistically significant (P = 0.029). In contrast, women who underwent laparoscopic procedures had a reduced risk of infertility, with an odds ratio of 0.45 (95% CI: 0.25–0.96, P = 0.021), indicating a possible protective effect of minimally invasive surgery (Table 6).

A multivariable logistic regression was then performed (Table 7). The strongest independent predictors of infertility were salpingectomy (OR = 13.2, 95 % CI 2.2–78.5, P = 0.005), undergoing ≥ 2 open abdominal surgeries (OR = 3.6, 95 % CI 1.1–11.8, P = 0.035), and history of STDs (OR = 1.4, 95 % CI 1.12–1.66, P = 0.04).

Age, higher BMI, and ovarian cystectomy were also significantly associated with infertility, while myomectomy and ectopic pregnancy surgery were not. Hosmer–Lemeshow test showed good model fit (P= 0.48), AUC was 0.78, and Nagelkerke R^2 was 0.23.

Table 6. Association Between Surgical Frequency and Infertility

Surgical frequency	Control group	Case group	OR	95% CI	P-value
Open surgery (once)	93 (79.5%)	184 (79.7%)	1.01	0.58 – 1.75	1.000
Open surgery (≥ 2 times)	5 (4.3%)	27 (11.7%)	2.96	1.11 – 7.91	0.029*
Laparoscopic surgery	19 (16.2%)	20 (8.7%)	0.45	0.25 – 0.96	0.021*
Total	117 (100%)	231 (100%)			

*OR = Odds Ratio; CI = Confidence Interval. *Statistically significant at P< 0.05.*

Table 7. Multivariable logistic regression analysis of demographic, clinical, and surgical predictors of female infertility

Variables	Wald	Sig.	OR	95% C.I. Lower	EXP(B) Upper
Women's age	9.8	.002	0.95	.922	.982
BMI (kg/m2)	10.9	.04	0.16	.074	.336
History of STD's	4.2	.04	1.4	1.12	1.66
Myomectomy	.34	.56	1.34	.495	3.67
Ovarian cystectomy	4.1	.042	1.02	1.01	1.05
Ectopic pregnancy	.023	.88	.936	.398	2.20
Salpingectomy (hydrosalpinx, pyosalpinx etc)	8.0	.005	13.2	2.2	78.5
Appendectomy	3.5	.051	2.1	.966	4.46
Open surgery (once)	13.7	.001	0.05	.009	.235
Open surgery (≥ 2 times)	4.46	.001	3.6	1.09	11.8

Discussion

The findings of this study underscore the various factors that contribute to infertility related to tubal and pelvic adhesions in Mongolian women, particularly highlighting how past abdominal or gynecological surgeries can negatively affect reproductive success.

Impact of General Abdominal Surgeries:

Our study's association between previous general abdominal surgeries and infertility reflects the importance of intra-abdominal adhesion formation. Women with a history of appendectomy had a twofold increased risk of infertility, corroborating earlier studies suggesting that postoperative adhesions from appendiceal inflammation may extend to the adnexal structures.[12-14] Becker, et al. reported that almost 25% of women seeking care at their fertility clinic had a positive history of appendectomy, suggesting a possible association.[14] Beyond the long-term consequences of appendicitis or appendectomy, several case reports in the literature highlight acute complications following appendectomy that may negatively affect fertility. For instance, Singh-Ranger, et al. (2008) documented a case involving a 17-year-old girl who developed acute coliform salpingitis three months after undergoing an appendectomy.[15] Similarly, Nyogi, et al. (2009) and Limberg, et al. (2015) each reported instances of recurrent hydrosalpinx occurring after surgery for perforated appendicitis.[16,17] Additionally, Vyas, et al. (2008) described a case where an appendicolith appeared to migrate into the right fallopian tube, resulting in a tubo-ovarian abscess.[18]

According to a study by Sharma, et al. the prevalence of infertility among women with abdominal and genital tuberculosis ranges from 40% to 80%.[19] In our study, women who underwent surgery due to abdominal tuberculosis had a 14-fold increased risk of infertility. However, this elevated risk may be attributed not solely to the surgical intervention itself, but rather to the direct pathogenic effects of Mycobacterium tuberculosis. The organism may damage the fallopian tubes[20] and endometrial lining[21], disrupt endocrine function, and lead to anovulation[22], thereby impairing fertility.

Gynecologic Surgeries and Tubal Factor Infertility

Our findings showed a strong association between several types of surgery and infertility. Salpingectomy had the highest observed impact, with a 16.5-fold increase in infertility risk. This is expected, as removing one or both fallopian tubes directly compromise the pathway for oocyte and sperm interaction. Bilateral salpingectomy is considered an absolute indication for in vitro fertilization (IVF). According to Liu et al., the intrauterine pregnancy (IUP) rate within 24 months following salpingectomy was 55.5 percent[23], while Fernandez, et al. reported a slightly higher rate of 56.5 percent.[24]

Myomectomy, being a primary surgical intervention, inherently carries risks such as damage to the myometrium and endometrium, along with the formation of pelvic adhesions.[25] Postoperative adhesions are a well-documented complication of myomectomy.[26] While it remains unclear whether these adhesions significantly impair fertility, particular concern arises with posterior wall fibroid removal due to the increased likelihood of adnexal structure involvement. One study reported that postoperative adhesions occurred in 94% of patients who underwent posterior uterine wall incisions, compared to only 55% among those with incisions on the anterior wall of the uterus.[27]

A decline in ovarian reserve markers such as anti-Müllerian hormone (AMH) and antral follicle count (AFC) following ovarian cystectomy has been confirmed by multiple studies.[28-32] Furthermore, some studies reported poor IVF outcome after ovarian surgery, and suggested that a decreased ovarian reserve was the cause of poor outcome.[33,34]

Oophorectomy and hysterectomy, while not frequently performed on women of reproductive age, were linked to significant odds ratios, highlighting their permanent effects on fertility. These operations suggest deeper issues, highlighting the need for fertility counseling before surgery.

Surgical Approach and Frequency

The analysis further supports the advantage of laparoscopic approaches over open surgery. Women who had undergone open surgery had a 2.8-fold higher risk of infertility compared to those who had laparoscopic procedures. Moreover, repeated open surgeries (≥2 times) nearly tripled infertility risk (OR = 2.96), while laparoscopy showed a protective effect (OR = 0.45). One review found that 71% of adhesions were associated with the laparotomy incision site.[35] Minimal invasive procedures like laparoscopy, which reduce the size of the surgical wound, may therefore lower the risk of adhesion formation. Additionally, these techniques may limit intra-abdominal exposure to foreign materials, such as gauze sponges, which are known contributors to adhesion development.[36]

The literature presents conflicting perspectives on the frequency of postoperative adhesions following laparoscopic versus open appendectomy. Lundorff, et al. reported fewer adhesions after laparoscopic tubal procedures than open surgeries.[37] Similarly, De Wilde, et al. conducted second-look laparoscopies three months after either laparoscopic or open appendectomy for acute appendicitis. They found abdominal adhesions in 80% of patients who had undergone open surgery, while only 20% of those who had laparoscopic surgery developed adhesions.[38] Vrijland, et al. supported this conclusion, suggesting that laparoscopy may lead to fewer adhesions than open approaches.[39] However, other studies question the extent of laparoscopy's advantage in preventing adhesions. These authors argue that the benefits observed in earlier clinical impressions and adhesiolysis outcomes may have been overstated. In fact, excluding tubal sterilization, the readmission rate due to adhesion-related complications was similar between laparoscopic and open surgical procedures.[40]

Clinical and Public Health Implications

The findings of this study highlight the importance of prioritizing minimally invasive surgical approaches whenever possible. Patients should also receive counseling about the potential impact of gynecologic or abdominal surgeries on their fertility. Furthermore, the research supports the integration of fertility-preserving methods into the routine surgical care and reproductive health strategies of Mongolia. Improving laparoscopic training and facilities, along with boosting public knowledge about avoidable factors contributing to infertility, may aid in decreasing the occurrence of tubal factor infertility.

Limitations

Several limitations must be acknowledged. The retrospective design is susceptible to recall and selection bias. Additionally, the study was conducted at a single center, which may limit generalizability to broader populations.

Conclusion

Postoperative intra-abdominal adhesions, particularly following open gynecologic and abdominal surgeries, significantly increase the risk of infertility in women. To mitigate this risk, laparoscopic techniques should be prioritized whenever possible. It is essential to incorporate minimally invasive methods and adhesion prevention strategies to preserve fertility in women of reproductive age.

Conflict of Interest

The authors declare that they have no conflict of interest concerning this study.

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Authors Contribution

Amarzaya Lkhagvasuren: Conceptualization, data curation, software, writing original draft, formal analysis, validation
Khadbaatar Ravdan-Ochir: Visualization, writing review and editing, supervision
Kherlen Oyunbaatar: Software, investigation, resources
Erkhembaatar Tudevdorj: Writing review and editing, supervision
Jargalsaikhan Badarch: Project administration, methodology, supervision
All authors have read and approved the final published version of the manuscript.

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