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# Effect of hysteroscopic adhesiolysis for mild intrauterine adhesions on live birth rate following embryo transfer: a retrospective cohort study

Yu Li[1,2,3,5,6,7,8,9], Yu Dai[10], Mingming Deng[1,2,3,5,6,7,8,9], Hong Lv[1,2,3,5,6,7,8,9], Yanlei Dong[11,12*] and Lei Yan[1,2,3,4,5,6,7,8,9,13*]

## Abstract

**Background** Numerous studies have demonstrated that the presence of IUAs can have detrimental effects on female reproductive function, potentially leading to infertility. Hysteroscopic adhesiolysis is widely regarded as the primary treatment for IUAs. A 2021 consensus development study on the top 10 research priorities for the future of infertility suggested that the impact on live birth rates after surgical treatment of mild IUAs is uncertain.

**Materials and methods** The study was a retrospective cohort study that included 442 patients who were diagnosed with mild IUAs and underwent embryo transfer (fresh or frozen embryo) from January 2017 to December 2023 at a University-based reproductive medical center. Patients were divided into two groups according to whether underwent hysteroscopic adhesiolysis. The non-surgical group consisted of 204 patients, while the surgical group consisted of 238 patients. all patients underwent fresh or frozen embryo transfer. We compared the pregnancy outcomes and obstetric outcomes of the first embryo transfer after diagnosis or surgery of IUAs between the two groups. The main outcome measure is live birth rates. Between-group variances were evaluated using either the Pearson $\chi^2$ test or the t-test. Multiple logistic regression analyses were applied to control for potential confounding effects.

**Results** There were no significant differences in live birth rates of the non-surgical group and the surgical group(45.1% versus 42.0%,aOR,0.824;95%CI,0.558–1.217;P,0.330).All other pregnancy indicators showed no significant difference between the groups either.

**Conclusion** Hysteroscopic adhesiolysis does not significantly improve the live birth rates in patients with mild IUAs. Therefore, for patients with mild IUAs, it is recommended to prioritize expectant treatment.

**Clinical trial number** Not applicable.

**Keywords** Intrauterine adhesions, Asherman syndrome , Hysteroscopy, Adhesiolysis

*Correspondence:
Yanlei Dong
13515411811@163.com
Lei Yan
yanlei@sdu.edu.cn

Full list of author information is available at the end of the article

## Introduction

Intrauterine adhesions (IUAs), also known as Asherman syndrome, refer to the partial or complete obstruction of the uterine cavity typically due to endometrial trauma. Clinical manifestations of IUA include menstrual irregularities (such as amenorrhea or hypomenorrhea), cyclical abdominal pain or dysmenorrhea, and infertility or recurrent pregnancy loss [1, 2]. Notably, many patients with IUAs may not exhibit any symptoms, which complicates determining the prevalence of the disease [3]. Studies have indicated that the prevalence of IUAs following miscarriage, termination of pregnancy, retained products of conception and myomectomy ranges from 16–45.5% [4, 5].

Numerous studies have demonstrated that the presence of IUAs can have detrimental effects on female reproductive function, potentially leading to infertility [1, 6, 7]. The possible etiologic factors for infertility caused by IUAs include deformation of the uterine cavity which impairs sperm transportation, functional endometrial deficiency leads to decreased endometrial receptivity, affecting embryo implantation, and defective vascularization of the residual endometrial tissue due to fibrosis of endometrium [8].

Hysteroscopic adhesiolysis is widely regarded as the primary treatment for IUAs. Despite achieving successful restoration of normal uterine anatomy and menstrual flow, studies have indicated that approximately one-third of women experience a recurrence of IUAs [9]. Numerous studies indicate that IUAs reduce pregnancy rates in women undergoing in vitro fertilization and embryo transfer (IVF-ET) and increase the risk of pregnancy-related complications [3, 10, 11]. A favorable uterine cavity environment is essential for successful embryo implantation [8]. Thus, when IUAs are identified in the process of infertility evaluation and treatment(even in the case of mild IUAs), the recommended measure is hysteroscopic adhesiolysis, a rule that applies almost universally to women with IUAs undergoing IVF [2–4, 12]. However, to date, there is no consensus on the need for surgical intervention for mild IUAs, several researches have suggested that mild IUAs do not have an impact on reproductive performance [13, 14]. From a patient care perspective, Treating all mild cases could expose patients to unnecessary risks, such as cervical laceration, uterine perforation, infection, and fluid overload [15]. From a healthcare system perspective, unnecessary surgery for mild IUAs may increase the waste of healthcare resources. Conversely, delayed intervention in progressive cases could require more complex secondary surgeries, increasing patient morbidity and resource use. Resolving this dilemma is crucial for developing evidence-based guidelines that balance patient needs with responsible use of medical resources.

A 2021 consensus development study on the top 10 research priorities for the future of infertility suggested that the impact on live birth rates after surgical treatment of mild IUAs is uncertain [16]. Trying to answer this question, we conducted a retrospective analysis of medical records from patients diagnosed with mild IUAs at university-affiliated hospitals between 2017 and 2023. The purpose of this study is to determine whether surgical treatment is necessary by evaluating the pregnancy and obstetric outcomes of infertile patients with mild IUAs.

## Materials and methods

### Study design

We reviewed the electionic records of female patients who underwent embryo transfer therapy from January 2017 to December 2023 at our center (Reproductive Hospital Affiliated to Shandong University). The patients met the following exclusion criteria: (1) Patients with maternal age ≥ 45 years old; (2)Untreated hydrosalpinx、submucous myoma、endometrial polyps; (3)Oocyte donor treatment cycles; (4)Moderate or severe adhesions; (5) 3 or more embryo transfer cycles. Our center routinely performs hysteroscopy in infertility assessment to determine the presence of Uterine cavity abnormalities. The presence of IUAs were diagnosed by hysteroscopy during the infertility evaluation and scored using the American Fertility Society (AFS) scoring system. The AFS classification is based on the extent of cavity involved, type of Adhesions, and menstrual pattern of the patient. Mild IUAs defined as AFS score ≤ 4 [17].

After that, professional hysteroscopic surgery specialists explain to patients the influence of IUAs on fertility, as well as the efficacy and risks of surgery. Patients and surgery specialists decided whether to undergo surgical therapy. Hysteroscopic adhesiolysis was carried out by one skilled and experienced hysteroscopic surgeon using microscissors excision within 3 to 10 days after completion of menstruation. After dilation of the cervix with a number 7 Hegar dilator, a 6.5-mm therapeutic hysteroscope was inserted. Microscissors were introduced through the operative port of the hysteroscope. The success criteria for the procedure is to restore the normal anatomy of the uterine cavity according to the guidelines. Postoperative patients receive oestrogen-progestin sequential therapy to promote endometrial growth and prevent adhesion recurrence and were assessed for recurrence of adhesions by transvaginal ultrasound prior to embryo transfer. Patients with recurrent adhesions were excluded from this study. The included patients were divided into two groups depending on whether they received surgical treatment or not: surgical group(study group)and nonsurgical group (control group).

### Ethics statement

Ethical approval for this study (Ethical Committee N° 2022-63) was provided by the Ethical Committee Reproductive Hospital Affiliated to Shandong University, Jinan, Shandong on 11 June 2022. All participants had given their informed consent.

### Main outcomes of all the included patients

The recorded baseline data included the basic characteristics and controlled ovarian stimulation (COS) characteristics of 442 women. The primary outcome was the live birth rate of the first embryo transfer (fresh or frozen embryo) after surgery or diagnosis of adhesions, defined as the number of deliveries that resulted in at least one live birth, expressed per 100 embryo transfer cycles attempts. The live birth rate, as the primary outcome, stands out as the most recommended and patient-focused outcome for infertility research [18]. Other outcomes evaluated in this retrospective study encompassed clinical pregnancy rate, clinical miscarriage(MR) rate, biochemical MR rate, and preterm birth rate.

In addition to, we compared the two groups in terms of maternal and fetal obstetric outcomes. Fetal outcomes included weight and neonatal dysplasia, while maternal outcomes comprised rates of cesarean section, placental abnormality, gestational diabetes, gestational hypertension, preterm rupture of membranes, preeclampsia, hyperemesis gravidarum.

### Statistical analysis

Data analysis was conducted using SPSS 27.0 (IBM, Armonk, NY, USA). Quantitative data were presented as mean ± standard deviation, while categorical data were presented as percentages. Between-group variances were evaluated using either the Pearson $\chi^2$ test or the t-test. Multiple logistic regression analyses were applied to control potential confounding effects and determine the impact of IUAs on pregnancy outcomes. To visually demonstrate the differences between the surgical and non-surgical groups in the main pregnancy outcomes, we utilized R programming to create a forest plot. We also performed sub-group analyses by types of embryo transfer(Fresh and frozen embryo).Results were presented with odds ratios (ORs) and 95% CIs. A $P < 0.05$ was considered statistically significant.

## Results

During the study period, 3475 patients at our institution were diagnosed with IUAs and underwent embryo transfer treatment. Among them, 442 patients met the inclusion criteria and were categorized into two groups based on whether they received surgical treatment: 203 in the non-surgical group (study group) and 238 in the surgical group (control group) (Fig. 1).

Clinical characteristics of the 442 women are shown in Table 1. There were no significant differences among the two groups. Comparison of COS characteristics between the two groups revealed no statistically significant differences in total dosage、start up dosage and duration of gonadotropin (Gn), endometrial thickness on hCG trigger day, protocol type, mean oocytes retrieved. Baseline characteristics revealed significant differences between the surgical and non-surgical groups in the number of antral follicles, number of embryo transfers, type of embryo transfer (fresh or frozen embryo), and days to embryo transfer ($P < 0.05$) (Table 2). As these variables may have a significant impact on pregnancy outcomes, we adjusted for them in the logistic regression model to reduce potential confounding effects.

The primary and secondary pregnancy outcomes of the two groups of 442 patients are demonstrated in Table 3 The live birth rate was 45.1% (92 of 204) in the non-surgery group, and 42.0% (100 of 238) in the surgery group. The frequency of live births was similar between groups(aOR,0.824;95%CI,0.558–1.217;P,0.330). Hysteroscopic examination images of several patients who did not receive surgical treatment but successfully achieved live birth are displayed in Fig. 2. Secondary outcome indicators, including preterm labor, clinical pregnancy rates, clinical pregnancy loss, early and mid-to-late-term miscarriages, as well as biochemical pregnancy losses, did not display statistical significance between the two groups.

Table 4 presents the obstetric outcomes of the two groups. There were no significant difference in gestational diabetes, gestational hypertension, preeclampsia, oligohydramnios, hyperemesis gravidarum, placental abnormalities and premature rupture of membranes. Concerning neonatal outcomes, no statistically significant disparities were identified between the two groups regarding extremely low birth weight, low birth weight, and developmental abnormalities. However, the surgical group had a higher rate of multiple pregnancy, although this was not significant (aOR,2.987;95%CI,0.956–9.336;P,0.060).

Figures 3 and 4 present the comparison results between the surgical and non-surgical groups in the main pregnancy outcomes. The forest plots summarize the odds ratios (OR) and their 95% confidence intervals (CI) for various pregnancy outcomes. The vertical line in the forest plot represents the line of no effect (OR = 1). As shown in Figs. 3 and 4, there was no statistical significance observed between the surgical and non-surgical groups of patients with mild IUAs in all pregnancy outcomes ( $P > 0.05$).

Subgroup analyses stratified by embryo transfer type revealed no significant differences in live birth rates(fresh: aOR,0.914;95%CI,0.529–1.582;P,0.749;frozen: aOR,0.818;95%CI,0.476–1.406;P,0.468) between the

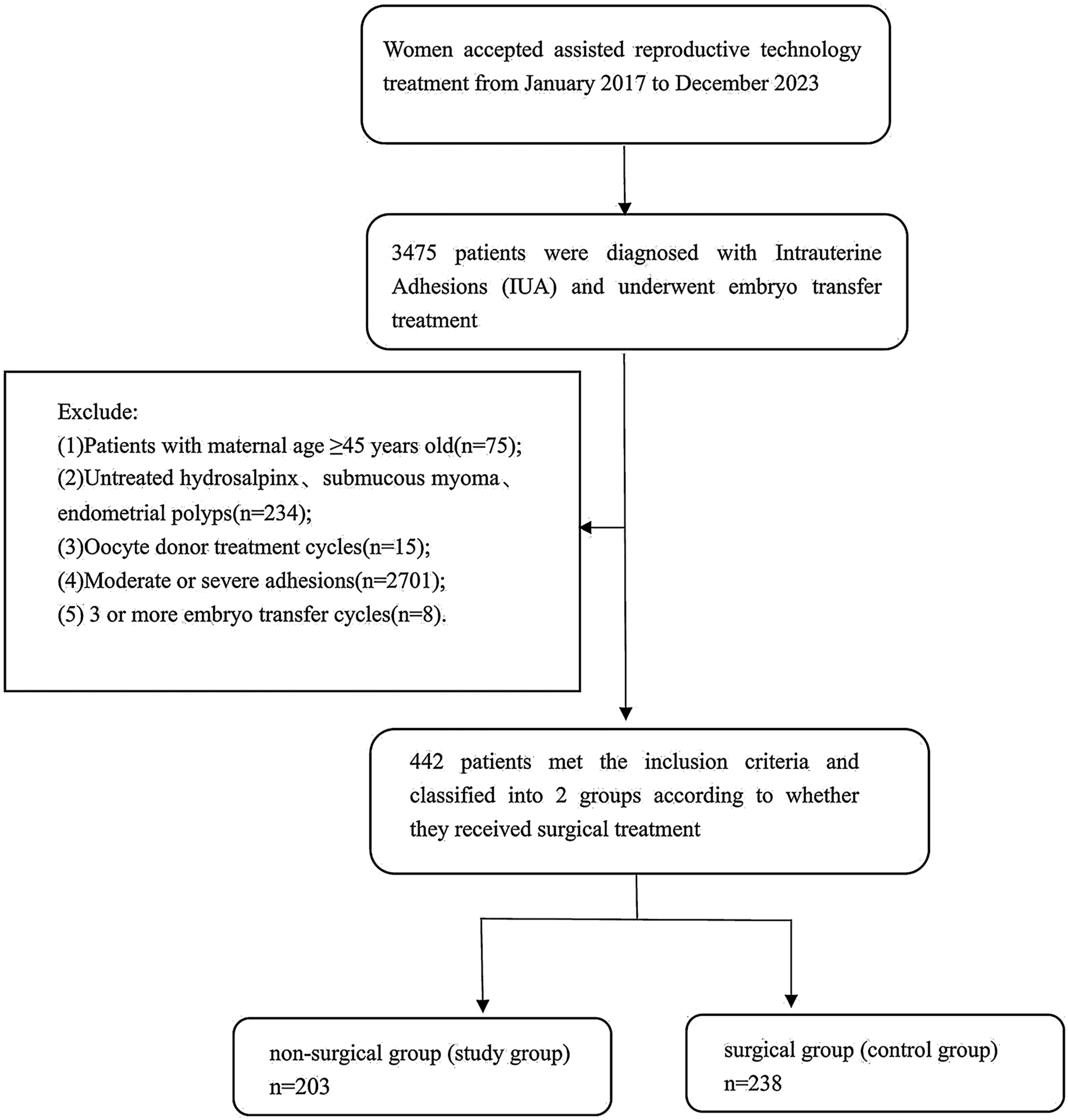


**Fig. 1** Flowchart of this study

surgical and non-surgical groups (e Tables 1 and 8 in Supplement 1).

## Discussions

IUAs are a common cause of female infertility, resulting from damage to the basal layer of the endometrium [19–21]. Hysteroscopic adhesiolysis is a standard treatment method aimed at restoring the normal anatomical structure of the uterine cavity and the functionality of the endometrium, thereby increasing the chances of conception [2, 22]. Nevertheless, the postoperative recurrence rate is still high, ranging from 20–60% [23, 24].

In our study, 100 out of 238 women in the surgical group achieve live births, while 92 out of 204 women in the non-surgical group achieve live births(42.0%vs45.1%, $P = 0.330$). The retrospective study shows that for infertile patients with mild IUAs, surgical treatment does not significantly increase the live birth rate. Thickness of the endometrium is crucial for implantation, A thin endometrium is an independent and critical factor predisposing the woman to implantation failure [25, 26]. Our study showed no significant difference in endometrial thickness between the two groups, suggesting that mild IUAs have

**Table 1** Patient characteristics

| Characteristic | Non-surgery group $N = 204$ | Surgery group $N = 238$ | *P*-value |
|---|---|---|---|
| Age(years) | 33.2(4.5) | 32.5(4.5) | 0.081 |
| BMI(kg/m$^2$) | 24.1(3.5) | 24.1(3.8) | 0.965 |
| Basal FSH(IU/L) | 7.1(2.5) | 6.7(2.2) | 0.054 |
| Basal LH (IU/L) | 5.4(3.2) | 5.7(3.5) | 0.403 |
| Basal PRL (ng/ml) | 15.4(7.4) | 16.5(8.3) | 0.145 |
| Infertility duration (years) | 2.9(2.4) | 2.8(2.3) | 0.833 |
| Antral follicle count | 13.5(8.6) | 15.3(9.2) | **0.033** |
| Previous pregnancy loss | 1.5(1.3) | 1.3(1.2) | 0.229 |
| Infertility type(n, %) | | | 0.663 |
| Primary | 49(24.0%) | 53(22.3%) | |
| Secondary | 155(76.0%) | 185(77.7%) | |
| Indication for ART(n, %) | | | 0.518 |
| Tubal factor | 142(69.6%) | 155(65.1%) | |
| Male factor | 25(12.3%) | 30(12.6%) | |
| Ovulatory dysfunction | 7(3.4%) | 15(6.3%) | |
| Others | 30(14.7%) | 38(16.0%) | |
| Insemination method(n, %) | | | 0.445 |
| IVF | 138(67.6%) | 164(68.9%) | |
| ICSI | 50(24.5%) | 49(20.6%) | |
| PGT | 16(7.8%) | 25(10.5%) | |
| History of ectopic pregnancy(n, %) | | | 0.573 |
| Yes | 36(17.6%) | 47(19.7%) | |
| No | 168(82.4%) | 191(80.3%) | |
| Oligomenorrhea(n, %) | | | 0.716 |
| No | 175(85.8%) | 207(87.0%) | |
| Yes | 29(14.2%) | 31(13.0%) | |
| AFS score | 3.5(0.5) | 3.5(0.5) | 0.326 |

BMI = body mass index; FSH = follicular stimulation hormone; LH = luteinizing hormone; PRL = prolactin; ART = assisted reproductive technology; IVF = in vitro fertilization; ICSI = intracytoplasmic sperm injection; PGT = preimplantation genetic testing; AFS = American Fertility Society

Data are presented as n (%) or average ± standard deviation. Display data with $P < 0.05$ in bold

less effect on the endometrium, which may explain our findings.

The surgical and non-surgical groups differed significantly in baseline characteristics, including embryo transfer parameters and ovarian reserve markers. To address this, we rigorously adjusted for these variables in the regression model, as they are not only potential confounders but also key determinants of pregnancy success. For example, a higher number of embryos transferred is associated with increased implantation rates, while frozen embryo transfers may reflect optimized endometrial preparation. By explicitly controlling these factors, our analysis strengthens the validity of the observed association between surgery and improved outcomes.

On the other hand, while the difference was not significant, the live birth rate in the non-surgical group was slightly higher than in the surgical group. Considering that fresh embryo transfer may desynchronize endometrial and embryo development due to the effects of ovulation induction drugs, leading to decreased endometrial receptivity and reduced embryo implantation potential, whereas frozen embryo transfer adjusts the endometrial status to ensure optimal thickness, morphology, and blood flow, precise control of endometrial development through exogenous hormones (such as estrogen and progesterone) can better optimize the uterine environment and improve the success rate of pregnancy [27]. To further control for this confounding factor, we conducted a subgroup analysis of frozen and fresh embryos, the results show no significant differences in live birth rates between the surgical and non-surgical groups (fresh embryo: 46.7% vs. 44.6%, $P = 0.749$; frozen embryo: 43.9% vs. 38.9%, $P = 0.468$). This result suggests that the independent effect of surgical intervention on live birth rates may be limited regardless of the embryo transfer strategy. However, due to sample size limitations after grouping, this result should be cautiously extrapolated to other populations.

In a prospective cohort study, Sanad et al. included 61 patients with infertility (primary or secondary) or recurrent pregnancy loss caused by IUAs, the study demonstrated that the live birth rate of patients could significantly increase from 14.7% preoperatively to 36% postoperatively [28]. A previous retrospective study indicated that there were no significant differences in clinical pregnancy, live birth, preterm birth, and obstetric outcomes between patients with IUAs who underwent surgical treatment and the general infertility population [29]. Both studies included patients with moderate to severe adhesions, making it difficult to determine the exact impact of surgical treatment on pregnancy and obstetric outcomes in patients with mild IUAs.

The impact of mild IUAs on reproductive performance is not clear. A recent meta-analysis indicated that women with hysteroscopic identified and treated mild IUAs have lower pregnancy and live birth rate compared to the general population(90% vs. 62.3% and respectively 99.5% vs. 86.6%) [30].Currently, several mechanisms are proposed to explain the impact of IUAs on reproductive performance. For instance, the presence of adhesions can block the cervical canal, the openings of the fallopian tubes, or the uterine cavity itself, thereby hindering the migration of sperm and the implantation of embryo. In addition, vascular formation defects and a lack of functional endometrium lead to decreased endometrial receptivity, potentially hindering implantation and placental formation [8].

Adhesion severity is negatively correlated with subsequent live birth rate, with previous data reporting the live birth rate of about 54.8% for women with mild,25.0% for women with moderate, and only 22.2% for women with severe adhesions [1, 22, 31].In our study, the live birth rates for the two groups were 42.0% and 45.1%,

**Table 2** Controlled ovarian stimulation characteristics

| Characteristic | Non-surgery group *N* = 204 | Surgery group *N* = 238 | *P*-value |
|---|---|---|---|
| Endometrial thickness on hCG trigger day, mm | 8.7(1.8) | 8.8(1.8) | 0.322 |
| Mean oocytes retrieved | 11.0(6.3) | 11.5(6.3) | 0.403 |
| Duration of gonadotropin stimulation, d | 10.3(2.4) | 10.0(2.2) | 0.295 |
| Starting dose of gonadotropin, IU | 180.5(53.6) | 183.3(57.8) | 0.594 |
| Total dosage of gonadotropin per cycle, IU | 2118.8(1021.6) | 2090.8(963.4) | 0.766 |
| Protocol(n, %) | | | 0.754 |
| Antagonist protocol | 67(32.8%) | 88(37.0%) | |
| Long protocol | 84(41.2%) | 90(37.8%) | |
| Short protocol | 29(14.2%) | 36(15.1%) | |
| Other | 24(11.8%) | 24(10.1%) | |
| Number of embryos transferred(n, %) | | | **0.011** |
| Single embryo transfer | 150(73.5%) | 148(62.2%) | |
| Double embryo transfer | 54(26.5%) | 90(37.8%) | |
| Embryo(s) transferred(n, %)[a] | | | **0.005** |
| Days 3 | 58(28.4%) | 103(43.3%) | |
| Days 5 | 120(58.8%) | 109(45.8%) | |
| Days6 | 26(12.7%) | 26(10.9%) | |
| Types of embryo transfer(n, %) | | | **0.028** |
| Fresh embryo | 90(44.1%) | 130(54.6%) | |
| Frozen embryo | 114(55.9%) | 108(45.4%) | |

hCG = human chorionic gonadotropin; Data are presented as n (%) or average ± standard deviation. Display data with $P < 0.05$ in bold

[a]Day of embryo transferred represented days of embryos cultured in vitro

**Table 3** Pregnancy outcomes after fresh or frozen embryo transfer in patients with mild IUAs

| Pregnancy outcomes | Non-surgery group *N* = 204 | Surgery group *N* = 238 | **P*-value | *aOR(95%CI) |
|---|---|---|---|---|
| Live birth, n/N (%) | 92/204(45.1%) | 100/238(42.0%) | 0.330 | 0.824(0.558–1.217) |
| Preterm delivery, n/N (%) | 13/92(14.1%) | 15/100(15.0%) | 0.839 | 0.916(0.393–2.134) |
| Clinical pregnancy, n/N (%) | 118/204(57.8%) | 131/238(55.0%) | 0.316 | 0.819(0.553–1.211) |
| Clinical pregnancy loss[a] ,n/N (%) | 25/118(21.2%) | 30/131(22.9%) | 0.711 | 1.124(0.606–2.082) |
| Early miscarriages, n/N (%) | 15/118(12.7%) | 18/131(13.7%) | 0.553 | 1.261(0.587–2.709) |
| Mid-to-late-term miscarriages, n/N (%) | 10/118(8.5%) | 12/131(9.2%) | 0.944 | 0.968(0.389–2.410) |
| Biochemical pregnancy loss, n/N(%) | 10/128(7.8%) | 12/143(8.4%) | 0.685 | 1.205(0.489–2.974) |
| Biochemical pregnancy, n/N(%) | 128/204(62.7%) | 143/238(60.1%) | 0.354 | 0.828(0.556–1.234) |

*Logistic regression analysis was conducted by adjusting for the number, type and day of embryo transfer and the number of antral follicles. aOR: Adjusted Odds ratio; CI: Confidence interval; Data are presented as n (%)

[a]clinical pregnancy loss include early and mid-to-late-term miscarriages

respectively. One explanation for the relatively low live birth rates is that our study only compared the outcomes of the first embryo transfer following the diagnosis or treatment of IUAs.

According to the AFS classification system, the location and density of adhesions may have an important impact on the prognosis of infertile women. This is because the majority of embryo implantation occurs in the top and bottom parts of the uterus, and adhesions in the uterine horn may lead to tubal obstruction [17]. Additionally, different types of adhesions (such as filmy adhesions and dense adhesions) may affect surgical outcomes, therefore, the "type" or "extent of involvement" of adhesions may have greater clinical significance than simple classification. To explore specific patient populations that may benefit from surgical intervention, in this study, we conducted further analysis on patients reported as having dense adhesions, fibrous adhesions, or involvement of key areas (such as the uterine fundus or near the tubal ostia) based on hysteroscopy findings. The results showed no significant differences between the surgical and non-surgical groups in terms of live birth rates and clinical pregnancy rates(e Tables 9, 10 and 11). However, the density and extent of adhesions rely on the subjective assessment of the operator, and with the limited sample size in this study, it may affect the reliability of the results.

Women with hysteroscopic identified and treated IUAs are prone to obstetric complications, such as placental implantation, postpartum hemorrhage, premature birth [6, 30, 32].A recent matched retrospective cohort study comparing obstetric outcomes in women who had undergone hysteroscopic adhesiolysis and those who had not revealed that the risk of placental attachment disorders was significantly increased. (OR = 17.93, 95%CI

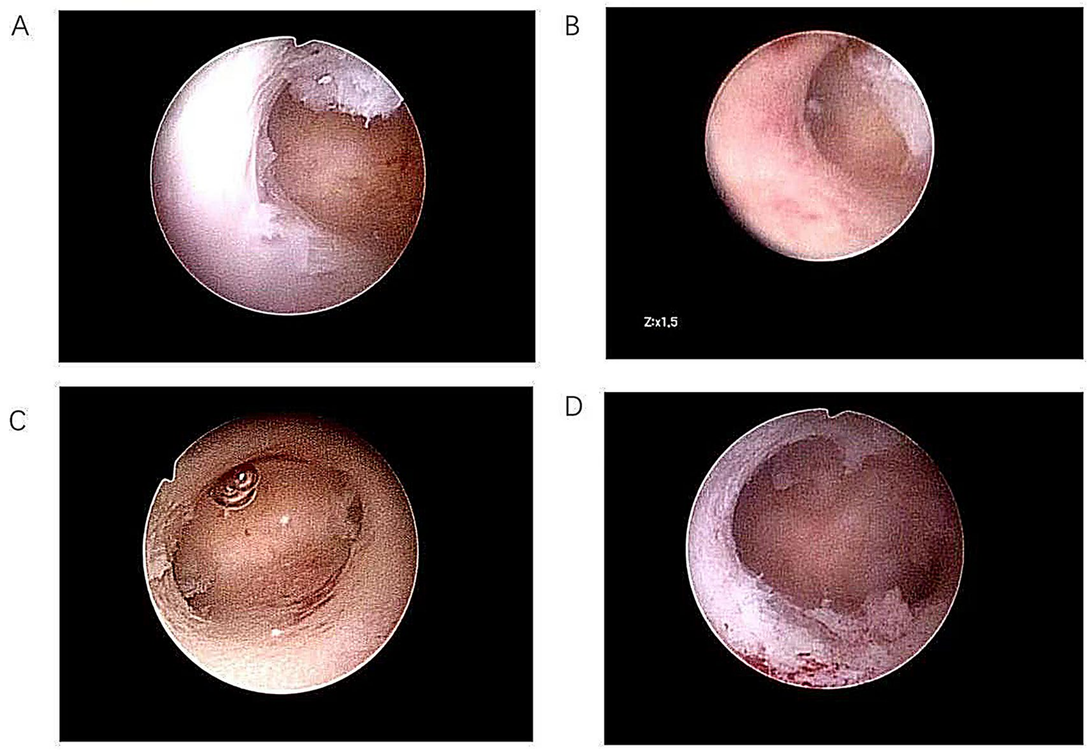


**Fig. 2** Images of the uterine cavity in patients with mild IUAs. (**A**),(**B**) Adhesion located on the right wall of the uterine cavity. (**C**),(**D**) Adhesions were seen on both walls of the uterine cavity

**Table 4** Maternal and neonatal obstetric outcomes after fresh or frozen embryo transfer in patients with mild IUAs

| Outcomes | Non-surgery group *N* = 204 | Surgery group *N* = 238 | **P*-value | *aOR(95%CI) |
|---|---|---|---|---|
| Multiple pregnancy, n/N (%) | 5/92(5.4%) | 17/100(17.0%) | 0.060 | 2.987(0.956–9.336) |
| Pregnancy-related diseases, n/N (%) | 18/118(15.3%) | 16/131(12.2%) | 0.448 | 0.750(0.357–1.577) |
| Gestational diabetes mellitus, n/N (%) gestational hypertension, n/N (%) | 6/103(5.8%) | 5/113(4.4%) | 0.592 | 0.708(0.201–2.497) |
| Hyperemesis gravidarum, n/N (%) | 2/118(1.7%) | 1/131(0.8%) | 0.557 | 0.477(0.040–5.645) |
| Preeclampsia, n/N (%) | 1/118(0.8%) | 2/131(1.5%) | 0.657 | 1.747(0.149–20.525) |
| Premature rupture of membranes, n/N (%) | 2/118(1.7%) | 2/131(1.5%) | 0.917 | 1.121(0.131–9.560) |
| Placental abnormalities, n/N (%) | 2/118(1.7%) | 1/131(0.8%) | 0.690 | 0.606(0.052–7.095) |
| Oligohydramnios, n/N (%) | 1/118(0.8%) | 2/131(1.5%) | 0.489 | 2.376(0.205–27.514) |
| Neonatal obstetric outcomes | 2/97(2.1%) | 3/118(2.5%) | 0.868 | 0.852(0.129–5.646) |
| Birth weight, n/N (%) | 10/97(10.3%) | 15/118(12.7%) | 0.929 | 1.042(0.420–2.587) |
| extremely low birth weight[a] low birth weight[b] developmental abnormality, n/N (%) | 3/97(3.1%) | 3/118(2.5%) | 0.669 | 0.690(0.126–3.779) |

*Logistic regression analysis was conducted by adjusting for the number, type and day of embryo transfer and the number of antral follicles. aOR: Adjusted Odds ratio; CI: Confidence interval; Data are presented as n (%)

[a]Birth weight lower than 1500 g

[b]Birth weight lower than 2500 g

8.18–39.33) [33]. Another retrospective study showed that there was no significant difference in the risk of obstetric complications after hysteroscopic adhesiolysis compared to the general population [29].However, both studies included patients with moderate to severe disease and the control group was a population with no history of IUAs.

Our current study revealed that surgical treatment did not significantly minimize maternal and fetal obstetric complications in comparison to untreated patients with mild IUAs. The rate of multiple pregnancy was higher in the surgical group in this study(5.4%vs17.0%,$P = 0.060$), although the difference was not significant, which may be related to higher double embryo transfer in surgical patients. The results of the subgroup analysis seem

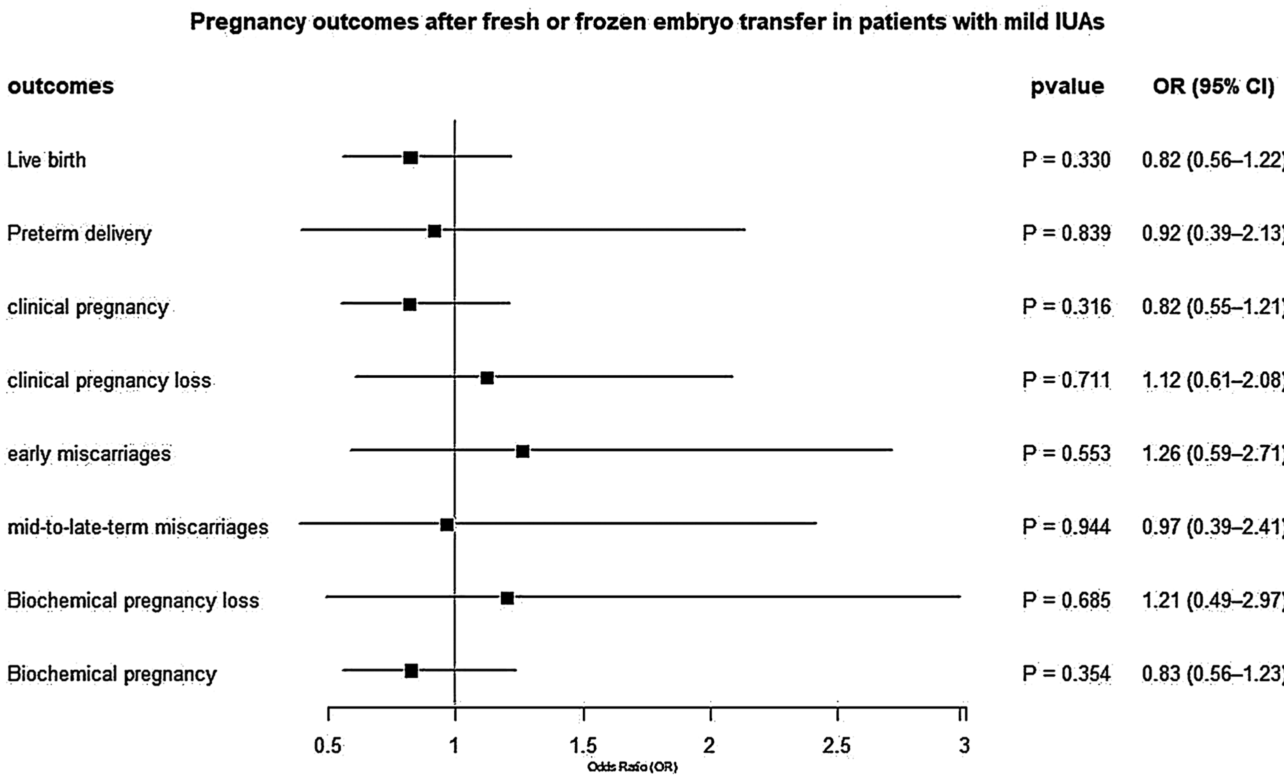


**Fig. 3** Forest plot comparing pregnancy outcomes between the surgical and non-surgical groups of patients with mild IUAs. Lists the odds ratios (OR) and their 95% confidence intervals (CI) for each outcome. The vertical line represents the line of no effect (OR = 1), and if the confidence interval crosses this line, it indicates that the result is not statistically significant

to support this interpretation. Women in the surgical group with fresh embryo transfer also had a higher rate of double embryo transfer and their multiple pregnancy rate was also higher(9.5%vs27.6%,$P = 0.055$).However, due to the retrospective nature of this study and the lack of detailed obstetric data, there are certain limitations, more comprehensive prospective multicenter studies are required in the future to assess the influence of IUAs on obstetric outcomes.

Compared to the general population, patients with IUAs have lower pregnancy rates and live birth rates even following adhesiolysis [7]. Therefore, prevention is crucial. Repeated curettage is a high-risk factor for the occurrence of IUAs [5], and intrauterine procedures should be minimized to avoid damage to the basal layer of the endometrium. Previous studies have indicated that patients with a first-trimester procedure as a cause of IUAs, more mild adhesions and less uterine impairment., whereas patients undergoing postpartum procedures were more likely to have a higher grade of adhesions and require multiple procedures to treat the disease [9, 34, 35]. To prevent the recurrence of adhesions, the most common choices are placing an IUD or a Foley balloon catheters, therapy of adjuvant hormones and the use of hyaluronic acid gel [36, 37].For postpartum residual patients, the formation of IUAs should be considered when determining treatment plans, if possible hysteroscopic techniques should be used instead of blind curettages in order to minimalize the damage to the uterus.

Several limitations should be considered in this study. First, this retrospective study may result in recall bias, despite we believe that live births and pregnancy outcomes are unlikely to be forgotten. Second, the decision of whether to receive surgical treatment in this study was made by the patients and doctors, which may lead to selection bias. Third, due to the limited number of patients with AFS scores of 1–2 included in this study, stratified analysis of mild IUAs patients (e.g., 1–2 vs. 3–4) was not feasible. This limitation restricts our ability to comprehensively assess pregnancy outcomes in mild IUAs patients and compare the effectiveness of surgical versus non-surgical treatments. Future studies should expand the sample size to comprehensively evaluate the impact of different degrees of adhesion on pregnancy outcomes. Furthermore, patients with mild IUAs only underwent transvaginal ultrasound follow-up after surgery and may have undetected recurrence of adhesions, which may therefore have affected the results of this study. we believe that large-scale multicenter prospective studies should be carried out to further explore the management issues in patients with mild IUAs.

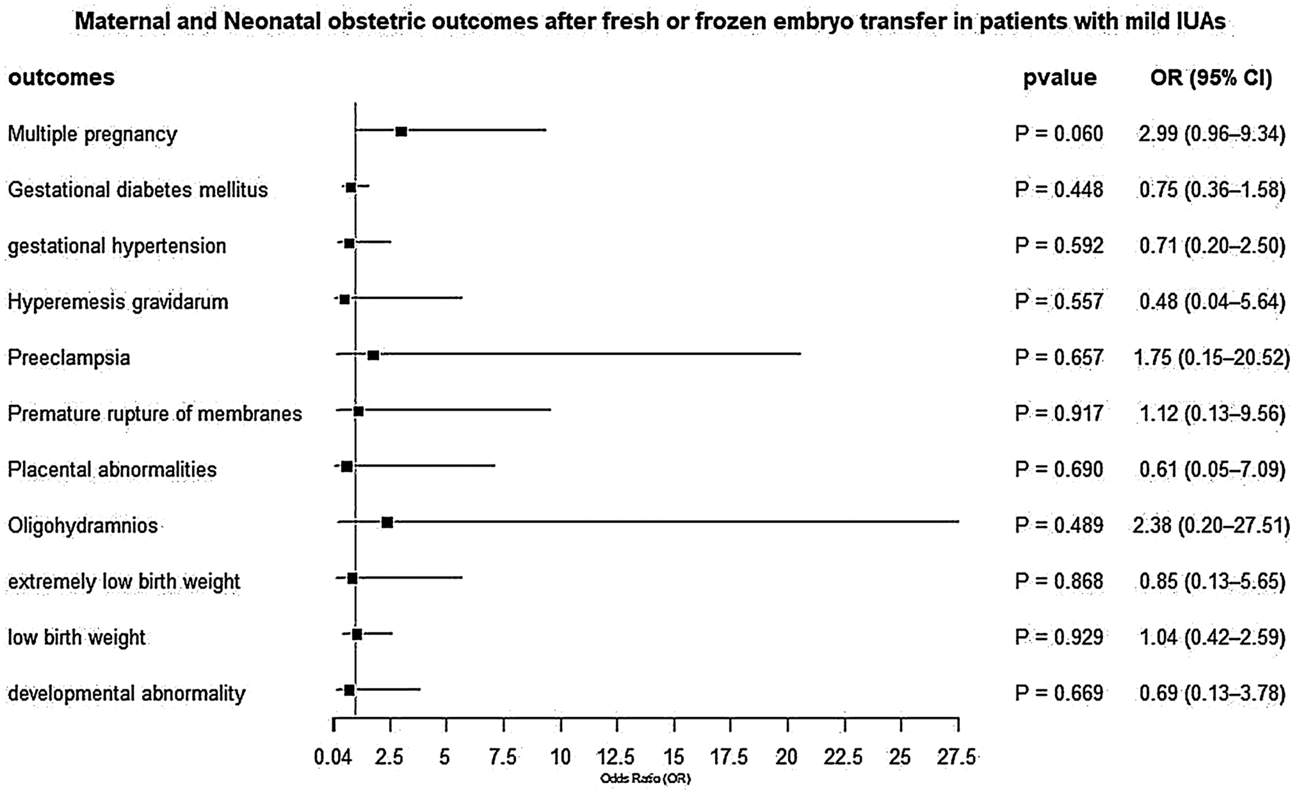


**Fig. 4** Forest plot comparing maternal and neonatal obstetric outcomes between the surgical and non-surgical groups of patients with mild IUAs. Lists the odds ratios (OR) and their 95% confidence intervals (CI) for each outcome. The vertical line represents the line of no effect (OR = 1), and if the confidence interval crosses this line, it indicates that the result is not statistically significant

## Conclusion

For infertile patients with mild IUAs, our study indicates that routine hysteroscopic adhesiolysis does not significantly improve live birth rates compared to expectant management. Therefore, for patients with mild IUAs, it is recommended to prioritize expectant treatment, such as hormonal therapy and endometrial preparation before embryo transfer. However, clinical decisions should be individualized, and surgical intervention may still be considered in the following circumstances: progression of adhesions after conservative treatment, adhesions located at the uterine fundus or denser adhesions, multiple failed embryo transfers, and patient non-compliance due to anxiety about untreated adhesions. It is important to note that due to the limitations of a single-center design and variations in surgical techniques in this study, clinicians should exercise caution when considering these recommendations.

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12884-025-07498-z.

Supplementary Material 1

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**Author contributions**
Yu Li has participated in data curation, investigation, methodology and writing original draft. Yu Dai has made contributions in Funding acquisition, Project administration and Supervision. Mingming Deng has participated in investigation, software and Visualization. Hong Lv has made contributions in data curation and writing-review&editing. Yanlei Dong and Lei Yan has participated in data curation, funding acquisition, ,investigation, methodology, supervision, writing-review&editing.All authors reviewed the manuscript.

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**Data availability**
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

## Declarations

**Ethics approval and consent to participate**
Ethical approval for this study (Ethical Committee N° 2022-63) was provided by the Ethical Committee Reproductive Hospital Affiliated to Shandong University, Jinan, Shandong on June 11, 2022. This study was conducted in accordance with the principles of the Declaration of Helsinki.

**Consent for publication**
Not applicable.

**Competing interests**
The authors declare no competing interests.

**Author details**
[1]Institute of Women, Children and Reproductive Health, Shandong University, Jinan, Shandong 250012, China
[2]State Key Laboratory of Reproductive Medicine and Offspring Health, Shandong University, Jinan, Shandong 250012, China
[3]Medical Integration and Practice Center, Shandong University, Jinan, Shandong 250012, China
[4]National Research Center for Assisted Reproductive Technology and Reproductive Genetics, Shandong University, Jinan, Shandong 250012, China
[5]Key Laboratory of Reproductive Endocrinology(Shandong University), Ministry of Education, Jinan, Shandong 250012, China
[6]Shandong Technology Innovation Center for Reproductive Health, Jinan, Shandong 250012, China
[7]Shandong Provincial Clinical Research Center for Reproductive Health, Jinan, Shandong 250012, China
[8]Shandong Key Laboratory of Reproductive Research and Birth Defect Prevention(Under Construction), Jinan, Shandong 250012, China
[9]Research Unit of Gametogenesis and Health of ART-Offspring, Chinese Academy of Medical Sciences, (No.2021RU001), Jinan, Shandong 250012, China
[10]Shenzhen Maternity & Child Healthcare Hospital, Guangzhou, Guangdong, China
[11]Obstetrics and Gynecology Department of the Second Hospital of Shandong University, Jinan, Shandong 250012, China
[12]The Second Hospital of Shandong University, No. 247 Beiyuan Street, Jinan, Shandong 250033, China
[13]Reproductive Hospital Affiliated to Shandong University, No. 157 Jingliu Road, Jinan, Shandong 250012, China

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