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Hormonal therapies for post-abortion uterine recovery: Comparison of estradiol ± dydrogesterone, transdermal estradiol gel and combined oral contraceptives

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Abstract: **Background**: Induced abortion can impair endometrial repair, increasing risks for infertility. This study directly compared three hormonal regimens for enhancing post-abortion uterine recovery. **Objectives**: This study aimed to compare the efficacy and safety of different hormonal regimens on uterine recovery following surgically induced abortion. **Methods**: In this randomized controlled trial, 320 patients undergoing induced abortion at Leshan People's Hospital (May 2021 to January 2023) were allocated a computer-generated random number sequence into four groups (n=80 each): Group A received estradiol tablets/estradiol and dydrogesterone tablets, Group B received estradiol gel, Group C received drospirenone and ethiny lestradiol tablets (II) and Group D was a blank control. Primary outcomes included duration of vaginal bleeding, postoperative endometrial thickness, time to first menstruation and incidence of intrauterine adhesions and adverse events. **Results**: The duration of vaginal bleeding was significantly shorter in the treatment groups (Group A: 4 days [IQR 2-6]; Group B: 4 days [IQR 2-7]; Group C: 3 days [IQR 2-6.5]) compared to the control group (6 days [IQR 4-7]; P<0.05). Endometrial thickness was significantly greater in Group B (0.6 cm [IQR 0.5-0.8]) than in Groups A (0.5 cm [IQR 0.4-0.7]), C (0.4 cm [IQR 0.3-0.5]) and D (0.4 cm [IQR 0.4-0.6]; P<0.05). The time to menstrual resumption was shorter in Groups A (33 days [IQR 31-37]) and C (32 days [IQR 29-35]) compared to Groups B (36 days [IQR 33.5-42]) and D (38 days [IQR 35-44]; P<0.05). No significant differences were observed in postoperative infection or adhesion rates. The incidence of irregular bleeding was higher in Group C (44.4%) than in Group D (13.0%; P<0.05), but all adverse events were self-limiting. **Conclusion**: This study provides direct comparative evidence that specific hormonal regimens offer distinct benefits for post-abortion recovery. For women seeking contraception through drospirenone and ethinyl estradiol tablets are valuable for shortening bleeding and promoting menstrual regularity. For those with future fertility goals, estradiol gel is valuable for significantly enhancing endometrial regeneration. All regimens demonstrated good safety, enabling personalized clinical decision-making to improve patient outcomes after induced abortion.

Keywords: Dydrogesterone; Estradiol; Ethinyl estradiol; Induced abortion; Uterine hemorrhage

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INTRODUCTION

The uterine cavity operation of induced abortion can directly damage the basal layer of endometrium, resulting in endometrial regeneration disorder, so that embryos are not suitable for implantation and cause secondary infertility (Liu *et al.*, 2025). In addition, it may lead to postoperative infection, long-term bleeding, decreased menstrual flow, intrauterine adhesion and even amenorrhea, which seriously affect women's fertility. Studies have shown that the more induced abortions, the higher the possibility of secondary infertility. The incidence of infertility is as high as 92.1% when there are more than 4 induced abortions and the history of induced abortion is reported to be a significant contributing factor in a substantial proportion of infertility cases (Horvath *et al.*, 2023). Among them, thin endometrium is the main one. Some studies show that about 20% of patients with induced abortion may have thin endometrium and the number of patients with two or more abortions rises to 53.33% (Li *et al.*, 2024). At present, infertility caused by thin endometrium has become a difficult problem in treatment and induced abortion is one of the important factors leading to its occurrence and development, so it is particularly important to intervene effectively in the early stage of the disease to prevent its formation.

At present, the main research direction is the treatment of thin endometrium after occurrence and the research on early preventive use to reduce endometrial damage and intrauterine adhesion caused by induced abortion is limited, mainly observational research and some conclusions are contrary and there is a lack of direct comparison and randomized controlled research between groups to confirm the effectiveness and safety of different treatment schemes. According to the Expert Consensus on Endometrial Repair after Induced Abortion, the main methods for endometrial repair after induced abortion are single estrogen, estrogen-progesterone sequential therapy and compound short-acting oral contraceptives (Li *et al.*, 2024; Toma *et al.*, 2025). In order to standardize the related treatments to promote endometrial repair, make up for the existing research defects and improve the understanding of medical

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staff at all levels on the treatment of endometrial injury after induced abortion, a randomized controlled study is planned to be conducted to compare the effectiveness and safety of routine use of estradiol tablets/estradiol progesterone tablets, estradiol gel and drospirenone ethinyl estradiol tablets after induced abortion (II) in shortening the days of vaginal bleeding after induced abortion, reducing the time of first menstrual regain, reducing intrauterine adhesion and postoperative infection and increasing the thickness of endometrium, so as to provide for clinical decision-making.

MATERIALS AND METHODS

Study design and participants

This single-center, randomized, parallel-group, controlled trial was conducted at Leshan People's Hospital from May 2021 to January 2023. The protocol was prospectively registered (China Clinical Trial Registration Center: MR-51-22-005407). All participants provided written informed consent.

Women aged 18–40 years undergoing elective surgical abortion for an intrauterine pregnancy (≤10 weeks of gestation) were eligible. Key exclusion criteria included contraindications to study drugs, severe hepatic/renal/cardiovascular disease, thrombotic disorders and concurrent use of interfering medications.

Using a computer-generated random number sequence, 320 eligible participants were allocated in a 1:1:1:1 ratio to four groups (n=80 each). The allocation sequence was concealed from enrolling investigators (Fig. 1).

Interventions and standard care

All participants underwent standardized surgical care consisting of a superconducting visual painless abortion and received routine postoperative medication (a second-generation cephalosporin and oxytocin nasal spray). Specific hormonal regimens, initiated on the day of surgery, were as follows: Group A (Sequential Therapy) received oral estradiol tablets (1 mg/day for 28 days) with dydrogesterone tablets (10 mg/day) added from day 15 to 28; Group B (Transdermal Estrogen) applied topical estradiol gel (2.5 g twice daily, delivering 3 mg estradiol/day) for 28 days; Group C (Combined Oral Contraceptive - COC) took oral drospirenone and ethiny lestradiol tablets (3 mg/0.02 mg, one tablet daily) for 28 days; and Group D (Control) received no hormonal treatment. Adherence was monitored using medication diary cards, pill/gel packet counts at follow-up visits and weekly telephone reminders. Good compliance was prospectively defined as consumption of ≥80% of the prescribed doses.

Outcomes and assessments

The primary outcomes were the duration of postoperative vaginal bleeding (in days) and endometrial thickness measured at the first follow-up. Secondary outcomes included the time to first menstruation, the incidence of intrauterine adhesions (IUA), postoperative infection and adverse events (AEs). Participants were assessed at 22±7 days post-operation and again at 6 months. The duration of vaginal bleeding and the resumption of menstruation were tracked prospectively using patient diaries and verified during follow-up appointments. Endometrial thickness was measured via transvaginal ultrasound at the 22±7-day visit by one of two experienced sonographers following a standardized protocol; a pre-study calibration session confirmed high inter-observer consistency (ICC=0.94). Intrauterine adhesions were diagnosed clinically in symptomatic patients (e.g., those with hypomenorrhea or amenorrhea) or following ultrasound suspicion, with confirmation by hysteroscopy; this pragmatic approach may not have identified mild, asymptomatic adhesions. All reported or observed adverse events were systematically recorded and classified.

Statistical analysis

Statistical analyses were conducted using SPSS software (version 25.0). Three analysis sets were pre-defined: the Full Analysis Set (FAS), based on the intention-to-treat principle, which included all randomized subjects who received at least one dose of treatment and had one post-treatment assessment; the Per-Protocol Set (PPS), a subset of the FAS comprising participants with good compliance, complete key outcome data and no major protocol deviations; and the Safety Set (SS), which included all subjects who received at least one treatment dose. Continuous, non-normally distributed data are presented as median and interquartile range (IQR) and were compared using the Kruskal-Wallis H test, with post-hoc pairwise Mann-Whitney U tests and Bonferroni correction for multiple comparisons. Categorical data are presented as counts and percentages (%) and were compared using the Chi-square test or Fisher’s exact test, as appropriate.

Handling of missing data and sensitivity analyses

For the primary FAS analysis, a complete-case approach was used due to the low proportion of missing data (<9% per group), which was judged to be missing completely at random. The robustness of the primary findings was verified through sensitivity analyses: (1) applying the Last Observation Carried Forward (LOCF) method for key continuous outcomes in the FAS and (2) comparing results between the FAS and PPS. A post-hoc ANCOVA adjusting for age and high-risk status was also performed for the primary outcome.

A post-hoc power analysis using GPower software, based on the observed effect size for vaginal bleeding duration, confirmed a statistical power >95% (α=0.05). A CONSORT flow diagram details participant progression through the trial stages (Fig. 1).

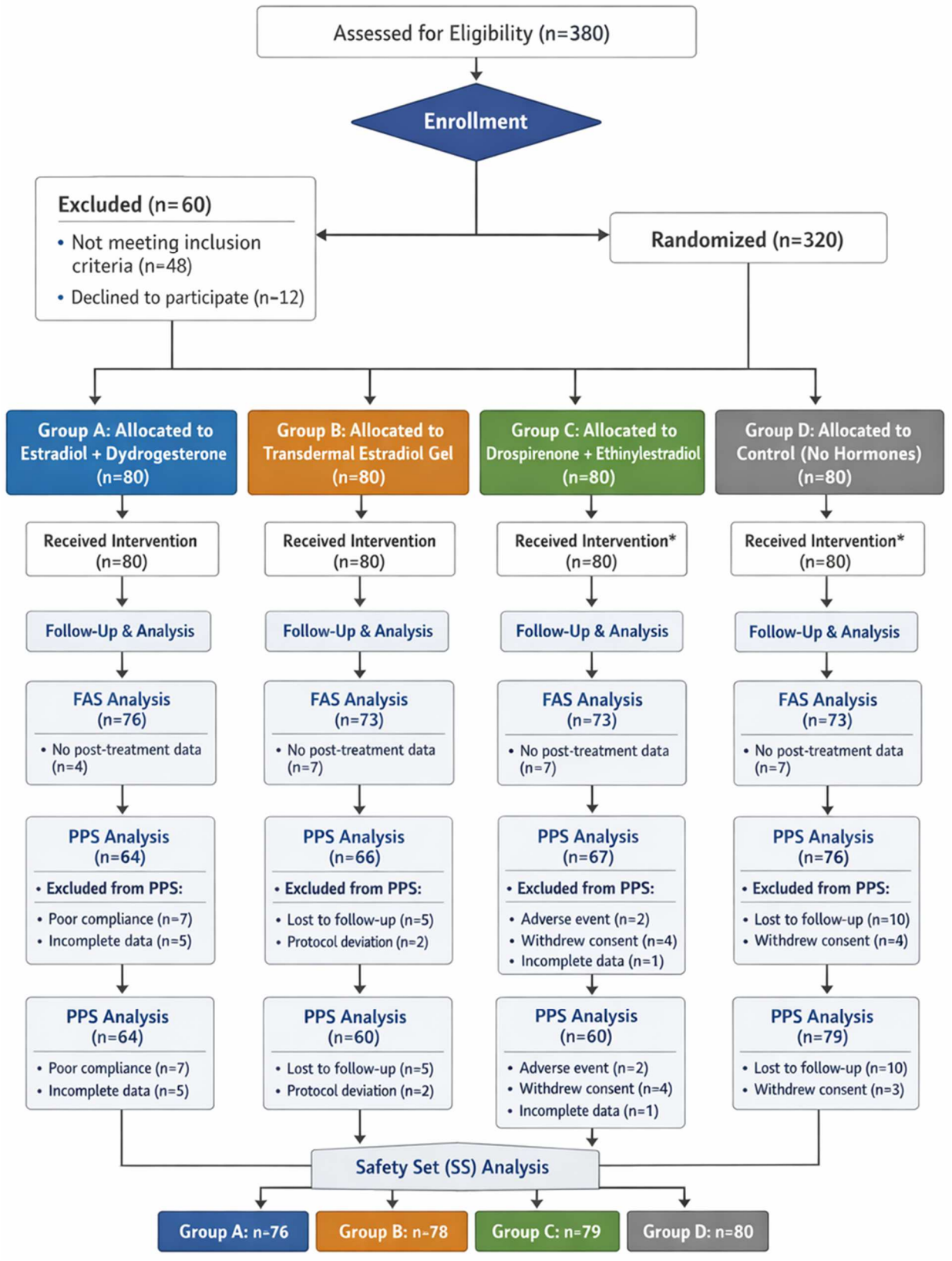

Fig. 1: CONSORT flow diagram detailing participant enrollment, allocation, follow-up, and analysis. FAS = Full Analysis Set; PPS = Per-Protocol Set; SS = Safety Set. *Group D received standard surgical/postoperative care without hormonal treatment.

RESULTS

Participant flow and baseline characteristics

A total of 320 patients were randomized. The flow of participants through enrollment, allocation, follow-up and analysis is detailed in the CONSORT diagram (Fig. 1). The primary reasons for dropout were loss to follow-up (n=18) and withdrawal of consent for personal reasons unrelated to treatment (n=6); only two subjects in Group C discontinued due to an adverse event (irregular bleeding). The final analysis sets comprised: Full Analysis Set (FAS, n=296), Per-Protocol Set (PPS, n=257) and Safety Set (SS, n=313). The distributions are shown in table 1.

Baseline demographic and clinical characteristics were well-balanced across the four groups in both the FAS and PPS, confirming successful randomization. There were no significant differences in age or the proportion of patients with high-risk factors for poor uterine recovery (e.g., history of multiple abortions) (Tables 2 and 3, all $P > 0.05$). Adherence rates, defined as taking ≥80% of the study medication, were high and comparable across active treatment groups (Group A: 92%, Group B: 90%, Group C: 91%).

Comparison of general data

Patients included in FAS and PPS data sets are similar ($P > 0.05$) in terms of age, whether there are high-risk factors (missed abortion, abortion times of two or more times, incomplete abortion and curettage, infectious abortion, history of placenta adhesion or uterine cavity operation, etc.) (Tables 2 and 3), which are comparable.

Postoperative outcomes

Significant differences were observed among the four groups regarding the duration of postoperative vaginal bleeding ($P<0.001$). Pairwise comparisons revealed that all three active treatment groups had a significantly shorter median duration of bleeding (Group A: 4 days [IQR 2-6]; Group B: 4 days [2-7]; Group C: 3 days [2-6.5]) compared to the control group (6 days [4-7]) (all $P<0.05$ after Bonferroni correction). There were no significant differences among the active treatment groups. These findings are detailed in table 4.

Regarding the days to first menstruation after operation, a significant difference was also noted among the four groups ($P<0.05$). Pairwise comparisons indicated that Groups A and C had a significantly shorter time to menstrual regain compared to Groups B and D ($P<0.05$). However, there was no significant difference between Group A and Group C ($P>0.05$), nor between Group B and Group D ($P>0.05$). These results are also presented in table 4.

Conversely, no significant differences were found among the four groups in the incidence of postoperative infection ($P=0.123$) or clinically diagnosed IUA ($P=0.583$) during the six-month follow-up (Table 4).

Finally, analysis of postoperative endometrial thickness measured at 22±7 days post-operation, endometrial thickness differed significantly among groups ($P<0.001$, Table 5). Post-hoc analysis showed that Group B (Transdermal Estradiol Gel) achieved a significantly greater median endometrial thickness (0.6 cm [0.5-0.8]) than Group A (0.5 cm [0.4-0.7]), Group C (0.4 cm [0.3-0.5]) and the control group (0.4 cm [0.4-0.6]) (all $P<0.05$). The distributions for Groups C and D, while sharing an identical median (0.4 cm), were significantly different (Mann-Whitney U, $p=0.032$), with Group C showing a tighter, lower range. A post-hoc analysis confirmed no correlation between the exact day of ultrasound measurement within the 15-29 days window and endometrial thickness (Spearman's $\rho = -0.08$, $p = 0.17$).

Safety and adverse events

Safety was analyzed in the SS (n=313). The overall incidence of AEs differed significantly among groups ($P<0.001$, Table 6). Group C (COC) had a significantly higher rate of AEs (46.6%) compared to the control group (12.1%) and Group A (13.8%) (both $P<0.008$ after correction). The most common AE was irregular uterine bleeding, which was significantly more frequent in Group C (44.4% of events) than in the control group (13.0%) ($P<0.001$). A post-hoc exploratory analysis within Group C found no association between irregular bleeding and patient age, parity, or high-risk status (all $p > 0.10$). All reported AEs were mild and self-limiting, requiring no intervention. A detailed account of AEs is provided in table 6, where the 'Overall adverse reaction' row counts unique patients and subcategories count the number of event occurrences.

Sensitivity analyses

The results for all primary and secondary efficacy outcomes were consistent between the FAS and PPS analyses. A sensitivity analysis applying the Last Observation Carried Forward (LOCF) method to the FAS for key continuous outcomes yielded findings congruent with the primary complete-case analysis. Furthermore, a post-hoc ANCOVA for the primary outcome (vaginal bleeding days), adjusting for age and high-risk status, did not alter the statistical conclusions.

DISCUSSION

This randomized controlled trial demonstrates that prophylactic hormonal treatment following induced abortion offers significant benefits for uterine recovery, with different regimens providing distinct advantages. Our key findings are threefold: first, all three active treatments (estradiol + dydrogesterone, estradiol gel and drospirenone + ethinyl estradiol) effectively shortened the duration of postoperative vaginal bleeding compared to no treatment.

Table 1: Distribution of statistical analysis data set.

Group	FAS data set	PPS data set	SS data set	Falloff case	Rejection number	Dropping rate (%)
Femostone	76	64	76	4	12	5.00
Estradiol gel	73	66	78	7	7	8.75
Yousiyue	74	67	79	6	7	7.50
Blank group	73	60	80	7	13	8.75

Note: FAS = Full Analysis Set (all randomized patients who received at least one dose of study treatment and had at least one post-baseline efficacy assessment). PPS = Per-Protocol Set (patients who completed the study without major protocol violations). SS = Safety Set (all patients who received at least one dose of study treatment). Falloff case = number of patients who discontinued the study prematurely. Rejection number = number of patients excluded from the PPS due to major protocol deviations. Dropping rate (%) = (Rejection number / FAS) × 100.

Table 2: General situation of each group [M (P25, P75)] (FAS).

Variable	Groups					
	Group A (n=76)	Group B (n=73)	Group C (n=74)	Group D (n=73)	F/χ2 value	P value*
Age (years)	28 (24,30.5)	27 (24,29)	30 (26,32)	28 (25,33)	6.698	0.082
High risk factors (%)	43 (23.9)	41 (22.8)	47 (26.1)	49 (27.2)	2.680	0.445

*Difference between the four groups, $P < 0.05$.

Note: M = median; P25 = 25th percentile; P75 = 75th percentile. Group A = Femostone; Group B = Estradiol gel; Group C = Yousiyue; Group D = Blank group (control). FAS = Full Analysis Set (defined in Table 1). High risk factors = presence of any of the following: smoking, body mass index ≥25 kg/m², prior uterine surgery, or history of pelvic inflammatory disease. F value = statistic from one-way ANOVA for age; χ^2 value = Chi-square statistic for high risk factors. P-value = significance level for differences among the four groups. A P value < 0.05 was considered statistically significant. In this table, all P values > 0.05, indicating no significant differences among groups at baseline.

Table 3: General situation of each group [M (P25, P75)] / (%) (PPS).

Variable	Groups					
	Group A (n=76)	Group B (n=73)	Group C (n=74)	Group D (n=73)	F/χ2 value	P value*
Age (years)	28 (25,30)	26 (24,29)	30 (26,32)	28.5 (25,32)	6.541	0.088
High risk factors (%)	38 (24.1)	39 (24.7)	41 (25.9)	40 (25.3)	0.963	0.813

*Difference between the four groups, $P < 0.05$.

Note: M = median; P25 = 25th percentile; P75 = 75th percentile. Group A = Femostone; Group B = Estradiol gel; Group C = Yousiyue; Group D = Blank group (control). PPS = Per-Protocol Set (defined in Table 1). High risk factors = presence of any of the following: smoking, body mass index ≥25 kg/m², prior uterine surgery, or history of pelvic inflammatory disease. F value = statistic from one-way ANOVA for age; χ^2 value = Chi-square statistic for high risk factors. P-value = significance level for differences among the four groups. A P value < 0.05 was considered statistically significant. In this table, all P values > 0.05, indicating no significant differences among groups in the PPS population.

Second, the regimens had divergent effects on other outcomes; both the sequential (estradiol + dydrogesterone) and combined oral contraceptive (drospirenone + ethinyl estradiol) regimens promoted a faster return of menstruation, while transdermal estradiol gel was uniquely superior in significantly increasing endometrial thickness. Third, all treatments exhibited a good safety profile, with irregular bleeding being the most common, yet self-limiting, adverse event, particularly in the combined oral contraceptive group.

Induced abortion may lead to a series of sequelae, such as traumatic bleeding, postoperative infection, intrauterine adhesions, menstrual disorders, infertility, premature delivery, etc., which seriously affect female fertility (Toma *et al.*, 2025; Shen *et al.*, 2022).

Table 4: Effectiveness results [M (P25, P75)].

Variable	Groups					
	Group A (n=76)	Group B (n=73)	Group C (n=74)	Group D (n=73)	H/χ2 value	P value #
Average postoperative vaginal bleeding days (d)a	4 (2,6)	4 (2,7)	3 (2,6.5)	6 (4,7)	31.092	0.000
Days of first menstrual regain after operation (d)b	33(31,37)	36(33.5,42)	32 (29,35)	38 (35,44)	54.560	0.000
Postoperative infection (%)	1 (5.3)	5 (26.3)	6 (31.6)	7 (36.8)		0.123*
Intrauterine adhesion (%)	3 (13.6)	6 (27.3)	6 (27.3)	7 (31.8)	1.950	0.583
Mild adhesion (%)	3 (21.4)	5 (35.7)	4 (28.6)	2 (14.3)		
Moderate adhesion (%)	0 (0.0)	1 (16.7)	2 (33.3)	3 (50.0)		0.302a
Severe adhesion (%)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)		

Note: *Fisher exact test; # Difference between the four groups, P < 0.05; (a) A-B group P=1.000, A-C group P=1.000, A-D group P=0.000, B-C group P=1.000, B-D group P=0.001, C-D group P=0.000; (b) A-B group P=0.001, A-C group P=0.668, A-D group P=0.000, B-C group P=0.000, B-D group P=1.000, C-D group P=0.000. Conversely, no significant differences were found among the four groups in the incidence of postoperative infection (P=0.123) or clinically diagnosed IUA (P=0.583) during the six-month follow-up (Table 4). M = median; P25 = 25th percentile; P75 = 75th percentile. Group A = Femostone; Group B = Estradiol gel; Group C = Yousiyue; Group D = Blank group (control). H value = Kruskal-Wallis test statistic for continuous variables; χ^2 value = Chi-square test statistic for IUA.

Table 5: Endometrial thickness [M (P25, P75)].

Variable	Groups					
	Group A (n=64)	Group B (n=66)	Group C (n=67)	Group D (n=60)	H value	P value #
Endometrial thickness (cm)c	0.5 (0.4,0.7)	0.6 (0.5,0.8)	0.4 (0.3,0.5)	0.4 (0.4,0.6)	33.018	0.000

Note: # Difference between the four groups, P < 0.05; (c) A-B group P=0.033, A-C group P=0.093, A-D group P=0.393, B-C group P=0.000, B-D group P=0.000, C-D group P=1.000

Table 6: Comparison of adverse events.

Variable	Groups					
	Group A (n=76)	Group B (n=78)	Group C (n=79)	Group D (n=80)	χ2 value	P value #
Overall adverse reaction (%) d	8 (13.8)	16 (27.6)	27 (46.6)	7 (12.1)	21.309	0.000
Nausea and vomiting (%)	1 (33.3)	0 (0.0)	2 (66.7)	0 (0.0)		0.286*
Tender breasts (%)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)		0.744*
Irregular uterine bleeding (%) e	7 (13.0)	16 (29.6)	24 (44.4)	7 (13.0)	17.611	0.001

Note: *Fisher exact test; # Difference between the four groups, P < 0.05; (d) group d: A-B P=0.068, group A-C P=0.000, group A-D P=0.707, group B-C P=0.041, group B-D P=0.030, group C-D P=0.000, p < 0.008; (e) group e: A-B P=0.049, group A-C P=0.001, group A-D P=0.920, group B-C P=0.156, group B-D P=0.036, group C-D P=0.001, p < 0.008. M = median; P25 = 25th percentile; P75 = 75th percentile. Endometrial thickness was measured by transvaginal ultrasound on day 21 of the menstrual cycle (or corresponding day for anovulatory patients) during the third post-treatment cycle. PPS = Per-Protocol Set (patients who completed the study without major protocol violations, as defined in Table 1). H value = Kruskal-Wallis test statistic for comparison among the four groups. P-value = significance level for differences among the four groups. A P value < 0.05 was considered statistically significant.

In particular, its direct damage to the endometrium may lead to the formation of thin endometrium, which not only makes the pregnancy probability low, but also may cause a significant increase in the risk of miscarriage and ectopic pregnancy (Mouhayar *et al.*, 2019; Zheng *et al.*, 2022). At the same time, the low birth weight and premature delivery have also increased by two times and the risk of intrauterine growth restriction and compound adverse perinatal outcome has increased significantly (Kale and Fonseca, 2023; Carvalho *et al.*, 2024). Therefore, it is particularly important to prevent the formation of thin endometrium caused by induced abortion.

The primary benefit of reduced postoperative bleeding aligns with the known hemostatic and stabilizing effects of exogenous hormones on the disrupted endometrium (Hu *et*

al., 2023; Sallam and Shady, 2019). The comparable efficacy of all three active regimens in this regard underscores their utility as foundational interventions. The most clinically distinctive finding was the superior effect of transdermal estradiol gel on endometrial thickness (Carvalho *et al.*, 2024). This may be attributed to its pharmacokinetic profile, which provides continuous, stable systemic delivery of estradiol, avoiding hepatic first-pass metabolism. This likely results in higher and more consistent bioavailable estrogen levels at the endometrial level compared to the lower-dose (1 mg) oral estradiol used in Group A, thereby more robustly stimulating proliferation of the basal layer (Parkpinyo *et al.*, 2025).

The comparable time to first menstruation in the sequential therapy (Group A) and COC (Group C) groups, both of which were shorter than in the gel-only and control groups, can be explained by their shared pharmacological mechanism of inducing scheduled withdrawal bleeding. In Group A, dydrogesterone stabilizes and differentiates the estrogen-primed endometrium; its planned withdrawal triggers menses. Similarly, the fixed regimen of estrogen and progestin in Group C maintains the endometrium, with menstruation predictably following the hormone-free interval (Barretta and Grandi, 2025). Thus, both regimens provide an external hormonal schedule that overrides the disrupted endogenous cycle, leading to faster and more predictable menstrual recovery. In contrast, unopposed estrogen (Group B), while excellent for proliferation, does not provide the progestogenic trigger for organized shedding, resulting in a menstrual return time similar to the untreated group.

The higher incidence of irregular bleeding in the COC group, while a known side effect, did not correlate with any baseline demographic factors in our post-hoc analysis and was manageable in all cases (Barretta and Grandi, 2025). This reinforces its safety profile for use in this setting. The absence of a significant difference in postoperative infection and clinically diagnosed intrauterine adhesions (IUA) should be interpreted with caution (Zheng *et al.*, 2020; Xu *et al.*, 2024). Our diagnostic strategy for IUA, while pragmatic and reflective of real-world practice, was contingent on symptoms or ultrasound suspicion, likely underestimating the true incidence of mild, asymptomatic adhesions (Khan *et al.*, 2025; Efficace *et al.*, 2022; Monaghan *et al.*, 2021). Therefore, our study cannot definitively conclude on the preventive effect of these regimens on adhesion formation, only on symptomatic disease.

Several limitations must be acknowledged when interpreting our results. First, the single-center design may affect the generalizability of our findings. The lack of blinding, though unavoidable given the different drug formulations (oral vs. transdermal), may have introduced bias in patient-reported outcomes. Second, our follow-up period was sufficient to assess short-to-medium-term recovery markers but not long-term fertility outcomes. Third, while our primary analysis was robust and supported by sensitivity analyses (LOCF, FAS vs. PPS), we did not pre-specify covariate-adjusted models. A post-hoc ANCOVA confirmed the robustness of our primary finding, but future studies may consider such adjustments for increased precision. Fourth, as noted, the diagnosis of IUA was not universally confirmed by hysteroscopy, potentially missing subclinical cases. Finally, while compliance was high and monitored, the reliance on self-report and packet counts, though standard, has inherent limitations.

CONCLUSION

This study enables more personalized clinical decision-making post-abortion. For women seeking reliable contraception, drospirenone-ethinylestradiol tablets (COC) are valuable, effectively shortening bleeding, promoting rapid cycle regularity and providing contraception. For women prioritizing future fertility, particularly those at risk for thin endometrium, transdermal estradiol gel offers a significant advantage in promoting endometrial regeneration. If cycle regulation is also desired in this group, sequential estrogen-progesterone therapy presents a balanced option. All regimens demonstrated a favorable safety profile. These findings provide a clear evidence base for tailoring post-abortion hormonal support to align with immediate contraceptive needs and long-term reproductive goals.

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Authors' contributions
QH: Writing – original draft; HL, XD and XW: Review and editing; SW: Writing – review and editing, funding acquisition and supervision.

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Data availability statement
All data are available on request from the corresponding author.

Ethical approval
This study was conducted in accordance with the ethical standards of the institutional and national research committees and the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of Leshan People's Hospital [approval no. 107 (20210)]. Informed consent was obtained from all participants prior to their inclusion in the study. This study was performed in adherence with the CONSORT guidelines. See supplementary file for the CONSORT checklist.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary data

https://www.pjps.pk/uploads/2026/05/SUP1778927270.pdf

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