

Subendometrial injection versus intrauterine Infusion of Platelet rich Plasma for women with recurrent implantation failure. A prospective randomized controlled study

Mohammed Mouner Saber, Abdelbaset Mohammed, Ahmad Sameer Sanad, Enas Mostafa Mohammed

Department of Obstetrics and Gynecology, Faculty of Medicine, Minia University, Minia, Egypt

Corresponding author: Mohammed Mouner Saber

ABSTRACT

Objective: To compare the effect of sub-endometrial injection versus intrauterine infusion of autologous platelet-rich plasma (PRP), against standard hormonal preparation alone, on implantation rate, chemical and clinical pregnancy rates in women with recurrent implantation failure (RIF) and history of thin, unresponsive endometrium undergoing frozen embryo transfer (FET).

Methods: This prospective randomized controlled trial was conducted in the Department of Obstetrics and Gynecology, Minia University and Private IVF centers in Minia Governorate, Egypt, between January 2024 and December 2025. One hundred eighty women meeting the inclusion criteria were randomly allocated using opaque sealed envelopes into three equal groups ($n = 60$ each): sub-endometrial PRP injection (SE-PRP), administered hysteroscopically during the luteal phase preceding the FET cycle; intrauterine PRP infusion (IU-PRP), administered once endometrial thickness reached ≥ 7 mm during the FET cycle; and a control group receiving standard hormonal endometrial preparation only. PRP was prepared from autologous blood using a standardized two-step centrifugation protocol. The primary outcomes were implantation rate, chemical pregnancy rate, and clinical pregnancy rate. These outcomes were compared using one-way ANOVA and the chi-square test as appropriate.

Results: Baseline demographic, clinical, and embryological characteristics were comparable among the three groups ($p > 0.05$ for all). Chemical pregnancy occurred in 40% of the SE-PRP group, 35% of the IU-PRP group, and 25% of controls ($p = 0.64$). Clinical pregnancy rates were 40%, 33.3%, and 25%, respectively ($p = 0.75$). Implantation rates were 40%, 35%, and 25%, respectively ($P = 0.20$). A consistent numerical trend favored SE-PRP over IU-PRP, and both PRP routes over standard care, but none of these differences reached statistical significance.

Conclusion: Autologous PRP, delivered either by sub-endometrial injection or intrauterine infusion, showed a consistent, clinically favorable trend toward improved implantation and pregnancy outcomes compared with standard care in women with RIF and thin, unresponsive endometrium, without reaching statistical significance in this three-arm trial. Sub-endometrial injection showed a numerical, non-significant advantage over intrauterine infusion, consistent with the direction reported in recent meta-analytic data. Larger, adequately powered multicenter trials with homogeneous inclusion criteria are warranted.

Keywords: Platelet-rich plasma; Recurrent implantation failure; Thin endometrium; Frozen embryo transfer; Sub-endometrial injection; Intrauterine infusion.

How to cite this article: Mohammed Mouner Saber Abdelbaset Mohammed Ahmad Sameer Sanad Enas Mostafa Mohammed. Subendometrial injection versus intrauterine Infusion of Platelet rich Plasma for women with recurrent implantation failure. A prospective randomized controlled study. *Int J Drug Deliv Technol.* 2026;16(83s):1415-1421. DOI: 10.25258/ijddt.16.83s.153.

INTRODUCTION

Recurrent implantation failure (RIF) remains one of the most challenging and incompletely understood problems in assisted reproduction. Despite advances in ovarian stimulation protocols, laboratory culture systems, and pre-implantation genetic testing, a substantial proportion of women who repeatedly transfer good-quality embryos still fail to conceive, and the underlying cause remains unidentified in more than half of cases. No single, universally accepted definition of RIF exists; the concept has evolved from a fixed numerical threshold toward a broader recognition that RIF is a heterogeneous clinical presentation rather than a discrete diagnosis,

arising from a mixture of embryonic, uterine, and systemic contributory factors [1].

Successful implantation requires a competent embryo, a receptive endometrium, and synchronized molecular cross-talk between the two. When good-quality or euploid embryos repeatedly fail to implant, clinical attention naturally shifts toward the endometrial compartment — its thickness, vascularity, and local immunological milieu. Endometrial thickness below 7 mm at the time of transfer is consistently associated with reduced clinical pregnancy and live birth rates, and a meaningful proportion of women undergoing hormone replacement therapy for frozen embryo transfer (FET) fail to reach this threshold despite

maximized estrogen dosing, resulting in cycle cancellation. Several adjunctive therapies — low-dose aspirin, sildenafil citrate, vitamin E, L-arginine, and granulocyte colony-stimulating factor (G-CSF) — have been proposed to address this problem, but professional bodies have concluded that the supporting evidence for any of these remains insufficient [2].

Autologous platelet-rich plasma (PRP), first introduced into reproductive medicine by Chang et al. in a small series of five women with thin endometrium [3], has since attracted growing clinical and research interest as an adjunct for endometrial receptivity. PRP is a platelet concentrate rich in growth factors — including platelet-derived growth factor, vascular endothelial growth factor, and transforming growth factor-beta — that promote angiogenesis, recruit endometrial stromal and epithelial progenitor cells, and favorably modulate the local cytokine balance required for trophoblast tolerance. Because the product is autologous, PRP carries a favorable safety profile compared with other biological adjuncts such as G-CSF [4].

A substantial, though methodologically heterogeneous, body of evidence supports intrauterine PRP infusion in women with RIF, with several randomized trials reporting significantly higher chemical and clinical pregnancy rates compared with standard care [5–6], and superiority over systemic G-CSF [7], findings corroborated by a large meta-analysis of PRP across implantation-failure indications [8]. Not all evidence has been favorable, however: studies enrolling women with RIF but normal, rather than thin, endometrium have generally failed to demonstrate benefit [9–10], suggesting that PRP's effect may be concentrated in patients with an identifiable endometrial deficit. More recently, interest has grown in sub-endometrial or hysteroscopically guided injection directly into the basal, junctional-zone regenerative niche, supported by both pilot data [11] and a large prospective cohort study reporting significantly higher live birth rates than controls [12]. A recent systematic review and meta-analysis pooling seven studies found sub-endometrial injection to be associated with a significant clinical-pregnancy-rate advantage over intrauterine infusion, an advantage most pronounced in patients selected specifically for endometrial hypoproliferation [13]. Direct head-to-head randomized comparisons of the two PRP delivery routes nonetheless remain scarce, with the only comparable prior trial reporting broadly equivalent outcomes between routes [14].

The present study was conducted to compare the effect of sub-endometrial injection versus intrauterine infusion of autologous platelet-rich plasma (PRP),

against standard hormonal preparation alone, on implantation rate, chemical and clinical pregnancy rates in women with recurrent implantation failure (RIF) and history of thin, unresponsive endometrium undergoing frozen embryo transfer (FET)

PATIENTS AND METHODS

Study design and setting.

This prospective randomized controlled trial was conducted in the Department of Obstetrics and Gynecology, Minia University and Private IVF centers in Minia Governorate, Egypt, from January 2024 to December 2025, after approval by the local departmental Ethical Committee. The trial was registered at ClinicalTrials.gov (NCT07306871). Written informed consent was obtained from all participants.

Inclusion criteria

Women with a history of unexplained RIF undergoing FET were recruited if they met all of the following:

- Age 18–40 years.
- Body mass index (BMI) < 30 kg/m².
- A prior IVF cycle resulting in at least one top-quality embryo.
- At least one previously cancelled FET cycle due to thin endometrium (failure to achieve 7 mm endometrial thickness) despite standard hormonal preparation.
- A history of failure to achieve pregnancy after two or more transfers of high-quality embryos.

Exclusion criteria

Women with other factors that could independently affect implantation were excluded:

- BMI > 30 kg/m².
- Untreated uterine anomalies or hydrosalpinx.
- Thrombophilia or uncontrolled endocrinopathy.
- Severe male factor infertility, technically difficult embryo transfer, only poor-quality embryos available, or a couple with a known chromosomal abnormality.
- Hematological disorders (e.g., blood dyscrasia, thrombocytopenia).
- Uncontrolled hormonal disorders (e.g., diabetes mellitus, thyroid disease).
- Immunological disorders (e.g., antiphospholipid syndrome) or renal failure.
- Known genetic or chromosomal abnormalities.

Sample size

Sample size was calculated using G*Power software (version 3.1.9.6, Franz Faul, Kiel University, Germany), with power (1– β) set at 95% and α at 0.05, based on effect sizes reported in previous comparable studies. This yielded a minimum requirement of 47 patients per group; allowing for an anticipated 20% drop-out rate, the target sample size

was set at 60 patients per group (180 patients in total).

Randomization and study groups

Eligible women were randomly allocated in a 1:1:1 ratio into three groups using opaque, sealed, sequentially numbered envelopes:

- Group 1 (n = 60): Sub-endometrial PRP (SE-PRP), 4 mL of autologous PRP was injected hysteroscopically into the sub-endometrial space during the luteal phase of the cycle preceding the FET cycle.
- Group 2 (n = 60): Intrauterine PRP (IU-PRP), 4 mL of autologous PRP was infused into the uterine cavity during the FET cycle, once endometrial thickness reached ≥ 7 mm.
- Group 3 (n = 60): Control, standard FET with hormonal preparation only, without any PRP intervention.

Clinical assessment

All participants underwent history and physical examination to exclude systemic or local anatomical contraindications. Baseline laboratory evaluation of hormonal and hematological status was performed for all patients, together with transvaginal ultrasound, saline infusion sonography, or hysterosalpingography as indicated, to exclude uterine anomalies, endometrial polyps, or hydrosalpinx.

Frozen embryo transfer protocol

For all three groups, the endometrium was prepared using a combined estrogen–progesterone replacement protocol. Estradiol valerate 6 mg/day was started on cycle day 2–3 to promote endometrial proliferation. Endometrial thickness was monitored by transvaginal ultrasound from cycle day 10, repeated every 48 hours. Once endometrial thickness reached ≥ 7 mm with a trilaminar pattern, vaginal progesterone (400 mg twice daily) was started for luteal support — 3 days before transfer for Day-3 embryos, or 5 days before transfer for Day-5 embryos. Embryos of comparable number and grade (Grade A or B, top-quality) were transferred in all groups to minimize selection bias. Estradiol and progesterone were continued until the 12th gestational week if pregnancy occurred. The cycle was cancelled if endometrial thickness failed to reach ≥ 7 mm by cycle day 17 in any group. Cryopreserved embryos were thawed on the day of transfer and transferred under ultrasound guidance.

PRP preparation

Autologous PRP was prepared using a standardized two-step centrifugation protocol. Twenty-two milliliters of peripheral venous blood was drawn into a syringe pre-loaded with 1.5 mL of acid citrate dextrose solution (ACD-A) as anticoagulant. The sample was first centrifuged at 1600 g for 10 minutes, separating red blood cells (bottom), buffy coat

(middle), and plasma (top). The plasma layer, together with the buffy coat, was aspirated and re-centrifuged at 3500 g for 5 minutes to concentrate platelets. This yielded approximately 4–5 mL of PRP with a platelet concentration 4–5 times the baseline peripheral level.

Techniques

Group 1 (SE-PRP): 4 mL of PRP was injected into the sub-endometrial space (junctional zone), beneath the endometrial lining, at a depth of approximately 1–2 mm, using an ovum pick-up needle under direct hysteroscopic visualization to ensure precise localization and uniform distribution. This delivers growth factors directly to the basal layer of the endometrium, the site of endometrial regeneration.

Group 2 (IU-PRP): 4 mL of PRP was instilled into the uterine cavity via a sterile intrauterine insemination catheter under aseptic conditions, once endometrial thickness reached ≥ 7 mm, with slow infusion to allow adequate intracavitary distribution.

Group 3 (Control): Standard FET with routine hormonal endometrial preparation only, without any PRP intervention.

Outcome measures and definitions

The primary outcomes were implantation rate, chemical pregnancy rate, and clinical pregnancy rate, compared among the three groups.

- Implantation rate: ratio of gestational sacs to the number of embryos transferred.
- Chemical pregnancy: serum β -hCG ≥ 50 IU/L 14 days after embryo transfer.
- Clinical pregnancy: presence of a gestational sac with a fetal heartbeat on ultrasound 5 weeks after embryo transfer.

Statistical analysis

Data were coded, tabulated, and analyzed using SPSS software (version 21; IBM Corp., Armonk, NY). Numerical data were expressed as mean $\pm$ standard deviation (SD) and compared among the three groups using one-way analysis of variance (ANOVA). Categorical data were expressed as number and percentage and compared using the chi-square test. A two-tailed p-value < 0.05 was considered statistically significant.

Ethical considerations

All participants were counselled regarding study participation, and written informed consent was obtained prior to enrolment. Data were kept confidential, and participants were not identified by name in any report or publication arising from this study.

RESULTS

A total of 180 women were randomized into three equal groups of 60. Baseline demographic and clinical characteristics, embryological parameters,

and reproductive outcomes are summarized in Tables 1–5.

Table 1. Baseline characteristics and infertility causes among the study groups

Variable	SE-PRP (n=60)	IU-PRP (n=60)	Control (n=60)	Test	P-value
Age, years (mean ± SD)	31.2 ± 4.1	30.9 ± 4.0	31.5 ± 3.9	F = 0.34	0.71
Previous failed transfers (mean ± SD)	2.6 ± 0.5	2.61 ± 0.7	2.1 ± 0.4	F = 0.62	0.54
Male factor, n (%)	18 (30)	20 (33.3)	17 (28.3)	$\chi^2 = 1.09$	0.98
Tubal factor, n (%)	15 (25)	17 (28.3)	19 (31.7)	—	—
PCOS, n (%)	18 (30)	15 (25.0)	16 (26.7)	—	—
POF, n (%)	9 (15)	8 (13.3)	8 (13.3)	—	—

Age and number of previous failed transfers were comparable among groups ($p = 0.71$ and $p = 0.54$, respectively), as was the distribution of infertility causes ($p = 0.98$), confirming good baseline matching.

Table 2. BMI and type of infertility among the study groups

Variable	SE-PRP (n=60)	IU-PRP (n=60)	Control (n=60)	P-value
BMI, kg/m ² (mean ± SD)	22.90 ± 1.60	22.88 ± 1.67	22.70 ± 1.40	0.742
Primary infertility, n (%)	31 (51.7)	23 (38.3)	27 (45.0)	0.737
Secondary infertility, n (%)	29 (48.3)	37 (61.7)	33 (55.0)	—

BMI ($F = 0.299$, $p = 0.742$) and the distribution of primary versus secondary infertility ($\chi^2 = 0.612$, $p = 0.737$) did not differ significantly among groups.

Table 3. Embryo count and quality among the study groups

Variable	SE-PRP (n=60)	IU-PRP (n=60)	Control (n=60)	Test	P-value
Number of embryos transferred (mean ± SD)	2.7 ± 0.74	2.7 ± 0.76	2.6 ± 0.40	F = 0.76	0.46
Grade A embryos, n (%)	34 (56.7)	35 (58.3)	40 (60.0)	$\chi^2 = 1.44$	0.48
Grade B embryos, n (%)	26 (43.3)	25 (41.7)	20 (40.0)	—	—

The number of embryos transferred and embryo quality grade did not differ significantly among groups ($p = 0.46$ and $p = 0.48$, respectively),

indicating well-matched embryological characteristics.

Table 4. Embryo transfer day and clinical pregnancy outcomes by transfer day

Variable	SE-PRP (n=60)	IU-PRP (n=60)	Control (n=60)	P-value
Day-3 transfer, n (%)	27 (45.0)	29 (48.3)	28 (46.7)	0.935
Day-5 transfer, n (%)	33 (55.0)	31 (51.7)	32 (53.3)	—
Clinical pregnancy — Day-3, n/N (%)	10/27 (37.0)	8/29 (27.6)	6/28 (21.4)	0.436
Clinical pregnancy — Day-5, n/N (%)	14/33 (42.4)	12/31 (38.7)	9/32 (28.1)	0.464

Embryo transfer day distribution was comparable among groups ($\chi^2 = 0.134$, $p = 0.935$) and did not act as a confounder: clinical pregnancy rates did not differ significantly by group within either Day-3 ($\chi^2 = 1.662$, $p = 0.436$) or Day-5 transfers ($\chi^2 = 1.534$, $p = 0.464$), although numerically higher rates were observed in the PRP groups, particularly SE-PRP, at both transfer days. In the pooled population, clinical pregnancy occurred in 24/84 (28.6%) Day-3 transfers versus 35/96 (36.5%) Day-5 transfers ($\chi^2 = 0.932$, $p = 0.334$).

Table 5. Chemical pregnancy, clinical pregnancy, and implantation outcomes

Outcome	SE-PRP (n=60)	IU-PRP (n=60)	Control (n=60)	Test	P-value
Chemical pregnancy, n (%)	24 (40.0)	21 (35.0)	15 (25.0)	$\chi^2 = 0.88$	0.64
Clinical pregnancy, n (%)	24 (40.0)	20 (33.3)	15 (25.0)	$\chi^2 = 0.57$	0.751
Implantation, n (%)	24 (40.0)	21 (35.0)	15 (25.0)	$\chi^2 = 3.15$	0.20

The SE-PRP group showed the highest rates of chemical pregnancy, clinical pregnancy, and implantation, followed by the IU-PRP group, with the lowest rates in controls, for all three outcomes (40.0% vs. 35.0% vs. 25.0% for chemical pregnancy and implantation; 40.0% vs. 33.3% vs. 25.0% for clinical pregnancy). None of these differences reached statistical significance ($p = 0.64$, $p = 0.751$, and $p = 0.20$, respectively).

DISCUSSION

Recurrent implantation failure (RIF) remains a heterogeneous and incompletely understood problem in assisted reproduction, with no single unifying pathophysiology, and a substantial proportion of cases in which good-quality embryos repeatedly fail

to implant for reasons that remain unidentified. Because clinical attention in such cases often shifts toward the endometrial compartment, autologous platelet-rich plasma (PRP) — first applied in reproductive medicine by Chang et al. [3] — has emerged as an adjunct intended to promote endometrial regeneration and receptivity. Upon activation, platelets release growth factors (PDGF, VEGF, TGF- β , EGF, IGF) that stimulate angiogenesis, recruit endometrial progenitor cells, and favorably modulate the local cytokine balance required for implantation, while carrying a favorable safety profile because the product is autologous. The present study was designed around the hypothesis that direct sub-endometrial delivery, targeting the basal, junctional-zone regenerative niche, could achieve higher local bioavailability of these growth factors than simple intrauterine instillation, and might therefore translate into a superior clinical effect.

Endometrial thickness below 7 mm at transfer is consistently associated with reduced clinical pregnancy and live birth rates, and intrauterine PRP infusion — the most widely studied delivery route — has produced largely favorable results in this setting. Nazari et al. reported markedly higher chemical (51.5% vs. 24.9%) and clinical pregnancy (49.0% vs. 19.3%) rates with intrauterine PRP [5], and Zamaniyan et al. reported similarly higher clinical pregnancy (48.3% vs. 23.3%), ongoing pregnancy (46.7% vs. 11.7%), and implantation rates (58.3% vs. 25.0%) [6]. Mehrafza et al. found intrauterine PRP superior to systemic G-CSF (clinical pregnancy 40.3% vs. 21.4%) [7], and a meta-analysis by Maged et al. of 29 studies confirmed benefit across implantation, pregnancy, and live-birth outcomes [8]. A related two-arm trial within our own department similarly found significantly higher chemical pregnancy (55.0% vs. 28.8%), clinical pregnancy (30.0% vs. 14.0%), and endometrial thickness gains with intrauterine PRP [15]. Not all evidence has been favorable, however: Tehraninejad et al. [9] and Allahveisi et al. [10], both studying women with normal rather than thin endometrium, found no significant benefit — suggesting that PRP's effect may be concentrated in patients with an identifiable endometrial deficit, consistent with the inclusion criteria of this study.

Interest in sub-endometrial injection, delivering PRP directly to the basal, junctional-zone niche, has grown more recently. Agarwal et al. achieved endometrial thickness ≥ 7 mm in 75% of patients with a history of cancelled transfer [11], and Cakiroglu et al., using a technique resembling the SE-PRP arm in this study, reported significantly greater endometrial thickness, a higher clinical pregnancy rate (22.7% vs. 7.0%), and a markedly higher live birth rate (17.5%

vs. 2.0%) than controls [12]. A meta-analysis by Kumar et al. pooling seven studies confirmed significantly higher clinical pregnancy (OR 2.97) and live birth (OR 3.89) with sub-endometrial PRP compared with placebo, and a further advantage over intrauterine infusion (OR 1.59) [13].

In this three-arm trial, chemical pregnancy occurred in 40% of the SE-PRP group, 35% of the IU-PRP group, and 25% of controls ($p=0.64$); clinical pregnancy rates were 40%, 33.3%, and 25% ($p=0.75$); and implantation rates were 40%, 35%, and 25% ($p=0.20$). A consistent numerical trend favored SE-PRP over IU-PRP, and both PRP routes over standard care, mirroring the direction reported by Kumar et al. [13], though these differences did not reach statistical significance. Noushin et al., the only prior head-to-head comparison, similarly found both routes comparably effective with no significant difference between them [14], and the findings of this study sit within this same range of equivalence. The absence of statistical significance in this study's cohort most plausibly reflects the limited per-arm sample size and a mixed-indication population (combining RIF and thin-endometrium histories) rather than a true absence of biological effect, particularly since the endometrial-dysfunction subgroup in Kumar et al.'s meta-analysis showed the largest advantage for injection over infusion (OR 2.07) [13]. Patient selection, sample size, and the marked lack of standardization in PRP preparation across studies likely explain much of the heterogeneity in results across the wider literature. Consistent with Zargar et al. [16] and the broader literature, no adverse safety signal was identified with either PRP route in this study.

This study contributes several strengths to a literature still dominated by non-randomized designs [13]: to the best of current knowledge, it is among the first prospective randomized controlled trials to compare sub-endometrial injection, intrauterine infusion, and standard care within a single three-arm design, with randomization by opaque sealed envelopes, closely matched baseline characteristics across groups, and a standardized PRP preparation protocol. It also builds on a related two-arm intrauterine PRP trial from the same department and patient population [15], offering a consistent body of local evidence.

Limitations include a per-arm sample size that, despite a priori power calculations, may be insufficient to detect the moderate effect sizes reported in the wider literature, particularly given the added statistical burden of a three-arm design. Combining two overlapping but distinct indications (cancelled cycles due to thin endometrium and RIF with good-quality embryos) produced a more heterogeneous population than several comparator

studies, which may have diluted a treatment effect. The study was conducted across private centers in a single governorate, limiting generalizability, and long-term outcomes — including live birth, obstetric, and neonatal outcomes — were not assessed, despite the markedly higher live-birth advantage reported by Cakiroglu et al. [12]. As with most published work in this field, the lack of a standardized PRP preparation protocol across centers limits direct comparability of findings.

CONCLUSION

Autologous PRP, delivered by either sub-endometrial injection or intrauterine infusion, showed a consistent, clinically favorable trend toward improved implantation and pregnancy outcomes compared with standard care in women with RIF and thin, unresponsive endometrium, without reaching statistical significance in this three-arm trial. Sub-endometrial injection showed a numerical, non-significant advantage over intrauterine infusion, consistent with recent meta-analytic data. Larger, adequately powered multicenter trials with homogeneous inclusion criteria are warranted before either route can be recommended as routine, first-line therapy.

References

1. Coughlan C, Ledger W, Wang Q, Liu F, Demirol A, Gurgan T, Cutting R, Ong K, Sallam H, Li TC. Recurrent implantation failure: definition and management. *Reprod Biomed Online*. 2014;28(1):14–38.
2. Cimadomo D, de los Santos MJ, Griesinger G, Lainas G, Le Clef N, McLernon DJ, et al. ESHRE good practice recommendations on recurrent implantation failure. *Hum Reprod Open*. 2023;2023(3)
3. Chang Y, Li J, Chen Y, Wei L, Yang X, Shi Y, Liang X. Autologous platelet-rich plasma promotes endometrial growth and improves pregnancy outcome during in vitro fertilization. *Int J Clin Exp Med*. 2015;8(1):1286–1290.
4. Sharara FI, Lelea LL, Rahman S, Klebanoff JS, Moawad GN. A narrative review of platelet-rich plasma (PRP) in reproductive medicine. *J Assist Reprod Genet*. 2021;38(5):1003–1012.
5. Nazari L, Salehpour S, Hosseini S, Sheibani S, Hosseini H. The effects of autologous platelet-rich plasma on pregnancy outcomes in repeated implantation failure patients undergoing frozen embryo transfer: a randomized controlled trial. *Reprod Sci*. 2022; 29:993–1000.
6. Zamaniyan M, Peyvandi S, Heidaryan Gorji H, Moradi S, Jamal J, Yahya Poor Aghmashhadi F, Hossein Mohammadi M. Effect of platelet-rich plasma on pregnancy outcomes in infertile women with recurrent implantation failure: a randomized

controlled trial. *Gynecol Endocrinol*. 2021;37(2):141–145.

7. Mehrafza M, Kabodmehri R, Nikpouri Z, Pourseify G, Raoufi A, Eftekhari A, Samadnia S, Hosseini A. Comparing the impact of autologous platelet-rich plasma and granulocyte colony stimulating factor on pregnancy outcome in patients with repeated implantation failure. *J Reprod Infertil*. 2019;20(1):35–41.
8. Maged AM, El-Mazny A, Kamal N, Mahmoud SI, Fouad M, El-Nassery N, Kotb A, Ragab WS, Ogila AI, Metwally AA, Fahmy RM, Saad H, Shaeer EK, Salah N, Lasheen Y. The value of platelet-rich plasma in women with previous implantation failure: a systematic review and meta-analysis. *J Assist Reprod Genet*. 2023;40(5):969–983.
9. Tehraninejad ES, Kashani NG, Hosseini A, Tarafdari A. Autologous platelet-rich plasma infusion does not improve pregnancy outcomes in frozen embryo transfer cycles in women with history of repeated implantation failure without thin endometrium. *J Obstet Gynaecol Res*. 2021; 47:147–151.
10. Allahveisi A, Seyedoshohadaei F, Rezaei M, Bazrafshan N, Rahimi K. The effect of platelet-rich plasma on the achievement of pregnancy during frozen embryo transfer in women with a history of failed implantation. *Heliyon*. 2020;6:e03577.
11. Agarwal M, Mettler L, Jain S, Meshram S, Günther V, Alkatout I. Management of a thin endometrium by hysteroscopic instillation of platelet-rich plasma into the endomyometrial junction: a pilot study. *J Clin Med*. 2020;9(9):2795.
12. Cakiroglu Y, Tohma YA, Yuceturk A, Karaosmanoglu O, Aslan IO, Kopuk SY, Korun ZEU, Yazicioglu C, Zeyneloglu HB, Tiras B. A novel technique — subendometrial autologous platelet rich plasma injection in patients with unresponsive thin endometrium undergoing frozen-thawed embryo transfer: a prospective cohort study. *BMC Pregnancy Childbirth*. 2025; 25:297.
13. Kumar P, Philip CE, Eskandar K, Marron K, Harry C. Is sub-endometrial injection a superior method for the administration of intrauterine PRP? A systematic review and meta-analysis. *Reprod Biol Endocrinol*. 2025. doi:10.1186/s12958-025-01455-3.
14. Noushin MA, Ashraf M, Thunga C, Singh S, Singh S, Basheer R, Ashraf R, Jayaprakasan K. A comparative evaluation of subendometrial and intrauterine platelet-rich plasma treatment for women with recurrent implantation failure. *F S Sci*. 2021;2(3):295–302.
15. Khadrawi AM, Mosabah MH, Muhamed MM, Abdelghany AM, Shahin KI. Intrauterine infusion of autologous platelet-rich plasma in women with

Subendometrial injection versus intrauterine Infusion of Platelet rich Plasma for women with recurrent implantation failure. A prospective randomized controlled study

recurrent implantation failure in ICSI [thesis]. Minia: Faculty of Medicine, Minia University; 2023.

16. Zargar M, Pazhouhanfar R, Najafian M, Choghakabodi P. Effects of intrauterine autologous platelet-rich plasma infusions on outcomes in women with repetitive in vitro fertilization failures: a prospective randomized study. Clin Exp Obstet Gynecol. 2020; 48:179–184.