



Effects of lianggu decoction combined with Gonal-F on IVF outcomes, embryo quality, and pregnancy in infertility patients undergoing IVF-ET



Yan Wang, Peng Peng, Meijuan Hao, Shangqing Wu*, Xuchu Wang

Department of Reproductive Medicine, Cangzhou Hospital of Integrative Chinese and Western Medicine, Cangzhou 061000, China

ARTICLE INFO

Keywords:

Lianggu decoction
Gonal-F
IVF-ET
Infertility
Pregnancy outcome

ABSTRACT

Objective: To investigate the effects of Lianggu decoction combined with Gonal-F on the outcomes of in vitro fertilization and embryo transfer (IVF-ET) outcomes in infertility patients, including embryo quality and pregnancy outcomes.

Methods: A total of 205 patients receiving IVF-ET treatment for infertility at our hospital from June 2022 to January 2024 were selected for the study. Patients were randomly divided into the observation group (102 cases) and the control group (103 cases). The control group received IVF-ET following the conventional Early-Follicular Phase Long-Acting Gonadotropin-Releasing Hormone Agonist Long Protocol (EFL) therapy, while the observation group was additionally treated with Lianggu decoction to promote ovulation in conjunction with the same regimen. The clinical efficacy, traditional Chinese medicine (TCM) syndrome scores, sex hormone levels at various time points, ovulation induction and oocyte retrieval outcomes, in vitro fertilization results, pregnancy outcomes, and adverse reactions were compared between the two groups.

Results: The total effective rate in the observation group (92.2%) was significantly higher than that in the control group (75.7%) ($P < 0.05$). The TCM syndrome scores in the observation group were significantly lower than those in the control group ($P < 0.05$). The levels of estrogen (E2), LH, and progesterone (P) at baseline were significantly higher compared to those on HCG day in both groups ($P < 0.05$). Furthermore, on HCG day, the levels of E2, LH, and P in the observation group were significantly higher than those in the control group ($P < 0.05$). The observation group had a significantly lower Gn usage duration and total Gn dosage, along with a higher metaphase II (MII) oocyte rate, compared to the control group ($P < 0.05$), while there were no significant differences in endometrial thickness or oocyte retrieval rates between the two groups ($P > 0.05$). The fertilization rate, 2-pronucleus (2PN) formation rate, good-quality embryo rate, blastocyst formation rate, and implantation rate were significantly higher in the observation group compared to the control group ($P < 0.05$), but there was no significant difference in the 2PN cleavage rate between the two groups ($P > 0.05$). The clinical pregnancy rate and live birth rate in the observation group were significantly higher, and the miscarriage rate was significantly lower than those in the control group ($P < 0.05$). There was no significant difference in the incidence of adverse reactions between the two groups ($P > 0.05$).

Conclusion: Lianggu decoction combined with Gonal-F can significantly improve TCM syndromes in infertility patients undergoing IVF-ET, promote ovulation, increase clinical pregnancy rates, reduce miscarriage rates, and demonstrate good safety.

Introduction

According to the latest statistics by the World Health Organization in April 2023, 1 in 6 people is affected by infertility, making it a major global public health issue that imposes significant physical and psychological burdens on patients.¹ One of the most commonly used

treatments for infertility is in vitro fertilization and embryo transfer (IVF-ET).² IVF-ET is a highly complex procedure that requires extensive use of medications and equipment, yet its success rate remains relatively low at approximately 30%.³ Therefore, identifying methods to improve the success rate of IVF-ET is of great importance for infertility patients.

* Corresponding author.

E-mail address: yangdong343@163.com (S. Wu).

<https://doi.org/10.1016/j.prmedi.2025.100015>

Received 26 July 2024; Received in revised form 5 September 2024; Accepted 30 September 2024

Available online 12 March 2025

2950-5232/© 2025 Chinese General Practice Publishing House Co., Ltd. Publishing services by Elsevier B.V. on behalf of KeAi Communications Co. Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

In recent years, research has shown that traditional Chinese medicine (TCM) can enhance IVF-ET success rates⁴ In this study, we used Lianggu decoction combined with Gonal-F. Lianggu decoction has the effect of warming and tonifying yang energy, drawing from the principles outlined in Jingyue's Complete Work, and is designed to strengthen and replenish the Thoroughfare and Conception Vessels, warm and invigorate kidney yang, and stabilize the fetal vitality. To investigate the effects of Lianggu decoction combined with Gonal-F on IVF outcomes in infertility patients, we selected 205 patients undergoing IVF-ET treatment at our hospital between June 2022 and January 2024. The study is reported as follows.

Materials and methods

Participants and criteria of inclusion and exclusion

This prospective study included 205 infertility patients undergoing IVF-ET treatment at our hospital from June 2022 to January 2024 (see attachment for details). Inclusion criteria: patients diagnosed with infertility according to the western medical diagnostic standards referenced in Obstetrics and Gynecology⁵: more than one year of regular sexual activity without contraception or pregnancy, with no abnormalities in the male semen; or according to The TCM diagnosis was based on *Guidelines for Clinical Research of New Chinese Medicines*⁶: The TCM syndrome is diagnosed as kidney yang deficiency, with the primary symptoms including long-term infertility, lower back pain, and decreased libido. Secondary symptoms include dizziness, tinnitus, cold intolerance in the limbs, insomnia, and forgetfulness. Pale tongue with a white coating. The pulse is deep and thin or deep and slow, especially weak at the Chi position. Age 21–35 years. The cause of infertility was purely due to tubal obstruction, and no hormone or endocrine-influencing drugs were taken in the three months prior to inclusion. Exclusion criteria: patients undergoing IVF for reasons other than tubal obstruction; either partner had severe mental illness, acute infections or sexually transmitted diseases of the reproductive or urinary system, or had harmful habits like drug abuse, exposure to radiation, toxins, or teratogenic drugs; with genetic diseases unsuitable for reproduction under the *Maternal and Child Health Law*; known allergies to medications used in this study; non-compliance with national fertility policies; poor adherence.

Patients were randomly divided into two groups: 102 in the observation group and 103 in the control group. The observation group included patients aged 21–35 years (mean age 28.56 ± 3.14 years), while the control group had patients aged 22–35 years (mean age 28.97 ± 3.61 years). The study was approved by the hospital's ethics committee (CZZX-19052). All patients provided informed consent. There were no statistically significant differences in baseline characteristics between the two groups ($P > 0.05$), as shown in Table 1.

Treatment regimen

The control group underwent IVF-ET following standard EFLI for ovulation induction. Gonadotropin (Gn) (Maanshan Fengyuan Pharmaceutical, China) was administered based on the patient's hormone levels and ultrasound findings. Follicular development was monitored through ultrasound, and when three or more follicles reached a diameter

of ≥ 1.8 cm, Gn administration was stopped. A dose of 4000–10000 IU of human chorionic gonadotropin (HCG) (Livzon Pharmaceutical, China) was injected intramuscularly. Oocyte retrieval was performed 37 hours after the HCG injection, guided by vaginal ultrasound.

The embryos were cultured in vitro for 3–6 days, followed by blastocyst transfer. Post-transfer, patients received medication, including dydrogesterone, progesterone injections and vaginal sustained-release gel. Fourteen days after the transfer, an HCG blood test was performed to confirm pregnancy. At 28 days, a vaginal ultrasound was conducted to confirm clinical pregnancy by checking for a gestational sac, fetal bud, and primitive cardiac tube pulsation. Patients with confirmed clinical pregnancy were followed up at 12 weeks, 28 weeks, and around two weeks before and after their expected delivery date. In the treatment group, Lianggu decoction was added to the standard ovulation induction protocol used for the control group to enhance ovulation.

The formula for Lianggu decoction includes 15 g of *Rehmannia glutinosa*, 12 g of *Angelica sinensis*, 15 g of *Cuscuta chinensis*, 15 g of *Lycium barbarum*, 15 g of *Dioscorea opposita*, 15 g of *Rubus chingii*, 12 g of *Epimedium*, 10 g of *Cynomorium*, 12 g of *Achyranthes bidentata*, 12 g of *Dipsacus*, and 10 g of *Morinda officinalis*. One dose of Lianggu decoction is taken daily. For emotional distress or breast tenderness, rose flower and curcuma are added. For fatigue, codonopsis, stir-fried atractylodes, and honey-fried astragalus are included. If menstrual blood clots are present, safflower and peach kernel are added. For coldness in the lower abdomen and cold limbs during menstruation, cinnamon and fennel are added. The herbs are soaked in water for 30 minutes, then brought to a boil and simmered on low heat for 30 minutes. This process is repeated twice, and 150 mL of the resulting decoction is obtained. The decoction is consumed warm in two doses, 75 mL each, taken morning and evening. The treatment starts at the beginning of EFLI and continues until the HCG injection.

Evaluation indicators

Efficacy determination: According to the Guidelines for Clinical Research of New Chinese Medicines,⁷ efficacy is assessed as follows. Cured: The patient becomes pregnant, or the efficacy index is reduced by $\geq 95\%$, with symptoms completely disappearing. Significant effect: Efficacy index decreases between 70% and 95%, with symptoms either disappearing or being significantly alleviated. Effective: Efficacy index decreases between 30% and 70%, with symptoms improving compared to before treatment. Ineffective: Efficacy index decreases by less than 30%, with no obvious improvement or worsening of symptoms. Total efficacy rate = cure rate + significant effect rate + effective rate. Efficacy index = (score before treatment - score after treatment) / score before treatment $\times 100\%$.

TCM syndrome score: The main symptoms include long-term infertility after marriage, lower back pain, and decreased libido. Secondary symptoms include dizziness, tinnitus, cold limbs, insomnia, and forgetfulness. Each symptom is rated as none, mild, moderate, or severe, corresponding to scores of 0, 1, 2, and 3, respectively. Tongue and pulse conditions are not included in the scoring, and the total score is 30.

Hormone levels at different time points: On the baseline day (oocyte retrieval) and on the HCG day (14 days post-embryo transfer), 4 mL of fasting venous blood was collected from both groups in the morning. The samples were centrifuged at 2000 rpm for 10 minutes with a 10 cm radius.

Table 1
Comparison of basic characteristics between the two groups.

Group	Cases (n)	Age (years)	Infertility Duration (years)	BMI (kg/m ²)
Observation	102	28.56 ± 3.14	3.71 ± 1.13	23.67 ± 2.72
Control	103	28.97 ± 3.61	3.64 ± 1.07	23.85 ± 3.01
t value		0.867	0.456	0.449
P value		0.389	0.649	0.654

Note: BMI: body mass index.

Table 2
Comparison of clinical efficacy.

Group	Cases (n)	Cured n (%)	Significant Effect n (%)	Effective n (%)	Ineffective n (%)	Total Effective Rate n (%)
Observation	102	34 (33.3)	35 (34.3)	25 (24.5)	8 (7.8)	94 (92.2)
Control	103	19 (18.4)	31 (30.1)	28 (27.2)	25 (24.3)	78 (75.7)
χ^2 value						10.241
P value						0.001

Table 3
Comparison of TCM syndrome scores.

Group	Before Treatment (Mean \pm SD)	After Treatment (Mean \pm SD)	t value	P value
Observation (n = 102)	28.37 \pm 5.83	10.22 \pm 3.44	27.079	0.000
Control (n = 103)	28.19 \pm 6.04	13.72 \pm 3.21	21.470	0.000
t value	0.217	7.532		
P value	0.828	0.000		

Note: TCM: traditional Chinese medicine; SD, standard deviation.

After centrifugation, the supernatant was collected and stored for testing. Estrogen (E2), luteinizing hormone (LH), and progesterone (P) levels were measured using the Roche Cobas 8000 e602 electrochemiluminescence immunoassay analyzer and its corresponding reagent kits.

Ovulation induction and oocyte retrieval: The thickness of the endometrium was measured using a GE-E8 four-dimensional color Doppler ultrasound diagnostic instrument. The duration and total dose of Gn used were recorded for both groups.

In vitro fertilization outcomes: The outcomes included the oocyte retrieval rate, MII oocyte rate, fertilization rate, 2PN formation rate, 2PN cleavage rate, good-quality embryo rate, blastocyst formation rate, and implantation rate. Oocyte retrieval rate = (number of oocytes retrieved / number of follicles) \times 100%. MII oocyte rate = (number of MII oocytes / total oocytes retrieved) \times 100%. Fertilization rate = (2PN + 1PN + multi-PN + late cleavage) / total oocytes retrieved \times 100%. 2PN formation rate = (number of 2PNs / total oocytes retrieved) \times 100%. 2PN cleavage rate = (number of cleaved 2PNs / number of 2PNs) \times 100%. Good-quality embryo rate = (number of high-quality embryos / number of cleaved 2PNs) \times 100%. Blastocyst formation rate = (number of blastocysts / total number of embryos cultured for blastocyst formation) \times 100%. Implantation rate = (number of implanted embryos / total number of transferred embryos) \times 100%.

Pregnancy Outcomes: The clinical pregnancy rate, miscarriage rate, and live birth rate were recorded for both groups. Fourteen days after embryo transfer, serum HCG levels were measured to confirm early pregnancy. At 28 days post-transfer, a vaginal ultrasound was performed to check for a gestational sac and primitive cardiac tube pulsation, confirming clinical pregnancy.

Adverse Reactions: The occurrence of adverse reactions, such as ovarian enlargement, gastrointestinal reactions, and abdominal pain, was documented for both groups.

Statistical analysis

All data were statistically analyzed using SPSS version 26.0. Measurement data following a normal distribution were analyzed using the *t*-test. Categorical data were expressed as percentages (%) and analyzed using the chi-square (χ^2) test. A *P* < 0.05 was considered statistically significant.

Results

Comparison of clinical efficacy

As shown in [Table 2](#), the total effective rate in the observation group (92.2%) was significantly higher than that in the control group

(75.7%), with a statistically significant difference.

Comparison of TCM syndrome scores before and after treatment

After treatment, the TCM syndrome scores in the observation group were significantly lower compared to the control group. See [Table 3](#) for details.

Comparison of hormone levels at different time points

There were no statistically significant differences in E2, LH, and P levels between the two groups on the baseline day. Compared to the HCG day, the baseline E2, LH, and P levels in both groups significantly increased. On the HCG day, the E2, LH, and P levels in the observation group were significantly higher than those in the control group. The results were shown in [Table 4](#).

Comparison of in vitro fertilization outcomes between the two groups

As shown in [Table 6](#), after treatment, the observation group showed significantly higher fertilization rate, 2PN formation rate, good-quality embryo rate, blastocyst formation rate, and implantation rate compared to the control group. There was no statistically significant difference in the 2PN cleavage rate between the two groups.

Comparison of pregnancy outcomes between the two groups

The clinical pregnancy rate, live birth rate, and miscarriage rate showed significant differences between the observation group and the control group, with the observation group having a higher clinical pregnancy and live birth rate, but a lower miscarriage rate. See [Table 7](#) for details.

Comparison of adverse reactions between the two groups

There was no statistically significant difference in the incidence of adverse reactions, including ovarian enlargement, gastrointestinal reactions, and abdominal pain, between the observation group and the control group. See [Table 8](#) for details.

Discussion

Tubal obstructive infertility is one of the primary causes of infertility, and its incidence has been rising in recent years.⁸ Current Western medical treatments include hysteroscopic fluid surgery, tubal catheterization, and tubal adhesion separation. However, these

Table 4
Comparison of hormone levels at different time points between the two groups.

Group	E2 (pmol/L)		LH (mIU/mL)		Progesterone (µg/L)		t value	P value
	Baseline Day	HCG Day	Baseline Day	HCG Day	Baseline Day	HCG Day		
Observation (n = 102)	200.56 ± 71.29	2813.27 ± 612.39	4.01 ± 1.31	6.02 ± 0.68	0.51 ± 0.14	1.73 ± 0.37	31.146	0.000
Control (n = 103)	203.47 ± 75.63	2601.44 ± 620.35	4.08 ± 1.47	5.23 ± 0.87	0.49 ± 0.13	1.50 ± 0.41	23.832	0.000
t value	0.283	2.460	0.360	7.239	1.060	4.215		
P value	0.777	0.015	0.719	0.000	0.290	0.000		

Note: E2: estrogen; LH: luteinizing hormone; HCG: human chorionic gonadotropin.

procedures carry significant risks, such as recurrence and ectopic pregnancy.⁹ IVF-ET is a commonly used option for patients with fertility needs, but challenges include low oocyte and embryo quality, high miscarriage and malformation rates, low live birth rates, and increased risk of ovarian hyperstimulation. IVF-ET is a highly complex technique with a relatively low success rate.¹⁰ Therefore, finding methods to improve IVF-ET success is crucial for infertility patients.

Infertility, from the perspective of TCM, can be categorized under menstrual irregularities, scant menstruation, amenorrhea, sterility, and premature ovarian failure.¹¹ The kidney is considered the foundation of life. As stated in Ling Shu - Jing Mai, “Life begins with the essence”.¹² The essence stored in the kidneys is closely related to genetic material. The pathology of infertility due to kidney yang deficiency is mainly associated with insufficient kidney yang and diminished fire of the Mingmen (life gate). The kidney governs reproduction, and when kidney yang is insufficient and the fire of Mingmen declines, it leads to dysfunction in the organs, affecting reproductive function and resulting in infertility.¹³ Symptoms often include extended menstrual cycles, amenorrhea, reduced flow with pale red color, accompanied by weakness in the lower back and knees, cold intolerance in the limbs, decreased libido, and uterine coldness, which can lead to infertility. As stated in Plain Questions - Chapter on the Circulation of Vital Energy: “Yang energy is like the heavens and the sun; without it, life fades and remains obscure.” This illustrates that the normal functioning of the body depends on the yang energy. The concept of “warmth brings life, coldness destroys life” further emphasizes that the process of reproduction is akin to nurturing young seedlings, much like sunlight is essential for plant growth. Similarly, the body’s yang energy is crucial for conception, playing a vital role in embryo implantation and development.¹⁴ The TCM treatment principle for infertility due to kidney yang deficiency is to tonify the kidneys, warm the yang, and nourish the essence and blood.

Lianggu decoction is Guo Zhiqiang’s classic base formula for treating infertility. It is derived from Liuwei Dihuang Pill and Wuzhiyanzong Pill, with an emphasis on warming and tonifying yang energy. The method for tonifying yang comes from the principles outlined in Jingyue’s Complete Work.¹⁵ Rehmannia glutinosa nourishes blood and yin, enriching the essence and marrow; Angelica and Achyrantes nourish the liver and kidneys, promote blood circulation; Cuscuta supports pregnancy and nourishes the liver and kidneys; Lycium barbarum nourishes yin and blood; Dioscorea improves spleen function and strengthens qi. Rubus chingii nourishes the liver and kidneys, and has astringent properties that help stabilize and consolidate bodily functions, while Epimedium warms and tonifies kidney yang. Cynomorium tonifies kidney yang and replenishes essence and blood; Dipsacus and Morinda officinalis strengthen the marrow and kidney yang, promote bone health, and support the growth of endometrium and the basal follicles.¹⁶ The combination of Epimedium and Cynomorium in a yin-nourishing formula follows the principle of “seeking yang within yin”. Epimedium, mild and warm nature, and enters the liver and kidney meridians, warming and tonifying kidney yang while strengthening muscles and bones. Cynomorium, sweet in taste, also enters the kidney meridian, where it warms kidney yang and nourishes essence and blood. When combined with yin-nourishing herbs such as Rehmannia glutinosa, Dioscorea, and Cornus officinalis, the formula works synergistically to both warm and tonify kidney yang. This combination strengthens yang energy and lays a foundation for the healthy development of ovarian follicles. Further ingredients that warm and tonify the liver and kidneys are added to regulate the Chong and Ren channels. Angelica nourishes and activates blood, renowned for replenishing blood in TCM, while Achyrantes warms the liver and kidneys and is known for its downward-moving properties, promoting blood circulation. Achyrantes not only directs the medicinal effects downward but also enhances the efficacy of tonifying herbs without causing stagnation. Flexibly applying Lianggu decoction helps to warm and tonify the spleen and kidneys, balancing yin and yang to support fertility.

Table 5
Comparison of ovulation induction and oocyte retrieval outcomes between the two groups.

Group	Endometrial Thickness (mm)	Gn Usage Days (d)	Total Gn Dosage (IU)	Oocyte Retrieval Rate (%)	MII Oocyte Rate (%)
Observation (n = 102)	9.01 ± 1.42	10.9 ± 0.8	1947.38 ± 201.47	91.0 (1321/1451)	84.0 (1110/1321)
Control (n = 103)	8.92 ± 1.34	12.2 ± 1.3	2487.26 ± 508.46	90.0 (1236/1373)	79.0 (976/1236)
t/χ ² value	0.467 ^a	8.612 ^a	9.976 ^a	0.855	10.892
P-value	0.641	0.000	0.000	0.355	0.001

Note: Gn: Gonadotropin; MII: metaphase II.^a represents the t value.

Table 6
Comparison of in vitro fertilization outcomes between the two groups.

Group	Fertilization Rate (%)	2PN Formation Rate (%)	2PN Cleavage Rate (%)	Good-Quality Embryo Rate (%)	Blastocyst Formation Rate (%)	Implantation Rate (%)
Observation (n = 102)	80.1 (1058/1321)	79.0 (1044/1321)	94.7 (989/1044)	53.8 (562/1044)	60.1 (338/562)	63.7 (65/102)
Control (n = 103)	70.0 (865/1236)	67.0 (828/1236)	92.9 (769/828)	40.1 (332/828)	50.1 (166/332)	48.5 (50/103)
χ ² value	34.981	47.202	2.786	34.914	8.730	4.796
P value	0.000	0.000	0.095	0.000	0.003	0.029

Note: 2PN: 2-pronucleus.

Table 7
Comparison of pregnancy outcomes between the two groups.

Group	Clinical Pregnancy Rate (%)	Miscarriage Rate (%)	Live Birth Rate (%)
Observation (n = 102)	57.8 (59/102)	4.9 (5/102)	36.3 (37/102)
Control (n = 103)	40.8 (42/103)	17.5 (18/103)	18.4 (19/103)
χ ² value	5.972	8.134	8.204
P value	0.015	0.004	0.004

Table 8
Comparison of adverse reactions between the two groups.

Group	Ovarian Enlargement	Gastrointestinal Reaction	Abdominal Pain	Adverse Reaction Rate (%)
Observation (n = 102)	1	2	2	4.95
Control (n = 103)	3	5	3	10.7
χ ² value				2.090
P value				0.148

Adjustments are made according to specific symptoms to maximize its effect, fulfilling the role of TCM in preventive treatment. Overall, the formula works to strengthen the Chong and Ren channels, warm and nourish kidney yang, and stabilize the fetal essence, promoting a healthy reproductive environment.^{17,18}

Our study indicated that the total effective rate in the observation group (92.2%) was significantly higher than that in the control group (75.7%) (P < 0.05). This demonstrates that Lianggu decoction combined with exogenous hormones has a synergistic effect, improving TCM syndrome scores, increasing the rates of high-quality oocytes and embryos, and ultimately enhancing pregnancy rates in patients undergoing IVF-ET. The study also showed that TCM syndrome scores were significantly lower in the observation group and hormone levels of E2, LH, and P on HCG day were higher. These findings suggest that Lianggu decoction can significantly improve TCM syndrome scores, regulate the imbalance of sex hormone levels in patients, and enhance their reproductive capacity. Additionally, it increases uterine receptivity, providing a favorable environment for embryo implantation and aiding in the development of oocytes and the implantation of fertilized eggs.

Poor follicular development is often caused by insufficient kidney essence and qi. The kidney qi of the mother is essential for normal follicular growth and development. When kidney qi is abundant, oocytes develop and mature properly, but kidney yin deficiency can lead to fewer oocytes and slower development.¹⁹ This study showed that the

observation group had significantly fewer Gn administration days and a lower total Gn dosage compared to the control group, while the MII oocyte rate was higher. Endometrial thickness and oocyte retrieval rates showed no significant differences between the two groups. This suggests that adding Lianggu decoction can reduce the duration and dosage of ovulation-inducing drugs, minimizing the side effects of long-term hormone use. Moreover, it effectively increases the rate of high-quality oocytes, providing a better foundation for the formation of fertilized eggs.

Most patients with tubal obstruction have pelvic adhesions, which may affect ovarian blood supply and lead to functional disorders such as poor follicular maturation, difficulty in ovulation, and luteal insufficiency.²⁰ This study found that the observation group had significantly higher fertilization rate, 2PN formation rate, good-quality embryo rate, blastocyst formation rate, and implantation rate compared to the control group, with no significant difference in 2PN cleavage rate. The observation group also had a higher clinical pregnancy rate and live birth rate, and a lower miscarriage rate. This suggests that Lianggu decoction combined with exogenous hormones can improve high-quality fertilization and embryo rates, and implantation rates, ultimately enhancing clinical pregnancy rates and reducing miscarriage rates.

Due to the blood-activating and stasis-dispelling effects of Angelica and Achyranthes in Lianggu decoction, ovarian blood supply is

effectively improved, and the metabolic function of the fallopian tubes and pelvic tissues is improved, aiding in the restoration of normal tubal function. Rehmannia glutinosa and Lycium nourish the blood, enhance immunity, and improve the patient's overall constitution. Cuscuta and Epimedium have hormone-like effects, tonifying kidney qi and stabilizing pregnancy. Epimedium, being a warming herb, is particularly effective in warming kidney yang in yang-deficient patients, though it should be used in moderation. Thus, Lianggu decoction has the effects of warming the kidneys and promoting yang, activating blood circulation and removing stasis, and stabilizing the fetal essence. Additionally, there was no significant difference in the incidence of adverse reactions between the two groups, though the observation group had slightly fewer adverse reactions. This is likely because the adverse reactions observed in the study were mainly caused by Gonal-F, and the addition of Lianggu decoction helped alleviate some of these side effects, increasing the safety of the treatment.

Conclusion

Lianggu decoction combined with Gonal-F can significantly improve TCM syndrome symptoms in infertility patients undergoing IVF-ET, promote ovulation, increase clinical pregnancy rates, reduce miscarriage rates, and demonstrates good safety.

Declarations

Not applicable.

Authors' contributions

Y. Wang: Proposed the primary research goals, conceptualized and designed the study, implemented the research, drafted the manuscript, supervised quality control, and reviewed the article, taking overall responsibility for the manuscript. P. Peng: Collected and organized data, performed statistical analysis, and created and presented figures and tables. M. Hao, S. Wu, X. Wang: Revised the manuscript.

Ethics approval and consent to participate

The study received approval from the Medical Ethics Committee of Cangzhou Hospital of Integrative Chinese and Western Medicine (CZZX-19052).

Consent for publication

Not applicable.

Data availability

Not applicable.

Funding

This study was supported the 2024 TCM Scientific Research Project of Hebei Provincial Administration of Traditional Chinese Medicine.

Declaration of Competing 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.

Acknowledgements

Not applicable.

Authors' other information

Not applicable.

References

- Chinese Society for Preventive Medicine - Subcommittee on Reproductive Health. Chinese expert consensus on total management of tubal infertility (2023 Edition) (Chinese). *Chin J Pract Gynecol Obstet.* 2023;39(3):318–324. <https://doi.org/10.19538/j.fk2023030114>
- Zhao ZB, Yuan XF, Yan HL, et al. Traditional chinese medicine in IVF treatment for polycystic ovary syndrome (Chinese). *J Liaoning Univ Tradit Chin Med.* 2023;25(1):43–47. <https://doi.org/10.13194/j.issn.1673-842x.2023.01.010>
- Chow DJX, Wijesinghe P, Dholakia K, et al. Does artificial intelligence have a role in the IVF clinic? *Reprod Fertil.* 2021;2(3):C29–C34. <https://doi.org/10.1530/RAF-21-0043>
- Wang C, Li XB. Staged treatment with chinese herbal medicine in a controlled ovarian hyperstimulation of in vitro fertilization-embryo transfer programme (Chinese). *J Tradit Chin Med.* 2024;65(2):219–223. <https://doi.org/10.13288/j.11-2166/r.2024.02.017>
- Xie X, Gou WL. *Obstetrics and Gynecology (Chinese)*. 8th ed Beijing: People's Medical Publishing House; 2013:472–483.
- Zheng XY. *Guiding Principles For Clinical Research of New Chinese Medicine (Chinese)*. Beijing: China Traditional Chinese Medicine Press; 2002:239–387.
- Ministry of Health of the People's Republic of China. *Guiding Principles for Clinical Research of New Chinese Medicine (Chinese)*. Beijing: China Medical Science and Technology Press; 2002:253–258.
- Bai ZZ, Meng HL, Yu YX. Effect of multipath traditional Chinese medicine treatment on the fallopian tube recanalization rate, serum CTGF level, and uterine artery blood flow in patients with tubal obstruction infertility after surgery (Chinese). *J Clin Exp Med.* 2024;23(3):281–285. <https://doi.org/10.3969/j.issn.1671-4695.2024.03.015>
- Li YY. Noninvasive diagnosis and interventional treatment of tubal obstructive infertility (Chinese). *Chin. J Fam. Plan Gynecotokol.* 2022;14(9):51–53. <https://doi.org/10.3969/j.issn.1674-4020.2022.09.13>
- Ning Y, Wang X. Application of chinese herbs for tonifying kidney and activating blood circulation in in vitro fertilization-embryo transfer (Chinese). *J Liaoning Univ Tradit Chin Med.* 2022;24(12):201–204. <https://doi.org/10.13194/j.issn.1673-842x.2022.12.039>
- Di HF, Zheng J, Wang BQ. GUO Zhiqiang's Experience in Treating Infertility Caused by Polycystic Ovary Syndrome (Chinese). *J Tradit Chin Med.* 2019;60(23):1997–2000. <https://doi.org/10.13288/j.11-2166/r.2019.23.005>
- Zhang JW, Li J, Yan PJ, et al. Guo Zhiqiang Chongyang academic perspective in the treatment of chronic pelvic inflammatory infertility (Chinese). *Guid J Tradit Chin Med Pharmacol.* 2020;26(12):185–187.
- Zhang YD, Li J, Zhu YY, et al. Prof.Guo Zhiqiang's experience with the application of Chongyang the-ory to the treatment of repeated embryo transfer implantation failure (Chinese). *J Beijing Univ Tradit Chin Med.* 2021;28(6):32–35. <https://doi.org/10.3969/j.issn.2095-6606.2021.06.007>
- Zheng J, Di HF, Ding X, et al. GUO Zhiqiang's Experience in the Treatment of Luteal Dysfunction Infertility with Lianggu Decoction (Chinese). *J Tradit Chin Med.* 2020;61(12):1042–1045. <https://doi.org/10.13288/j.11-2166/r.2020.12.006>
- Wang Q, Li J, Yin XY, et al. Prof.GuoZhiqiang's experience in treating polycystic ovary syndrome with the therapeutic method of Tihu Jiegai (diffusing the lung) (Chinese). *J Beijing Univ Tradit Chin Med.* 2021;28(5):43–46. <https://doi.org/10.3969/j.issn.2095-6606.2021.05.010>
- Tan Y, Wang RX, Zou YJ, et al. An exploration of the synergistic effect of traditional Chinese medicine in the treatment of infertility by assisted reproductive technology (Chinese). *Jiangsu J Tradit Chin Med.* 2023;55(9):1–7. <https://doi.org/10.19844/j.cnki.1672-397X.2023.09.001>
- Yang YP, Song YJ, Liu YJ, et al. Influence of IVF-ET controlled ovarian hyperstimulation on traditional chinese medicine syndromes of infertile patients with polycystic ovary syndrome based on cluster analysis (Chinese). 2023 *World J Integr Tradit West Med.* 2022;17(10):2024–2028. <https://doi.org/10.13935/j.cnki.sjzx.221023>
- Zhang JD, Liu JF, Zhang YS, et al. Evaluation index research of the randomized controlled trial of infertility treated by Traditional Chinese Medicine (Chinese). *Int J Tradit Chin Med.* 2023;45(4):492–497. <https://doi.org/10.3760/cma.j.cn115398-20210323-00282>
- Li XP, Tang HX, Luo J, et al. Clinical study on the effect of differential treatment with Yishen Zhuyun decoction on endometrial receptivity and pregnancy rate (Chinese). 1336 *Mod J Integr Tradit Chin West Med.* 2022;31(10):1328–1331. <https://doi.org/10.3969/j.issn.1008-8849.2022.10.003>
- Chen YD, Mo Z, Xu LP, et al. Effects of Bushen Zhuyun decoction on TCM symptoms scores,serum sex hormones levels and oocyte quality in patients with polycystic ovarian syndrome infertility of kidney-yang deficiency (Chinese). *Shaanxi J Tradit Chin Med.* 2023;44(5):575–578. <https://doi.org/10.3969/j.issn.1000-7369.2023.05.007>