Am J Transl Res 2026;18(8):6889-6900
www.ajtr.org /ISSN:1943-8141/AJTR0172870

Original Article

The effect of acupoint catgut embedding combined with cyproterone acetate and ethinylestradiol plus metformin on sex hormones, glycolipid metabolism and insulin resistance in patients with polycystic ovary syndrome

Ailing Zhao[1], Hong Qu[2], Ming Wei[3], Xuemei Zhang[1]

[1]Department of Acupuncture and Moxibustion I, Gansu Provincial Hospital of Traditional Chinese Medicine, No. 306 Guazhou Road, Qilihe District, Lanzhou 730000, Gansu, China; [2]Department of Gynaecology, Gansu Provincial Hospital of Traditional Chinese Medicine, No. 418 Guazhou Road, Qilihe District, Lanzhou 730000, Gansu, China; [3]Department of Neurosurgery, Gansu Provincial Hospital of Traditional Chinese Medicine, No. 418, Guazhou Road, Qilihe District, Lanzhou 730000, Gansu, China

Received March 25, 2026; Accepted June 24, 2026; Epub August 15, 2026; Published August 30, 2026

Abstract: Objective: To evaluate the efficacy of acupoint catgut embedding combined with cyproterone acetate/ethinylestradiol and metformin in treating polycystic ovary syndrome (PCOS), focusing on sex hormones, glucose and lipid metabolism, and insulin resistance. Methods: This retrospective study included 311 PCOS patients (April 2023-July 2025). The control group (n=152) received sham embedding plus medications, while the intervention group (n=159) received authentic embedding plus same drugs over three menstrual cycles. Reproductive hormones, metabolic parameters, and HOMA-IR were assessed. Results: Baseline characteristics were comparable. Post-treatment, the intervention group showed significantly greater improvements in testosterone, luteinizing hormone, follicle-stimulating hormone, estradiol, fasting and postprandial glucose, lipid profile, and HOMA-IR than controls (all $P<0.05$). Menstrual recovery was superior ($P<0.05$). Clinical efficacy grading favored the intervention group ($Z=2.401$, $P=0.016$). Adverse events were similar between the groups ($P=0.600$). HOMA-IR correlated positively with testosterone, luteinizing hormone, total cholesterol, and triglycerides, but negatively with follicle-stimulating hormone, estradiol, and HDL-cholesterol ($P<0.001$). Conclusion: Acupoint catgut embedding combined with conventional pharmacotherapy synergistically improves hormonal dysregulation, metabolic disturbances, and insulin resistance in PCOS with a favorable safety profile.

Keywords: Acupoint catgut embedding, cyproterone acetate and ethinylestradiol, metformin, PCOS, glucose and lipid metabolism, insulin resistance

Introduction

Polycystic ovary syndrome (PCOS) represents a prevalent endocrine-metabolic condition affecting reproductive-aged women worldwide, with reported global incidence estimated between 6% and 20%. The disorder demonstrates considerable phenotypic diversity, manifesting across multiple clinical domains. Beyond reproductive and dermatological complications - including oligo/amenorrhea, subfertility, hyperandrogenic skin changes (hirsutism and acne) - PCOS substantially elevates long-term cardiometabolic risks. These encompass impaired glucose tolerance, dyslipidemia, heightened cardiovascular morbidity, and endometrial pathologies, frequently underpinned by underlying insulin resistance [1, 2]. The core pathophysiological characteristics of this disease revolve around hyperandrogenemia, insulin resistance, and the vicious cycle between them, resulting in dual disorders of the reproductive endocrine and energy metabolism networks [3, 4]. Therefore, an ideal treatment strategy should be able to simultaneously and synergistically intervene in these two key links to achieve holistic regulation, which remains a major challenge in current clinical practice.

At present, conventional Western medicine treatment regimens for PCOS mostly adopt targeted management. For patients with predominant

https://doi.org/10.62347/JGFM7966

hyperandrogenemia and menstrual disorders, short-acting oral contraceptives such as cyproterone acetate and ethinylestradiol are standardized first-line options, which can effectively reduce androgen levels and regulate menstrual cycles [5]. In individuals with concurrent insulin resistance, excess body weight, or prediabetic glucose dysregulation, metformin serves as a first-line sensitizing therapy to optimize insulin action. Through this mechanism, the drug indirectly facilitates endocrine rebalancing [6, 7]. However, long-term practice has also exposed the limitations of single or combined Western medicine therapy: some patients have poor responses to drugs, and side effects such as gastrointestinal discomfort, weight gain, and potential thrombotic risks affect treatment compliance [8]. This indicates that relying solely on Western medicine may be difficult to fundamentally disrupt the complex pathological network of PCOS, and it is urgent to explore novel therapeutic strategies with more holistic, individualized, and long-lasting effects.

Traditional Chinese medicine (TCM) conceptualizes PCOS through a unique pathophysiological framework, positing that its fundamental etiology arises from visceral disharmony - particularly involving hepatic, splenic, and renal systems. This internal imbalance subsequently engenders the pathological accumulation of phlegm-turbidity and blood stasis [9]. Under the guidance of this theory, TCM emphasizes holistic syndrome differentiation and comprehensive conditioning. As an innovative TCM external therapy, acupoint catgut embedding achieves sustained and mild long-acting acupoint stimulation by implanting absorbable catgut into specific acupoints, which continuously harmonizes visceral qi and blood, unblocks meridians, and exhibits unique potential in regulating the neuro-endocrine-immune network [10]. Contemporary research indicates that acupoint catgut embedding confers pleiotropic benefits, encompassing the modulation of hypothalamic-pituitary-ovarian (HPO) axis activity, optimization of sex steroid concentrations, and - according to nascent evidence - adjunctive roles in body weight management, insulin sensitivity enhancement, and glucose-lipid metabolic regulation [11]. This provides a theoretical intersection for the integrated TCM and Western medicine treatment of PCOS: holistic regulation through acupoint catgut embedding may create a more favorable internal environment for the targeted hormone regulation and metabolic improvement of Western medicine, and the combination is expected to exert synergistic and complementary effects at multiple targets and levels in terms of mechanism of action.

Despite promising theoretical foundations, robust evidence from methodologically stringent trials assessing this specific TCM-Western medicine combination therapy's effects on reproductive and metabolic biomarkers in PCOS cohorts is still lacking. Whether its combined application can significantly outperform the Western medicine-only regimen in the comprehensive improvement of sex hormone profiles, glucose and lipid metabolism indicators, and insulin resistance index remains to be verified. Based on this, this study aims to systematically evaluate the intervention effect of this triple therapy on sex hormones, glucose and lipid metabolism indicators, and insulin resistance in PCOS patients, while observing the safety and feasibility of the regimen.

Methods

Study population

This retrospective cohort comprised 311 PCOS inpatients (April 2023-July 2025), stratified by intervention type: 152 underwent sham embedding (needle insertion without catgut implantation) with standard hormonal and metformin therapy, while 159 received combined catgut embedding and identical drug regimens. Ethical clearance was secured from Gansu Provincial Hospital of Traditional Chinese Medicine's Review Board.

Inclusion and exclusion criteria

Inclusion criteria: (1) Study participants fulfilled the 2003 Rotterdam consensus criteria for PCOS diagnosis [12]; (2) Aged 18-40 years, women of childbearing age; (3) With insulin resistance (HOMA-IR >2.69) or abnormal glucose and lipid metabolism (elevated fasting glycemia (≥5.6 mmol/L), hypertriglyceridemia (≥1.7 mmol/L), or hypercholesterolemia (≥5.2 mmol/L)); (4) No history of taking drugs affecting sex hormones or glycolipid metabolism within 3 months prior to treatment; (5) Complete clinical medical records.

Exclusion criteria: (1) Complicated with other endocrine and metabolic diseases; (2) Complicated with organic gynecological diseases; (3) Intolerance to the treatment modality or hypersensitivity to the drugs used; (4) Pregnant or lactating women.

Treatment regimens

Control group (sham catgut embedding plus combined Western medicine therapy): (1) Sham catgut embedding procedure: Identical acupoints to those of the treatment group were selected. Following routine cutaneous disinfection, a disposable acupuncture needle (0.30 mm × 40 mm) was swiftly inserted into each acupoint to a depth of 1-2 cm. After 10 seconds of lifting-thrusting and twisting-manipulating acupuncture maneuvers, the needle was pulled out immediately without catgut implantation. The intervention was conducted once every two weeks, matching the embedding frequency adopted in the treatment group. Needle retention specification: During authentic catgut embedding, the embedding needle delivers the catgut suture right after puncture and is then withdrawn with no subsequent needle retention. Accordingly, the sham manipulation precisely replicates this whole workflow: needle insertion, 10 seconds of lifting-thrusting plus twisting manipulation, and immediate needle removal. The only distinction from genuine embedding is the omission of catgut implantation. No extra needle retention was performed in either group. The manipulation intensity (twisting range and frequency) was regulated with a metronome set at 60 rotations per minute and standardized force sensors.

(2) Western medicine therapy: Cyproterone acetate and ethinylestradiol tablets: Oral administration was initiated on the 5th day of the menstrual cycle, 1 tablet per day for 21 consecutive days, followed by a 7-day drug withdrawal period, which constituted one treatment cycle. Metformin hydrochloride tablets: The initial dose was 500 mg, twice daily, taken after meals. One week later, the dose was adjusted to 1000 mg, twice daily according to the patient's gastrointestinal tolerance, and this maintenance dose was continued until the end of treatment.

Treatment group (acupoint catgut embedding plus combined Western medicine therapy): (1) Acupoint catgut embedding procedure: Acupoint selection: Guanyuan (CV4), Qihai (CV6), Zusanli (ST36), Sanyinjiao (SP6), Taichong (LR3) and Fenglong (ST40) were selected. Operational process: The patient was placed in a supine position. The local skin of the acupoints was routinely disinfected, and a sterile drape was placed over the area. Local infiltration anesthesia was performed with 2% lidocaine. A 1-1.5 cm segment of absorbable catgut was implanted into the acupoint using a disposable catgut embedding needle (0.7 mm × 60 mm). After Deqi (needling sensation) was achieved, the embedding needle was slowly withdrawn. The needle hole was pressed for 5 minutes to stop bleeding, then covered with a sterile dressing. The needle hole was kept dry within 24 hours. Treatment frequency: The treatment was given once every 2 weeks for a total of 3 sessions, which was synchronized with the course of Western medicine therapy.

(2) Western medicine therapy: The types, doses and administration methods of drugs were exactly the same as those in the control group.

Metformin dose adjustment criteria: The dose was escalated from 500 mg twice daily to 1000 mg twice daily after 7 days only if the patient reported no or only mild gastrointestinal symptoms (defined as nausea, diarrhea, or abdominal discomfort that did not interfere with daily activities). If moderate to severe gastrointestinal symptoms occurred (defined as symptoms interfering with daily activities or requiring medication), the dose remained at 500 mg twice daily, and the escalation was deferred by one week with re-assessment. If severe intolerance persisted, the dose was reduced to 500 mg once daily. In the treatment group, 142 patients successfully escalated to 1000 mg twice daily by the second week; 12 patients remained on 500 mg twice daily due to mild gastrointestinal intolerance; 5 patients were reduced to 500 mg once daily. In the control group, 136 patients escalated to 1000 mg twice daily; 10 patients remained on 500 mg twice daily; 6 patients were reduced to 500 mg once daily. There was no significant difference in the final metformin dosage distribution between the two groups (P=0.892).

Catgut specifications: Sterile absorbable surgical suture (polyglycolic acid, 2-0 size, 1.0 cm length per segment; Hangzhou Huadong Medical Device Co., Ltd., China). Implantation

depth per acupoint: Guanyuan (CV4): 1.0-1.5 cm; Qihai (CV6): 1.0-1.5 cm; Zusanli (ST36): 1.5-2.0 cm; Sanyinjiao (SP6): 1.0-1.5 cm; Taichong (LR3): 0.8-1.0 cm; Fenglong (ST40): 1.5-2.0 cm. Depth was adjusted based on the patient's body habitus. Criteria for successful implantation: Deqi (needling sensation) was confirmed by the patient reporting sensations such as local soreness, distension, numbness, or radiating sensation; additionally, successful implantation was verified by the absence of catgut retraction upon needle withdrawal and by palpation confirming catgut placement at the target depth. Implantation failure rate: The procedure was successfully completed in all 159 patients without any implantation failure (0%). In 3 cases (1.89%), minor catgut protrusion was observed, which was managed by gentle repositioning; these cases were not counted as failures.

Efficacy evaluation criteria

The criteria for evaluating therapeutic efficacy were as follows [13]: (1) Marked efficacy: Resolution of clinical manifestations; restoration of regular menstrual cycling; normalization of ultrasonographic and laboratory parameters; and composite improvement index (calculated as percentage reduction in combined symptom and laboratory scores) ≥70%. (2) Effective: Attenuation of clinical manifestations relative to baseline; near-restoration of regular menses; amelioration of sonographic and laboratory parameters; composite improvement index 30-69%. (3) Ineffective: Minimal to no symptomatic or menstrual modification, with potential deterioration; aggregate amelioration below 30%.

Observational indicators and efficacy evaluation

(1) Baseline data collection: Comprehensive demographic and clinical data were gathered prior to intervention initiation for both cohorts, encompassing: age, illness duration, body mass index (BMI), systolic (SBP) and diastolic (DBP) blood pressures, Ferriman-Gallwey hirsutism severity score, reproductive history (infertility), menstrual pattern characteristics, hereditary diabetes predisposition, and lifestyle factors (tobacco and alcohol consumption).

(2) Biochemical Assessments: Fasting venous specimens (5 mL) were obtained at baseline (menstrual cycle days 3-5) and following three complete treatment cycles (corresponding cycle days 3-5). Post-centrifugation serum aliquots underwent multimodal analysis: Reproductive endocrine panel: Total testosterone, luteinizing hormone, follicle-stimulating hormone, and estradiol concentrations were quantified via chemiluminescent immunoassay (Beckman Access 2 platform), with subsequent computation of the LH-to-FSH ratio. Glucoregulatory and insulin sensitivity markers: Fasting glycemia was assessed by glucose oxidase methodology; fasting insulinemia via chemiluminescence. Insulin resistance was indexed through homeostatic model assessment: HOMA-IR = (fasting glucose × fasting insulin)/22.5. Lipid profile: Total cholesterol, triglycerides, LDL-cholesterol, and HDL-cholesterol were analyzed on a Hitachi 7600 automated chemistry system.

(3) Efficacy evaluation: After 3 treatment cycles, the therapeutic efficacy was evaluated according to the improvement of clinical symptoms and the recovery of laboratory indicators.

(4) Adverse reaction monitoring: During the treatment period, the incidence of adverse reactions in both groups was recorded, including local redness and swelling, gastrointestinal discomfort, menstrual abnormalities and irregular bleeding.

(5) Menstrual pattern assessment: After 3 treatment cycles, the menstrual patterns of all patients were recorded and categorized as normal menstruation, oligomenorrhea, or amenorrhea.

(6) BMI-based subclassification: The cohort was stratified according to baseline body mass index into lean PCOS (BMI<25 kg/m^2) and obese PCOS (BMI≥25 kg/m^2) subpopulations. Comparative efficacy analyses were then conducted between treatment groups independently within each weight category.

Statistical methods

Data processing was conducted using SPSS version 26.0. Distribution characteristics of quantitative parameters were initially examined with Shapiro-Wilk testing; Gaussian-distributed

Table 1. Baseline data table

	Treatment Group (n=159)	Control Group (n=152)	t/χ^2	P
Age (years)	28.04±4.13	27.68±3.90	0.790	0.430
Disease Course (years)	3.94±1.46	4.18±1.64	1.402	0.162
BMI (kg/m^2)	25.53±3.69	25.29±3.23	0.604	0.546
Systolic Blood Pressure (mmHg)	103.56±11.00	104.21±12.12	0.494	0.622
Diastolic Blood Pressure (mmHg)	77.85±4.42	78.18±4.96	0.606	0.545
Ferriman-Gallway Hirsutism Score	7.70±1.88	7.95±2.12	1.124	0.262
Infertility			0.175	0.676
Yes	58 (36.48)	52 (34.21)		
No	101 (63.52)	100 (65.79)		
Oligomenorrhea or Amenorrhea			0.610	0.435
Yes	134 (84.28)	123 (80.92)		
No	25 (15.72)	29 (19.08)		
Family History of Diabetes			1.820	0.177
Yes	16 (10.06)	23 (15.13)		
No	143 (89.94)	129 (84.87)		
Smoking History			1.025	0.311
Yes	37 (23.27)	43 (28.29)		
No	122 (76.73)	109 (71.71)		
Drinking History			0.330	0.566
Yes	29 (18.24)	24 (15.79)		
No	130 (81.76)	128 (84.21)		

BMI: body mass index.

measurements were expressed as arithmetic mean ± standard deviation. Qualitative variables were tabulated as counts (proportions) and compared through chi-square analysis. Within-group comparisons: Paired t-tests were used for all pre-post comparisons of normally distributed continuous variables. Normality was verified using the Shapiro-Wilk test ($P>0.05$ for all variables listed). For non-normally distributed variables, the Wilcoxon signed-rank test was used. Between-group comparisons: Independent t-tests were used for normally distributed continuous variables; the Mann-Whitney U test was used for non-normally distributed variables. Ordinal efficacy data: The Wilcoxon rank-sum test is appropriate for ordinal outcomes and does not rely on the assumption of normality. Prior to correlation analysis, all post-treatment variables were tested for normality using the Shapiro-Wilk test. Normally distributed variables were analyzed using Pearson correlation and expressed as r; non-normally distributed variables were analyzed using Spearman's rank correlation and expressed as ρ. The threshold for statistical significance was established at $\alpha=0.05$ (two-tailed).

Results

Comparison of baseline data between the two groups

Pretreatment profiles were well-balanced between arms. No significant differences emerged in quantitative measures (age, disease duration, BMI, hemodynamic indices, hirsutism scoring) or qualitative factors (infertility, menstrual irregularities, familial diabetes, substance use) across comparison groups ($P>0.05$; **Table 1**).

Comparison of changes in sex hormone levels

Baseline androgen and gonadotropin concentrations were comparable between cohorts (all $P>0.05$). Post-intervention, both arms exhibited reduced testosterone and luteinizing hormone levels alongside elevated follicle-stimulating hormone and estradiol concentrations relative to pretreatment values. Notably, the intervention group demonstrated more pronounced hormonal improvements: significantly greater reductions in T and LH, coupled with enhanced FSH and E_2 elevations, compared

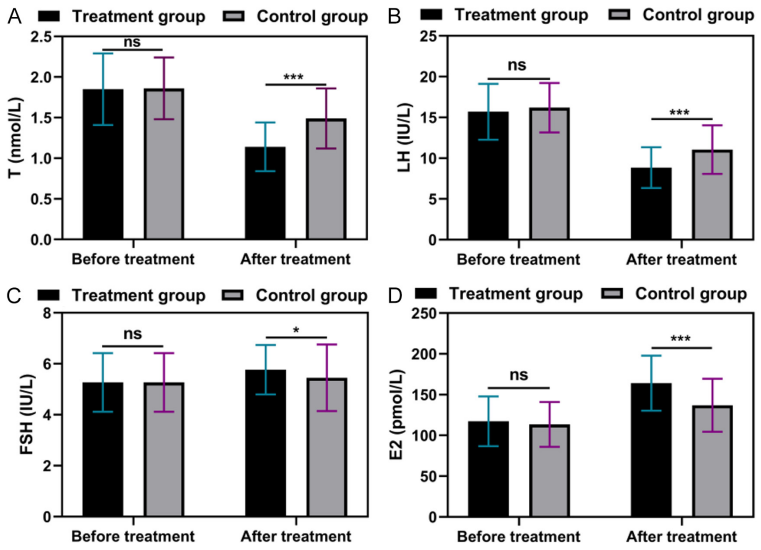

Figure 1. Comparison of changes in sex hormone levels. T: testosterone, LH: luteinizing hormone, FSH: follicle-stimulating hormone, E_2: estradiol. ^{ns}P>0.05, *P<0.05, ***P<0.001.

with the conventional arm (**Figure 1**). Post-treatment, the treatment group showed greater reductions in T (from 1.85±0.44 nmol/L to 1.14±0.30 nmol/L) than the control group (from 1.86±0.38 nmol/L to 1.49±0.37 nmol/L) (P<0.001). Similarly, LH decreased more substantially in the treatment group (from 15.69±3.43 IU/L to 8.84±2.50 IU/L) than the control group (from 16.19±3.03 IU/L to 11.16±2.98 IU/L) (P<0.001). FSH increased from 5.27±1.15 IU/L to 5.77±0.96 IU/L in the treatment group, and from 5.24±1.13 IU/L to 5.45±1.31 IU/L in the control group. E_2 increased from 117.34±30.50 pmol/L to 164.02±33.79 pmol/L in the treatment group, and from 113.49±27.51 pmol/L to 136.89±32.51 pmol/L in the control group.

Comparison of changes in glucose and lipid metabolism indicators

Pretreatment HOMA-IR indices, glycemic markers, and lipoprotein profiles were well-matched between the cohorts (all P>0.05). Post-intervention, both groups manifested reduced insulin resistance, improved glucose homeostasis (lower fasting and postprandial glycemia), and favorable lipid modifications - decreased total cholesterol, triglycerides, and LDL-cholesterol alongside elevated HDL-cholesterol. The intervention arm, however, achieved significantly superior metabolic outcomes: more pronounced reductions in HOMA-IR, FBG, 2h PBG, TC, TG, and LDL-C, coupled with greater HDL-C elevation, relative to the control group (**Figure 2**). In the treatment group, HOMA-IR decreased from 6.12±0.94 at baseline to 2.32±0.36 post-treatment, while in the control group, HOMA-IR decreased from 6.12±1.09 to 3.14±0.38. FBG decreased from 6.29±0.90 mmol/L to 5.07±0.68 mmol/L in the treatment group, and from 6.28±0.83 mmol/L to 5.61±0.73 mmol/L in the control group. 2h PBG decreased from 8.62±1.39 mmol/L to 6.58±1.18 mmol/L in the treatment group, and from 8.81±1.28 mmol/L to 7.28±1.20 mmol/L in the control group. TC decreased from 5.32±0.84 mmol/L to 4.36±0.56 mmol/L in the treatment group, and from 5.32±0.76 mmol/L to 4.81±0.64 mmol/L in the control group. TG decreased from 1.85±0.47 mmol/L to 1.18±0.41 mmol/L in the treatment group, and from 1.85±0.54 mmol/L to 1.53±0.41 mmol/L in the control group. LDL-C decreased from 3.32±0.69 mmol/L to 2.47±0.47 mmol/L in the treatment group, and from 3.23±0.70 mmol/L to 2.83±0.53 mmol/L in the control group. HDL-C increased from 1.10±0.22 mmol/L to 1.48±0.30 mmol/L in the treatment group, and from 1.13±0.26 mmol/L to 1.24±0.27 mmol/L in the control group.

Comparison of clinical efficacy

Intergroup comparison of ordinal efficacy outcomes employed Wilcoxon rank-sum methodology. Analysis demonstrated statistically significant heterogeneity in clinical response grade distributions across treatment arms (Z=2.401, P=0.016), with superior grade clustering observed in the active-treatment group (**Table 2**).

Comparison of menstrual recovery

After treatment, the rate of normal menstrual recovery in the treatment group was significantly higher than that in the control group, while the proportions of oligomenorrhea and amenorrhea were significantly lower, with sta-

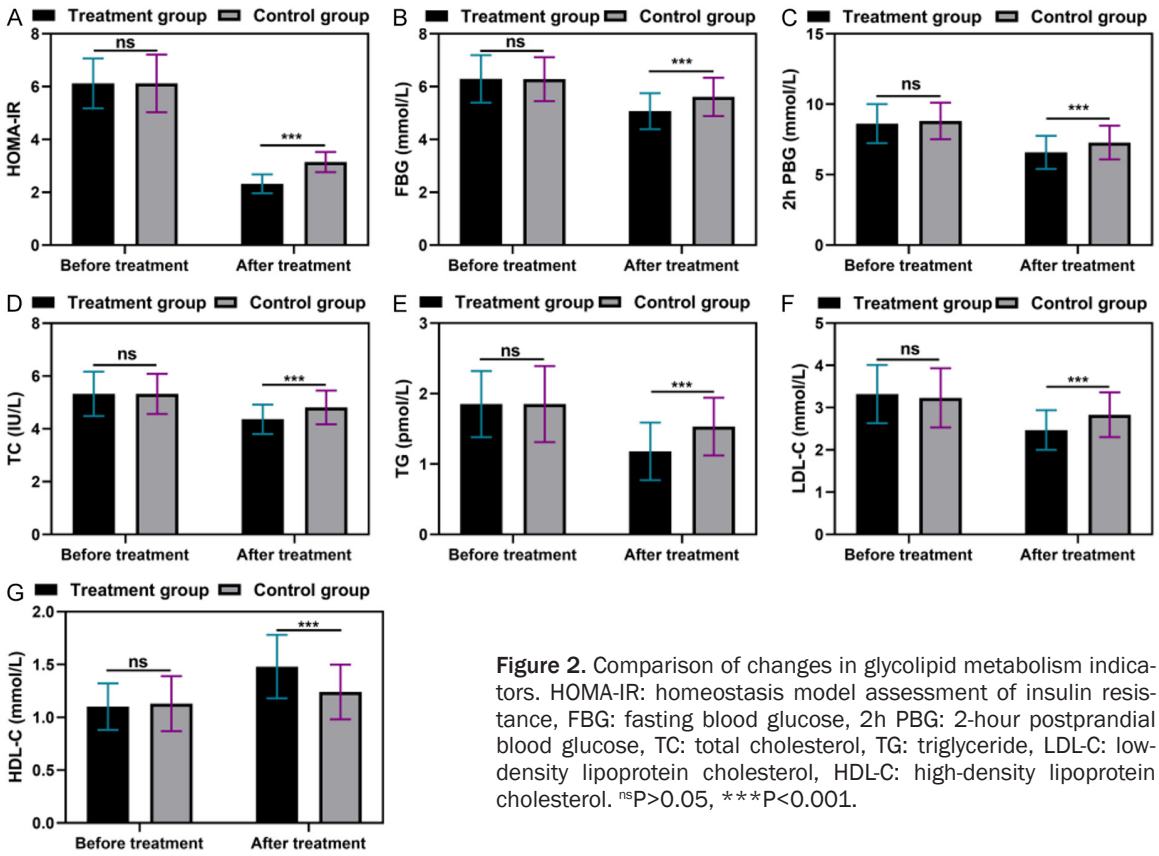

Figure 2. Comparison of changes in glycolipid metabolism indicators. HOMA-IR: homeostasis model assessment of insulin resistance, FBG: fasting blood glucose, 2h PBG: 2-hour postprandial blood glucose, TC: total cholesterol, TG: triglyceride, LDL-C: low-density lipoprotein cholesterol, HDL-C: high-density lipoprotein cholesterol. ^{ns}P>0.05, ***P<0.001.

Table 2. Clinical efficacy profile

	Treatment Group (n=159)	Control Group (n=152)	Z	P
Marked Efficacy	35 (22.01)	27 (17.76)	2.401	0.016
Effective	108 (67.92)	91 (59.87)		
Ineffective	16 (10.06)	34 (22.37)		

tistically significant differences (P<0.05), as shown in **Table 3**.

Comparison of the incidence of adverse reactions

Analysis of treatment-emergent adverse events revealed similar safety profiles across both arms. The aggregate incidence of untoward reactions did not differ significantly between the intervention and control groups (P=0.374; **Table 4**).

Correlation analysis between insulin resistance indicators and sex hormone levels after treatment

Spearman's rank correlation analysis revealed significant linear relationships between insulin resistance indices and reproductive hormonal parameters. HOMA-IR exhibited strong positive correlations with testosterone (ρ=0.660, P<0.001) and luteinizing hormone (ρ=0.615, P<0.001), alongside inverse associations with follicle-stimulating hormone (ρ=-0.459, P<0.001) and estradiol (ρ=-0.601, P<0.001), all P<0.001 (**Figure 3**).

Correlation analysis between insulin resistance indicators and lipid metabolism indicators after treatment

Spearman's rank correlation testing revealed that post-intervention HOMA-IR indices exhibited robust positive linear relationships with atherogenic lipoproteins - TC (ρ=0.631, P<0.001), TG (ρ=0.623, P<0.001), and LDL-C (ρ=0.534, P<0.001) - alongside a significant negative correlation with cardioprotective HDL-C (ρ=-0.624, P<0.001), as depicted in **Figure 4**.

Subgroup efficacy analysis stratified by BMI

The cohort was partitioned according to pretreatment body mass index into non-obese

Table 3. Comparison of menstrual recovery between the two groups after treatment

	Normal menstruation	Oligomenorrhea	Amenorrhea	χ^2	P
Treatment Group (n=159)	112 (70.44)	38 (23.90)	9 (5.66)		
Control Group (n=152)	88 (57.89)	45 (29.61)	19 (12.50)	6.888	0.032

Table 4. Adverse reaction profile

	Treatment Group (n=159)	Control Group (n=152)	χ^2	P
Local Redness and Swelling	16 (10.06)	4 (2.63)		
Gastrointestinal Discomfort	19 (11.95)	19 (12.50)		
Menstrual Abnormalities	8 (5.03)	10 (6.58)		
Irregular Bleeding	5 (3.14)	6 (3.95)		
Total Incidence Rate	48 (30.20)	39 (25.66)	0.792	0.374

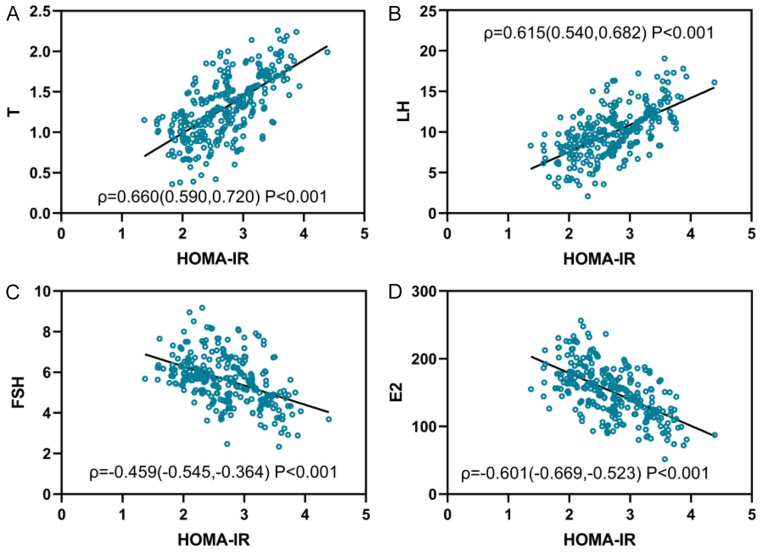

Figure 3. Correlation between insulin resistance indicators and sex hormone levels after treatment. T: testosterone, LH: luteinizing hormone, FSH: follicle-stimulating hormone, E_2: estradiol, HOMA-IR: homeostasis model assessment of insulin resistance.

(BMI<25 kg/m^2) and obese (BMI≥25 kg/m^2) metabolic subtypes. Comparative efficacy evaluation revealed enhanced total response rates in the active-treatment group across both weight categories, with statistically greater between-group separation observed among obese PCOS patients (P<0.05; **Table 5**).

Discussion

PCOS is a complex disease involving dual disorders of reproductive endocrinology and energy metabolism, and its treatment needs to address the two core pathological links of hyperandrogenemia and insulin resistance simultaneously [14]. This retrospective analysis suggests that adjunctive acupoint catgut embedding enhances the therapeutic index of standard PCOS management. Active intervention outperformed sham embedding across endocrine, metabolic, and insulin sensitivity endpoints, maintaining comparable safety profiles. These findings verify the potential synergistic value of the integrated traditional Chinese and Western medicine regimen in PCOS treatment.

Treatment across both arms yielded favorable shifts in reproductive hormones - declining androgens and LH, rising FSH and E_2 - with the active-embedding group demonstrating significantly superior hormonal normalization versus sham-embedding controls, validating the adjunctive value of this integrative approach [15]. Notably, the combination with acupoint catgut embedding produced additional improvements.

The potential mechanism may be multi-target and multi-level. First, from the perspective of neuroendocrine regulation, the selected acupoints such as Guanyuan (CV4) and Sanyinjiao (SP6) are key acupoints for regulating the thoroughfare vessel, conception vessel, and uterine functions [16]. The sustained and mild stimulation generated by catgut embedding may regulate the function of the hypothalamic-pituitary-ovarian axis, normalize the abnormal

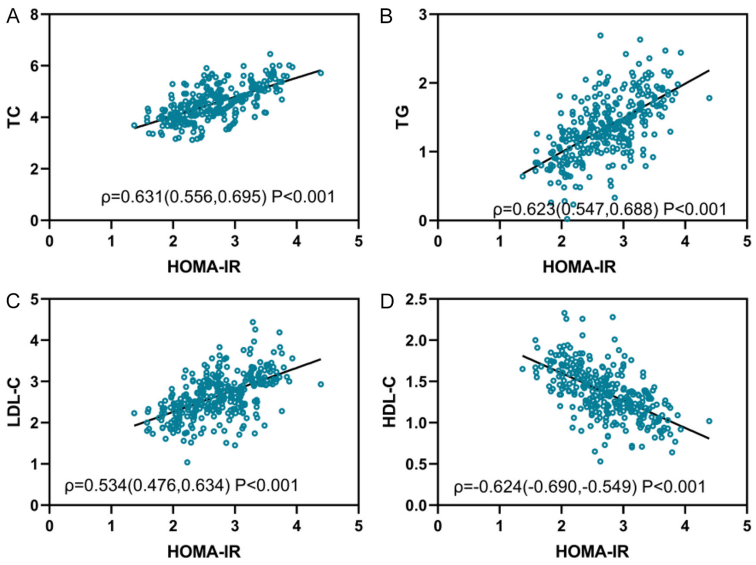

Figure 4. Correlation between insulin resistance indicators and lipid metabolism indicators after treatment. HOMA-IR: homeostasis model assessment of insulin resistance, TC: total cholesterol, TG: triglyceride, LDL-C: low-density lipoprotein cholesterol, HDL-C: high-density lipoprotein cholesterol.

Table 5. Comparison of clinical efficacy between the two groups in different BMI subgroups

	Treatment group	Control group	Z	P
BMI<25 kg/m^2	n=74	n=71		
Markedly effective	18 (24.32)	12 (16.90)	2.018	0.044
Effective	49 (66.22)	43 (60.56)		
Ineffective	7 (9.46)	16 (22.54)		
BMI≥25 kg/m^2	n=85	n=81		
Markedly effective	17 (20.00)	13 (16.05)	2.297	0.022
Effective	59 (69.41)	45 (55.55)		
Ineffective	9 (10.59)	23 (28.40)		

BMI: body mass index.

secretion rhythm of gonadotropins, thereby down-regulating the excessive secretion of LH and correcting the disordered LH/FSH [17]. Second, from the perspective of local microenvironment and metabolic regulation, insulin resistance and hyperinsulinemia can stimulate excessive androgen secretion by ovarian theca cells [18]. This study confirmed that the treatment group had more advantages in improving insulin resistance, which provides a favorable metabolic environment for reducing ovarian-derived androgens. In addition, relevant studies have shown that acupoint stimulation may promote the normal development of follicles and the balanced synthesis of steroid hormones by regulating local growth factors, improving ovarian blood flow, and enhancing mitochondrial function [19]. Therefore, acupoint catgut embedding may work synergistically with Western medicines to more comprehensively correct the endocrine disorders of PCOS.

Abnormal glucose and lipid metabolism and insulin resistance are the core manifestations of PCOS metabolic syndrome and also predictors of long-term cardiovascular risks [20]. The results of this study showed that the treatment group was significantly superior to the control group in reducing fasting blood glucose, 2-hour postprandial blood glucose, fasting insulin, HOMA-IR, as well as improving blood lipid profiles. This may indicate that acupoint catgut embedding has an independent improvement effect on metabolic disorders in PCOS and produces a synergistic effect with metformin.

The underlying mechanism may be related to the regulation of lipid metabolism and energy balance. The long-acting stimulation of acupoint catgut embedding may affect autonomic nervous function, regulate the activities of enzymes related to lipolysis and lipid synthesis, promote triglyceride decomposition, and reverse cholesterol transport, which is consistent with the superior lipid improvement observed in the treatment group [21].

The efficacy advantages demonstrated in this study reflect the synergistic effect produced by the combination of acupoint catgut embedding and targeted Western medicine intervention. Western medicines have clear effects and relatively rapid onset, but may be associated with side effects and rebound after drug withdrawal. As a physical long-acting stimulation, acupoint catgut embedding exerts a milder and more

sustained effect through systemic regulation of the meridian-neuroendocrine-immune network [22]. In the combined therapy, Western medicines can quickly control the main symptoms, while catgut embedding may consolidate the therapeutic effect through continuous regulatory action.

The results of Spearman's rank correlation analysis in this study provide strong pathophysiological evidence for the necessity of the above-mentioned combined therapy. The analysis showed that after treatment, HOMA-IR was significantly positively correlated with the levels of T, LH, TC, and TG, and negatively correlated with E_2 and HDL-C in patients. This finding strongly supports the classic vicious cycle theory of insulin resistance-hyperandrogenemia-dyslipidemia in PCOS [23, 24]. In terms of safety, there was no statistically significant difference in the total incidence of adverse reactions between the two groups, indicating that the combined regimen was generally well tolerated. It is worth noting that the incidence of local redness and swelling was slightly higher in the treatment group, which was mainly related to the minimally invasive stimulation of the catgut embedding procedure itself, and most of these reactions were mild and transient. The clinical efficacy advantages of the combined regimen were further reflected in the significant improvement in menstrual recovery. The results showed that the rate of normal menstrual resumption in the treatment group was significantly higher than that in the control group, while the proportions of oligomenorrhea and amenorrhea were significantly lower. Notably, subgroup analysis based on baseline BMI revealed that the therapeutic advantage of the combined regimen was more pronounced in obese PCOS patients. Obesity is not only an important phenotype of PCOS but also a key aggravating factor for insulin resistance and metabolic disorders. Obese PCOS patients often exhibit more severe endocrine and metabolic disturbances and are less responsive to conventional medication. The results of this study suggest that acupoint catgut embedding may provide additional benefits for this specific population. Its potential mechanisms may involve the regulation of appetite, promotion of energy metabolism, improvement of chronic inflammatory states associated with obesity, and enhancement of insulin sensitivity, thereby creating better internal conditions for Western medicine to exert its effects. This finding provides a basis for the precise and stratified application of integrated Traditional Chinese and Western medicine therapy for PCOS, suggesting that obese PCOS patients may benefit more from the combination of acupoint catgut embedding.

However, this study also has several limitations. First, the study adopted a retrospective analysis design. Although the baseline data of the two groups were balanced, there may still be residual confounding biases. Second, the exploration of the mechanism remains superficial; the correlation analysis only indicates an association and fails to further clarify the specific molecular biological pathways through which acupoint catgut embedding exerts its effects. Third, the observation indicators need to be expanded. In future studies, more sensitive indicators such as anti-Müllerian hormone, sex hormone-binding globulin, and inflammatory factors can be added to more comprehensively evaluate ovarian reserve function and chronic inflammatory status. This study did not conduct pre-specified subgroup analyses based on PCOS Rotterdam phenotypes or baseline insulin resistance severity. Therefore, the generalizability of the current findings across various patient subtypes requires further validation. Future prospective studies should incorporate a stratified design a priori to clarify the precise efficacy of this combination therapy in subgroups with distinct pathophysiological characteristics. Fourth, although the sham catgut embedding was strictly standardized to mimic the genuine procedure apart from omitting catgut implantation, the acupuncture manipulation itself may induce nonspecific physiological responses, such as improved local microcirculation or afferent nerve stimulation. Accordingly, intergroup differences observed in this study may consist of both specific therapeutic effects of catgut embedding and distinct acupuncture-related effects. Future trials should adopt more inert placebo controls, for instance non-penetrating sham needles, to completely isolate the specific therapeutic efficacy derived from catgut embedding therapy. Fifth, the retrospective design and short-term observation period (3 treatment cycles) preclude conclusions regarding long-term durability of treatment effects, optimal maintenance protocols, and impact on

hard endpoints such as cardiovascular events, type 2 diabetes incidence, and fertility outcomes. The clinical translation framework proposed above requires validation through prospective, multicenter randomized controlled trials with extended follow-up periods.

In conclusion, on the basis of conventional treatment with cyproterone acetate and ethinylestradiol combined with metformin, the addition of acupoint catgut embedding therapy can more effectively improve sex hormone disorders, abnormal glucose and lipid metabolism, and insulin resistance in patients with polycystic ovary syndrome, achieve better comprehensive clinical efficacy, and not increase safety risks. These findings support the development of standardized integrative protocols, with particular consideration for obese PCOS patients who demonstrate enhanced therapeutic response. Future prospective studies with long-term follow-up are essential to validate sustained clinical benefits, establish maintenance regimens, and evaluate impacts on reproductive outcomes and cardiometabolic endpoints.

Acknowledgements

This work was supported by the Natural Science Foundation of Gansu Province (23JRRA1236).

Disclosure of conflict of interest

None.

Address correspondence to: Xuemei Zhang, Department of Acupuncture and Moxibustion I, Gansu Provincial Hospital of Traditional Chinese Medicine, No. 306 Guazhou Road, Qilihe District, Lanzhou 730000, Gansu, China. E-mail: Zhangxuemei3932@163.com

References

[1] Fang YQ, Ding H, Li T, Zhao XJ, Luo D, Liu Y and Li Y. N-acetylcysteine supplementation improves endocrine-metabolism profiles and ovulation induction efficacy in polycystic ovary syndrome. J Ovarian Res 2024; 17: 205.

[2] Saleh FL, Starkman H, Furness A, Pfeifer SM and Kives S. Polycystic ovary syndrome in adolescents. Obstet Gynecol Clin North Am 2024; 51: 679-693.

[3] Chappell NR, Gibbons WE and Blesson CS. Pathology of hyperandrogenemia in the oocyte of polycystic ovary syndrome. Steroids 2022; 180: 108989.

[4] Zeng X, Xie YJ, Liu YT, Long SL and Mo ZC. Polycystic ovarian syndrome: correlation between hyperandrogenism, insulin resistance and obesity. Clin Chim Acta 2020; 502: 214-221.

[5] Singhal R, Tewari S, Sharma R, Singhal S, Tanwar N and Sangwan A. Effect of cyproterone acetate/ethinyl estradiol combination on periodontal status and high-sensitivity C-reactive protein levels in women with polycystic ovary syndrome: a cross-sectional study. Quintessence Int 2024; 55: 274-285.

[6] Notaro ALG and Neto FTL. The use of metformin in women with polycystic ovary syndrome: an updated review. J Assist Reprod Genet 2022; 39: 573-579.

[7] Rashid R, Mir SA, Kareem O, Ali T, Ara R, Malik A, Amin F and Bader GN. Polycystic ovarian syndrome-current pharmacotherapy and clinical implications. Taiwan J Obstet Gynecol 2022; 61: 40-50.

[8] Jungari M, Choudhary A and Gill NK. Comprehensive management of polycystic ovary syndrome: effect of pharmacotherapy, lifestyle modification, and enhanced adherence counseling. Cureus 2023; 15: e35415.

[9] Chen H, Deng C, Meng Z and Meng S. Effects of TCM on polycystic ovary syndrome and its cellular endocrine mechanism. Front Endocrinol (Lausanne) 2023; 14: 956772.

[10] Chen PB, Chen J, Cui J and Yang XF. Effects of the acupoint catgut embedding on nerve-endocrine-immune network in dysmenorrhea rats. Zhen Ci Yan Jiu 2018; 43: 30-34.

[11] Li S, Zhou H, Zhou M, Lou L, Luo L and Ji S. The effects of acupoint catgut embedding therapy on anthropometric parameters and endocrine function in obese women: a systematic review and meta-analysis. Front Nutr 2025; 12: 1583556.

[12] Rotterdam ESHRE/ASRM-Sponsored PCOS consensus workshop group. Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome (PCOS). Hum Reprod 2004; 19: 41-47.

[13] Li L, Huang N, Qi Y, Li Y and Wang L. Effect of Wenshentiaojing decoction on hormone level and follicular number in patients with menstrual disorder of polycystic ovary syndrome. Evid Based Complement Alternat Med 2021; 2021: 4975867.

[14] Zhang H, Wang W, Zhao J, Jiao P, Zeng L, Zhang H, Zhao Y, Shi L, Hu H, Luo L, Fukuzawa I, Li D, Li R and Qiao J. Relationship between body composition, insulin resistance, and hormonal profiles in women with polycystic ovary syndrome. Front Endocrinol (Lausanne) 2023; 13: 1085656.

[15] Morin-Papunen L, Vauhkonen I, Koivunen R, Ruokonen A, Martikainen H and Tapanainen JS. Metformin versus ethinyl estradiol-cyproterone acetate in the treatment of nonobese women with polycystic ovary syndrome: a randomized study. J Clin Endocrinol Metab 2003; 88: 148-156.
[16] Liao BD, Liu YE, Peng ZM, Zhou C, Liu C, He JJ and Yu R. Therapeutic effects on primary dysmenorrhea treated with moxibustion at Shenque (CV 8) and warm needling at Guanyuan (CV 4) and Sanyinjiao (SP 6). Zhongguo Zhen Jiu 2019; 39: 367-370.
[17] Wang J, Cheng K, Qin Z, Wang Y, Zhai L, You M and Wu J. Effects of electroacupuncture at Guanyuan (CV 4) or Sanyinjiao (SP 6) on hypothalamus-pituitary-ovary axis and spatial learning and memory in female SAMP8 mice. J Tradit Chin Med 2017; 37: 96-100.
[18] Torstensson S, Ascani A, Risal S, Lu H, Zhao A, Espinosa A, Lindgren E, Johansson MH, Eriksson G, Barakat M, Karlsson MCI, Svensson C, Benrick A and Stener-Victorin E. Androgens modulate the immune profile in a mouse model of polycystic ovary syndrome. Adv Sci (Weinh) 2024; 11: e2401772.
[19] Lin G, Liu X, Cong C, Chen S and Xu L. Clinical efficacy of acupuncture for diminished ovarian reserve: a systematic review and meta-analysis of randomized controlled trials. Front Endocrinol (Lausanne) 2023; 14: 1136121.
[20] Ormazabal V, Nair S, Elfeky O, Aguayo C, Salomon C and Zuñiga FA. Association between insulin resistance and the development of cardiovascular disease. Cardiovasc Diabetol 2018; 17: 122.
[21] Song Y, Shi X, Gao Z, Li R, Tian J, Cao X, Yang B, Zhao S and Yang Y. Acupoint catgut embedding improves lipid metabolism in exercise-induced fatigue rats via the PPAR signaling pathway. Animals (Basel) 2023; 13: 558.
[22] HuiYan Z, Purumea J, Chaewon L and Chang-Hyun H. Acupoint catgut embedding for simple obesity in animal studies: a systematic review and meta-analysis. J Tradit Chin Med 2023; 43: 860-867.
[23] Klop B, Elte JW and Cabezas MC. Dyslipidemia in obesity: mechanisms and potential targets. Nutrients 2013; 5: 1218-1240.
[24] Uehara K, Santoleri D, Whitlock AEG and Titchenell PM. Insulin regulation of hepatic lipid homeostasis. Compr Physiol 2023; 13: 4785-4809.