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# Comparative efficacy of acupuncture and acupoint catgut embedding in diminished ovarian reserve: A prospective randomized controlled trial

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Diminished ovarian reserve (DOR) is a significant health issue affecting women, leading to hormonal imbalances and infertility. Traditional Chinese Medicine (TCM) therapy plays a vital role in its treatment. This study aimed to compare the efficacy of traditional acupuncture and acupoint catgut embedding in improving ovarian function in women diagnosed with DOR. A single center randomized controlled trial was conducted with 61 participants aged 18-40 years diagnosed with DOR. Participants were randomly assigned to receive either acupuncture or acupoint catgut embedding. Primary outcomes included changes in follicle-stimulating hormone (FSH), estradiol (E2), anti-Müllerian hormone (AMH), antral follicle count (AFC), and menstrual cycle regularity. Quality of life was assessed using Kupperman scores and SF-36. Intra-group analyses showed significant improvements in FSH ($p<0.001$), E2 ($p<0.001$), AMH ($p<0.001$), and AFC ($p<0.001$) in both groups, with the acupoint catgut embedding group demonstrating superior improvements in FSH and luteinizing hormone (LH) levels ($p=0.010$ and $p=0.022$, respectively). Quality of life scores indicated better symptom control and general health in the catgut embedding group ($p<0.001$). Both acupuncture and acupoint catgut embedding were effective in enhancing ovarian function in women with DOR, with acupoint catgut embedding showing greater improvements in hormonal profiles and quality of life metrics. Further studies are warranted to confirm these findings and explore the underlying mechanisms.

**Keywords**: Acupoint catgut embedding, Acupuncture, Diminished ovarian reserve, Quality of life

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Diminished ovarian reserve (DOR) is characterized by a condition in which women of reproductive age exhibit a reduced ovarian response to stimulation, despite maintaining regular menstrual cycles[1]. This impairment manifests in the ovarian cortex, where the growth, development, and formation of viable follicles are compromised, leading to a decline in both the quantity and quality of ovarian follicles. Consequently, DOR can result in ovarian insufficiency, reproductive endocrine dysfunction, and decreased fertility, as evidenced by decreased levels of anti-Müllerian hormone (AMH), diminished antral follicle count (AFC), and elevated follicle-stimulating hormone (FSH) levels. As the condition progresses, patients may experience irregular menstruation, amenorrhea, and, in severe cases, premature ovarian failure (POF) and infertility.

With societal advancements and improvements in living standards, the prevalence of diminished ovarian function among women has been steadily increasing, rendering it one of the most pressing concerns in gynecological medicine[2,3]. In a study conducted at a U.S. infertility clinic, approximately 10% of women (around 275,000) were diagnosed with DOR[4]. Similarly, in China, the infertility rate among couples of reproductive age has escalated from 3% two decades ago to 15% today[5], with DOR accounting for 10% of female infertility cases[6]. If not addressed with timely and effective interventions, patients with DOR risk ovarian atrophy and may progress to primary ovarian insufficiency (POI) within 1 to 6 years[7].

Traditional Chinese medicine (TCM), with its distinct theoretical framework and therapeutic modalities, has shown significant advantages in the management of gynecological disorders. Among its various practices, acupuncture has been widely employed in treating diminished ovarian function. However, traditional acupuncture often faces challenges such as lengthy treatment cycles and variable outcomes, necessitating the exploration of alternative therapies to enhance

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treatment efficacy for DOR. Acupoint catgut embedding, a novel TCM approach that has gained traction in recent years, involves embedding specific materials at acupoints to provide continuous stimulation, thus facilitating the regulation of physiological functions. In comparison to traditional acupuncture, acupoint embedding presents advantages such as simpler operational procedures and prolonged therapeutic effects. Unlike traditional acupuncture requiring frequent sessions (e.g., 3×/week), catgut embedding provides sustained mechanical stimulation to acupoints via biodegradable collagen threads[8]. This continuous stimulus may enhance neuroendocrine regulation of the hypothalamic-pituitary-ovarian (HPO) axis, potentially improving ovarian follicular recruitment and hormonal balance with fewer clinical visits[9].

This study aims to investigate the therapeutic potential of acupoint embedding in treating diminished ovarian function by conducting a comparative analysis of its clinical efficacy relative to traditional acupuncture. Specifically, the study seeks to determine whether acupoint embedding yields superior therapeutic outcomes while also assessing its safety and feasibility in clinical practice, ultimately providing scientific evidence to support its broader application in clinical settings.

## Materials and Methods

### Trial design and patients

This study is a single center, randomized controlled trial conducted at the gynecology outpatient clinic of Chongqing Traditional Chinese Medicine Hospital from January 2022 to December 2023. We recruited female patients diagnosed with diminished ovarian reserve (DOR) based on the following inclusion criteria: (1) aged 18 to 40 years; (2) hormonal profile indicating FSH >10 mIU/mL (confirmed at least twice with an interval of more than one month) and AMH <1.1 ng/mL, with normal or elevated luteinizing hormone (LH) levels; (3) antral follicle count (AFC) <5-7; and (4) absence of any ovarian organic pathology as determined by ultrasound examination. Exclusion criteria included: (1) allergy to collagen catgut; (2) abnormal skin conditions at acupoint sites (e.g., surgical scars, rashes); (3) severe hepatic, renal, or coagulation dysfunction; (4) prior treatment with other therapies; and (5) conditions such as ovarian insensitivity syndrome or gonadal dysgenesis. A flowchart summarizing the study design is presented in Figure 1.

Patients were randomly assigned to either the traditional acupuncture group or the acupoint catgut

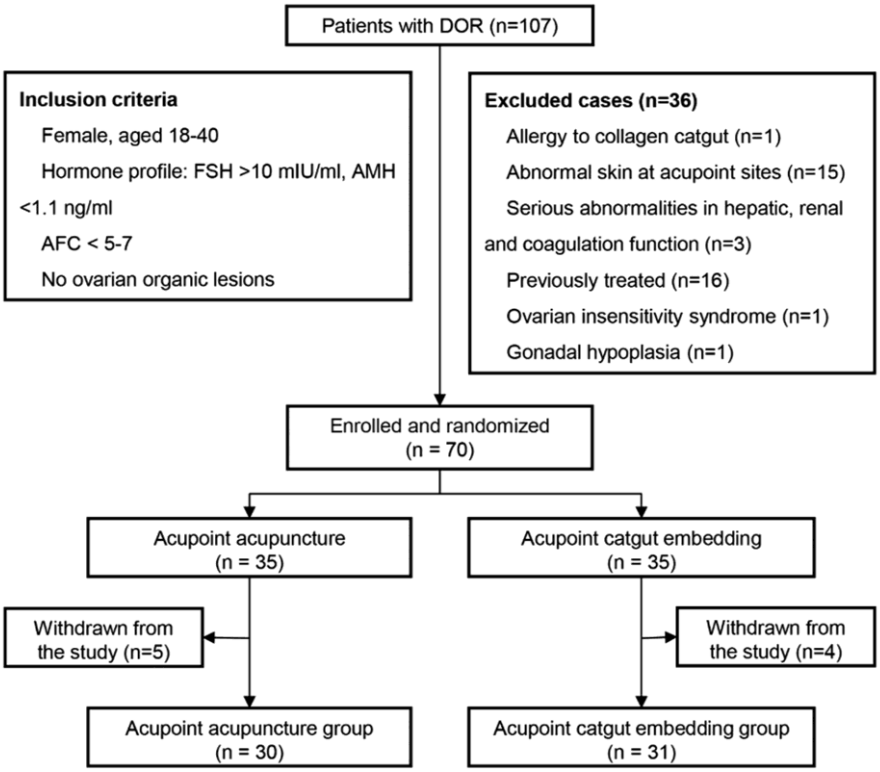


Fig. 1 — Study design and profile DOR, diminished ovarian reserve; FSH, follicle-stimulating hormone; AMH, anti-Müllerian hormone; AFC, antral follicle count

embedding group in a 1:1 ratio, using computer-generated randomization. Each group comprised 30 patients. All participants provided informed consent after receiving comprehensive information about the study's purpose and design. The study adhered to the principles of the Declaration of Helsinki and was approved by the ethics committee of Chongqing Traditional Chinese Medicine Hospital (Approval number: 2023-ky-80).

Randomization was conducted by a gynecologist serving as a research assistant, who ensured that both patients and clinicians were blinded to group assignments prior to treatment. During the treatment, we employed a single-blind method. Specifically, patients were blinded to their treatment group, and clinicians administering the treatments were not blinded, as it is not feasible to conceal the differences in the interventions. Treatments were administered by three licensed Traditional Chinese Medicine (TCM) practitioners, each possessing a minimum of three years of clinical experience in acupuncture and catgut embedding. Prior to the study, practitioners underwent training on the study protocol and standardized treatment procedures.

**Power calculation and sample size**

The sample size was calculated using the PASS software (Power analysis and sample size, version 15.0, NCSS, LLC). Based on the previous study evaluating therapy effect in gynecological disorders, we estimated the effect size for the primary outcome variables[10]. With an expected difference in means of 1.5 mIU/mL and a standard deviation of 2.0 mIU/mL for FSH, we determined that a sample size of 30 participants per group would provide 80% power at a significance level of 0.05.

**Treatment methods**

Selection of Acupoints: The acupoints selected for treatment included ST25 (Tianshu), CV6 (Qihai), CV4 (Guanyuan), EX-CA1 (Zigong), BL18 (Ganshu), BL23 (Shenshu), and SP6 (Sanyinjiao) (Fig. 2). All acupoints were located according to the World Health Organization standards for acupoint locations[11,12]. Detailed locations of the acupoints are as follows:

*ST25* (*Tianshu*): Located on the abdomen, 2 cun* lateral to the navel. (*, cun, a unit of length in Chinese medicine, 1 cun equals about 3.3 cm)

*CV6* (*Qihai*): Located in the lower abdomen, 1.5 cun below the navel, along the anterior midline.

*CV4* (*Guanyuan*): Located in the lower abdomen, 3 cun below the navel, along the anterior midline.

*EX-CA1* (*Zigong*): Located in the lower abdomen, 4 cun below the navel, 3 cun lateral to the anterior midline.

*BL18* (*Ganshu*): Located on the back, below the ninth thoracic vertebra, 1.5 cun lateral to the posterior midline.

*BL23* (*Shenshu*): Located in the lumbar region, below the second lumbar vertebra, 1.5 cun lateral to the posterior midline.

*SP6* (*Sanyinjiao*): Located on the medial side of the lower leg, 3 cun above the tip of the medial malleolus, posterior to the tibial border.

A detailed comparison of the two treatment methods was provided in Table 1.

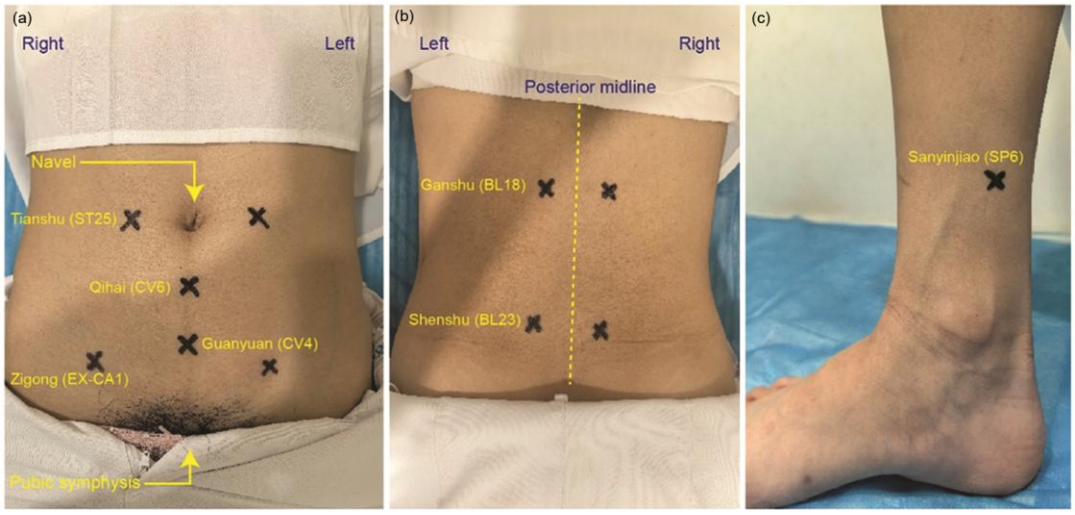


Fig. 2 — The acupoints selected for acupuncture and acupoint catgut embedding treatment, (a) Acupoints on the ventral side, (b) Acupoints on the dorsal side, (c) Acupoints on the lower limb

**Acupuncture treatment**

The acupuncture treatment was guided by the clinical experience of the corresponding author. Each session lasted 30 min, with treatments administered three times per week over three menstrual cycles, accommodating adjustments for menstruation. For abdominal acupuncture points, patients were placed in a supine position, and selected acupoints were marked. The acupuncturist utilized a three-finger technique (using the thumb, index, and middle fingers) to manipulate the needle, mimicking a brush-like motion. Needles were inserted into the skin at the acupoints until a needling sensation was elicited, after which the needles were removed.

**Acupoint catgut embedding**

The acupoint catgut embedding treatment followed the same acupoint selection as the acupuncture method and was based on the corresponding author's clinical expertise. Embedding occurred once every two weeks for three menstrual cycles, with menstruation adjustments. Initially, patients were positioned prone, followed by supine for acupoint selection and marking. The procedure was performed under aseptic conditions. A hollow needle with a core was used to insert absorbable surgical sutures (collagen threads, Shandong Boda Medical Supplies Co., Ltd., 3-0), cut into lengths of 1 to 2 cm. The hollow needle was adapted from a disposable, sterile injection needle (Zhejiang Kangdelai Medical Devices Co., Ltd., 0.7 × 32 TWLB), combined with a suitably sized acupuncture needle (Wuxi Jiajian Medical Instruments Co., Ltd., 0.30 mm × 75 mm) featuring a smooth, sharpened tip.

To perform the procedure, a 5 mm segment of the collagen thread was rinsed with 0.9% saline and placed within the needle. Local anesthesia was not required; the needle was rapidly inserted into the acupoint to a depth typically ranging from 3 to 6 mm, depending on local skin thickness. Patients were expected to experience a sensation of "Qi" (energy), characterized by feelings of soreness, distension, or numbness. The needle core was then advanced to release the thread while withdrawing the needle. Acupuncture techniques such as lifting, thrusting, and twisting were employed as needed to enhance the sensation of qi at the acupoint. Subsequently, a sterile cotton swab was used for local compression to achieve hemostasis, followed by standard disinfection procedures and application of a sterile dressing over the insertion site.

**Precautions**

During treatment, patients were advised to avoid medications, including hormones, contraceptives, and herbal remedies. Strict aseptic techniques were maintained throughout all procedures. Catgut sutures were not permitted to remain exposed outside the skin, and patients were instructed to keep the local area dry for 8 h post-embedding. Care was taken to avoid large blood vessels, nerves, and abdominal organs, and the local skin was monitored for signs of infection or foreign body reactions.

**Endpoints and assessments**

Primary endpoints included AFC, FSH, LH, E2, AMH, ovarian volume, menstrual cycle regularity, and treatment-related adverse events. These parameters were evaluated at baseline and 12 weeks post-treatment. AFC was assessed using transvaginal ultrasound conducted on days 2-5 of the menstrual cycle, defined as the number of visible ovarian follicles measuring 2-10 mm in average diameter. A low AFC is indicative of poor ovarian response during in vitro fertilization (IVF).

Additional patient data collected included age, duration of illness, marital status, parity, education level, smoking and alcohol consumption history, body mass index (BMI) pre- and post-treatment, and laboratory results (including complete blood count, liver and kidney function tests, and coagulation profile).

**Safety evaluation criteria**

Carefully assess adverse events, thoroughly evaluate the status of adverse events, and truthfully complete the

Table 1 — Comparison of treatment frequency and duration between acupuncture and acupoint catgut embedding groups

| Timeline | Menstrual cycle 1 | | | | Menstrual cycle 2 | | | | Menstrual cycle 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Week 1 | 2 | 3 | 4 | Week 1 | 2 | 3 | 4 | Week 1 | 2 | 3 | 4 |
| Acupuncture* | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ |
| Catgut embedding# | ✓ | | ✓ | | ✓ | | ✓ | | ✓ | | ✓ | |

Both groups chose the same acupoints, includingST25 (Tianshu), CV6 (Qihai), CV4 (Guanyuan), EX-CA1 (Zigong), BL18 (Ganshu), BL23 (Shenshu), and SP6 (Sanyinjiao). *, the duration of each acupuncture session was about 30 min. #, the duration of each acupoint catgut embedding was 10 - 15 min (procedure time).

adverse event report form. Adverse events were coded according to the Medical Dictionary for Regulatory Activities, version 24.0, and were graded according to the Common Terminology Criteria for Adverse Events, version 5.0[13].

#### Measurement of quality of life

To assess the impact of treatment on ovarian function and quality of life, Kupperman scores and SF-36 quality of life scores were collected at baseline and after 12 weeks of treatment. The Kupperman score evaluates the severity of menopausal symptoms and ovarian function, while the SF-36 is a comprehensive health survey developed by the Boston Health Research Institute, encompassing nine dimensions: physical function, role limitations due to physical health, bodily pain, general health, vitality, social function, emotional function, role limitations due to emotional problems, and health change.

#### Statistical analysis

Data analysis was performed using SPSS version 26.0 (Statistical Package for the Social Sciences, Chicago, IL, USA). Categorical variables were expressed as frequencies and percentages, and differences between treatment groups were assessed using the chi-square test or Fisher's exact test. Continuous variables with a normal distribution were presented as means ± standard deviations and analyzed using independent-samples t-tests. Non-normally distributed continuous variables were expressed as medians with interquartile ranges (25th and 75th percentiles) and compared using the Wilcox on rank-sum test. Paired t-tests were employed to compare changes in BMI, hormone levels, and quality of life scores pre- and post-treatment. All statistical tests were two-sided, with a p-value of $<0.05$ considered statistically significant.

## Results

#### Baseline clinical characteristics

A total of 107 women were screened at the outpatient clinic by experienced physicians. Of these, 70 women met the inclusion criteria and provided informed consent to participate in the study. These participants were randomly assigned in a 1:1 ratio to either the acupuncture treatment group or the acupoint catgut embedding group (Fig.) 1. In the acupuncture group, 3 patients withdrew due to scheduling conflicts, 1 due to treatment intolerance, and 1 due to perceived lack of therapeutic effect. In the acupoint catgut embedding group, withdrawals included 1 patient for scheduling issues, 1 for treatment intolerance, and 2 who relocated. Ultimately, 30 patients in the acupuncture group and 31 in the catgut embedding group completed the study.

There were no significant differences between the two groups regarding age, disease duration, marital and reproductive history, education level, smoking and alcohol use, body mass index (BMI), and laboratory assessments of blood routine, hepatic, renal, and coagulation function (Table 2). The mean age of participants was 33.69±4.82 years, with an average disease duration of 6.61±3.33 months and a BMI of 21.67±1.97 kg/m². In both groups, the majority of patients were married (76.7% vs. 80.6%), had at least a college education (70.0% vs. 74.2%), were non-smokers (90.0% vs. 83.9%), and did not consume alcohol (76.7% vs. 64.5%) (Table 2).

#### Treatment outcomes

Intra-group analyses were performed to assess pre- and post-treatment changes within each group. In the acupuncture group, after 12 weeks of treatment, there was a modest improvement in menstrual cycle regularity, increasing from 73.3% to 80.0% ($p=0.542$). Significant reductions in FSH levels were noted, along with increases in E2, AMH, and AFC. LH levels did not exhibit significant changes.

In the acupoint catgut embedding group, significant improvements were observed after 12 weeks, including enhanced menstrual cycle regularity (58.1% to 83.9%, $p=0.025$), a substantial decrease in FSH levels, and increases in LH, E2, AMH, and AFC (Table 3).

Inter-group comparisons revealed that no significant differences were observed between the two groups for menstrual cycle regularity, E2, AMH, AFC, or treatment-related adverse events ($p>0.05$) (Fig. 3). However, the acupoint catgut embedding group exhibited significantly greater improvements in FSH ($p=0.010$) and LH ($p=0.022$) levels (Table 4).

In terms of treatment-related adverse events, 2 patients in the acupuncture group and 3 in the acupoint catgut embedding group experienced prolonged local pain, while local bruising was reported in 3 patients from the acupuncture group and 2 from the catgut embedding group. One patient in the catgut embedding group developed mild skin swelling. All adverse reactions were resolved within one week, and there were no significant differences in the incidence of side effects between the two groups.

No serious adverse events were reported during the study (Fig. 4).

**Quality of life**

Post-treatment analysis of quality of life indicated no significant differences between the two groups in scores for Physical Functioning, Role-Physical, Bodily Pain, and Role-Emotional ($p>0.05$). However, patients in the acupoint catgut embedding group exhibited significantly lower Kupperman scores, indicating improved symptom control. Furthermore, the catgut embedding group scored higher in general health, vitality, social functioning, mental health, and reported health transition Table 5.

## Discussion

This study compared the efficacy and safety of acupoint catgut embedding versus traditional acupuncture in treating DOR in women. The findings indicate that acupoint catgut embedding demonstrates superior outcomes in improving menstrual cycle regularity, reducing FSH, increasing AMH and AFC,

Table 2 — Clinical and demographical data

| Characteristics | Acupuncture group (n =30) | Acupoint catgut embedding group (n = 31) | Statistical value | p-value |
|---|---|---|---|---|
| Age (years) | 34.13±4.26 | 33.26±5.34 | t = 0.707 | 0.482 |
| Course prior to visit (month) | 6.47±3.56 | 6.74±3.14 | t = 0.321 | 0.750 |
| Marriage status | | | $\chi^2$ = 0.144 | 0.704 |
| Married | 23 (76.7%) | 25 (80.6%) | | |
| Others | 7 (23.3%) | 6 (19.4%) | | |
| Educational level | | | $\chi^2$ = 0.133 | 0.715 |
| >= University | 21 (70.0%) | 23 (74.2%) | | |
| <= High school | 9 (30.0%) | 8 (25.8%) | | |
| Fertility status | | | $\chi^2$ = 0.012 | 0.912 |
| Yes | 17 (56.7%) | 18 (58.1%) | | |
| No | 13 (43.3%) | 13 (41.9%) | | |
| BMI (kg/m2) | 21.55 ± 1.85 | 21.79±2.11 | t = 0.469 | 0.641 |
| Smoking status | | | $\chi^2$ = 0.109 | 0.707 |
| No | 27 (90.0%) | 26 (83.9%) | | |
| Current | 3 (10.0%) | 5 (16.1%) | | |
| Drinking status | | | $\chi^2$ = 1.082 | 0.298 |
| No | 23 (76.7%) | 20 (64.5%) | | |
| Current | 7 (23.3%) | 11 (35.5%) | | |
| Laboratory data | | | | |
| Leucocyte (*$10^9$/L) | 5.73±1.29 | 5.77±1.35 | t = 0.104 | 0.918 |
| Neutrophil percentage (%) | 62.47±8.32 | 63.28±7.25 | t = 0.406 | 0.686 |
| C-reactive protein (mg/L) | 5.29±1.68 | 5.02±2.27 | t = 0.540 | 0.591 |
| AST (U/L) | 19.80±3.41 | 20.52±5.42 | t = 0.620 | 0.538 |
| ALT (U/L) | 17.40±7.78 | 17.95±9.05 | t = 0.233 | 0.817 |
| Creatinine (umol/L) | 56.33±6.97 | 58.58±4.57 | t = 1.484 | 0.144 |
| PT (s) | 12.77±1.70 | 12.72±1.57 | t = 0.357 | 0.723 |
| APTT (s) | 29.02±3.51 | 29.39±3.27 | t = 0.433 | 0.667 |
| FIB (g/L) | 2.76±0.46 | 2.55±0.39 | t = 1.936 | 0.058 |

BMI, body mass index. AST, aspartate transaminase. ALT, alanine transaminase. PT, prothrombin time. APTT, activated partial thromboplastin time. FIB, fibrinogen.

Table 3 — The results of the treatment within the groups, respectively

| Results | Acupuncture group (n = 30) | | | Acupoint catgut embedding group (n = 31) | | |
|---|---|---|---|---|---|---|
| | Baseline | After 12 weeks | p-value | Baseline | After 12 weeks | p-value |
| Menstrual cycle and duration | | | 0.542 | | | 0.025 |
| Regular | 22 (73.3%) | 24 (80.0%) | | 18 (58.1%) | 26 (83.9%) | |
| Non-regular | 8 (26.7%) | 6 (20.0%) | | 13 (41.9%) | 5 (16.1%) | |
| FSH (mIU/mL) | 16.25±3.50 | 9.31±1.92 | < 0.001 | 15.70±3.37 | 8.11±1.59 | <0.001 |
| LH (mIU/mL) | 4.40±2.10 | 4.97±1.46 | 0.211 | 4.58±2.38 | 5.71±0.95 | 0.030 |
| E2 (pg/mL) | 35.74±15.34 | 43.59±9.04 | <0.001 | 54.37±35.22 | 42.91±12.93 | 0.039 |
| AMH (ng/mL) | 0.56±0.35 | 1.23±0.26 | <0.001 | 0.50±0.31 | 1.32±0.25 | <0.001 |
| AFC | 2.47±1.07 | 5.73±1.51 | <0.001 | 2.19±1.17 | 6.06±1.65 | <0.001 |

and enhancing ovulation rates compared to traditional acupuncture. Furthermore, it also significantly improved the patient's quality of life, providing strong scientific support for the clinical application of acupoint catgut embedding in the treatment of DOR.

The study found that the catgut embedding group outperformed the traditional acupuncture group in reducing FSH levels, a key marker of ovarian reserve function. Elevated FSH is a hallmark of diminished ovarian reserve, while its reduction reflects an improvement in ovarian function[14,15]. Although FSH levels were significantly reduced in both groups, the decrease was more pronounced in the catgut embedding group. Similarly, AMH, another crucial indicator of ovarian reserve, increased significantly in the catgut embedding group, suggesting an enhancement in the follicle pool and overall ovarian function[14,16]. In this study, the AMH level was

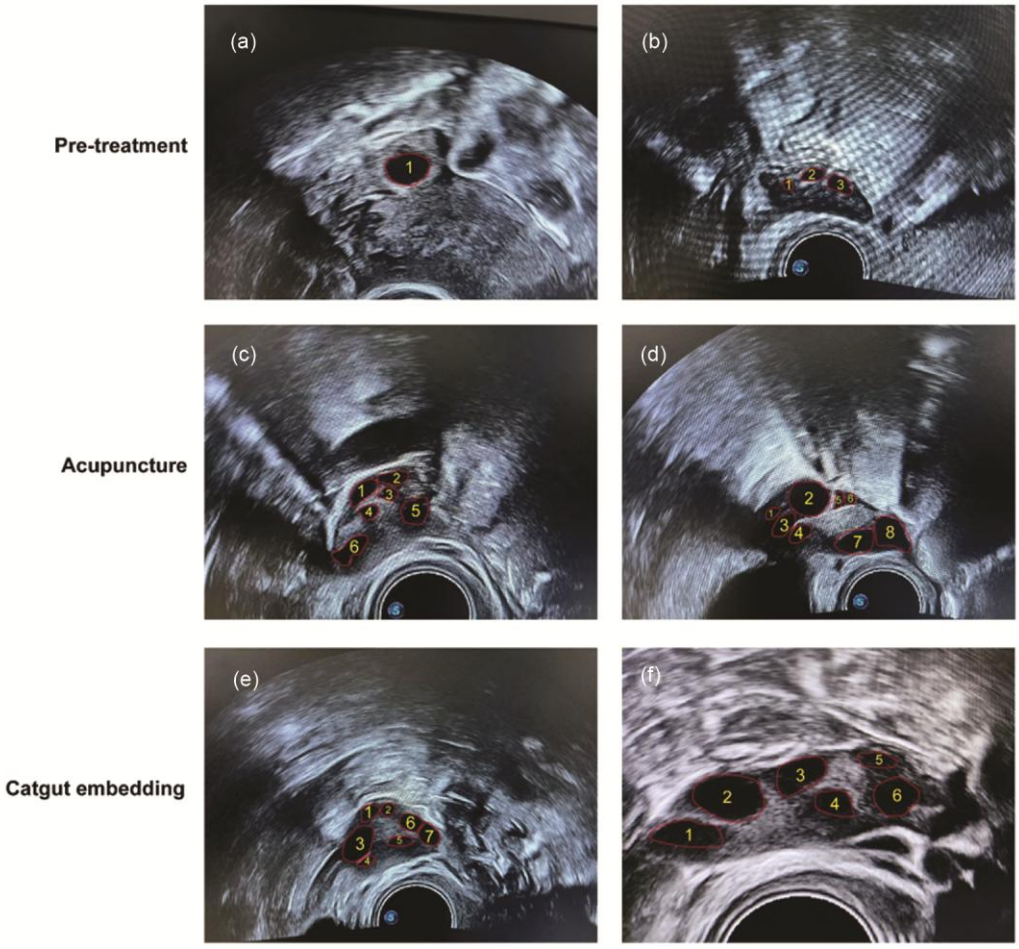


Fig. 3 — Representative images of ultrasound probing of antral follicle count, (a) and (b), pre-treatment, (c) and (d), after 12 weeks of acupuncture treatment, (e) and (f), after 12 weeks of acupoint catgut embedding treatment

Table 4 — Comparison of outcomes after 12 weeks of treatment

| Characteristics | Acupuncture group (n =30) | Acupoint catgut embedding group (n = 31) | Statistical value | p-value |
|---|---|---|---|---|
| Irregular menstruation | 8 (100.0%) | 13 (100.0%) | $\chi^2 = 2.651$ | 0.183 |
| Effective improvement | 2 (25.0%) | 8 (61.5%) | | |
| FSH (mIU/mL) | 9.31±1.92 | 8.11±1.59 | t = 2.656 | 0.010 |
| LH (mIU/mL) | 4.97±1.46 | 5.71±0.95 | t = 2.351 | 0.022 |
| E2 (pg/mL) | 43.59±9.04 | 42.91±12.93 | t = 0.237 | 0.813 |
| AMH (ng/mL) | 1.23±0.26 | 1.32±0.25 | t = 1.316 | 0.193 |
| AFC | 5.73±1.51 | 6.06±1.65 | t = 0.817 | 0.417 |
| Treatment-related adverse events | 5 (16.7%) | 6 (19.4%) | $\chi^2 = 0.075$ | 0.785 |

FSH, follicle-stimulating hormone. LH, luteinizing hormone. E2, estradiol. AMH, anti-Müllerian hormone. AFC, antral follicle count.

significantly increased in the acupoint catgut embedding group, indicating that the therapy was effective in increasing follicular reserve and thus improving ovarian function.

Antral follicle count (AFC), a direct measure of ovarian reserve[17], also increased in both groups following treatment. However, the catgut embedding group showed a greater increase in AFC and ovulation rates, reflecting a more substantial improvement in ovarian reserve function compared to the acupuncture group. This study showed that both AFC and ovulation rate could be effectively improved by acupoint catgut embedding and acupoint acupuncture treatments. Compared with the acupuncture group, the increase in AFC and ovulation rate was greater in the acupoint catgut embedding group, indicating that the ovarian reserve function of patients in this group was significantly improved after treatment.

In our study, both traditional acupuncture and acupoint catgut embedding demonstrated significant improvements in ovarian reserve markers within each group. However, the intergroup differences were moderate, with only FSH and LH showing statistically significant greater improvement in the acupoint catgut embedding group. This finding aligns with previous studies that the both interventions share common pathways in modulating the neuroendocrine axis and improving ovarian perfusion, which may explain the overlapping intra-group benefits observed in hormonal regulation and follicular development[18,19]. However, it is important to interpret these result effects in the context of clinical relevance, rather than simply statistical magnitude alone. A modest but consistent additional benefit, especially in FSH and LH normalization, can have meaningful implications for patients seeking to preserve or restore fertility potential[20]. Moreover, the unique feature of catgut embedding, providing prolonged, continuous stimulation of specific acupoints, may produce cumulative effects that are more apparent over longer follow-up periods, which this short-term trial could not fully capture[21]. Future studies with larger sample sizes and extended observation periods are warranted to validate whether the additional benefits of catgut embedding can translate into higher pregnancy rates or better long-term ovarian function.

However, it is important to interpret LH result with caution. Although moderate LH elevation may reflect improved hypothalamic–pituitary–gonadal axis responsiveness, persistently high LH levels can be

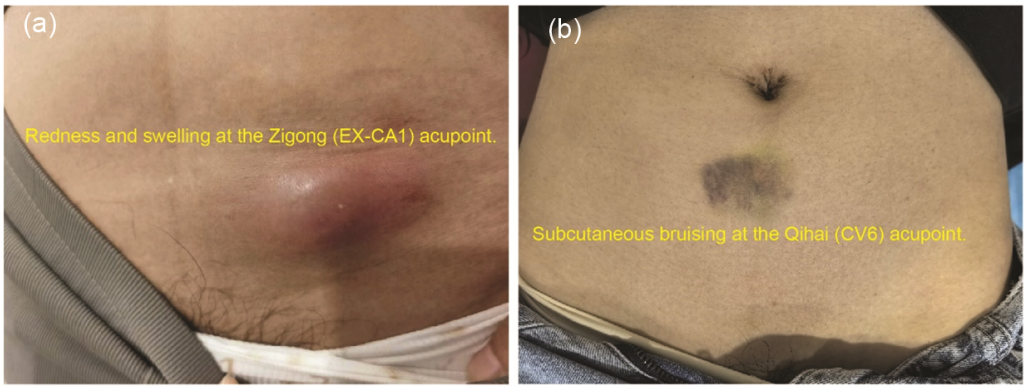


Fig. 4 — Representative images of treatment-related adverse events, (a) Redness and swelling at the Zigong (EX-CA1) acupoint, (b) Subcutaneous bruising at the Qihai (CV6) acupoint

Table 5 — Comparison of quality of life after 12 weeks of treatment

| Characteristics | Acupuncture group (n =30) | Acupoint catgut embedding group (n = 31) | Statistical value | p-value |
|---|---|---|---|---|
| Kupperman score | 15.10±6.49 | 7.60±5.28 | t = 4.912 | <0.001 |
| Physical functioning | 87.83±13.24 | 92.58±8.55 | t = 1.669 | 0.100 |
| Role-physical | 82.50±22.89 | 87.10±23.16 | t = 0.780 | 0.439 |
| Bodily pain | 91.95±16.82 | 95.79±7.21 | t = 1.152 | 0.256 |
| General health | 54.83±9.14 | 63.39±10.20 | t = 3.446 | 0.001 |
| Vitality | 76.83±11.02 | 85.97±13.19 | t = 2.930 | 0.005 |
| Social functioning | 72.50±14.83 | 92.74±10.09 | t = 6.252 | <0.001 |
| Role-emotional | 91.11±17.36 | 96.77±10.02 | t = 1.554 | 0.127 |
| Mental health | 69.47±12.41 | 77.81±12.21 | t = 2.646 | 0.010 |
| Reported health transition | 65.83±15.37 | 75.81±15.12 | t = 2.555 | 0.013 |

detrimental in women with DOR. Excessive LH secretion has been associated with impaired folliculogenesis and poor oocyte maturation in poor ovarian responders (POR)[22,23]. In our study, the post-treatment LH levels remained within normal physiological ranges, suggesting a balanced endocrine response rather than pathological hypersecretion. Nevertheless, clinicians should carefully monitor LH dynamics during DOR treatment and avoid overstimulation, ensuring that any therapeutic strategy involving acupuncture or catgut embedding achieves endocrine regulation within an optimal range.

Although the acupoint catgut embedding group demonstrated a higher proportion of patients with regular menstrual cycles after treatment, the difference compared to the acupuncture group did not reach statistical significance. Therefore, the observed trend toward improved menstrual regularity should be interpreted with caution. It is possible that the continuous stimulation of specific acupoints by the embedded catgut may help modulate reproductive endocrine balance over time, but larger studies with longer follow-up are needed to confirm whether this effect on menstrual cycle regularity is clinically meaningful. The sustained stimulation provided by catgut embedding remains a potential factor for enhanced therapeutic benefit compared to standard acupuncture[24].

The catgut embedding group demonstrated more notable effects on AMH and estradiol (E2) levels. Both AMH and E2 are important hormones reflecting ovarian function, and their changes directly impact female fertility[25,26]. This study found significant increases in AMH and E2 levels in both groups, likely due to the stimulation of ovarian follicle development by the acupoint treatments, which helps balance hormone levels[27].

The study also evaluated the impact of both treatments on the patients' quality of life. The acupoint catgut embedding group showed significant improvements across multiple quality-of-life metrics, including Kupperman score, General Health, Vitality, Social Functioning, Mental Health, and Reported Health Transition. These results suggest that catgut embedding not only improves ovarian function physiologically but also provides better psychological and social support, leading to a significant enhancement in overall quality of life.

One notable advantage of acupoint catgut embedding over traditional acupuncture is the durability of its therapeutic effect. While traditional acupuncture often requires frequent treatments (e.g., three times per week), catgut embedding provides sustained stimulation with fewer interventions, reducing the treatment burden on patients and potentially improving adherence. The superior FSH/LH modulation in the catgut group likely stems from prolonged acupoint stimulation, which may lead to more stable regulation of the hypothalamic-pituitary-ovarian (HPO) axis. Continuous stimulation has been shown to maintain local neuroendocrine activation, enhance ovarian blood flow, and prolong the release of neuropeptides and cytokines at the embedded site, thereby sustaining follicular development and hormonal balance for a longer period than the transient effect of manual acupuncture sessions[28]. This prolonged effect may explain the greater improvements in FSH suppression and AMH elevation observed in our study. Recent experimental models also indicated that the embedded suture material induces mild tissue responses that can further strengthen local acupuncture-like signals, contributing to the long-acting therapeutic mechanism[29].

The catgut embedding procedure is relatively simple, does not require frequent sessions, and provides continuous acupoint stimulation, making it more acceptable and tolerable for patients[30,31]. Although both treatment groups experienced mild adverse reactions, such as local pain, bruising, and itching, these effects were short-lived and resolved without serious complications. This demonstrates the favorable safety profile and practicality of acupoint catgut embedding.

The mechanism of action of acupoint catgut embedding may involve multiple pathways, including the regulation of the neuroendocrine system[32,33], improvement in ovarian blood flow, and enhanced nourishment of ovarian follicles[34,35], thereby promoting the recovery of ovarian function. While this study provides preliminary evidence of the clinical efficacy of acupoint catgut embedding, further research is needed to elucidate the precise physiological mechanisms involved[10]. Additionally, future studies should consider larger sample sizes and longer follow-up periods to fully evaluate the long-term efficacy and potential side effects of this treatment.

Despite the promising results, several limitations of this study should be acknowledged. First, the relatively small sample size limits the generalizability of the

findings. Larger, multicenter clinical trials are needed to validate these results and ensure broader applicability. Second, we did not include a placebo or sham group. Future study should ideally incorporate a placebo or sham control to enhance the rigor of the results. Third, the 12-week follow-up period may be insufficient to capture the full spectrum of long-term effects and potential side effects of acupoint catgut embedding. Future studies should extend the follow-up period to better assess the longevity of treatment effects and safety. Lastly, although the study design controlled multiple confounding factors, other potential influences, such as dietary habits and lifestyle choices, were not accounted for. Future research should consider these variables to minimize potential biases.

## Conclusion

In conclusion, this study demonstrates that acupoint catgut embedding offers significant therapeutic advantages over traditional acupuncture in the treatment of DOR, particularly in improving menstrual cycle regularity, reducing FSH, increasing AMH and AFC, enhancing ovulation rates, and improving patients' quality of life. These findings provide new insights and evidence for the clinical application of acupoint catgut embedding in DOR management. However, further large-scale, multicenter studies are required to confirm its efficacy and safety and to explore the underlying physiological mechanisms, which will better guide clinical practice.

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## Conflicts of Interest

No conflict of interest exists in the submission of this manuscript, and the manuscript is approved by all authors for publication.

## Author Contributions

SL was responsible for data collection and writing the first draft; SL, CH, SW and ST were responsible for data collection and analysis; SL, CH, SW and YD were responsible for patients' management and follow-up; YD, SW and YD were responsible for the treatments of acupuncture and catgut embedding; YD and SB were responsible for topic selection, design, paper review, and revision. All authors had final approval of the manuscript. The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors consent to the publication of this study.

## Ethics Approval

The authors are accountable for all aspects of the work and ensure that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study adhered to the principles of the Declaration of Helsinki and was approved by the Ethics Committee of Chongqing Traditional Chinese Medicine Hospital, approval number: 2023-ky-80. This study has been registered in the Chinese Clinical Trial Registry, ChiCTR2400094373. https://www.chictr.org.cn/index.html.

## Informed Consent

All participants were fully informed about the purpose, procedures, potential risks, and benefits of this study. Written informed consent was obtained from each participant prior to enrollment, in accordance with the principles of the Declaration of Helsinki.

## Data Availability

The original data presented in the study are included in the article. Further inquiries can be directed to the corresponding author.

## References

1 P C A S R M, Testing and interpreting measures of ovarian reserve: a committee opinion, *Fertil Steril*, 114 (6) (2020) 1151-1157.

2 Butts S F, Ratcliffe S, Dokras A & Seifer D B, Diagnosis and treatment of diminished ovarian reserve in assisted reproductive technology cycles of women up to age 40 years: the role of insurance mandates, *Fertil Steril*, 99 (2) (2013) 382-388.

3 Devine K, Mumford S L, Wu M, DeCherney A H, Hill M J, *et al*., Diminished ovarian reserve in the United States assisted reproductive technology population: diagnostic trends among 181, 536 cycles from the society for assisted reproductive technology clinic outcomes reporting system, *Fertil Steril*, 104 (3) (2015) 612-619.e613.

4 Levi A J, Raynault M F, Bergh P A, Drews M R, Miller B T, *et al*., Reproductive outcome in patients with diminished ovarian reserve, *Fertil Steril*, 76 (4) (2001) 666-669.

5 Zhou Z, Zheng D, Wu H, Li R, Xu S, *et al*., Epidemiology of infertility in China: apopulation-based study, *BJOG Int J Obstet Gynaecol*, 125 (4) (2018) 432-441.

6 Messerlian C, Maclagan L & Basso O, Infertility and the risk of adverse pregnancy outcomes: a systematic review and meta-analysis, *Hum Reprod*, 28 (1) (2013) 125-137.

7 Pastore L M, Christianson M S, Stelling J, Kearns W G & Segars J H, Reproductive ovarian testing and the alphabet soup of diagnoses: DOR, POI, POF, POR, and FOR, *J Assist Reprod Genet*, 35 (1) (2018) 17-23.

8 Wu X, Mo Q, He T, Zhi N, Huang Y, *et al*., Acupoint catgut embedding for the treatment of obesity in adults: A systematic review protocol, *Medicine*, 98 (8) (2019) e14610.

9 Peng J, Cui Y, Liang H, Xu S, Weng L, *et al*., Integrated transcriptomic hypothalamic-pituitary-ovarian axis network analysis reveals the role of energy availability on egg production in layers, *Anim Nutr*, 20 (2025) 66-79.

10 Kim J, Lee H, Choi T Y, Kim J I, Kang B K, *et al*., Acupuncture for poor ovarian response: A randomized controlled trial, *J Clin Med*, 10 (10) (2021) 2182.

11 Lim S, WHO Standard acupuncture point locations, *Evid Based Complement Alternat Med*, 7 (2) (2010) 167-168.

12 Qiu T & Li L, Discussion on the Chinese edition of the WHO standard acupuncture point locations in the Western Pacific Region, *Zhongguo Zhen Jiu*, 31 (9) (2011) 827-830.

13 Freites-Martinez A, Santana N, Arias-Santiago S & Viera A, Using the common terminology criteria for adverse events (CTCAE - Version 5.0) to evaluate the severity of adverse events of anticancer therapies, *Actas Dermo-sifiliogr*, 112 (1) (2021) 90-92.

14 P C A S R M, Testing and interpreting measures of ovarian reserve: a committee opinion, *Fertil Steril*, 103 (3) (2015) : e9-e17.

15 Jiao X, Meng T, Zhai Y, Zhao L, Luo W, *et al*., Ovarian reserve markers in premature ovarian insufficiency: within different clinical stages and different etiologies, *Front Endocrinol*, 12 (2021) 601752.

16 Moolhuijsen L M E & Visser J A, Anti-müllerian hormone and ovarian reserve: update on assessing ovarian function, *J Clin Endocrinol Metab*, 105 (11) (2020) 3361-3373.

17 Deadmond A, Koch C A & Parry J P, Ovarian reserve testing, In: *Endotext*, K.R. Feingold, B. Anawalt, M.R. Blackman, A. Boyce, G. Chrousos, *et al*., (Eds.), (MDText.com Inc., South Dartmouth (MA)), Copyright © 2000-2024, MDText.com, Inc.).

18 Chen G Z, Xu Y X, Zhang J W, Liu S H & Guo Z Y, Effect of acupoint catgut-embedding on the quality of life, reproductive endocrine and bone metabolism of postmenopausal women, *Chin J Integr Med*, 16 (6) (2010) 498-503.

19 Zhang J, Huang X, Liu Y, He Y & Yu H, A comparison of the effects of Chinese non-pharmaceutical therapies for premature ovarian failure: A PRISMA-compliant systematic review and network meta-analysis, *Medicine*, 99 (26) (2020), e20958.

20 Di Segni N, Busnelli A, Secchi M, Cirillo F & Levi-Setti PE, Luteinizing hormone supplementation in women with hypogonadotropic hypogonadism seeking fertility care: Insights from a narrative review, *Front Endocrinol*, 13 (2022) 907249.

21 Li Q, Huang G, Pei X, Tang X, Zhang R, *et al*., The Effect of catgut embedding at acupoints versus nonacupoints in abdominal obesity: protocol for a multicenter, double-blind, 16-week randomized controlled trial, *JMIR Res Protoc*, 12 (2023) e46863.

22 Kumar P & Sait S F, Luteinizing hormone and its dilemma in ovulation induction, *J Hum Reprod Sci*, 4 (1) (2011) 2-7.

23 Alviggi C, Vigilante L, Cariati F, Conforti A & Humaidan P, The role of recombinant LH in ovarian stimulation: what's new?, *Reprod Biol Endocrinol*, 23 (Suppl 1) (2025) 38.

24 Liu X, Yang L, Su Z, Ma X, Liu Y, *et al*., Acupoint catgut embedding alleviates experimental autoimmune encephalomyelitis by modulating neuroinflammation and potentially inhibiting glia activation through JNK and ERK pathways, *Front Neurosci*, 18 (2024) 1520092.

25 Bedenk J, Vrtačnik-Bokal E & Virant-Klun I, The role of anti-Müllerian hormone (AMH) in ovarian disease and infertility, *J Assist Reprod Genet*, 37 (1) (2020) 89-100.

26 Iwase A, Asada Y, Sugishita Y, Osuka S, Kitajima M, *et al*., Anti-Müllerian hormone for screening, diagnosis, evaluation, and prediction: A systematic review and expert opinions, *J Obstet Gynaecol Res*, 50 (1) (2024) 15-39.

27 Ma R, Song J, Si J, Liu Y, Li X, *et al*., Acupuncture for diminished ovarian reserve: Protocol for a systematic review and meta-analysis, *Medicine*, 98 (34) (2019) e16852.

28 Yang Q, Xing L, Dong Q, Chen H, Xia C, *et al*., Effect of acupoint embedding on serum Leptin and Hypothalamus Leptin receptor expression in rats with simple obesity, *Evid Based Complement Alternat Med*, 2021 (2021) 3500409.

29 Hou X, Liang X, Lu Y, Zhang Q, Wang Y, *et al*., Investigation of local stimulation effects of embedding PGLA at Zusanli (ST36) acupoint in rats based on TRPV2 and TRPV4 ion channels, *Front Neurosci*, 18 (2024) 1469142.

30 Qiu J, Xu J, Cai Y, Li M, Peng Y, *et al*., Catgut embedding in acupoints combined with repetitive transcranial magnetic stimulation for the treatment of postmenopausal osteoporosis: study protocol for a randomized clinical trial, Front Neurol, 15 (2024) 1295429.

31 Garcia-Vivas J M, Galaviz-Hernandez C, Becerril-Chavez F, Lozano-Rodriguez F, Zamorano-Carrillo A, *et al*., Acupoint catgut embedding therapy with moxibustion reduces the risk of diabetes in obese women, *J Res Med Sci*, 19 (7) (2014) 610-616.

32 Kazemi A H, Adel-Mehraban M S, Jamali Dastjerdi M & Alipour R, A comprehensive practical review of acupoint embedding as a semi-permanent acupuncture: A mini review, *Medicine*, 103 (23) (2024) e38314.

33 Ding S S, Hong S H, Wang C, Guo Y, Wang Z K, *et al*., Acupuncture modulates the neuro-endocrine-immune network, *QJM*: 107 (5) (2014) 341-345.

34 Xu J Y, Zhao A L, Xin P, Geng J Z, Wang B J, *et al*., Acupuncture for female infertility: discussion on action mechanism and application, *Evid Based Complement Alternat Med*, 2022 (2022) 3854117.

35 Fu Y, Ding D N, Shen Y, Jia L Y, Yan M Y, *et al*., Complementary and alternative medicine for premature ovarian insufficiency: A review of utilization and mechanisms, *Evid Based Complement Alternat Med*, 2022 (2022) 9053930.