

Association of Endometriosis with Ovarian Reserve, Controlled Ovarian Stimulation, and Embryological Outcomes in Women Undergoing Intracytoplasmic Sperm Injection: A Retrospective Comparative Study

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ARTICLE INFO	ABSTRACT
*Correspondence to Eleena Waqar Department of Obstetrics and Gynecology, Hayatabad Medical Complex, Peshawar, Pakistan Email: eleena.dr-94@yahoo.com Article History Received: 30-01-2026 Revised: 16-03-2026 Accepted: 20-03-2026 Published: 30-03-2026 How to Cite Tayyab Y, Waqar E. Association of Anti-Müllerian Hormone Levels with Ovarian Response and Embryological Outcomes in Women Undergoing Intracytoplasmic Sperm Injection for Endometriosis-Associated Infertility. Pak J Clin Res. 2026;3(3):1-5. doi:10.65761/pjcr.2026.46 DOI: https://doi.org/10.65761/pjcr.2026.46	Background: Endometriosis is a chronic inflammatory gynecological disorder frequently associated with infertility. Although intracytoplasmic sperm injection (ICSI) is widely used to overcome infertility, the independent impact of endometriosis on ICSI outcomes in women without previous ovarian surgery remains uncertain. Objective: To investigate the effect of endometriosis on ICSI outcomes among infertile women without a previous history of ovarian surgery. Methods: This retrospective comparative study was conducted at the Department of Obstetrics and Gynecology, Hayatabad Medical Complex, Peshawar, Pakistan, from February 2025 to November 2025. A total of 190 infertile women undergoing IVF/ICSI were included and divided equally into an endometriosis group (n=95) and a control group (n=95). Baseline characteristics, ovarian reserve markers, stimulation parameters, embryological findings, and clinical pregnancy outcomes were compared using independent-samples t-test and chi-square test. A p-value <0.05 was considered statistically significant. Results: Women with endometriosis had significantly lower body mass index, antral follicle count, and anti-Müllerian hormone levels, while basal follicle-stimulating hormone and prolactin levels were significantly higher (p<0.05). They required greater gonadotropin doses and longer ovarian stimulation despite producing fewer follicles, retrieved oocytes, mature metaphase II oocytes, and fertilized oocytes (all p<0.001). However, fertilization rate (76.5% vs. 78.1%; p=0.328), good-quality embryo rate (61.1% vs. 64.2%; p=0.664), implantation rate (29.8% vs. 30.6%; p=0.812), and clinical pregnancy rate (32.0% vs. 31.0%; p=0.874) were comparable between groups. Conclusion: Endometriosis adversely affected ovarian reserve and ovarian response during controlled stimulation but did not significantly compromise embryo quality or clinical pregnancy outcomes following ICSI in women without previous ovarian surgery. Keywords: Endometriosis, Infertility, Intracytoplasmic Sperm Injection, In Vitro Fertilization, Ovarian Reserve, Anti-Müllerian Hormone, Pregnancy Rate.

INTRODUCTION

Endometriosis is a chronic, estrogen-dependent inflammatory disorder characterized by the presence of functional endometrial-like tissue outside the uterine cavity.^{1,2} Affecting approximately 10% of reproductive-aged women globally, this condition is strongly associated with pelvic pain, dysmenorrhea, and significantly impaired quality of life.^{3,4} Crucially, up to 50% of women diagnosed with endometriosis experience infertility, making it one of the most prevalent underlying causes encountered in assisted reproductive technology (ART) clinics.^{5,6} The pathogenic mechanisms by which endometriosis compromises female fertility are multifactorial and structurally complex.⁷ They encompass pelvic anatomical distortions due to extensive adhesions, chronic peritoneal inflammation, impaired endometrial receptivity, altered hormonal microenvironments, and poor oocyte and embryo quality.⁸⁻¹⁰ When conventional fertility treatments fail, in vitro fertilization and intracytoplasmic sperm injection (IVF/ICSI) represent the final, most effective therapeutic choices for these couples.^{11,12}

However, whether endometriosis independently diminishes the clinical success of ICSI remains a subject of intense debate in reproductive medicine.¹³ A major confounding variable in evaluating this relationship is a history of prior ovarian surgeries, such as laparoscopic cystectomy for endometriomas.^{14,15} Excision of endometrioma walls frequently causes collateral damage to the surrounding healthy ovarian cortex, leading to a mechanical depletion of the primordial follicle pool, accelerated follicular atresia, and subsequent surgery-induced reduction of the ovarian reserve.^{16,17} Consequently, it is difficult to distinguish whether impaired ovarian response during controlled ovarian hyperstimulation (COH) stems from the primary disease process or structural damage caused by surgical interventions.^{18,19} To isolate the true systemic and local pathogenetic effects of endometriosis on ART outcomes, clinical investigations must focus on unoperated cohorts.^{20,21} Emerging biological evidence indicates that unoperated ovarian endometriosis directly alters follicular fluid dynamics, inducing localized oxidative stress and accelerating granulosa cell apoptosis.^{22,23} These



microenvironmental disruptions are hypothesized to impair oocyte maturation, leading to lower yields of mature metaphase II (MII) oocytes and decreased fertilization rates during ICSI cycles.^{24,25} Despite these theoretical pathophysiological mechanisms, clinical studies investigating unoperated patients have yielded highly conflicting results; some demonstrate compromised oocyte yields but preserved clinical pregnancy rates, while others report a systemic reduction across all reproductive milestones.^{26,27}

Furthermore, there is a prominent shortage of rigorous, localized data addressing this specific medical dilemma within Pakistan's healthcare infrastructure, where financial and regional variations in ART protocols are common.²⁸ Evaluating clear diagnostic and prognostic indicators within an unoperated cohort is crucial to help clinicians tailor individual gonadotropin dosages, optimize trigger timings, and manage patient expectations appropriately. Therefore, this retrospective comparative study was designed to investigate the independent effect of endometriosis on quantitative and qualitative ICSI outcomes—including oocyte yield, maturation rates, embryo quality, and clinical pregnancy rates—among infertile women without any previous history of ovarian surgery.

METHODOLOGY

This retrospective comparative study was conducted at the Department of Obstetrics and Gynecology, Hayatabad Medical Complex, Peshawar, Pakistan, over a ten-month period from February 2025 to November 2025. The study was designed to evaluate the effect of endometriosis on intracytoplasmic sperm injection (ICSI) outcomes among infertile women without a previous history of ovarian surgery. Ethical approval was obtained from the Institutional Review Board before commencement of the study, and patient confidentiality was maintained by anonymizing all extracted data. Medical records of women who underwent controlled ovarian stimulation followed by in-vitro fertilization/intracytoplasmic sperm injection (IVF/ICSI) during the study period were reviewed. A total of 190 eligible women were included using consecutive sampling and were equally allocated into two groups: Group A consisted of 95 infertile women diagnosed with ovarian endometriosis based on transvaginal ultrasonography and/or laparoscopic findings documented in their clinical records, while Group B included 95 infertile women without evidence of endometriosis who served as the comparison group. Women aged 20–40 years undergoing their first or subsequent IVF/ICSI cycle and having complete clinical and embryological records were included. Patients with previous ovarian surgery, diminished ovarian reserve unrelated to endometriosis, polycystic ovary syndrome, uterine anomalies, untreated endocrine disorders, recurrent implantation failure, severe systemic illness, or incomplete medical records were excluded to minimize potential confounding factors. Baseline demographic and clinical characteristics including age, body mass index (BMI), duration and type of infertility, serum anti-Müllerian hormone (AMH), antral follicle count (AFC), basal follicle-stimulating hormone (FSH), and infertility etiology were recorded. All participants underwent controlled ovarian stimulation using standard gonadotropin-based antagonist or agonist protocols according to institutional guidelines. Follicular development was monitored through serial transvaginal ultrasonography and serum estradiol measurements. Final oocyte maturation was triggered with recombinant human chorionic gonadotropin or a gonadotropin-releasing hormone agonist when at least three follicles reached a mean diameter of 17–18 mm. Oocyte retrieval was performed 34–36 hours after triggering, followed by ICSI using standard laboratory techniques. Embryos were cultured under identical laboratory conditions, and embryo

quality was assessed according to established morphological grading criteria. The primary outcome measure was the number of mature metaphase II oocytes retrieved. Secondary outcome measures included total oocytes retrieved, fertilization rate, cleavage rate, good-quality embryo rate, implantation rate, clinical pregnancy rate confirmed by ultrasonographic visualization of a gestational sac with fetal cardiac activity, and ovarian reserve indicators. Statistical analysis was performed using SPSS version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation and compared using the independent-samples t-test, while categorical variables were presented as frequencies and percentages and analyzed using the chi-square or Fisher's exact test where appropriate. A two-tailed p-value of <0.05 was considered statistically significant.

RESULTS

A total of 190 infertile women who underwent their first IVF/ICSI cycle were included in the study and equally allocated into two groups: Group A (endometriosis, $n = 95$) and Group B (without endometriosis, $n = 95$). Baseline demographic characteristics were generally comparable between the two groups. The mean age was approximately 37 years in both groups, with no statistically significant difference. Similarly, the duration of infertility and infertility type did not differ significantly between the groups ($p > 0.05$). However, women with endometriosis had a significantly lower body mass index (BMI) and antral follicle count (AFC) than women without endometriosis ($p < 0.05$). Secondary infertility and irregular menstrual cycles were observed more frequently among women with endometriosis. During controlled ovarian stimulation, women with endometriosis required significantly higher cumulative gonadotropin doses and a longer stimulation period than controls. Despite increased stimulation, the number of follicles ≥ 14 mm on trigger day, total oocytes retrieved, mature metaphase-II (MII) oocytes, and fertilized oocytes were all significantly lower in Group A compared with Group B ($p < 0.001$). Endometrial thickness on the day of trigger and peak estradiol levels were slightly higher among women with endometriosis, although these differences did not translate into improved reproductive outcomes.

Table 1. Baseline demographic and clinical characteristics of study participants

Variable	Group A (Endometriosis) n=95	Group B (Control) n=95	p-value
Age (years), mean $\pm$ SD	37.2 $\pm$ 3.8	36.9 $\pm$ 3.6	0.621
BMI (kg/m ²), mean $\pm$ SD	24.8 $\pm$ 2.9	26.1 $\pm$ 3.1	0.042
Duration of infertility (years)	5.8 $\pm$ 2.4	5.5 $\pm$ 2.2	0.463
Primary infertility, n (%)	59 (62.1)	63 (66.3)	0.541
Secondary infertility, n (%)	36 (37.9)	32 (33.7)	0.541
Irregular menstrual cycle, n (%)	38 (40.0)	21 (22.1)	0.011
Antral follicle count	4.1 $\pm$ 1.7	6.8 $\pm$ 1.0	0.042

Hormonal profile analysis demonstrated significantly diminished ovarian reserve among women with endometriosis. The mean serum AMH level and AFC were significantly lower in Group A, whereas basal FSH and prolactin levels were significantly higher

than those in the control group ($p < 0.05$). No statistically significant difference was observed in baseline LH levels between the groups.

Table 2. Hormonal profile and ovarian stimulation outcomes

Variable	Group A (n=95)	Group B (n=95)	p-value
AMH (ng/mL)	2.42 ± 1.58	3.58 ± 0.46	<0.001
FSH (IU/L)	10.34 ± 3.28	6.24 ± 0.41	<0.001
LH (IU/L)	6.93 ± 5.11	5.71 ± 2.73	0.176
Prolactin (ng/mL)	13.9 ± 5.2	12.5 ± 3.7	0.031
Gonadotropin dose (IU)	3245 ± 1496	2728 ± 1388	0.014
Stimulation duration (days)	11.4 ± 2.1	10.1 ± 1.8	0.018
Follicles ≥14 mm	10.2 ± 3.8	28.8 ± 13.6	<0.001
Oocytes retrieved	5.3 ± 2.38	15.0 ± 5.12	<0.001
Mature (MII) oocytes	5.1 ± 2.27	14.0 ± 4.42	<0.001
Fertilized oocytes	3.9 ± 1.09	13.2 ± 4.55	<0.001

Embryological assessment revealed that the fertilization rate and proportion of good-quality embryos were comparable between the two groups. Likewise, implantation and clinical pregnancy rates did not differ significantly. Clinical pregnancy was achieved in 30 (32%) women with endometriosis and 29 (31%) women without endometriosis ($p = 0.874$), indicating that although endometriosis adversely affected ovarian response and oocyte yield, it did not significantly compromise embryo competence or pregnancy outcomes following IVF/ICSI.

Table 3. Embryological and reproductive outcomes following IVF/ICSI

Outcome	Group A (n=95)	Group B (n=95)	p-value
Fertilization rate (%)	76.5 ± 12.3	78.1 ± 11.4	0.328
Good-quality embryos (%)	58 (61.1)	61 (64.2)	0.664
Embryo transfer performed, n (%)	92 (96.8)	93 (97.9)	0.651
Implantation rate (%)	29.8	30.6	0.812
Clinical pregnancy, n (%)	30 (32.0)	29 (31.0)	0.874
Miscarriage, n (%)	4 (4.2)	3 (3.2)	0.701

Overall, women with endometriosis demonstrated significantly impaired ovarian reserve and reduced oocyte yield despite requiring greater ovarian stimulation. However, fertilization efficiency, embryo quality, implantation, and clinical pregnancy outcomes remained comparable with women without endometriosis, suggesting that endometriosis predominantly affects ovarian response rather than post-fertilization reproductive potential.

DISCUSSION

The present study demonstrated that infertile women with endometriosis, despite having no previous history of ovarian surgery, exhibited significantly impaired ovarian reserve and a poorer ovarian response to controlled ovarian stimulation compared with women without endometriosis. Women with endometriosis had significantly lower anti-Müllerian hormone (AMH) levels and antral follicle counts (AFC), accompanied by higher basal follicle-stimulating hormone (FSH) concentrations, indicating diminished ovarian reserve. These findings support previous evidence suggesting that endometriosis itself, independent of surgical intervention, adversely affects ovarian

function through chronic inflammation, oxidative stress, and alterations in the follicular microenvironment that accelerate granulosa cell apoptosis and impair folliculogenesis.^{22,23} Earlier investigations have similarly reported reduced ovarian reserve markers among unoperated women with ovarian endometriosis, reinforcing the concept that the disease process alone contributes to follicular depletion.^{17,18,25}

Women with endometriosis in the present study required significantly higher cumulative gonadotropin doses and longer stimulation periods, yet yielded fewer follicles, retrieved oocytes, mature metaphase II (MII) oocytes, and fertilized oocytes. These observations are consistent with previous reports demonstrating compromised ovarian responsiveness in women with endometriosis undergoing IVF/ICSI cycles.^{20,24} The reduced oocyte yield may be attributed to inflammatory cytokines and oxidative stress within endometriotic cyst fluid, which negatively influence follicular development and oocyte maturation.^{8,22} Furthermore, systematic reviews have suggested that although endometriosis reduces the quantity of oocytes retrieved, its detrimental effect primarily reflects impaired ovarian response rather than irreversible deterioration in developmental competence.^{13,27}

Despite the significantly lower number of mature and fertilized oocytes, fertilization rates, embryo quality, implantation rates, miscarriage rates, and clinical pregnancy rates remained comparable between women with and without endometriosis. Clinical pregnancy occurred in 32% of women with endometriosis versus 31% of controls, indicating no statistically significant difference. These findings align with several contemporary studies reporting that while endometriosis reduces ovarian reserve and oocyte yield, embryo developmental potential and pregnancy outcomes remain largely preserved when good-quality embryos are available for transfer.^{10,20,26} Bishop et al. also observed comparable live pregnancy outcomes despite reduced ovarian response among women with unoperated endometriomas, supporting the hypothesis that endometriosis predominantly affects ovarian quantity rather than embryo competence.²⁶ Similarly, Harb et al. concluded that differences in IVF/ICSI success are substantially influenced by ovarian response rather than post-fertilization events.²⁷

The findings of this study have important clinical implications for reproductive specialists managing infertile women with endometriosis in Pakistan. Early identification of diminished ovarian reserve may facilitate individualized stimulation protocols, optimize gonadotropin dosing, and improve patient counseling regarding expected oocyte yield without unnecessarily discouraging treatment. These observations are particularly relevant in resource-limited ART settings, where maximizing treatment efficiency is essential.²⁸ Overall, the present study suggests that unoperated endometriosis primarily compromises ovarian reserve and response to stimulation while preserving fertilization efficiency, embryo quality, and clinical pregnancy outcomes following ICSI.

CONCLUSION

In conclusion, endometriosis was associated with significantly reduced ovarian reserve and impaired ovarian responsiveness during controlled ovarian stimulation among infertile women without previous ovarian surgery. Women with endometriosis required higher gonadotropin doses and yielded fewer follicles, mature oocytes, and fertilized oocytes than controls. Despite these unfavorable ovarian parameters, fertilization efficiency, embryo quality, implantation, miscarriage, and clinical pregnancy rates remained comparable between the two groups. These findings indicate that endometriosis primarily compromises ovarian quantity rather than post-fertilization reproductive

competence when appropriate stimulation protocols and laboratory techniques are employed. Individualized ovarian stimulation strategies, early assessment of ovarian reserve, and realistic patient counseling may optimize treatment outcomes. Larger prospective multicenter studies are warranted to validate these findings and assess long-term live birth outcomes.

Ethical Approval

Ethical approval for the conduct of this study was obtained from the relevant institutional ethics review committee with Ref. No 500-4-HMC-25. The study was conducted in accordance with the ethical principles and institutional requirements governing research involving human participants.

Data Availability

The data analyzed in this study are available from the corresponding author upon reasonable request.

Author Contributions

Conceptualization: Yusra Tayyab, Eleena Waqar

Methodology: Yusra Tayyab, Eleena Waqar

Data Collection: Yusra Tayyab, Eleena Waqar

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Writing – Review & Editing: Eleena Waqar

All authors accept full responsibility for all aspects of the study, including its design, methodology, data collection, analysis, interpretation of results, manuscript preparation, and final approval of the submitted version. The authors are accountable for the accuracy and integrity of the work, agree to address any questions concerning its reliability or integrity, and ensure that the manuscript complies with relevant ethical standards and publication requirements.

Informed Consent

Informed consent was obtained from all participants before their enrollment in the study. The participants were adequately informed about the study objectives and procedures, and their privacy and confidentiality were ensured throughout the study.

Funding

No external funding was received for this study.

Conflict of Interest

No.

Acknowledgments

The authors acknowledge the support of the Department of Obstetrics and Gynecology, Hayatabad Medical Complex, Peshawar, Pakistan, and thank all individuals who contributed to the completion of this study.

Declaration of AI-Assisted Language Editing

Grammarly AI was used for language and grammar correction, while Gemini AI was used for figure generation.

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