Journal of Obstetrics, Gynecology and Cancer Research | ISSN: 2476-5848

# IVF Technique and its Relationship with Ovarian Reserve Based on Melatonin Level in Follicular Fluid

**Rihab Majeed Shareef[1*], Najah Shaker Yassen[1], Sallama Hamid Alkhudair[2]**

1. *Department of Gynecology Oncology, M.B.Ch.B., F.I.B.OG., Faculty of Medicine, University of Baghdad, Baghdad, Iraq*
2. *Department of Gynecology Oncology, Faculty of Medicine, Alzaitoon Specialized Fertility Center, Baghdad, Iraq*

**Article Info**

10.30699/jogcr.10.4.293

**Received:** 2023/09/08;
**Accepted:** 2023/11/13;
**Published Online:** 22 Feb 2025;

Use your device to scan and read the article online

**Corresponding Information:**
**Rihab Majeed Shareef,**
Department of Gynecology Oncology, M.B.Ch.B., F.I.B.OG., Faculty of Medicine, University of Baghdad, Baghdad, Iraq

**Email:** rizkaawidayanti13@gmail.com

**ABSTRACT**

**Background & Objective:** Melatonin plays a role in pubertal development and reproductive function through the hypothalamus-hypophysis-gonadal axis. In addition, melatonin production decreases with aging, so that indolamine could be an anti-ageing agent. The present study was conducted with aim to investigate the role of intra follicular melatonin level in ovarian reserve and IVF cycle outcomes.

**Materials & Methods:** This prospective and cross-sectional study was conducted from April 2022 to April 2023. Patients on a mini-long agonist, short agonist, and antagonist protocols were enrolled in the study. Using ultrasound, follicle development was observed from the stimulation day until the hCG day (done every 2 or 3 days).

**Results:** Melatonin levels were positively correlated with oocyte retrieved (r=0.705, P<0.001), number of fertilized oocyte (r=0.68, P<0.001), number of zygotes cleaved (r=0.660, P<0.001), high quality embryos (r=0.591, P<0.001), embryos for transplantation (r=0.604, P<0.001), percent of high quality embryos (r=0.58, P<0.001), and percent of blastocyst rate.

**Conclusion:** Melatonin mean levels in follicular fluid significantly decreased in poor response than in standard and high response. The follicular fluid melatonin levels were associated with each oocyte quantity and quality and can expect ICSI consequences and act as highly important biochemical indicators of ovarian reserve.

**Keywords:** Melatonin, Follicular Fluid, In Vitro Fertilization, Ovarian Reserve

Copyright © 2025, This is an original open-access article distributed under the terms of the Creative Commons Attribution-noncommercial 4.0 International License which permits copy and redistribution of the material just in noncommercial usages with proper citation.

## 1. Introduction

Melatonin, or its precursor, serotonin, is involved in reproductive processes such as the onset of puberty, ovulation, pregnancy and fertility, either through the hypothalamic-pituitary axis or by acting directly on the reproductive organs **(1)**. Melatonin may play a role in pubertal development and reproductive function through the hypothalamus-hypophysis-gonadal axis. In addition, melatonin production decreases with age, so that indolamine could be an anti-aging agent **(2)**. Pinealectomy leads to the acceleration of many aspects associated with aging. On the other hand, the decrease in estrogen serum due to ovarian aging leads to menopause, which is a cause of significant changes in lipid metabolism **(3, 4)**.

Indolamine has been noticed in the Follicular fluid (FF). In addition, its receptors MT1 and MT2 have been confined in oocytes and human cumulus cells, thus indicating the significance of melatonin for development of the oocyte **(5)**. Some receptor-mediated actions are common with other tissues, such as inhibition of adenylate cyclase leading to a decrease in the activity of the protein kinase A (PKA) **(6)**. FSH is frequently used in vitro maturation procedures of oocytes (IVM), carrying out a resumption of the meiosis, that is, and a nuclear maturation **(7)**.

The result of a study specifies that melatonin can prompt meiosis resumption at levels similar to gonadotropin. This study used control oocytes cultured without any hormone as a maturation reference that was exclusively spontaneous **(8)**. Untreated oocytes had the lowest rates of resumption compared to stimulation with FSH or melatonin, which supports the idea that these hormones induce this effect and rule out the spontane melatonin that could stimulate the resumption of meiosis. It could be related to the activation of the maturation-promoting factor (MPF). The MPF is vital in controlling the resumption and progression of meiosis. It is known that the decrease in

cyclic adenosine monophosphate (cAMP) levels activates the MPF and induces maturation and melatonin inhibits adenylate cyclase **(9)**. Therefore, it is likely that reduction of melatonin-induced cAMP levels is part of the underlying mechanism. In concordance, melatonin membrane receptors are present in bovine oocytes and cluster cells and decrease cAMP levels **(10)**.

On the other hand, the use of melatonin membrane receptor antagonist's decreases oocyte maturation, which is crucial to these receptors in the control of maturation **(10)**. In contrast, some studies have shown that melatonin supplementation in IVM processes (Supplementation of melatonin in vitro maturation) do not produce effects or even decreases its efficiency. Although there are contradictory results at first glance, it is necessary to interpret the modulations carried out by melatonin as a mechanism linked to the seasonal reproductive needs of organisms **(9, 11)**. The present study was conducted with aim to assess the role of intra follicular melatonin levels in ovarian reserve and the IVF cycle outcomes.

## 2. Materials and Methods

This prospective and cross-sectional study was conducted at the High Institute for Infertility Diagnosis and Assisted Reproductive Technologies / Al-Nahrain University and Kamal Al-Sameraie Hospital for infertility& in vitro fertilization, Baghdad-Iraq, from April 2022 to April 2023.

The Local committee of the Arab Board of Obstetrics and Gynecology in Iraq approved the study. Written consent was obtained from each patient after a detailed explanation of the study, and they were informed that all data would be confidential.

Participants in this study included 50 women who had recently undergone an ICSI or in-vitro fertilization treatment cycle. Patients had infertility due to male, tubal, or mixed factors. Data related to age, type and duration of infertility, BMI, and baseline demographic information, as well as any related prior medical history was collected for each participant. From the 2nd to 5th day of the previous MC, serum levels of each hormone assay (FSH before stimulation, LH, estrogen, and AMH) were measured.

Inclusion criteria were patients aged 18-40 years, BMI 18-30 Kg/$m^2$, ovarian and tubal factors infertility, and male partner with regular, mild or moderate male factors. Exclusion criteria were smokers, male partners with severe male factors, women presented with a uterine genetic abnormality, patients presented with ovarian tumors, and those patients with chronic diseases using medication.

### Stimulation protocols

Patients on a mini-long agonist, short agonist, and antagonist protocols were enrolled in the current study. Using ultrasound, follicle development was observed from the stimulation day until the hCG day (done every 2 or 3 days). Moreover, the levels of serum estradiol, follicular stimulating hormone, luteinizing hormone and progesterone were measured concurrently. After the prominent follicle mean touched 20 mm in diameter with a serum estradiol level of 150–200 pg/mL per mature follicle (> 14mm), hCG or triptorelin acetate were administered. Then U/s guided was used after 33-36 hours to collect oocyte.

The precise type and dose of human chorionic gonadotropin or triptorelin acetate was selected for everyone according to the patient's plasma estradiol levels and the mature oocytes number on the daytime of human chorionic gonadotropin administration.

### Collection of follicular fluid

At first, each woman's follicular fluid was collected by puncturing under TVU guidance from the 1st primary dominant follicle. It was centrifuged at 1000g/20 minutes at 0°C temperature to eliminate cellular constituents. Then, these supernatants were collected and frozen −20°C for later analysis within two months. All these procedures were achieved under light protection media.

### Melatonin test by ELISA

The mean level of melatonin in FF was measured by melatonin ELISA kits manufactured in the UK (Abcam213978). All ELISA tests were done in agreement with the company protocol.

Data was analyzed using SPSS software (version 25). Continuous variables were presented as mean, standard deviation, and discrete variables as numbers and percentages. The non-parametric tests were used for the statistical assessment of all patient data. Kruskal–Walli's test was applied to examine changes in parameter levels between patients in three studied groups (poor response, normal and high response) of the ovary to ovarian stimulation. Mann–Whitney U test was used to compare pairwise groups in the study when there is significance. The Spearman rank correlation coefficients (rs) test was used to analyze the relationship between follicular fluid melatonin levels and other parameters in the study. $P< 0.05$ was considered statistically significant.

## 3. Results

As shown in Table 1, the mean level of AMH in poor response was (0.92±0.47 ng/ml), while in normal response was (3.4±1.1 ng/ml) and in high response was (9.97±4.6 ng/ml) with a highly significant increase in high response ($P<0.001$). The mean level of FSH in poor response was (11.24 ± 3.6 IU/l), while in normal response was (7.8 ± 1.3) and in high response was (7.3±1.4) with a highly significant increase in high response ($P<0.001$). The mean level of LH in poor response was (5.92 ±1.24 IU/l), while in normal response was (5.42±1.75 IU/L) and in high response

was (5.082±1.31 IU/L) with no significant differences between the three groups (P=0.07). The mean level of baseline E2 in poor response was (27.43 ± 12.09 pg/ml), while in normal response was (33.52±15.18 pg/ml) and in high response was (35.44 ± 11.69 pg/ml) with a highly significant increase in high response (P<0.001). The mean level of E2 at the trigger day in poor response was (337±121.1pg/ml), while in normal response was (1287±533.7 pg/ml) and in high response was (2674±119.5 pg/ml) with a highly significant increase in high response (P<0.001).

**Table 1. Differences between hormonal assays in the studied groups**

| Variables (Mean ±SD) | Poor response (n=17) | Normal response (n=19) | High response (n=14) | P-value |
|---|---|---|---|---|
| **AMH(ng/mL)** | 0.92± 0.47 | 3.4±1.1 | 9.97±4.6 | <0.001 |
| **FSH (IU/L)** | 11.24 ± 3.6 | 7.8 ± 1.3 | 7.3 ± 1.4 | <0.001 |
| **LH (IU/L)** | 5.92 ± 1.24 | 5.42 ± 1.75 | 5.082 ± 1.31 | 0.07 Ns |
| **Baseline $E_2$(pg/mL)** | 27.43 ± 12.09 | 33.52 ± 15.18 | 35.44 ± 11.69 | <0.001 |
| **E2 at trigger day (pg/mL)** | 337 ± 121.1 | 1287 ± 533.7 | 2674 ± 119.5 | <0.001 |

There was a significant increase in the higher response group than the other two groups regarding number of oocytes retrieved, number of oocytes fertilized, number of zygotes cleaved, number of high-quality embryos, number of suitable embryos for transplantation, high-quality embryos, and blastocyst rate (P<0.001) (Table 2).

**Table 2. Differences between IVF outcomes in the studied groups**

| Variables (Mean ±SD) | Poor response (n=17) | Normal response (n=19) | High response (n=14) | P-value |
|---|---|---|---|---|
| **Oocytes retrieved (n.)** | 2.2 ± 1.01 | 10 ± 3.6 | 21.9 ± 5.7 | <0.001 |
| **Oocytes fertilized (n.)** | 1.2 ± 0.76 | 6.23 ± 2.9 | 14.8 ± 5.4 | <0.001 |
| **Zygotes cleaved (n.)** | 1.05 ± 0.8 | 8.3 ± 4.1 | 17.11 ± 4.8 | <0.001 |
| **High quality embryos** | 1.12 ± 0.9 | 2.9 ± 1.6 | 7.4 ± 5.8 | <0.001 |
| **Suitable embryos for transplantation (n.)** | 1.2 ± 0.8 | 3.3 ± 2.1 | 6.8 ± 2.9 | <0.001 |
| **High quality embryos** | 30 ± 13 | 38 ± 21 | 40 ± 19 | <0.001 |
| **Blastocyst rate (%)** | 12 ± 11 | 28 ± 23 | 42 ± 16 | <0.001 |

Melatonin mean levels in follicular fluid were (27.53 ± 20.19) in poor response, while (117.4 ± 102.57) in a normal response and (221.9 ± 183.81) in high response with a highly significant increase in normal and high response groups (P<0.001) (Table 3) (Figure 1).

**Table 3. Differences between melatonin levels in the studied groups**

| Variables Mean ±SD | Poor response (n=17) | Normal response(n=19) | High response(n=14) | P-value |
|---|---|---|---|---|
| **Follicular fluid melatonin levels (pg/ml)** | 27.53 ± 20.19 | 117.4 ± 102.57 | 221.9 ± 183.81 | <0.001 |

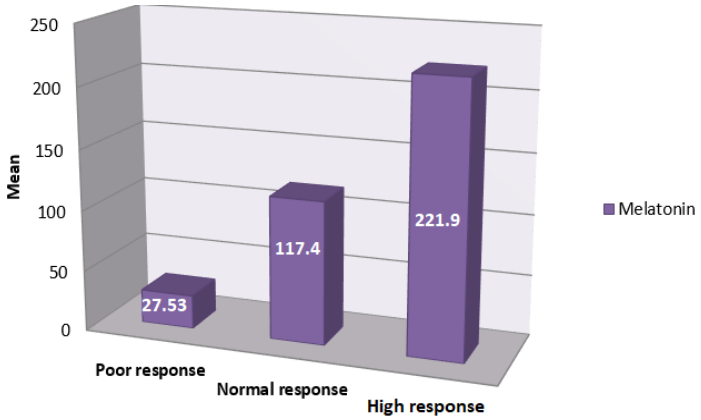



**Figure 1. Melatonin levels in the studied groups.**

The level of Melatonin in FF on the oocyte retrieval day was assessed to expect in vitro fertilization consequences. Significant positive correlation was found between levels of follicular fluid melatonin on the day of oocyte retrieval with the number of oocytes retrieved (r=0.705, P<0.001), number of oocytes fertilized (r=0.68, P<0.001), number of zygotes cleaved (r=0.660, P<0.001), high-quality embryos (r=0.591, P<0.001), embryos for transplantation (r=0.604, P<0.001), percent of high-quality embryos (r=0.58, P<0.001), and percent of blastocyst rate (r=0.336, P=0.007).

**Table 4. Correlation between levels of follicular fluid melatonin on the day of oocyte retrieval and IVF consequences variables**

| Variables | Levels of melatonin in FF | |
|---|---|---|
| | r | P value |
| **Oocytes retrieved (n.)** | 0.705 | <0.001 |
| **Oocytes fertilized (n.)** | 0.680 | <0.001 |
| **Zygotes cleaved (n.)** | 0.660 | <0.001 |
| **High quality embryos (n.)** | 0.591 | <0.001 |
| **Embryos for transplantation (n.)** | 0.604 | <0.001 |
| **High quality embryos (%)** | 0.588 | <0.001 |
| **Blastocyst rate (%)** | 0.336 | 0.007 |

As shown in Table 5, positive significance was found between levels of follicular fluid melatonin with LH, E2 and progesterone (P=0.005, P=0.001, and P<0.001, respectively).

**Table 5. Correlation between levels of follicular fluid melatonin and ovarian stimulation variables in the studied groups**

| Variables | Levels of melatonin in FF | |
|---|---|---|
| | r | P value |
| **FSH (IU/L)** | -0.07 | 0.4 Ns |
| **LH (IU/L)** | -0.362 | 0.005 |
| **$E_2$ (pg/mL)** | 0.621 | 0.001 |
| **Duration of stimulation (days)** | 0.172 | 0.09 Ns |
| **ET (mm)** | 0.136 | 0.6 Ns |
| **Total dose of GnRH (IU)** | -0.089 | 0.1 Ns |
| **P (ng/mL)** | 0.492 | <0.001 |

## 4. Discussion

Approximately one per five couples of reproductive age experience infertility problems and about half of them require reproductive treatments. ART is widely accepted as a method for treating fertility. The success rates of ART are varied, limiting the possibilities of gestation success. However, ART and the percentages of gestation by puncture or oocyte collection are highly variable in different countries **(12, 13)**. Many researchers found that melatonin, or its precursor, serotonin, is involved in reproductive processes such as the onset of puberty, ovulation, pregnancy and fertility, either through the hypothalamic-pituitary axis or by acting directly on the reproductive organs **(14-16)**. Unsuitably, no OR marker can accurately predict oocyte quality. AMH and basal FSH are now recognized as reliable serum markers of OR. However, AMH has no relationship to the caliber of the embryo; this is because it has an abysmal ability to predict future events **(17)**. Oocyte quality depends on the follicular fluid microenvironment because FF in vivo protects and feeds oocytes. Oocyte quality will decline due to increased reactive oxygen species in FF brought on by aging or IVF procedures **(18)**.

The FF regulates the acrosome reaction, maintains and enhances sperm motility, and participates in the final stage of sperm adaptation before fertilization. Additionally, contributing to the acrosome reaction, sperm hyperactivation, and chemotaxis is the progesterone found in FF **(19)**. In a recent study, the researchers compared melatonin-treated and untreated porcine oocytes during the IVM process. They found that oocytes treated with melatonin have significantly lower ROS. Additionally, melatonin has benefited from the nuclear and cytoplasmic maturation of porcine oocytes **(20)**. Another study conducted by Wiweko et al **(21)** revealed that both age and anti-Mullerian hormone levels were significantly related to ovarian reserve in the poor-responder group than that in another group **(21)**.

Moreover, a study revealed weak association between ovarian response and serum FSH and E2 levels **(22)**. The most common finding in the current study was a decreased level of melatonin significantly in patients with poor response than that with high response, which agrees with Zec et al.'s study that assessed the oxidative homeostasis in FF and reproductive outcomes–from bench to bedside **(23, 24)**. A randomized double blinded clinical trial carried out by Mokhtari et al **(25)** on patients with polycystic ovarian syndrome who experienced treatment by intrauterine insemination evaluated two groups in terms of chemical pregnancy rates. They found that the chemical pregnancy rate in melatonin was (32%), while in the control group there was (18%) with a significant difference **(25)**.

The other research revealed that melatonin could be given as a promising therapy in treating infertility of both males and females, mostly in cases of unexplained infertility and in treating PCOS female infertility conditions **(26)**. The current study showed no significant correlation between melatonin and FSH, which is not in agreement with the results found by Hsu and Chien **(27)**, who assessed the correlation between melatonin in post-menopausal overweight women and secretion of female hormones **(27)**. This may be attributed to the difference in sample size collection.

Tong et al **(24)** revealed that there is a powerful connection between levels of melatonin in FF with in vitro fertilization success **(24)**. Women with higher levels of these markers produced more oocytes. There was a significant increase in the number of oocytes fertilized, zygotes cleaved, high-quality embryos on day three, obtaining blastocysts, appropriate embryos for transplantation, as well as blastocyst rate in the high response group. The blastocyst rate indicates the ability to develop oocytes and the quality of the oocytes. As a result, melatonin levels in the follicular fluid can serve as an accurate predictor of ovarian reserve in addition to the effects of IVF because they are highly significant biochemical markers of oocyte quantity and quality.

## 5. Conclusion

Melatonin mean levels in follicular fluid were significantly decreased in poor response group than in standard and high response group. The follicular fluid melatonin levels were associated with oocyte quantity and quality and can expect ICSI consequences and act as highly important biochemical indicators of ovarian reserve.

## 6. Declarations


### Acknowledgments

We would like to thank all people who participate in this study.


### Ethical Considerations

Not applicable.

### Authors' Contributions

Author cooperates with the same in this project.

### Conflict of Interest

The authors declare no conflict of interest.


### Fund or Financial Support

This research received no specific grant from any funding agency in the public, commercial, or not for profit sector.

## References


1. Dragojevic Dikic S, Jovanovic AM, Dikic S, Jovanovic T, Jurisic A, Dobrosavljevic A. Melatonin: a "Higgs boson" in human reproduction. Gynecol Endocrinol. 2015;31(2): 92-101. [DOI:10.3109/09513590.2014.978851] [PMID]
2. Boafo A, Greenham S, Alenezi S, Robillard R, Pajer K, Tavakoli P, et al. Could long-term administration of melatonin to prepubertal children affect timing of puberty? A clinician's perspective. Nat Sci Sleep. 2019;11:1-10. [DOI:10.2147/NSS.S181365] [PMID] [PMCID]
3. Munmun F, Witt-Enderby PA. Melatonin effects on bone: Implications for use as a therapy for managing bone loss. J Pineal Res. 2021;71(1): e12749. [DOI:10.1111/jpi.12749] [PMID]
4. Zademodares S, Abbaspour M, Anbarluei M, Rahmati N, Fathi M, Naeiji Z. In vitro Fertilization outcome in Patients with Polycystic Ovary Syndrome: Role of Age and Maternal Body Weight. J Obstet Gynecol Cancer Res. 2021;6(4):161-6. [DOI:10.30699/jogcr.6.4.161]
5. Ezzati M, Velaei K, Kheirjou R. Melatonin and its mechanism of action in the female reproductive system and related malignancies. Mol Cell Biochem. 2021;476(8):3177-90. [DOI:10.1007/s11010-021-04151-z] [PMID]
6. Shan B, Ai Z, Zeng S, Song Y, Song J, Zeng Q, et al. Gut microbiome-derived lactate promotes to anxiety-like behaviors through GPR81 receptor-mediated lipid metabolism pathway. Psychoneuroendocrinology. 2020;117:104699. [DOI:10.1016/j.psyneuen.2020.104699] [PMID]
7. Strączyńska P, Papis K, Morawiec E, Czerwiński M, Gajewski Z, Olejek A, et al. Signaling mechanisms and their regulation during in vivo or in vitro maturation of mammalian oocytes. Reprod Biol Endocrinol. 2022;20(37):1-12. [DOI:10.1186/s12958-022-00906-5] [PMID] [PMCID]
8. Rodrigues-Cunha MC, Mesquita LG, Bressan F, Del Collado M, Balieiro JCC, Schwarz KRL, et al. Effects of melatonin during IVM in defined medium on oocyte meiosis, oxidative stress, and subsequent embryo development. Theriogenology. 2016;86(7):1685-94. [PMID] [DOI:10.1016/j.theriogenology.2016.05.026]
9. Nie J, Yan K, Sui L, Zhang H, Zhang H, Yang X, et al. Mogroside V improves porcine oocyte in vitro maturation and subsequent embryonic development. Theriogenology. 2020;141:35-40. [DOI:10.1016/j.theriogenology.2019.09.010] [PMID]
10. Tian X, Wang F, He C, Zhang L, Tan D, Reiter RJ, et al. Beneficial effects of melatonin on bovine oocytes maturation: a mechanistic approach. J Pineal Res. 2014;57(3):239-47. [DOI:10.1111/jpi.12163] [PMID]
11. He F, Wang F, Yang Y, Yuan Z, Sun C, Zou H, et al. The effect of growth hormone on the metabolome of follicular fluid in patients with diminished ovarian reserve. Reprod Biol Endocrinol. 2023;21(1):21. [PMID] [PMCID] [DOI:10.1186/s12958-023-01073-x]
12. Ostadian C, Mehrafza M, Eftekhari A, Aghajani S, Vahabzadeh H, Gholami M, et al. The Effect of Prolonged Incubation of Sperm at Testis Temperature versus Room Temperature on Semen Parameters- An Experimental Study. J Obstet Gynecol Cancer Res. 2022;7(4):323-8. [DOI:10.30699/jogcr.7.4.323]
13. Maan R, Majid H, Medhat S, Abdel-Hadi E. Association of interleukin-18 gene polymorphisms with susceptibility to inflammatory bowel disease in Iraqi patients through image process. Procedia Environ Sci Eng Manag. 2023;10(3):449-58.
14. Rai S, Gosh H. Modulation of human ovarian function by melatonin. Front Biosci. 2020;13(1): 140-57. [DOI:10.2741/875] [PMID]
15. Asadipour A, Mehrabani M, Najafi ML. Volatile oil composition of Centaurea aucheri (DC.) Wagenitz. DARU J Pharm Sci. 2005;13(4):160-4.
16. Yamashita K, Chirelli MQ, Tonhom SF, Peres CRFB, Massih Pio DA. Teaching-Service Integration in Health Training: Potentialities and Operationalization Process of Integrated Curriculum. 2023;16(se1):28-40. [DOI:10.14571/brajets.v16.nse1.28-40]
17. Najafi ML, Nasiri M. Review of drug abuse patterns and their association with some individual and social variables among addicts. J Adv Pharm Edu Res. 2019;9(2):99-101.
18. Donoso PC, Pérez MPS, Aguirre CC, Barbosa AO, Gómez CMG, Jimenez AM, et al. Angiosarcoma suprarrenal primario. Reporte de caso. Arch Pathol. 2022;3(3):96-103. [DOI:10.47579/AP.v3.i3.0102]
19. Hasan MM, Reshi QUA, Lättekivi F, Viil J, Godakumara K, Dissanayake K, et al. Bovine Follicular Fluid Derived Extracellular Vesicles Modulate the Viability, Capacitation and Acrosome Reaction of Bull Spermatozoa. Biology (Basel). 2021;10(11):1154. [PMCID] [DOI:10.3390/biology10111154] [PMID]
20. El-Sheikh M, Mesalam AA, Kang SM, Joo MD, Soliman SS, Khalil AAK, et al. Modulation of Apoptosis and Autophagy by Melatonin in Juglone-Exposed Bovine Oocytes. Animals

(Basel). 2023;13(9):1475. [DOI:10.3390/ani13091475] [PMID] [PMCID]

21. Wiweko B, Afdi QF, Harzif AK, Pratama G, Sumapradja K, Muharam R, et al. Analysis of factors associated with ovarian reserve in a group of poor responders to in vitro fertilization: A cross-sectional study. Int J Reprod Biomed. 2020; 18(12):1065-72. [PMID] [PMCID] [DOI:10.18502/ijrm.v18i12.8028]
22. Hu L, Sun B, Ma Y, Li L, Wang F, Shi H, et al. The Relationship Between Serum Delta FSH Level and Ovarian Response in IVF/ICSI Cycles. Front Endocrinol (Lausanne). 2020;11:536100. [DOI:10.3389/fendo.2020.536100] [PMID] [PMCID]
23. Zec I, Goldštajn M, Kuna K, Mikuš M, Stabile G, Bianco B, et al. Oxidative homeostasis in follicular fluid and reproductive outcomes - from bench to bedside. Prz Menopauzalny. 2022;21(4): 276-84. [DOI:10.5114/pm.2022.124019] [PMID] [PMCID]
24. Dawood MA, Assi M. Evaluation of her 2, and ki-67 expression immunohistochemically of gastric cancer in al-najaf province, Procedia Environmental Science. Eng Manag. 2024;11(3): 465-72.
25. Mokhtari F, Akbari Asbagh F, Azmoodeh O, Bakhtiyari M, Almasi-Hashiani A. Effects of Melatonin Administration on Chemical Pregnancy Rates of Polycystic Ovary Syndrome Patients Undergoing Intrauterine Insemination: A Randomized Clinical Trial. Int J Fertil Steril. 2019;13(3):225-9.
26. Alawad ZM, Al-Omary HL. Melatonin in male and female fertility. Al-Kindy Coll Med J. 2021; 17(3):145-51. [DOI:10.47723/kcmj.v17i3.398]
27. Hsu LW, Chien YW. Effects of Melatonin Supplementation on Lipid Metabolism and Body Fat Accumulation in Ovariectomized Rats. Nutrients. 2023;15(12):2800. [DOI:10.3390/nu15122800] [PMID] [PMCID]

**How to Cite This Article:**

Majeed Shareef, R., Yassen, N. S., Alkhudair, S. H. IVF Technique and its Relationship with Ovarian Reserve Based on Melatonin Level in Follicular Fluid. J Obstet Gynecol Cancer Res. 2025;10(4):293-99.

**Download citation:** RIS | EndNote | Mendeley |BibTeX |