e-ISSN: 0975-9506, p-ISSN:2961-6093

Available online on www.ijpqa.com doi: 10.25258/ijpqa.16.8.23

International Journal of Pharmaceutical Quality Assurance 2025; 16(7); 131-137

Original Research Article

Does Repeat Dose of Gonadotropin-Releasing Hormone Agonist Trigger in Normo and Hyper Responders Compared to Single Dose in Antagonist IVF Cycles Provides a Better Mature Oocyte Yield (MII)? - A Prospective Cohort Study

Meena Srikanth[1], Anuranjita Pallavi[2]

[1]Assistant Professor, MD, Department of Obstetrics and Gynaecology, Mahatma Gandhi Medical College, Maharashtra, 400706

[2]Consultant, MS Obstetrics and Gynaecology, Fertility Specialist, Department of Apollo Fertility, Apollo Hospital, Navi Mumbai, Maharashtra 400614

Received: 25-06-2025 / Revised: 23-07-2025 / Accepted: 09-08-2025

Corresponding Author: Dr. Meena Srikanth

Conflict of interest: Nil

Abstract:

Introduction: Controlled ovarian stimulation (COS) with a GnRH antagonist protocol is commonly used in in-vitro fertilization (IVF) cycles. GnRH agonist (GnRHa) trigger is an established alternative to hCG in preventing ovarian hyperstimulation syndrome (OHSS), especially in high responders. However, concerns remain about the adequacy of oocyte maturation with a single GnRHa trigger dose. Recent studies suggest that a repeat or dual GnRHa trigger may improve outcomes, particularly in specific responder groups.

Objective: To evaluate whether a repeat dose of GnRH agonist trigger, compared to a single dose, improves mature oocyte (MII) yield in normo-responders and hyper-responders undergoing IVF with an antagonist protocol.

Methods: This prospective observational study was conducted at Craft Hospital and Research Centre, Kerala, from December 2017 to August 2018, involving women undergoing IVF cycles with a GnRH antagonist protocol. The study compared the outcomes of single versus repeat doses of GnRH agonist trigger in normo- and hyper-responders. Key variables assessed included age, type of infertility, AMH, AFC, pre-trigger LH, peak estradiol, post-trigger progesterone and LH levels, number of mature oocytes (MII), and maturity rate. The aim was to evaluate whether a repeat dose offered improved oocyte maturation compared to a single dose.

Results: In this prospective observational study, baseline characteristics such as age, AMH, AFC, pre-trigger LH, peak estradiol, total gonadotropin dose, and stimulation duration were comparable between the single-dose (Group A) and repeat-dose (Group B) GnRH agonist trigger groups in antagonist IVF cycles. The majority had primary infertility in both groups. Although Group A showed slightly higher mean mature oocyte (MII) yield (15.69 vs. 14.73) and oocyte maturity rate (84% vs. 78%) than Group B, the differences were not statistically significant. Post-trigger LH and progesterone levels also did not differ significantly between groups. Thus, administering a repeat dose of GnRH agonist did not provide a significant advantage in mature oocyte yield compared to a single dose.

Conclusion: Repeat-dose GnRH agonist trigger appears to be a safe and effective strategy to improve mature oocyte yield in both normo- and hyper-responders undergoing GnRH antagonist IVF cycles. This approach may be particularly beneficial in optimizing outcomes in patients with a higher follicular response, without increasing the risk of OHSS.

Keywords: GnRH agonist trigger, antagonist IVF protocol, mature oocyte yield, repeat dose, normo-responder, hyper-responder, MII oocytes, OHSS prevention.

Introduction

GnRHa trigger for final oocyte maturation in a GnRH Antagonist protocol has been a revolutionary tool in the armamentarium of ART.

The GnRHa trigger effectively results in the induction of final oocyte maturation[1] and ovulation[2], in comparison with the standard human chorionic gonadotropin (hCG).[3] The gonadotropin response following GnRHa trigger has a much shorter duration when compared to that of an endogenous LH surge in a natural cycle.[4][5][6]

Hence, a single dose of GnRHa might not be able to maintain an LH concentration above a threshold

for 14–27 h, sufficient to induce optimal oocyte maturation and higher oocyte yield.

Thus, a repeat dose of Gnrh agonist was given to find out whether it resulted in better Mature oocyte(MII) number.

Materials and Methods

Study Design: Prospective Observational Study.

Place of study: Craft Hospital and Research Centre, Kodungallur, Kerala.

Period of study: December 2017 to august 2018 were recruited for the study.

Study Population: In patients admitted for elective caesarean section under spinal anaesthesia.

Study Variables

- Age
- Primary Infertility
- Secondary Infertility
- AMH
- AFC
- Pre Trigger LH
- Peak Estradiol
- Post Trigger P4
- Mature Oocytes (MII)
- Post Trigger LH
- Maturity Rate

Sample Size

140 Normo and Hyper responders undergoing IVF patients.

Group A(n=70): Included patients enrolled between Dec 2017 to April 2018.

Group B(n=70): Included patients enrolled between May to Aug 2018.

COS was carried out with Recombinant FSH (150-225 IU) for 4 days from cycle day 2/3 according to age, BMI, antral follicle count, AMH, and previous ovarian response to stimulation. Thereafter, the dose was adjusted on the basis of ovarian response and serum E2.

Flexible multiple dose protocol was followed wherein GnRH antagonist-Cetrorelix 0.25 mg/day subcutaneous (s.c) was started when the lead follicle was ≥12 mm and/or serum estradiol concentration was >600 pg/mL. Both gonadotropin and antagonist were continued till the day of trigger.

On the day of trigger, serum E2 and LH concentrations were measured. When two lead follicles achieved 18 mm diameter, the final oocyte maturation was triggered:

Group A: Single dose of GnRHa (Triporelin) 0.4 mg followed by oocyte retrieval after 36 hrs. Post trigger LH was estimated after 8 hrs

Group B: 0.2 mg GnRHa (Triptorelin) + repeat dose of 0.2 mg 8 h following the 1st dose. Oocyte retrieval was carried out 36 hrs after the first dose. Post-trigger luteinizing hormone (LH) was estimated after 8 hrs after each dose.

Inclusion Criteria

- Age 18-37 years
- 1st and 2nd IVF- ICSI attempt
- Normo responders
- Hyper responders

Exclusion Criteria

- Age > 37 years
- Single ovary
- Endometriotic cysts
- Hypogonadotropic Hypogonadism
- Poor responders and Diminished Ovarian reserve (according to Bologna Criteria)

Statistical Analysis: Statistical analysis was performed using appropriate software (e.g., SPSS version XX). Descriptive statistics were calculated for all baseline characteristics, and values were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR) for continuous variables, and as frequency and percentage for categorical variables.

The normality of data distribution was assessed using the Shapiro-Wilk test. Comparison between the single-dose and repeat-dose GnRH agonist trigger groups was carried out using the independent samples t-test or Mann–Whitney U test for continuous variables, and the chi-square test or Fisher's exact test for categorical variables. Subgroup analysis was performed for normo-responders and hyper-responders to evaluate the differential effect of trigger dose on mature oocyte yield (MII).

The primary outcome, mean number of MII oocytes retrieved, was compared between groups. The mature oocyte yield ratio (MII oocytes/total oocytes retrieved) was also analyzed. A p-value <0.05 was considered statistically significant.

Result

Table 1: Patients Characteristics

Variables	GROUP A (N=70)	GROUP B (N=70)	P value
Age	29.72 ± 3.85	30.49 ± 3.92	0.71
Primary Infertility	50 (72%)	45 (63%)	--
Secondary Infertility	20 (28%)	25 (37%)	--
AMH	6.23 ± 3.77	5.88 ± 4.08	0.87
AFC	23.35 ± 9.32	24.71 ± 8.71	0.74
Pre trigger LH	2.60 ± 1.47	2.54 ± 1.54	0.46
Peak Estradiol	3482.94±1190.85	3091 ± 1402.92	0.11
Total Dose of Gonadotropins	1522.91 ± 383.02	1571.10 ± 401.16	0.44
Total duration of stimulation (Days)	7.90 ± 1.01	7.70 ± 0.95	0.49

Table 2: Follicular and Post-Trigger Hormonal Parameters in Group A (Single Dose) and Group B (Repeat Dose) GnRH Agonist Trigger Groups

Variables	GROUP A (N=70)	GROUP B (N=70)	P value
Follicle ≥14mm on the final day of inj	15.27± 4.10	14.61 ± 5.05	0.13
Mature oocytes (MII)	15.69 ± 4.80	14.73 ± 4.98	0.23
Post trigger LH	72.91 ± 29.84	80.33 ± 36.95	0.17
Post trigger LH 8 hrs after the 1st dose	--	34.56 ±17.51	---
Post trigger P4	0.75 ± 0.46	1.11 ± 2.31	0.26
Maturity rate	1114/1321 (84%)	1031/1322 (78%)	0.36

The age, AMH, AFC, pre trigger LH, peak estradiol, total dose of gonadotropins and total duration of stimulation were comparable in both the groups. 72% had primary infertility in Group A whereas Group B had 63%. The baseline characteristics of the two groups were comparable. The mean age of participants in Group A was 29.72 ± 3.85 years, and in Group B was 30.49 ± 3.92 years, with no statistically significant difference (p = 0.71). The proportion of patients with primary infertility was slightly higher in Group A (72%) compared to Group B (63%), while secondary infertility was reported in 28% and 37%, respectively. The mean anti-Müllerian hormone (AMH) levels were similar between Group A (6.23 ± 3.77 ng/mL) and Group B (5.88 ± 4.08 ng/mL) (p = 0.87). Antral follicle count (AFC) was also comparable between the groups (23.35 ± 9.32 vs. 24.71 ± 8.71; p = 0.74). Pre-trigger luteinizing hormone (LH) levels were not significantly different between Group A and Group B (2.60 ± 1.47 vs. 2.54 ± 1.54; p = 0.46). Although the mean peak estradiol levels were higher in Group A (3482.94 ± 1190.85 pg/mL) compared to Group B (3091 ± 1402.92 pg/mL), the difference was not statistically significant (p = 0.11). The total dose of gonadotropins used and the duration of ovarian stimulation were similar between the two groups (1522.91 ± 383.02 IU vs. 1571.10 ± 401.16 IU, p = 0.44; and 7.90 ± 1.01 vs. 7.70 ± 0.95 days, p = 0.49, respectively). The mean number of follicles ≥14 mm on the day of final trigger was comparable between Group A and Group B (15.27 ± 4.10 vs. 14.61 ± 5.05; p = 0.13). The mean number of mature oocytes (MII) retrieved was slightly higher in Group A (15.69 ± 4.80) than in Group B (14.73 ± 4.98), but the difference was not statistically significant (p = 0.23). The post-trigger serum LH levels were 72.91 ± 29.84 mIU/mL in Group A and 80.33 ± 36.95 mIU/mL in Group B, also showing no significant difference (p = 0.17). In Group B, the LH level measured 8 hours after the first dose of GnRH agonist was 34.56 ± 17.51 mIU/mL. Post-trigger serum progesterone (P4) levels were 0.75 ± 0.46 ng/mL in Group A and 1.11 ± 2.31 ng/mL in Group B (p = 0.26). The oocyte maturity rate, calculated as the proportion of mature oocytes out of total oocytes retrieved, was 84% (1114/1321) in Group A and 78% (1031/1322) in Group B, with no statistically significant difference between the groups (p = 0.36). Our study showed that a repeat dose of Gnrh agonist when compared with single dose in terms of mature oocyte yield was not statistically significant.

Discussion

For more than three decades, hCG has lucratively been used as a surrogate for the endogenous mid-cycle LH surge in all IVF cycles as both hCG and LH bind to and activate the same receptor, LH receptor (LHr), promoting follicular maturation, luteinization, and ovulation.[17]However, the hCG molecule has a high biological activity, which is about six to seven times higher than the endogenous LH with a half-life exceeding 24 h, while, the half-life of LH is 60 min. hCG also has a greater affinity to LHr than LH, and thus exerts a more prolonged luteotrophic action for 8–9 days, multiple corpus luteum development, and raised serum levels of estradiol throughout the luteal phase[18], all of which increase the risk of developing OHSS in PCOS and hyper-responders. To reduce this

grave complication of OHSS and to achieve a favourable cycle outcome without cycle cancelation, GnRHa as a final oocyte maturation in GnRH antagonist protocol has emerged as a breakthrough modality.[6][19][20]

The LH surge in a natural cycle lasts 48 h and consists of three phases: ascending phase (14 h), plateau phase (14 h), and a descending phase (20 h).[21] On the contrary, the LH surge induced by GnRHa is shorter, lasts for 24 h; consisting of only two phases: a short ascending phase lasting for ~4 h and a descending phase lasting ~20 h.[22] Thus, the effective duration of action is shorter with a lower amount of gonadotropins (LH and FSH) being released when compared to natural cycle. [21][23] It is known that the expansion of cumulus cells and resumption of meiosis begin 18 h after the onset of LH surge[24] and that the LH concentration must be maintained above a threshold for 14–27 h to maximize the oocyte maturation.[25] Hence, a single dose of GnRHa might not be able to maintain an LH concentration above a threshold for 14–27 h, sufficient to induce optimal oocyte maturation and higher oocyte yield, which may be due to its shorter duration and lower LH levels post-trigger. It has been reported that repeated injections of GnRHa increase the duration of LH secretion (LH level was >100 IU/L) up to >14 h. [23]Theoretically, a third or even a fourth administration may improve the amplitude and duration of the resultant endogenous gonadotropin surge, which is practically neither feasible nor cost effective. The LH concentration peaks to levels of 130 ± 60 IU/L at 4 h with triptorelin and 107 ± 55 IU/L with leuprorelin, falling to 40 ± 20 IU/L at 12 h reflecting its clearance[1], with levels returning to baseline after 24 h. Thinking in the same lines, we postulated a repeat dose of GnRHa at 8 hrs could maintain the amplitude and the duration of gonadotropin surge, thereby optimizing the oocyte maturity and hence leading to more mature oocyte yield.

There is clearly a subgroup of patients who respond poorly following GnRHa trigger, with decreased oocyte yield, maturity, and quality [26]. This has been explained by an inadequate LH surge (magnitude and/or duration) and possibly, inadequate FSH surge leading to suboptimal signaling at the level of the follicles resulting in failure to achieve the final oocyte maturation. As the pituitary gland is the site of action for GnRHa, any temporary or permanent dysfunctions of the hypothalamic–pituitary–ovarian (HPO) axis might not produce optimal flare effect, resulting in deficient final follicular maturation. Hence, women with hypothalamic amenorrhea are not the candidates for GnRHa trigger. In a preliminary commendable work by Itskovitz et al. [22] in 1991, even before the advent of antagonists, they reported that a bolus dose of GnRHa was able to trigger an adequate mid-cycle LH/FSH surge, resulting in oocyte maturation. In the same study, involving 14 patients (6 normal responders and 8 hyper-responders), the group also reported that a second injection of GnRHa had no effect on LH release, at least as reflected in the serum levels of LH, 2 hours after its injection, suggesting that pituitary desensitization had already occurred 12 h after the first injection. This study involved the use of gonadotropins only without the occupation of GnRH receptors on the gonadotrophic cells by the antagonist for the agonist to displace allowing reevaluation of stimulating a mid-cycle rise in endogenous LH. Under these circumstances, the dynamics and endocrine profiles of the mid-cycle gonadotropin surge could vary. In our study,the maturity rate was 84% in Group A and 78% in Group B which was statistically insignificant. A rise in serum LH and progesterone following GnRHa trigger indicates that an endogenous flare has occurred and oocyte maturation has been initiated. In a retrospective study by Shapiro et al.,[39] a diminution in oocyte maturity was seen when LH levels measured at 12 h post-trigger were <52 IU/L, with a dramatic decrease when LH12 was <12 IU/L in hyper-responders and oocyte donors. Hence, we also evaluated the post-trigger LH, P4 at 8h following the first dose and repeated the LH measurement 8 hrs after the second dose also. In our study, the mean value of Post trigger LH after 8 hrs was 72.91 ± 29.84 in Group A, 80.33 ± 36.95 in Group B after 1st dose and further decline in the LH values at 16 hrs following the 2nd dose to a mean of 34.56 ±17.51. This however did not affect the mature Oocyte yiel(MII). Our study is the 2nd study to explore if a repeat dose of GnRHa in normo and hyper responders undergoing IVF in GnRH antagonist cycles would provide a higher mature oocyte(MII) yield. Post-trigger LH values, which was measured as a part of secondary outcome, would provide us insight about their predictability of oocyte maturity and empty follicle syndrome. According to a study by Deepika et al[36] (Milan Hospital Bangalore), 2017,A repeat dose of GnRHa 12 h following the first dose in PCOS undergoing IVF with antagonist protocol provided a better cycle outcome than a single dose in terms of mature oocyte yield. It was an RCT but the limitation of the study was a small sample size.

Conclusion

In this prospective cohort study comparing single versus repeat dose of Gonadotropin-Releasing Hormone (GnRH) agonist trigger in antagonist IVF cycles among normo- and hyper-responders, no statistically significant difference was observed between the groups in terms of mature oocyte (MII) yield, oocyte maturity rate, or post-trigger hormonal profiles. Both protocols resulted in comparable follicular responses, serum LH and progesterone levels post-trigger, and clinical outcomes. Repeat

dosing of GnRH agonist trigger does not confer a clear advantage over single dosing in improving mature oocyte yield in this population. Single-dose GnRH agonist trigger remains a sufficient and effective strategy for final oocyte maturation in normo- and hyper-responders undergoing antagonist IVF cycles.

References

1. Fauser BC, de Jong D, Olivennes F, Wramsby H, Tay C, Itskovitz-Eldor J, et al. Endocrine profiles after triggering of final oocyte maturation with GnRH agonist after cotreatment with the GnRH antagonist ganirelix during ovarian hyperstimulation for in vitro fertilization. J Clin Endocrinol Metab. 2002;87(2):709–15.
2. Emperaire JC, Ruffie A. Triggering ovulation with endogenous luteinizing hormone may prevent the ovarian hyperstimulation syndrome. Hum Reprod. 1991;6(4):506–10.
3. Kulikowski M, Wołczyński S, Kuczyński W, Grochowski D, Szamatowicz M. Use of GnRH analog for induction of the ovulatory surge of gonadotropins in patients at risk of the ovarian hyperstimulation syndrome. Gynecol Endocrinol. 1995;9(2):97–102.
4. Itskovitz-Eldor J, Kol S, Mannaerts B. Use of a single bolus of GnRH agonist triptorelin to trigger ovulation after GnRH antagonist ganirelix treatment in women undergoing ovarian stimulation for assisted reproduction, with special reference to the prevention of ovarian hyperstimulation syndrome: Preliminary report: Short communication. Hum Reprod. 2000;15(9):1965–8.
5. Engmann L, Siano L, Schmidt D, Nulsen J, Maier D, Benadiva C, et al. GnRH agonist to induce oocyte maturation during IVF in patients at high risk of OHSS. Reprod Biomed Online. 2006;13(5):639–44.
6. Engmann L, DiLuigi A, Schmidt D, Nulsen J, Maier D, Benadiva C, et al. The use of gonadotropin-releasing hormone (GnRH) agonist to induce oocyte maturation after cotreatment with GnRH antagonist in high-risk patients undergoing in vitro fertilization prevents the risk of ovarian hyperstimulation syndrome: A prospective randomized controlled study. Fertil Steril. 2008;89(1):84–91.
7. Humaidan P, Quartarolo J, Papanikolaou EG. Preventing ovarian hyperstimulation syndrome: Guidance for the clinician. Fertil Steril. 2010;94(2):389–400.
8. Humaidan P, Kol S, Papanikolaou EG; Copenhagen GnRH Agonist Triggering Workshop Group. GnRH agonist for triggering of final oocyte maturation: Time for a change of practice? Hum Reprod Update. 2011;17(4):510–24.
9. Griesinger G, Schultz L, Bauer T, Broessner A, Frambach T, Kissler S, et al. Ovarian hyperstimulation syndrome prevention by gonadotropin-releasing hormone agonist triggering of final oocyte maturation in a gonadotropin-releasing hormone antagonist protocol in combination with a "freeze-all" strategy: A prospective multicentric study. Fertil Steril. 2011;95(6):2029–33.
10. Honnma H, Hashiba Y, Asada Y, Endo T. Failure of triggering oocyte maturation with a GnRH agonist in polycystic ovary syndrome: Two case reports. Eur J Obstet Gynecol Reprod Biol. 2011;157(2):239–40.
11. Castillo JC, Garcia-Velasco J, Humaidan P. Empty follicle syndrome after GnRHa triggering versus hCG triggering in COS. J Assist Reprod Genet. 2012;29(3):249–53.
12. O'Neill KE, Senapati S, Dokras A. Use of gonadotropin-releasing hormone agonist trigger during in vitro fertilization is associated with similar endocrine profiles and oocyte measures in women with and without polycystic ovary syndrome. Fertil Steril. 2015;103(1):264–9.
13. Rotterdam ESHRE/ASRM-Sponsored PCOS Consensus Workshop Group. Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome. Fertil Steril. 2004;81(1):19–25.
14. Bodri D, Guillén JJ, Galindo A, Mataró D, Pujol A, Coll O, et al. Triggering with human chorionic gonadotropin or a gonadotropin-releasing hormone agonist in gonadotropin-releasing hormone antagonist-treated oocyte donor cycles: Findings of a large retrospective cohort study. Fertil Steril. 2009;91(1):365–71.
15. ALPHA Scientists In Reproductive Medicine, ESHRE Special Interest Group Embryology. Istanbul consensus workshop on embryo assessment: Proceedings of an expert meeting. Reprod Biomed Online. 2011;22(6):632–46.
16. Kuwayama M, Vajta G, Ieda S, Kato O. Comparison of open and closed methods for vitrification of human embryos and the elimination of potential contamination. Reprod Biomed Online. 2005;11(5):608–14.
17. Ascoli M, Fanelli F, Segaloff DL. The lutropin/choriogonadotropin receptor, a 2002 perspective. Endocr Rev. 2002;23(2):141–74.
18. Yen SS, Llerena O, Little B, Pearson OH. Disappearance rates of endogenous luteinizing hormone and chorionic gonadotropin in man. J Clin Endocrinol Metab. 1968;28(12):1763–7.
19. Kol S. Luteolysis induced by a gonadotropin-releasing hormone agonist is the key to prevention of ovarian hyperstimulation syndrome. Fertil Steril. 2004;81(1):1–5.
20. DiLuigi AJ, Engmann L, Schmidt DW, Maier DB, Nulsen JC, Benadiva CA, et al. Gonadotropin-releasing hormone agonist to induce final oocyte maturation prevents the development of ovarian hyperstimulation syndrome in

high-risk patients and leads to improved clinical outcomes compared with coasting. Fertil Steril. 2010;94(4):1111–4.
21. Hoff JD, Quigley ME, Yen SS. Hormonal dynamics at midcycle: A reevaluation. J Clin Endocrinol Metab. 1983;57(4):792–6.
22. Itskovitz J, Boldes R, Levron J, Erlik Y, Kahana L, Brandes JM, et al. Induction of preovulatory luteinizing hormone surge and prevention of ovarian hyperstimulation syndrome by gonadotropin-releasing hormone agonist. Fertil Steril. 1991;56(2):213–20.
23. Zelinski-Wooten MB, Lanzendorf SE, Wolf DP, Chandrasekher YA, Stouffer RL. Titrating luteinizing hormone surge requirements for ovulatory changes in primate follicles. I. Oocyte maturation and corpus luteum function. J Clin Endocrinol Metab. 1991;73(3):577–83.
24. Seibel MM, Smith DM, Levesque L, Borten M, Taymor ML. The temporal relationship between the luteinizing hormone surge and human oocyte maturation. Am J Obstet Gynecol. 1982;142(5):568–72.
25. Zelinski-Wooten MB, Hutchison JS, Chandrasekher YA, Wolf DP, Stouffer RL. Administration of human luteinizing hormone (hLH) to macaques after follicular development: Further titration of LH surge requirements for ovulatory changes in primate follicles. J Clin Endocrinol Metab. 1992;75(2):502–7.
26. Meyer L, Murphy LA, Gumer A, Reichman DE, Rosenwaks Z, Cholst IN, et al. Risk factors for a suboptimal response to gonadotropin-releasing hormone agonist trigger during in vitro fertilization cycles. Fertil Steril. 2015;104(3):637–42.
27. Devroey P, Polyzos NP, Blockeel C. An OHSS-free clinic by segmentation of IVF treatment. Hum Reprod. 2011;26(10):2593–7.
28. Youssef MA, Van der Veen F, Al-Inany HG, Mochtar MH, Griesinger G, Nagi Mohesen M, et al. Gonadotropin-releasing hormone agonist versus HCG for oocyte triggering in antagonist-assisted reproductive technology. Cochrane Database Syst Rev. 2014;10:CD008046.
29. Balaban B, Urman B, Ata B, Isiklar A, Larman MG, Hamilton R, et al. A randomized controlled study of human day 3 embryo cryopreservation by slow freezing or vitrification: Vitrification is associated with higher survival, metabolism and blastocyst formation. Hum Reprod. 2008;23(9):1976–82.
30. Maheshwari A, Pandey S, Shetty A, Hamilton M, Bhattacharya S. Obstetric and perinatal outcomes in singleton pregnancies resulting from the transfer of frozen thawed versus fresh embryos generated through in vitro fertilization treatment: A systematic review and meta-analysis. Fertil Steril. 2012;98(2):368–77.
31. Strickland S, Beers WH. Studies on the role of plasminogen activator in ovulation. In vitro response of granulosa cells to gonadotropins, cyclic nucleotides, and prostaglandins. J Biol Chem. 1976;251(17):5694–702.
32. Eppig JJ. FSH stimulates hyaluronic acid synthesis by oocyte-cumulus cell complexes from mouse preovulatory follicles. Nature. 1979;281(5730):483–4.
33. Yding Andersen C, Leonardsen L, Ulloa-Aguirre A, Barrios-De-Tomasi J, Moore L, Byskov AG, et al. FSH-induced resumption of meiosis in mouse oocytes: Effect of different isoforms. Mol Hum Reprod. 1999;5(8):726–31.
34. Imoedemhe DA, Sigue AB, Pacpaco EL, Olazo AB. Stimulation of endogenous surge of luteinizing hormone with gonadotropin-releasing hormone analog after ovarian stimulation for in vitro fertilization. Fertil Steril. 1991;55(2):328–32.
35. Humaidan P, Bredkjaer HE, Bungum L, Bungum M, Grøndahl ML, Westergaard L, et al. GnRH agonist (buserelin) or hCG for ovulation induction in GnRH antagonist IVF/ICSI cycles: A prospective randomized study. Hum Reprod. 2005;20(5):1213–20.
36. Krishna Deepika, Baiju P, Gautham P, Suvarna R, Arveen V, Rao K. Repeat dose of gonadotropin-releasing hormone agonist trigger in polycystic ovarian syndrome undergoing In Vitro fertilization cycles provides a better cycle outcome - a proof-of-concept study. Department of Reproductive Medicine, Milann, The Fertility Center, (A Unit of BACC Healthcare Pvt Ltd.), Bengaluru, Karnataka, India.
37. Chung K, Fogle R, Bendikson K, Christenson K, Paulson R. Microdose gonadotropin-releasing hormone agonist in the absence of exogenous gonadotropins is not sufficient to induce multiple follicle development. Fertil Steril. 2011;95(1):317–9.
38. Kummer NE, Feinn RS, Griffin DW, Nulsen JC, Benadiva CA, Engmann LL, et al. Predicting successful induction of oocyte maturation after gonadotropin-releasing hormone agonist (GnRHa) trigger. Hum Reprod. 2013;28(1):152–9.
39. Shapiro BS, Daneshmand ST, Restrepo H, Garner FC, Aguirre M, Hudson C, et al. Efficacy of induced luteinizing hormone surge after "trigger" with gonadotropin-releasing hormone agonist. Fertil Steril. 2011;95(2):826–8.