Review on Antagonists

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ABSTRACT
Gonadotropin-releasing hormone (GnRH) antagonists have been a breakthrough in reproductive medicine. The third generation antagonists (cetrorelix and ganirelix) do not have histamine releasing capability in the used doses. The competitive blockade of GnRH receptors by GnRH antagonists leads to an immediate but reversible arrest of gonadotropin secretion. Antagonists can be used as single-dose or multiple dose protocol in a fixed or flexible approach during ovarian stimulation to prevent premature luteinizing hormone surge. The stimulation remains close to the normal cycle, and more convenient and friendly to the patient with lesser dose and duration of stimulation. Recent Cochrane analysis suggests that there is no significant difference in the live birth rate when antagonists are compared with agonists (OR 0.86) and there is a significant reduction in the incidence of ovarian hyperstimulation syndrome (OHSS) (OR 0.43) with the use of antagonists. Gonadotropin-releasing hormone antagonists are of special benefit for use in patients with polycystic ovaries where agonist trigger can be used and OHSS can be prevented completely. Gonadotropin-releasing hormone antagonists have particular advantage in poor responders with lesser pituitary suppression in the early part of cycle. Gonadotropin-releasing hormone antagonists can be used in modified natural cycle, intrauterine insemination cycles, and frozen embryo transfer cycles. Novel uses of antagonists include suppression of established OHSS, and in various gynecological conditions (endometriosis, fibroids, precocious puberty).

Keywords: Antagonist, In vitro fertilization, OHSS, Poor responder.

INTRODUCTION
Though the first successful human in vitro fertilization (IVF) was a natural cycle IVF, soon there was a switch over to ovarian stimulation to enhance the number of oocytes, embryos and ultimately the pregnancy rates. Before the advent of gonadotropin-releasing hormone (GnRH) analogs, premature luteinizing hormone (LH) surges occurred in 20 to 50% of stimulated cycles leading to high cycle cancellation rates or poor cycle outcomes. The use of GnRH agonists to prevent LH surges in the early 1980s was a breakthrough in assisted reproduction which allowed the clinician to take control of the stimulated cycles and allowed more flexibility in scheduling oocyte retrieval.

The GnRH antagonists, though being available at that time, could not gain popularity due to their histamine-releasing capability and associated systemic edema. However, the development of third-generation GnRH antagonists has revolutionized the field of reproductive medicine.

STRUCTURE
Amino acids at positions 1, 2, 3, 6 and 10 play important roles in the structure and function of native GnRH molecule (decapeptide). Amino acid at position 6 is involved in enzymatic cleavage. Positions 2 and 3 are important in gonadotropin release and positions 1, 6 and 10 are important for the three-dimensional structure of the molecule. In GnRH agonists, there are important changes at positions 6 and 10 only. However, there are more complex changes in GnRH antagonists. Histidine (His) at position 2 and tryptophan (Trp) at position 3 are replaced and D-amino acids are substituted at position 6 by neutral D-ureidoalkyl amino acids. With these modifications, third-generation antagonists were developed, of which two are commercially available since 1999: (1) cetrorelix (Cetrotide, Serono International SA, Switzerland); and (2) ganirelix (Orgalutran, Organon, Oss, The Netherlands). These relatively newer drugs, though not so new now, have added a new dimension to the field of assisted reproduction.

MECHANISM OF ACTION
Gonadotropin-releasing hormone antagonists act as competitive blockers for the native GnRH receptors and hence block the ability of native GnRH to initiate dimer formation and signal transduction (release of follicle-stimulating hormone (FSH) and LH from pituitary). In contrast to GnRH agonists, antagonists do not possess any intrinsic activity. However, this concept has been challenged recently.
The competitive blockade of GnRH receptors leads to an immediate but reversible arrest of gonadotropin secretion. Hence, the action of GnRH antagonists is highly dose dependent in sharp contrast to the agonists. Also, since there is no receptor loss, a constant supply of antagonists is required to ensure that all GnRH receptors remain blocked. So, a higher dose of antagonists compared to agonists is required for effective pituitary suppression.

The conventional antagonist protocol starts with ovarian stimulation from day 2 or 3 of a spontaneous menstrual cycle and antagonist is added when there is a threat of LH surge. This permits optimal use of endogenous gonadotropins in the initial part of stimulation without undue suppression of pituitary and at the same time preventing premature LH surge in the mid- or late-follicular phases. Hence, the stimulation remains close to the normal cycle, and more convenient and friendly to the patient with lesser dose and duration of stimulation (and hence lesser cost).

**DOsAGE**

Cetrorelix can be used in two different dosages: 0.25 mg daily dose injections or 3 mg depot single-dose injection (effect lasting up to 96 hours). Cetrorelix was tested initially with a high dose (1 mg); when no LH surge occurred, the dose was decreased to 0.5, 0.25 mg and finally 0.1 mg. However, the minimal effective dose was 0.25 mg. Ganirelix can be used as 0.25 mg daily dose injections only. These dosages represent the minimal effective doses found in dose-finding studies (with doses ranging from 2 to 0.0625 mg) to prevent LH surges. Premature LH surges have been observed when using lesser doses. No adjustments in the dose for obese women are required for cetrorelix. However, tailoring of the dose to body weight may actually be required for ganirelix.

**ANTAGONIST PROTOCOLS**

**Single-dose Protocol**

Only cetrorelix can be used in this protocol (Fig. 1). Ovarian stimulation with gonadotropins is started on days 2 or 3 of menstrual cycle. Cetrorelix is given on day 7 as a fixed protocol (French protocol). A single injection prevents LH surge for 4 days. In case the patient does not get ready for human chorionic gonadotropin (hCG) trigger within this time frame, she is given additional daily doses of 0.25 mg cetrorelix till and including the day of hCG trigger. This protocol is easy to use, well-tolerated with only mild and transient injection site reactions, and ensures patient compliance.

**Multiple-dose Protocol**

Both cetrorelix and ganirelix can be used here (Fig. 2). This is the most commonly used protocol now. Ovarian stimulation with gonadotropins is started on days 2 or 3 of menstrual cycle. In the fixed protocol, GnRH antagonist is started on day 6 of stimulation, and is continued till and including the day of hCG trigger. In the flexible protocol (Ludwig protocol), GnRH antagonist is started once the leading follicle is greater than or equal to 14 mm.

Multiple dose protocol avoids profound LH suppression and associated drop in estradiol levels often seen in single-dose protocol when antagonist is given. Multiple dose protocol is a simple, safe and efficient approach for preventing LH surge.

The fixed protocol remains a simple approach and requires less monitoring of the cycle. On the contrary, the flexible protocol avoids unnecessary injections when risk of LH surge is minimal and hence uses less total antagonist ampoules and less gonadotropins. So, it appears as a more cost-effective approach.

**PHARMACODYNAMICS AND PHARMACOKINETICS**

Plasma concentrations of LH fall by 70% (52-91%) and plasma FSH concentrations by 30% (23-61%) within 6 hours (4-24 hours) of administration of GnRH antagonist. The amount and duration of this suppression are dose dependent. The half-life of cetrorelix, 3 mg single-dose and 0.25 mg daily dose, has been reported to be 62.8 and 20.6 hours respectively. The half-life of ganirelix, 0.25 mg daily dose, has been found to be 16.2 hours. The complete reversal occurs in 24 to 72 hours.
Incidence of Premature Luteinizing Hormone Surge

The incidence of LH surge with antagonists varies between 1 and 35% in various studies.18-21 However, patient’s compliance is very important as there is a risk of premature LH surge even if a single injection is missed. Rupture of follicles may result if the antagonist is delayed particularly if >36 hours from the last injection.

Ovulation Trigger

Timing

There has been quite a variable size range for ovulation trigger in various studies ranging from 17 to 22 mm for one or several follicles. Sometimes estradiol levels have also been defined as the criteria to trigger in the IVF cycle.

A prospective randomized study compared the cycle outcome with different timings of trigger (17 mm follicle or 2 days later).22 A significant improvement in cycle outcome was observed in the early hCG group in terms of improved implantation rates and ongoing pregnancy rates. The underlying mechanism could be improvement in oocyte quality or endometrial receptivity. Delaying hCG for greater than or equal to 2 days after 3 or more follicles of greater than or equal to 17 mm are seen, is associated with significant reduction in pregnancy rates.23

Type of Trigger

Worldwide hCG trigger [urinary human chorionic gonadotropin (uhCG) or recombinant hCG (rhCG)] has been the most commonly used triggers for the final maturation of oocytes. However, ovarian hyperstimulation syndrome (OHSS) continues to be a major concern.

Though the incidence of OHSS is significantly lesser (OR 0.43) in the antagonist cycles as compared to agonist cycles,24 it can still occur. Avoiding hCG and using GnRH agonist (0.2 mg triptorelin) as the final trigger virtually eliminates the development of OHSS (due to short half-life of endogenous LH surge), thereby preventing the associated morbidity and the costs involved in hospitalizations.25 GnRH agonist trigger also acts as a more physiological trigger for oocyte maturation.

But soon after introduction of agonist as the trigger, it was realized to be associated with premature luteolysis. A meta-analysis reported significantly decreased pregnancy rates with the use of GnRH agonist trigger in cases of fresh embryo transfer.26

Griesinger et al proposed cryopreservation of all embryos and replacement in a subsequent frozen-thawed cycle.27 Not only does this ensure better pregnancy rates but also prevents late-onset pregnancy-associated OHSS in fresh cycle.

Hence, GnRH agonist trigger can be used in patients at high risk of OHSS after counseling for lower pregnancy rates or when elective cryopreservation is planned. Also, agonist trigger opens a new window of opportunity for oocyte maturation in donor cycles or when fertility preservation is contemplated.28 This is a unique advantage with antagonist cycles since agonist cannot be used as a trigger in the long protocol.

Luteal Phase Support

Luteal phase support is mandatory in all agonist-treated cycles. Progesterone support is the most commonly used luteal phase support being as effective as hCG injections with lower risk of OHSS.

Initially, it was suggested that luteal support may not be required in antagonist cycles due to its short duration of action and rapid reversibility. However, no pregnancies were reported in a study without luteal support in antagonist cycles.29

It is now widely understood that luteal phase insufficiency is due to supraphysiological levels of sex hormones due to gonadotropin stimulation which by feedback mechanism leads to prolonged pituitary suppression. Hence, luteal phase support is required for endometrial development and maintenance of pregnancy irrespective of the analog used.30

Progesterone continues to be the main component of luteal phase support. Estrogen addition to progesterone does not result in significantly improved pregnancy rates.31

Endocrinological Considerations

Elevated estradiol or progesterone levels at the start of stimulation (e.g. with functional ovarian cyst) have been associated with significantly reduced pregnancy rates.32 One may consider postponing the stimulation cycle until next menstruation.

Occasionally, on the day of starting GnRH antagonist, a fall in estradiol (and LH) may be observed. With the start of antagonist, endogenous FSH drops suddenly and this reduces the total amount of FSH available for growing follicles. However, this fall is not associated with an adverse cycle outcome (number of mature oocytes, embryos, pregnancy rates or implantation rates).33

Elevated progesterone levels on the day of hCG trigger have been associated with significantly reduced pregnancy rates.34 This is due to endometrial effects of progesterone exposure. No pregnancy occurs if endometrial advancement occurs by greater than 3 days.35 In such cases, it is advisable to freeze all embryos and transfer in a subsequent cycle. A recent meta-analysis evaluated this subject and concluded that progesterone elevation on
the day of hCG is associated with a decreased probability of pregnancy in IVF cycles (OR 0.64 and NNH = 10). However, pregnancy rates are not compromised when embryos obtained from cycles with progesterone elevation are transferred to endometria not exposed to progesterone elevation (i.e. in frozen-thawed or in donor/recipient cycles). Evidence for an effect of progesterone elevation on endometrium has been provided directly by endometrial gene expression analysis.

**Safety Profile**

The potential of third-generation antagonists to release histamine is negligible since the dose required to do so is more than 1,000 times the effective plasma concentration.

Since, the advent of antagonists in clinical practice, thousands of infertile patients have been treated with third-generation antagonists without evidence of systemic or major local skin reactions. Common side-effects include minor injection-site reactions, nausea, headache, fatigue and malaise. Local skin reactions seem to occur less frequently with antagonists than GnRH agonists. No significant changes have been noted in serum chemistry or hematological indices. No significant drug interactions have been noted.

**Adverse Effects on Endometrium**

With the discovery of extrapituitary GnRH receptors, the safety of GnRH analogs with respect to ovary, oocyte, embryo and endometrium became a matter of debate. It was hypothesized that GnRH antagonists interact with mitotic programming of cells involved in folliculogenesis, blastomere formation and endometrial development. Follicular growth is unaffected by the dose of GnRH antagonists used but a dose-related decline is seen in the levels of late follicular phase LH, androstenedione and estradiol. GnRH antagonists at high doses may interfere with follicular steroidogenesis. Also, they may decrease the cleavage rate of embryos.

Later impaired endometrial receptivity was suggested as the underlying cause of dose-related reduced implantation rates as cryopreserved embryos from these cycles yielded normal pregnancy rates. This concept, however, was criticized by Mannaerts and Gordan as antagonists do not activate GnRH receptors. They can only block the actions of GnRH or GnRH agonists. Moreover, recent studies have failed to demonstrate any significant difference in ongoing pregnancy rates using GnRH antagonists.

No teratogenic or adverse effects on implantation or embryonic development have been demonstrated in animal studies.

Also, follow-up of children born so far with the use of antagonists is reassuring. The data available demonstrates good safety profile for the antagonists. No increase in malformations or abnormal development has been observed.

**EVIDENCE-BASED PRACTICE**

**GnRH Agonists vs GnRH Antagonists**

The meta-analysis by the Cochrane library in 2001 suggested a significantly lower chance of clinical pregnancy with the use of GnRH antagonists when compared to GnRH agonists. This generated a lot of anxiety among the practitioners regarding the efficacy of GnRH antagonists. However, the meta-analysis was criticized by Griesinger et al for the heterogeneity of the study population as antagonists were primarily used for women with poor pregnancy potential.

The meta-analysis has been updated twice (2006 and 2011). The recent Cochrane analysis suggests that there is no significant difference in the live birth rate when antagonists are compared with agonists (OR 0.86) and there is a significant reduction in the incidence of OHSS (OR 0.43) with the use of antagonists (Table 1).

However, this analysis has been criticized by Orvieto et al who maintain that GnRH agonists still have demonstrable superiority over antagonists in terms of ongoing pregnancy rates and live birth rates.

The reduction in the rate of OHSS can be attributed to the lesser number of retrieved oocytes and lower estradiol levels on the day of hCG in antagonist cycles. This may be due to more physiological way of follicular maturation in antagonist protocols with lesser small follicles as compared to GnRH agonist long protocol.

**Table 1: Comparison of gonadotropin-releasing hormone agonists and antagonists**

<table>
<thead>
<tr>
<th>Agonists</th>
<th>Antagonists</th>
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<tbody>
<tr>
<td>Initial flare up</td>
<td>Immediate gonadotropin suppression</td>
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<tr>
<td>Pituitary desensitization</td>
<td>Competitive blockade of GnRH receptors</td>
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<tr>
<td>Slow reversal</td>
<td>Rapid reversal</td>
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<tr>
<td>Longer duration of stimulation</td>
<td>Lesser duration of stimulation</td>
</tr>
<tr>
<td>More ampoules of gonadotropins required</td>
<td>Lesser amount of gonadotropins required</td>
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<tr>
<td>More risk of OHSS</td>
<td>Significantly lesser risk of OHSS</td>
</tr>
<tr>
<td>Only hCG or rLH as trigger</td>
<td>GnRH agonist, hCG or rLH as trigger</td>
</tr>
<tr>
<td>More estrogen deprivation symptoms</td>
<td>Lesser estrogen deprivation symptoms</td>
</tr>
<tr>
<td>Gold standard in normoresponders</td>
<td>Particularly advantageous in hyper- and poor-responders</td>
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</table>

Also, follow-up of children born so far with the use of antagonists is reassuring. The data available demonstrates good safety profile for the antagonists. No increase in malformations or abnormal development has been observed.
Single vs Multiple-Dose Protocol
Studies do not reveal any significant difference in the probability of clinical pregnancy between single and daily dose protocol.52,53

Fixed vs Flexible Protocol
The meta-analysis by Al-Inany et al54 did not reveal any significant difference in clinical pregnancy rates between fixed and flexible protocol.

Initiating GnRH antagonists in a fixed manner in a set of patients who have a slower follicular recruitment (PCOS, low responders), would cause a sudden reduction of endogenous gonadotropins secretion before follicular recruitment is reached, which could lead to cycle cancellation.55,56

Ludwig et al57 found that starting the GnRH antagonist in an individualized multiple dose manner, less GnRH antagonist vials were needed, lower recombinant FSH amount was used and a better response was obtained. However, in their study, gonadotropin dosage was increased when the antagonist was started. No conclusion related to pregnancy rate could be drawn due to small number of cases.

But flexible antagonist administration from day 3 onward (when LH was > 10 IU/L, and/or a follicle with mean diameter of > 12 mm was present, and/or serum E2 was > 150 pg/ml) did not reduce the incidence of LH rises compared with fixed antagonist administration on day 6 of stimulation.58

Escudero et al59 stated that starting GnRH antagonists in a flexible manner does not seem to improve cycle outcome except the use of one less antagonist vial when compared to fixed day regimen in young patient (≤ 35 years), with normal cycle length and normal basal hormonal profile. However, a trend toward less pregnancy rates was observed in flexible protocol, especially when GnRH antagonist was started beyond day 6 of stimulation, which is not associated with the occurrence of premature LH surge.60,61 It may be the inherent quality of oocytes that the follicles do not attain size of greater than or equal to 14 mm or estradiol production of greater than or equal to 400 pg/ml even by 8th day of stimulation. Nevertheless tailoring should not be started too late. It has been proposed to start GnRH antagonists with smaller follicles (day 5 of stimulation) to achieve optimal results.62

ORAL CONTRACEPTIVE PILL
PREPROGRAMMING
The use of oral contraceptive (OC) pill added several advantages in the GnRH agonist long protocol:
• Programming the cycle for batch-IVF
• Avoidance of cyst formation before starting gonadotropins
• Ensuring timely menstrual bleeding in oligomenorrhea or amenorrhea
• Suppression of high basal LH levels in polycystic ovarian syndrome (PCOS) (considered to have deleterious effects on oocyte and endometrium).

The stimulation in agonist cycles can be started when downregulation is confirmed (at the onset of menses or can be postponed if required). However, stimulation in antagonist cycles depends on the onset of menstruation alone.

The programming of IVF cycles is required to avoid oocyte retrievals on Sundays and in cases of batch-IVF. However, the number of days for stimulation is not fixed in both agonist and antagonist cycles. In antagonist cycle, programming can be done by starting stimulation from day 3 (instead of day 2) or by delaying hCG administration by 1 day if required.63

According to a recent meta-analysis, use of OC pill for programming antagonist IVF cycles is associated with a decreased probability of ongoing pregnancy. It is also associated with increased duration of stimulation and the amount of gonadotropins required.64

INCREASING THE DOSE OF GONADOTROPINS WITH ANTAGONIST
Pregnancy rates do not appear to increase by using a higher dose of FSH (200 IU or 225 IU) than the standard (150 IU) for a typical patient.65,66

Also, increasing the FSH dose at initiation of GnRH antagonists does not result in a significant increase in pregnancy rates when compared to continuing with the same FSH dose.67,68

SPECIAL SUBGROUPS
Hyperresponders
This group of patients (e.g. PCOS) is at a significant risk for OHSS, an iatrogenic life-threatening complication of ovarian stimulation. Overwhelming data from randomized controlled trials (RCTs) suggests that antagonists significantly reduce the risk of moderate and severe OHSS by about 50%.46,69 Failure to use GnRH antagonist protocol in high-risk patients for OHSS may be regarded as clinically negligent.

The reduction in the risk of OHSS with antagonists can be attributed to decrease in the total number of follicles developed (in particular smaller follicles) and the lesser estradiol levels on the day of hCG; both of which have significant association with development of OHSS. Moreover, GnRH antagonist protocol allows us to use
GnRH agonist as the final trigger for oocyte maturation (which is not possible in agonist cycles), providing a practically zero incidence of OHSS with the avoidance of hCG as endogenous LH has a much shorter half-life than hCG. Elective cryopreservation of embryos with subsequent transfer in a frozen-thawed cycle yields good pregnancy rates while avoiding OHSS totally (as there is no endogenous hCG-related OHSS resulting from pregnancy in a stimulation cycle). This makes antagonist protocol more patient-friendly employing lesser gonadotropin doses and avoiding the morbidity associated with OHSS.

POOR RESPONDERS

Since, GnRH antagonists are administered late in the follicular phase to prevent LH surge, profound pituitary suppression in the early part of cycle is prevented. This maximizes the potential of endogenous pituitary stimulation and allows obtaining a more natural follicular recruitment. Hence, this remains a viable alternative in poor responders.

Evidence states that GnRH antagonist protocol is as effective as the long agonist protocol in poor responders, while decreasing the duration of stimulation and the amount of gonadotropins. Clinical pregnancy rates and live birth rates appear to be similar.

The baseline FSH levels are known to fluctuate widely in poor responders. An unaltered, up-to-date baseline FSH level may be obtained during the actual cycle of stimulation when using antagonist protocol (in contrast to long protocol where this cannot be done due to pituitary desensitization). Hence, we can choose a treatment cycle when baseline FSH level is low which represents healthier and larger cohort of recruitable follicles in that cycle. This can decrease cycle cancellation rates and increase pregnancy rates in this group of patients.

Using premenstrual GnRH antagonists (single-dose of cetrorelix 3 mg on day 25 in the luteal phase of previous cycle) reduces diameters and size disparities of early antral follicles, possibly through the prevention of luteal FSH elevation and follicular development.

When compared with microdose flare protocol, most studies reveal similar implantation and clinical pregnancy rates in poor responder group of patients.

A combination of microflare and GnRH antagonist protocol has also been described for poor responders (Orvieto et al). This regime combines the stimulatory benefits of GnRH agonist on endogenous FSH release with simultaneous inhibition of LH surge with antagonist. Triptorelin [0.1 mg subcutaneously (SC)] is given from the 1st day of menstrual cycle for 3 days, followed by high-dose gonadotropins which are initiated from 3rd day. Cetrorelix (0.25 mg/day) is started on daily basis once the lead follicle attains a size of 14 mm and/or estradiol levels exceed 400 pg/ml. A reasonable clinical pregnancy rate has been reported in poor responder group of patients (14.3%).

However, a recent meta-analysis concluded that 'there is insufficient evidence to support the routine use of any particular intervention either for pituitary downregulation, ovarian stimulation, or adjuvant therapy in the management of poor responders.'

ALTERNATIVE GnRH-ANTAGONIST PROTOCOLS

Modified Natural Cycle in vitro Fertilization

Modified natural cycle (MNC) IVF is applied when exogenous hormones or any drugs are used when IVF is being performed during a spontaneous cycle with the aim of collecting a naturally selected single oocyte but with reduction in chances of cycle cancellation. This includes:

- Use of hCG to induce final oocyte maturation. Luteal phase support may or may not be administered.
- Use of GnRH antagonists to block the spontaneous LH surge with or without FSH or human menopausal gonadotropin (hMG) as add-back therapy. An hCG injection and luteal phase support are given.

This protocol was introduced by Paulson et al in 1994 reduces rate of premature ovulation (frequently observed in natural cycle IVF) and improves follicular growth dynamics with gonadotropins.

Several studies have compared the cycle outcomes of MNC with the conventional GnRH antagonist protocol and have reported mixed results. An RCT concluded that MNC provides comparable pregnancy rates with lower doses and shorter duration of gonadotropins and hence can be a safe, patient friendly and cost-effective option in poor responders.

Mild Stimulation Protocol

Clomiphene citrate is given from day 3 to 7 of a spontaneous cycle and gonadotropins are started either subsequently or in an overlapping fashion. GnRH antagonist is administered daily starting from day 6 of stimulation. This protocol provides an acceptable pregnancy rate but premature LH surges can occur. Hence, this protocol can be a valuable alternative in good responders, especially who are at high risk of OHSS and those who do not wish to have supernumerary oocytes or embryos for cryopreservation.
Antagonists from Day 1

GnRH antagonists were licensed to inhibit premature LH surge which is considered unlikely before day 6 of stimulation or in the absence of significant follicular development. However, LH levels remain unsuppressed during the early follicular phase and enhance E2 production.29 High exposure to LH and E2 in the early follicular phase of GnRH antagonist cycles has been related to a worse reproductive outcome, e.g., in patients with PCOS.80 Hence, administration of GnRH antagonists from day 1 of stimulation has been attempted with good cycle outcomes.81 However, large scale randomized studies are needed to substantiate this evidence.

Corifollitropin-α Protocol

This long-acting gonadotropin (FSH-carboxy terminal peptide) can initiate and sustain follicular growth for 1 week, so a single-dose can replace the first seven daily injections of FSH in controlled ovarian stimulation (COS). The first live birth from FSH-C-terminal peptide (CTP) cycle was reported in 2003, and has been approved now for use in Europe in combination with GnRH antagonists.

However, the higher incidence of OHSS and the fact that tailoring according to patient’s responses cannot be done remains a matter of concern. Therefore, careful patient selection is required before starting this protocol.52

Reinitiation in established Severe Ovarian Hyperstimulation Syndrome

There are few case reports on the use of GnRH antagonists in the management of severe OHSS in patients treated with long protocol. The women diagnosed with early-onset severe OHSS after oocyte retrieval were given antagonist for 2 to 7 days in different studies and it was found that the progression of OHSS was inhibited. There was a marked decrease in hematocrit, white blood cell (WBC) count, ascitic fluid, estradiol, progesterone levels and ovarian volume suggesting a luteolytic effect of GnRH antagonists which prevented progression.82 Even live births with concomitant use of GnRH antagonists for a week along with embryo transfer in cases of severe OHSS have been reported without any pregnancy-associated OHSS. However, more data is needed on safety of such interventions.83

Frozen Embryo Transfer

GnRH antagonists (instead of agonists) can also be used to prepare recipients for embryo transfer in frozen-thawed cycles or egg donation cycles. Comparable clinical outcomes in terms of implantation rates, clinical pregnancy rates and delivery rates have been obtained suggesting that antagonists do not adversely affect implantation. On the other hand, using antagonists improves patient’s satisfaction by decreasing the number of injections as compared to downregulated cycles using GnRH agonists.84

Antagonists in Intrauterine Insemination Cycles

Antagonists can be used in intrauterine insemination (IUI) cycles to prevent premature LH surge and also to program the timing of IUI. Some studies have reported higher pregnancy rates with this protocol.85 Gomez-Palomares et al86 concluded that adding GnRH antagonist to controlled ovarian stimulation-IUI cycles significantly increases pregnancy rates in multifollicular, but not monofollicular cycles. A meta-analysis on the use of GnRH antagonist in superovulated (with FSH) IUI cycles concluded that allowing for follicle growth and avoiding premature LH rise, increased pregnancy rates were observed with GnRH antagonist administration. A parallel trend for increased multiple pregnancy rates was observed in the antagonist group, though it did not reach statistical significance. The number needed to treat to prevent one additional LH rise was four and to achieve one additional clinical pregnancy was 19.87 Considering the high NNT for additional pregnancy, use of FSH for superovulation in antagonist IUI cycles, higher multiple pregnancy rates and additional cost of antagonist injections, the routine use of antagonists in IUI cycles cannot be justified at present.

OTHER USES OF ANTAGONISTS

By virtue of GnRH receptor blocking property (and hence suppression of gonadotropin secretion), GnRH antagonists hold promise in various gynecological conditions, e.g. endometriosis, fibroids, PCOS, central precocious puberty, dysfunctional uterine bleeding and hormone-dependent gynecological and breast cancers. GnRH antagonists are currently also being tried for male contraception, benign prostatic hypertrophy and prostatic carcinoma.

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