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Review Article

Anaesthesia considerations for assisted reproductive technology: a focused review ☆

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ABSTRACT

The global burden of infertility is significant and the evidence suggests it is increasing in prevalence worldwide. Assisted reproductive technologies (ARTs) are fertility related treatments used to achieve pregnancy which involve the manipulation of both oocytes and sperm. The specialty is rapidly growing and anaesthesia may be required for several stages in the ART cycle. Anaesthesiologists should appreciate the processes involved and how anaesthesia care can influence safe and effective treatment outcomes. In this review article we explain the key steps of the ART cycle and the role of anaesthesiologists in this process. We also highlight key patient considerations, the implications of remote site anaesthesia and the safety concerns with provision of sedation by non-anaesthesiologists. Finally we outline a typical anaesthetic technique used in our institution for transvaginal oocyte retrieval.

Introduction

Infertility, as defined by the World Health Organisation (WHO) is the failure to establish a clinical pregnancy after 12 months of regular, unprotected sexual intercourse.[1] Assisted reproductive technologies (ART) involves the manipulation of sperm and oocytes to achieve pregnancy. Since the birth of Louise Brown in 1978, the use of ART has grown significantly from approximately 140,000 in 1991 to over 3.2 million in 2018 with the highest use of ART in China, Japan and the United States.[2] The estimated total number of ART cycles performed globally since 1978 is approximately 60 million cycles resulting in approximately 10 million infants.[3] Anaesthesia may be required for several stages in the ART cycle and optimized anaesthetic care can promote safe and effective treatment outcomes (Fig. 1).

Infertility causes and work-up

Causes of infertility multifactorial and can involve the female and male reproductive systems. Ovulatory disorders represent 23% of cases, tubal factors 18%, uterine or peritoneal disorders 9%, male factors including testicular, genetic and hormonal disorders 27% and unexplained infertility account for 23% of cases.[4] In approximately 40% of cases, it is thought that infertility is due to a combined male and female disorder.[4]

Following referral to a fertility clinic basic investigations will be performed which usually include ovarian reserve testing (anti-mullerian hormone (AMH)) and a pelvic ultrasound (assessing for pelvic pathology and antral follicle count) for the female and a semen analysis for the male. Further work-up for infertility may also include assessment of tubal patency of the fallopian tubes via either imaging (hysterosalpingo contrast sonography or hysterosalpingogram) or a surgical laparoscopy and dye procedure. Some women may also require a hysteroscopy to assess for uterine or endometrial pathology such as polyps or fibroids.

Treatment of infertility

The management of infertility will depend on the underlying cause. Many women referred to an infertility clinic will proceed to undergo ART following investigation. The two most common forms of ART

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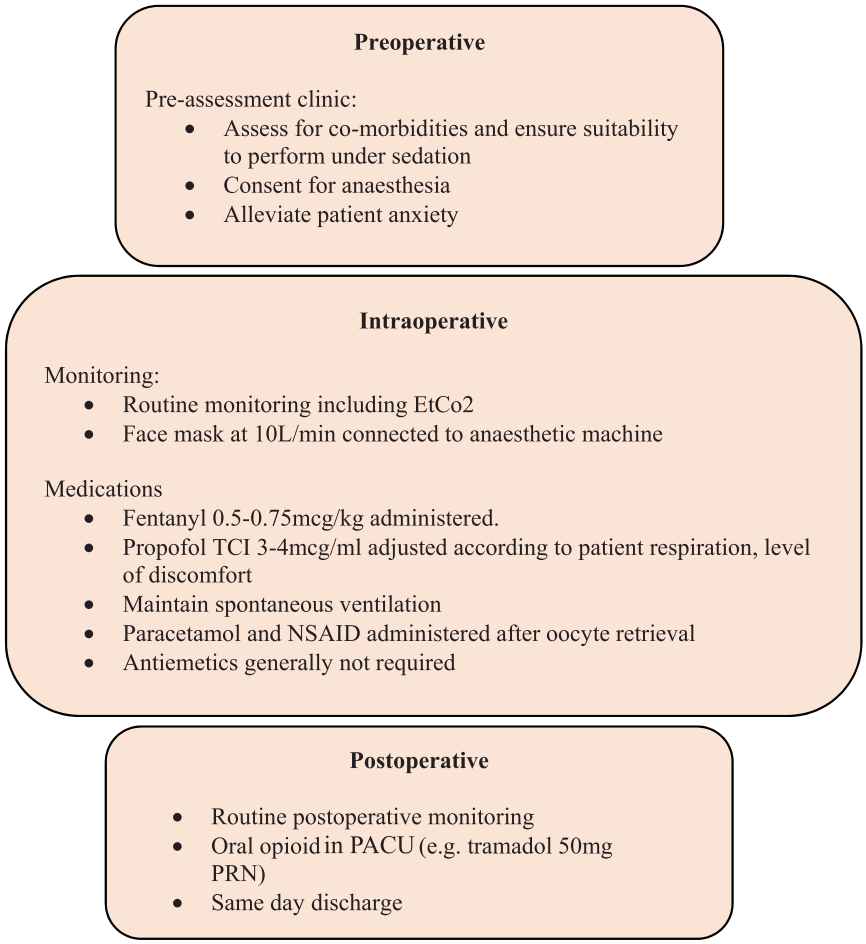

Fig. 1. Typical anaesthetic technique for oocyte retrieval under deep sedation. Figure Legend: ETCo2 − end tidal carbon dioxide. L/min- litres per minute. mcg/kg- micrograms per kilogram. mcg/ml- micrograms per millilitre. NSAID − non-steroidal anti-inflammatory drug. PRN – Pro re nata. PACU – postoperative care unit. TCI - target-controlled infusion.

are in-vitro fertilisation (IVF) and intracytoplasmic sperm injection (ICSI). Both methods involve oocyte retrieval (OCR). IVF involves fertilisation of oocytes in a laboratory following collection of oocytes and sperm from the couple. ICSI involves direct injection of the sperm into the oocyte. ICSI is commonly used for male factor related infertility but also in other circumstances including following unsuccessful IVF.

The assisted reproductive technology cycle

An ART cycle involves several steps including hormonal ovarian stimulation, OCR, sperm retrieval, fertilisation and embryo transfer. A similar regime is also used for oocyte or embryo vitrification in patients wishing to undergo fertility preservation. Vitrification involves rapidly freezing oocytes or embryos instantly solidifying them into a glass like structure without the formation of ice crystals allowing the specimens to be stored indefinitely. This process does decrease their viability compared to fresh specimens however outcomes are significantly better that the traditional slow freezing approach.

Ovarian stimulation

The aim of ovarian stimulation is to achieve a controlled ovarian multi-follicular growth by optimising the number of oocytes retrieved while maintaining patient safety. Stimulation regimes for OCR involve pituitary suppression, ovarian stimulation and ultimately ovulation trigger. Commonly used pituitary suppression regimes involve gonadotropin hormone-releasing hormone.

(GnRH) agonists or GnRH antagonists. This is followed by follicular stimulation with gonadotrophins. The dose of gonadotrophins must be carefully considered on an individual basis in order to optimise the number of oocytes retrieved while minimising the risk of ovarian hyperstimulation syndrome (OHSS). Finally, ovulation trigger, commonly with human chorionic gonadotropin (hCG) or a GnRH agonist in cases with increased risk of OHSS, leads to oocyte maturation through the resumption of meiosis allowing for OCR prior to ovulation. Ovarian stimulation regimes vary based on individual characteristics such as diagnosis, ovarian reserve, age and previous cycle outcomes. Overall however, a typical cycle of ovarian stimulation lasts somewhere between 8–13 days.

Oocyte retrieval

OCR is considered a minor surgical procedure which is performed 36 hour following trigger administration for the retrieval of mature oocytes from the ovaries.[5] In the early days of IVF, OCR was performed via laparoscopy.[5] However, this method was revised following initial reports on ultrasound guided OCR in the 1980′s.[6] Ultrasound guided biopsy was initially performed transvesically then transabdominally and ultimately transvaginally.[5] The use of ultrasound for OCR leads to shorter procedure times with less complications and reduced need for general anaesthesia. At present, transvaginal ultrasound guided

OCR is considered the most effective and least invasive method. Transabdominal ultrasound-guided follicular aspiration or laparoscopic approaches to OCR are only performed in cases where transvaginal access to the ovaries is restricted or contraindicated.[7]

Transvaginal OCR is performed with the patient in the lithotomy or semi-lithotomy position using a high frequency (5–8 MHz) transvaginal ultrasound transducer. Following puncture of the vaginal wall, the needle is guided along a biopsy line and follicles over 10 mm are punctured and aspirated. The embryologist then proceeds to assess the follicular fluid for the presence of an oocyte. Further follicles are then punctured and aspirated without re-puncture of the vaginal wall where possible.

Surgical sperm retrieval

Surgical sperm retrieval (SSR) is an invasive method to overcome mainly obstructive azoospermia in infertile men and it is used in combination with IVF and ICSI. The main aims of SSR are to safely retrieve sperm for immediate use or for cryopreservation with minimal damage to testicular tissue. Various different methods exist for SSR. These include percutaneous epididymal sperm aspiration (PESA), testicular sperm aspiration (TESA), testicular sperm extraction (TESE) and microsurgical epididymal sperm aspiration (MESA). PESA and TESA are percutaneous approaches to SSR, which are reported to yield less sperm, but are usually quicker, require less instruments and therefore more common.[8] PESA is performed by needle aspiration from the head of the epididymis. TESA on the other hand is performed by needle aspiration of the testis, and yields less amounts of tissue with higher failure rates.[9] Similar to OCR procedures, an embryologist is required to examine the tissue samples immediately following aspiration.

TESE and MESA are both considered open methods of SSR and generally have an increased sperm yield than PESA and TESA.[10] These methods can be used sequentially if percutaneous approaches have failed. Generally, a hemiscrotal incision is used in the side which is felt to contain the most healthy tissue. MicroTESE is a similar procedure with use of a microscope in order to limit the tissue sample required. MESA is reported to yield the highest clinical pregnancy rates however requires delivery of the testis and use of microscopy following incision to the tunica vaginalis.[8] An epididymotomy is then performed and sperm retrieved with epididymal fluid.

Anaesthesia for assisted reproductive technology procedures

Anaesthesia is generally required for transvaginal OCR as it is painful and stressful for patients.[11] Ensuring adequate patient comfort facilitates the process of follicular puncture and decreases the risk of inadvertent trauma to adjacent organs or major vessels.[12] Anaesthesia is also required for SSR and laparoscopic OCR, although typically not for embryo transfer. Various anaesthesia techniques are practiced worldwide including general or regional anaesthesia, sedation, patient controlled analgesia and alternative therapies such as acupuncture and transcutaneous electrical nerve stimulation (TENS). There is no consensus on the optimum method of anaesthesia and pain management for these procedures, with much depending on institutional set-up and the availability of an anaesthesiologist.[13] Features of an ideal anaesthetic technique are contained in Table 1.

Studies investigating the effects of anaesthesia techniques and drugs on fertilisation, implantation and pregnancy rates in addition to OCR parameters had various endpoints, presented conflicting results and were often of poor quality.[14,15] Several studies demonstrated the accumulation of anaesthetic agents in follicular fluid during OCR procedures[16] but this did not impact fertility outcomes.[17–19] Other studies have shown detrimental effects of certain anaesthetic approaches[20–24] but this this was not reproduced in subsequent studies.[25,26] We agree with other authors that there is insufficient evidence to recommend avoiding a particular anaesthetic technique but avoiding excessive dosing and minimising duration of anaesthesia is desirable. A summary of available literature is discussed below and contained in supplementary table 1.

Table 1
Features of the Ideal Anaesthesia Technique for ART Procedures

Ideal Anaesthetic Technique
• Alleviates significant patient anxiety • Provides effective analgesia • Well tolerated with minimum side effects • Minimises patient movement during procedure • No effects on oocyte, fertilisation, early embryo development and pregnancy rate • Suitable for day case surgery

There are several other anaesthetic considerations which apply to providing anaesthesia for patients undergoing fertility treatments.

Patient anxiety

Patients undergoing fertility treatments are frequently anxious. The stigma that can be associated with fertility treatment, the risk of failure and the financial cost involved can lead to significant levels of emotional and psychological stress.[12] In addition, certain patient groups may be more at risk including oocyte donors and the transgender population.[27]

Another vulnerable group are those with a new diagnosis of cancer many of whom have not yet started or fully completed their families. Cryopreservation of oocytes or embryos can be offered to these patients prior to oncological surgery and/or chemoradiotherapy. The need for fertility preservation should be weighed against the morbidity and mortality associated with the cancer diagnosis. Generally only a single attempt at OCR is possible so that cancer treatment is not delayed. There is a temptation therefore to recover the maximum number of oocytes using high-dose stimulation, which poses a risk of OHSS.[28] Other risks include theoretic stimulation of oestrogen-sensitive cancers and a risk of thromboembolic phenomena.[28]

Patient co-morbidity

Advanced maternal age is common among women undergoing ART treatment.[12] This can be a challenge for the anaesthesiologist due to in the increased likelihood of co-existing illnesses and concurrent medications. Both are important considerations in terms of provision of anaesthesia and fertility outcomes.

Genital tuberculosis (TB) is an important cause of female infertility worldwide. Genital TB is a common form of extrapulmonary TB (EPTB) and accounts for 9% of all EPTB.[29] Most patients are asymptomatic and are commonly diagnosed when undergoing fertility investigations.[29] A more common cause of infertility seen in Ireland are patients with cystic fibrosis (CF). CF is a multisystem disorder of the respiratory, hepatobiliary, gastrointestinal and musculoskeletal system. Ninety-eight per cent of men with CF suffer from congenital bilateral absence of the vas deferens.[30] Women have abnormally viscid cervical secretions, which impairs passage of sperm but can have successful pregnancies with IVF.[30] Patients with CF require careful preoperative assessment and optimisation prior to surgery, which may require consultation with other specialties of the multidisciplinary team.

A significant proportion of the women presenting to fertility clinics are obese. There is an increased risk of miscarriage in overweight and obese women after spontaneous conception, ovulation induction, IVF and oocyte donation.[31,32] Reduced success rates in ART have also been reported due to altered ovarian responsiveness and diminished oocyte

quality.[33] Although there is no international consensus on upper limits of body mass index (BMI) prior to undergoing ART, in the United Kingdom (UK), the BMI threshold is usually set at 30–35 kg/m^2 for access to publicly funded treatment.[34] Obesity negatively affects most bodily systems leading to diabetes mellitus, coronary artery disease, obstructive sleep apnoea, non-alcoholic fatty liver disease, cognitive dysfunction and increased risk of cancer.[33] Further challenges for the anaesthesiologist as regards obese patients includes management of the potential difficult airway, difficulties with IV access, challenges with patient positioning and dosing of anaesthetic agents.

Pelvic pathologies

OCR can be more challenging in patients with a history of underlying pelvic pathologies such as pelvic surgery, adhesions, endometriosis, polycystic ovary syndrome (PCOS), pelvic inflammatory disease or dermoid cysts. Antibiotics are usually recommended before the procedure in this cohort of patients due to increased risk of infection.[35] Access to the ovaries and OCR can be more challenging for the operator in these cases making the procedure longer or more painful and thus these patients may benefit from deeper sedation or general anaesthesia.

Ovarian hyperstimulation syndrome (OHSS)

OHSS is a complication of ART and exogenous gonadotrophins. It is characterised by increased capillary permeability and fluid retention leading to abdominal distension, nausea and vomiting.[36] In severe cases, the massive extravascular exudation can cause ascites, pleural and pericardial effusion, electrolyte imbalances, hypercoagulability and rarely multi-organ failure and death.[37,38] The exact cause and development of OHSS is not completely understood however certain risk factors have been identified, including younger age, PCOS, multiple follicles, retrieval of more than 20 oocytes, higher doses of exogenous gonadotropins, high serum E2 levels, conception and previous history of OHSS.[39] Management of OHSS is supportive and based on the severity of the clinical presentation. With the increasing use of ART this syndrome may be seen more frequently with some patients requiring admission to intensive care.

Remote site anaesthesia

Assisted reproductive technology procedures are frequently performed in stand-alone fertility clinics or in unfamiliar parts of the hospital away from operating theatres. This is necessary to reduce specimen travel time and allow for immediate analysis in the embryology lab. There are increased risk of adverse effects occurring when preforming anaesthesia or sedation in such settings.[40] This is due to the lack of medical, surgical and anaesthesia back-up, the unfamiliar environment, necessary equipment and drugs not being readily available,[41] and the lack of suitably trained anaesthesia assistants. Morbidity and mortality rates are higher in such circumstances where care is provided by non-anaesthesiologists.[42] Furthermore the presence of a consultant anaesthesiologists has contributed to the decrease in death and disability caused by perioperative events.[43].

Although many cases are performed under sedation, the preoperative assessment and preparation should always include the possibility of conversion to general anaesthesia. Underlying medical problems and previous anaesthesia history must be detailed preoperatively, as certain conditions may preclude the procedure from taking place remotely. Each site should have its own guidelines for the perioperative management of high-risk patients (e.g., high BMI and obstructive sleep apnoea).

Similar to any procedure occurring remotely from the operating room, ensuring all equipment and drugs are available is key, including resuscitative drugs. Contingencies should be made in the event of an emergency or adverse outcome, including a plan for transferring patients to a higher acuity care location or facility for treatment.

Anaesthetic techniques

Sedation

OCR can be performed safely under sedation. Levels of sedation can be classified under the American Society of Anaesthesiologists Continuum of Depth of Sedation ranging from minimal sedation (anxiolysis) to moderate sedation (conscious sedation, responds purposefully to verbal commands) to deep sedation (depression of consciousness but respond to painful stimulation) and ultimately general anaesthesia (loss of consciousness, not rousable).[44] Conscious sedation is used for OCR in 84% of IVF clinics in the UK and 95% of the IVF clinics in the USA.[11] It is preferred by many due to reduced recovery times and side effect profile compared to general anaesthesia.[24] It is our experience that when given the choice, many women prefer deeper levels of sedation compared to conscious sedation. A suggested anaesthetic technique for oocyte retrieval under deep sedation is shown in Fig. 1. The presence of an anaesthesiologist on-site allows the level of sedation to be tailored according to patient preference. Special caution needs to be taken in administration of deeper sedation to obese patients and those with underlying cardiovascular and/or respiration conditions.

Because the terminology is confusing even among healthcare providers, patients should be informed preoperatively if they are likely to be awake or remember part of the procedure. Conscious sedation is often explained to patients as a 'light sedation sleep,' but it often involves loss of consciousness (i.e., deep sedation or general anaesthesia). The distinction between deep sedation and general anesthesia is often unclear; deep sedation may be referred to when patients are unresponsive to verbal or painful stimuli but maintain ventilation independently or with minimal support. However, this may, in fact, be general anesthesia.

Studies suggested improved fertility outcomes with conscious sedation compared to general anaesthesia specifically with the use of remifentanil[25] but others have failed to show this benefit.[25,45] A Cochrane review from 2013 compared various conscious sedation methods and analgesic approaches for pain relief following OCR procedures, with insufficient evidence to recommend one technique over another regarding pain control and pregnancy outcomes, although combining conscious sedation with regional block may provide better pain relief[A1].[46] Finally, several studies have shown safe use of opioids on fertility outcomes when used as part of general anaesthesia or for sedation.[20,25,47–50]

Provision of sedation by non-anaesthesiologists requires careful consideration and can be associated with increased morbidity and mortality.[51] There are increased reports of propofol being used as a sedative agent by non-anaesthesiologists, which are of particular concern.[52] Recommendations have been published recently, including the need for formal training for all those involved in the administration of sedation.[53]

General anaesthesia (total intravenous anaesthesia or inhalational anaesthesia)

General anaesthesia provides the optimum surgical condition for transvaginal OCR. Aspiration of the follicular fluid is easier as the uterus is relaxed and there is no patient movement.[12] Immobilization significantly reduces the risk of accidental damage to nearby structures and increases patient comfort and ultimately successful OCR. General anesthesia requires an anaesthesiologist and a hospital-based environment, thus cannot be provided by many stand-alone fertility clinics.

General anaesthesia has been associated with prolonged recovery time and increased incidence of nausea and vomiting. Total intravenous anaesthesia (TIVA) has shown less nausea and vomiting, reduced requirement for anti-emetic medications and a lower probability of unplanned admission to hospital after day-case IVF procedures compared to inhalational anaesthesia.[54] It is our preference that when general anaesthesia is required or preferred that is provided by means of TIVA with propofol and a short acting opioid such as fentanyl. In such cases the airway can be maintained with a simple facemask or Laryngeal Mask Airway (LMA). We would recommend the use of an elevation pillow, high flow humidified nasal oxygen and/or oral airways in patients with high BMIs or obstructive sleep apnoea. Where laparoscopic OCR is required in cases where transvaginal access is not possible, general anaesthesia with intubation and muscle relaxation will be required.

Propofol accumulates in follicular fluid in a manner dependent of the amount administered and duration of administration, although these findings are not strongly associated with toxicity.[14,18] A number of studies have been carried out to examine its impact on reproductive outcomes.[14,18,24,55–59] Some studies suggest a negative influence but many of these are animal studies[57,58,60] or present conflicting results.[25] There are several studies suggesting it can be used safely for IVF procedures.[18,25,26,45] Thiopental has also been used for IVF procedures and its effects seem similar to that of propofol, however the improved pharmacokinetic profile of propofol limits thiopental use.[56] Ketamine has been studied as both an anaesthetic and sedative agent for use in OCR with conflicting results on its effect on fertility outcomes.[59,61] Inhalation agents have been used primarily for laparoscopic OCR with some evidence of improved fertilisation rates compared to intravenous agents. The rate of embryo development was similar between inhalation and intravenous groups but the sevoflurane group had a lower percentage of good embryos.[24]

Peripheral nerve blockade paracervical or pre ovarian block

Paracervical block (PCB) has been shown to be effective providing good analgesia for OCR procedures.[62,63] With PCBs local anaesthetic is usually deposited in four locations around the cervix in the vaginal mucosa. Bupivacaine or lidocaine can be used. Pain relief may be greater when PCBs are used in addition to sedation, as compared with sedation alone.[46] The local anaesthetic used can pass in to follicular fluid although this does not appear to effect pregnancy outcomes.[19] Use of PCBs does not increase the treatment success compared to general anaesthesia.[26,45]

A newer technique, called pre ovarian block (POB) involves infiltration of local anaesthesia under ultrasound guidance between the vaginal wall and the peritoneal surface near the ovary. The follicle aspiration needle is then inserted in the same location as the deposited lidocaine. The POB technique has been found to be easy to perform particularly in those with high BMI and produce good analgesia. A prospective randomised multicentre trial in 2006 reported no differences in overall pain experienced during OCR procedure with POB compared to PCB.[63]

Patient controlled analgesia (PCA)

PCA with short acting opioids including fentanyl and alfentanil have previously been used in motivated and co-operative patients. Its use is associated with high satisfaction scores, although it may be associated with inadequate analgesia during the procedure.[64] Remifentanil PCA with diclofenac has been shown to provide superior analgesic effect for OCR compared to midazolam and pethidine and is associated with reduced sedation.[65]

Alternative therapies: Acupuncture and transcutaneous electrical nerve stimulation (TENS)

Acupuncture, electroacupuncture and TENS have been used either alone or in combination with other techniques such as regional anaesthesia and conscious sedation.[66] Acupuncture stimulates endogenous opioid pathways increasing beta-endorphin levels and may also have antidepressant, anxiolytic and sympatho-inhibitory actions.[67] It is generally not recommended as a method of pain relief for OCR but could be an option for women requesting non pharmacological techniques.

Neuraxial anaesthesia

Both spinal and epidural anaesthesia have been used for transvaginal OCR. The sub arachnoid block is preferred over epidural due to lower failure rates, faster recovery rates along with decreased follicular concentration of the anaesthetic agents.[12] Enhanced fertilisation rates have been shown with neuraxial anaesthesia compared to general anaesthesia[21–23] although this has not been replicated elsewhere.[68] Challenges with the use of spinal anaesthesia include delayed return of motor and sensory function, which may delay discharge. Use of short acting local anaesthetic agents such as 2% prilocaine may be preferable when spinal anaesthetic is required.[69]

Other pharmacological considerations

Postoperative pain management and hormonal influences

Common first line analgesic medications such as paracetamol and NSAIDs have been investigated for their effects on fertility outcomes and there use is likely safe.[70–72] Prostaglandins are responsible for a localised inflammatory response and uterine contractions during embryo transfer, inhibiting successful embryo implantation. For this reason NSAIDs are considered as a possible way to mitigate this response and improve ART outcomes, although a recent Cochrane review failed to demonstrate a benefit.[72] Interestingly from a male perspective, paracetamol when used in high doses appears to affect the quality and morphology of sperm and hence fertilizing ability.[73] It is believed this is due to reduced testosterone synthesis, inducing oxidative stress, provoking apoptosis of spermatocytes, reducing nitric oxide production and inhibiting prostaglandin synthesis however more robust research is needed to confirm these effects.

A number of studies have investigated the effects of gonadal hormones on pain processing. The relative concentration of oestrogen compared to progesterone could regulate response to nociception.[74] This may be of particular relevance to patients undergoing infertility treatment where serum oestrogen levels rise from low to supraphysiologic concentrations. Indeed pain post OCR procedures may be predicted by peak oestrogen levels, in addition to baseline AMH and ovarian hyperstimulation syndrome.[75] Also patients with a history of endometriosis, prior abdominal surgery and more oocytes retrieved require more analgesics post procedure. While pain is often underappreciated,[75] it is our experience and that of others that patients rarely require an opioid prescription post procedure.[76]

Elevated oestrogen levels may also be on relevance for anaesthetic agent dosing with one study showing a significant positive correlation between serum oestrogen and Propofol dose ($r = 0.28, P = 0.008$) although Propofol requirements for those with high and low oestrogen concentrations seems to remain the same.[77]

Prolactin levels

Anaesthesia has previously been associated with a rise in prolactin levels, which can impair maturation of ovarian follicles and function of the corpus luteum. Bromocriptine, a dopamine agonist, has been used

to suppress the rise in prolactin which has shown positive effects on the development of the embryos.[78] Interestingly the antiemetics droperidol and metoclopramide are both associated with a rapid rise in serum prolactin levels, which adversely affects fertility success.[79] Lower prolactin levels during the ART process were associated with an increased incidence of pregnancy.[80] Ondansetron does not affect prolactin levels and is used by many for ART procedures.

Nitrous oxide

Nitrous oxide reduces methionine synthetase activity affecting (deoxyribonucleic acid) DNA synthesis. Exposure to extremely high dose nitrous oxide for 24 h or to low concentrations throughout the duration of pregnancy revealed an increased incidence of early foetal wastage and visceral and skeletal abnormalities in animal models.[81] These effects have only been seen in animal models under experimental conditions of extremely high nitrous oxide exposure over a long duration. Its use during OCR has failed to demonstrate clear effects on fertility outcomes, [91] with many studies examining its effect in combination with other agents.[23,82] While there may not be enough evidence to preclude its use in ART procedures anaesthesiologists may consider avoiding it for environmental reasons.

Conclusion

There is no robust evidence to suggest that anaesthesia affects fertility outcomes, and the choice of the anaesthetic technique for ART procedures should be tailored to the individual and the procedure itself. Transvaginal OCR and SSR procedures can be performed under conscious sedation, but many patients will benefit from deeper levels of sedation or general anaesthesia. Intravenous anesthesia with propofol and a short-acting opioid for conscious or deep sedation, as well as general anesthesia, offers several advantages for these ambulatory procedures.

CRediT authorship contribution statement

M. Egan: Writing – original draft. **L. Schaler:** Writing – original draft. **D. Crosby:** Writing – review & editing. **R. ffrench-O'Carroll:** Writing – review & editing.

Appendix A. Supplementary material

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