

## The parturient in the interventional radiology suite: New frontier in obstetric anaesthesia

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### ABSTRACT

The anaesthesiologist's presence during interventional radiology (IR) is increasing due to increasingly ill patients and intricate procedures. The management of a parturient in IR suite is complex in terms of logistics of an unfamiliar procedure in an unfamiliar area. The literature available is largely written by radiologists with little attention paid to anaesthetic details and considerations. In the Indian scenario, in the absence of hybrid operating rooms (ORs), logistics involve transport of a parturient back and forth between the IR suite and the OR. As members of a multidisciplinary team, anaesthesiologists should utilise their expertise in fluid management, transfusion therapy and critical care to prevent and treat catastrophic events that may accompany severe peri-partum bleeding. Ensuring familiarity with the variety of IR procedures and the peri-procedure requirements can help the anaesthesiologist provide optimum care in the IR suite.

**Key words:** Hybrid, interventional radiology, parturient paresis, post-partum haemorrhage, radiation exposure

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### INTRODUCTION

Haemorrhage is the major contributor (25%–30%) to maternal mortality worldwide.<sup>[1]</sup> With recent medical advances, interventional radiology (IR) plays an increasingly important role in the management of peri-partum haemorrhage occurring due to placenta accreta or post-partum haemorrhage (PPH). The rise in the incidence of caesarean sections has led to a rise in major obstetric haemorrhage due to placenta accreta<sup>[2]</sup> which has increased 10-fold in the past 50 years. The American College of Obstetricians and Gynecologists quotes a rate of 0.005% of all deliveries.<sup>[3]</sup>

The incidence of placenta accreta was 1 in 533 pregnancies from the period of 1982–2002.<sup>[4]</sup>

Ninety per cent of accretae will have a PPH, with 50% having a peri-partum hysterectomy.<sup>[3,5]</sup>

Prophylactic intra-arterial catheters are inserted electively in the internal iliac arteries which facilitate balloon occlusion and embolism in the event of uterine haemorrhage. This is a recognised and conservative

approach, by which peri-partum hysterectomy is avoided and fertility is preserved. A similar approach is used in the control of PPH.

IR for obstetrics is not universally available. A survey in the United Kingdom by Webster *et al.* (72% response rate) demonstrated that only 31% of responding units had experience of IR in the management of obstetric haemorrhage. Regarding emergency IR access, only 29% of units had 24 h availability of a specialised vascular radiologist.<sup>[6]</sup> Data from other countries are limited. Data from India are lacking though a number of institutes are now utilising interventional services where available. Literature on the anaesthetic management of obstetric patients

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in the IR suite is available but limited. However, the available literature describing IR procedures is largely written by radiologists, with little attention paid to anaesthetic considerations.

## CHALLENGES

### The parturient

Physiology during pregnancy and the developing foetus command different management as to selection of medication. The presence of ionising radiation makes management more challenging.

Preferentially, a left uterine displacement (LUD) is used to minimise compression of the inferior vena cava and aorta by the gravid uterus.

Electrocautery, if needed, requires careful planning so that the patient pad and the cautery are not positioned across the uterus for the fear of conducting electricity through the amniotic fluid.

Supplemental oxygen should be administered to the mother to maintain oxygenation and reduce foetal stress. Foetal monitoring should be performed immediately before and after the procedure. Where appropriate, such as in high-risk pregnancy and when deep sedation or analgesia are used, continuous foetal monitoring may be employed during the procedure.<sup>[7,8]</sup>

### THE INTERVENTIONAL RADIOLOGY SUITE: AWAY FROM CONVENTIONAL OPERATION ROOM

Key factors whilst evaluating areas away from the conventional operating room (OR) are adequacy of monitoring, staffing, equipment and emergency response. Sufficient anaesthesia support including specialised rapid response in case of emergency, recovery facilities and medical gases must be available to ensure that conditions are equivalent to those within the conventional OR.

Modern IR suites should have one room built to OR standards which includes laminar air flow, mandatory air exchanges, a positive in-suite pressure with respect to the surrounding rooms and corridors and appropriate flooring.<sup>[9]</sup> The IR table must accommodate versatile positioning, in particular, head down tilt for emergencies. A wedge is needed for pregnant patients.

In emergency situations, control of PPH usually involves transfer of the post-natal woman to the IR suite for the insertion of catheters.

In the elective situation, the location of the caesarean section after the procedure remains a subject of debate. If catheters are placed in the obstetric theatre, then an IR compatible table is necessary, but the radiological imaging quality through a C-arm is inferior. If catheters are placed electively in the radiology suite with subsequent transfer of the woman to obstetric theatre for the caesarean section, then there is a risk of sheath and catheter displacement during transport.

For each discipline involved, there will be a learning curve regarding operating out of their 'comfort zone'. A 'dry run' is advisable before embarking on the first couple of IR procedures to highlight logistic difficulties.

### ROLE OF ANAESTHESIOLOGIST IN OBSTETRIC HAEMORRHAGE

The involvement of anaesthesiologist before the delivery of patient is of fundamental importance [Table 1].<sup>[10,11]</sup> Bonnar describes a five-step management which involves organisation of a multidisciplinary team, the restoration of blood volume, correction of coagulopathy, evaluation of response to treatment and finally, treating the underlying cause of bleeding.<sup>[12]</sup>

A pre-anaesthetic evaluation is essential to recognise the patients with risk factors and prepare accordingly. Investigations requiring special attention are haemoglobin levels, coagulation studies, blood grouping and cross matching. Availability of whole blood and blood products has to be confirmed. Intravascular depletion should be assessed. The extent of bleeding is almost always underestimated in obstetric haemorrhage.

**Table 1: Important anaesthetic considerations for a parturient in Interventional Radiology Suite**

Physiological changes during pregnancy
Developing foetus
Familiarity with IR suite
Left uterine displacement
Caution with electrocautery
Fluid management and blood products transfusion
Monitoring: Maternal, intrauterine foetal and neonatal
Radiation exposure
Contrast agents
Counselling the parturient
Transport between obstetric theatre and IR suite
Choice of anaesthesia: regional or general
Multidisciplinary approach: Obstetrician, anaesthesiologist, neonatologist, interventional radiologist

Fluid therapy is guided by continual assessment of maternal vital signs, urine output, haemoglobin and acid-base balance. Facilities should be available in the IR suite for maternal and neonatal resuscitation as well as volume resuscitation. The cornerstones of resuscitation in peri-partum haemorrhage are restoration of both volume and oxygen carrying capacity. The clinical picture is the main determinant for the need of blood transfusion. The nature of fluid infused is of less importance than rapid administration and warming of the infusion.

Equal attention should be given to rebound hypercoagulation and thromboembolism that follows blood transfusion, especially in pregnancy which is a hypercoagulable state by itself. This can be prevented by usage of graduated compression stockings and pharmacological thromboprophylaxis.

There is a constant threat to the foetus in obstetric haemorrhage as the uteroplacental circulation is at risk because of compensatory selective vasoconstriction, and uterine blood flow reduces with reduction in maternal blood pressure due to absent autoregulatory capacity.

Foetal resuscitation can be achieved by maintaining the uteroplacental circulation. Maternal resuscitation is of paramount importance.

Monitoring foetal well-being is done using electronic foetal heart monitor. Guidelines advocate use of foetal scalp pH, foetal scalp lactate and foetal pulse oximetry to determine the adequacy of foetal circulation.

## **RADIATION EXPOSURE IN PARTURIENT**

Effects of ionising radiation on foetal development are well-described. At 1–2 weeks of age, when fertilisation and uterine implantation are occurring, exposure above 50 mGy may lead to a loss of pregnancy. By 2–15 weeks, organ formation begins and teratogenicity, microcephaly and mental retardation may occur in doses of above 100 mGy. Any form of genetic mutation may occur from 2 to 40 weeks where the risk of cancer is 0.06% per 10 mGy exposure.<sup>[13]</sup>

The National Council on Radiation Protection and Measurements states that radiation exposure <50 mGy to the foetus is considered negligible in comparison with baseline risks for all development abnormalities, but the risk increases significantly when exposure exceeds 150 mGy.<sup>[14]</sup>

Fluoroscopically guided procedures in the pelvis can deliver doses above 100 mGy and may place the foetus at risk for teratogenicity if exposed during first trimester of pregnancy.<sup>[15]</sup>

The two main types of radiation effects are deterministic and stochastic.

Deterministic effects are determined by the dose above a certain threshold; the severity of the detrimental effects is dose dependent. Examples of foetal deterministic effects include spontaneous abortion and teratogenicity depending on the gestational age during which exposure takes place.<sup>[16]</sup> The most important prenatal risk and deterministic effects occur at 8–15 weeks post-conception when the sensitive cortical cells of the developing brain are exposed to radiation greater than the threshold of 300 mGy. This may result in a decrease of the baby's intelligence quotient and mental retardation. Patients at term do not have this risk.

Stochastic effects originate from damage to single cells, enough to cause mutation but preserving the ability to divide.<sup>[17]</sup> Carcinogenesis (leukaemia) is an example. There is no safe level of radiation exposure below which stochastic effect is eliminated. Such a cancer risk has been determined to be around 5%–15% per Gy in some series, without a defined dose threshold.<sup>[18]</sup> It is associated with exposure of the foetus in later trimesters.

In the absence of definitive data about the health effects of radiation doses delivered by specific diagnostic imaging protocols, the National Council on Radiation Protection has advised that exposure be kept As Low As Reasonably Achievable (ALARA), widely referred to as the ALARA principle.<sup>[15]</sup>

Ultrasound should be used for guidance of interventional procedures whenever possible.

Methods for reducing foetal radiation exposure should include placement of lead aprons between the patient and the table.<sup>[19]</sup> Use of lead shielding for non-pelvic procedures does not provide significant protection but may impart a positive psychological effect on the patient. Other methods include minimising fluoroscopy time, use of magnification only when necessary, performing pulsed fluoroscopy at the lowest pulse rate that provides sufficient image quality, maximising the distance between the X-ray source

and the receptor, minimising the distance between the patient and the receptor, using collimators, reducing the tube current, removing the grid, reducing the number of cinematic acquisitions and avoiding real-time computed tomography (CT) fluoroscopy.

### USE OF CONTRAST AGENTS

Iodinated contrast (Category B) does not appear to be teratogenic.

Direct large dose contrast injection into the amniotic sac has resulted in hypothyroidism of the newborn (not seen with intravenous [IV] injection in pregnant patient) and no teratogenicity is seen in animal pregnancies. Avoiding use of iodinated contrast in first trimester is recommended. The American College of Radiology (ACR) recommends the use only when necessary and with informed consent from the patient.<sup>[20]</sup>

Diatrizoate meglumine and diatrizoate meglumine sodium fall into Category C and are to be avoided.

IV Gadolinium (Category C) crosses the placenta and in large and frequent doses has been teratogenic in animal studies. The ACR recommends avoiding use of gadolinium during pregnancy unless it is critical and only after full discussion and with informed consent from the patient.

### PSYCHOLOGY AND COUNSELLING BEFORE INTERVENTIONAL RADIOLOGY PROCEDURE

Benefits, risks and alternatives of the procedure, the use of sedatives and analgesics and other medications and potential radiation exposure should be discussed thoroughly to obtain an informed and written consent.

The use of radiation in pregnant woman is associated with a high level of anxiety. There should be no deficiency in the anaesthesiologist's knowledge when counselling a pregnant woman about the risks of radiation exposure in pregnancy. It is necessary to balance the benefits of such procedures with an accurate assessment of risk. Obstetric haemorrhage being an emergency, quick decision-making is required by the patient and her family. The anaesthesiologist should develop a quick rapport with the patient and her family, allay their anxiety and fear, solve their queries and provide reassurance. All these can be done during the pre-anaesthetic assessment. An overall

picture should be provided to them in a short time and explaining them the need of the hour and why the procedure can be life-saving for both the mother and the foetus.

### TRANSPORT BETWEEN OBSTETRIC THEATRE AND INTERVENTIONAL RADIOLOGY SUITE

Placenta accreta or percreta is diagnosed prenatally; it is ideally to be reviewed by a multidisciplinary team before the scheduled delivery. Specialists from obstetrics, neonatology, anaesthesiology, haematology and IR should be in attendance to discuss the clinical scenario, logistics and treatment plan.

Prophylactic peri-operative balloon occlusion and caesarean delivery are performed in ideal situations in a hybrid OR, which contains equipment and staff that can accommodate both endovascular and surgical procedures. However, this is possible only in the modern IR suite of very few institutions which are equipped at handling such obstetric emergencies.<sup>[21]</sup>

A hybrid OR serves the medical needs of different highly specialised disciplines.<sup>[22]</sup> It integrates interventional techniques for cardiovascular procedures and allows operations in the field of orthopaedic surgery, neurosurgery and maxillofacial surgery. The integration of all steps such as planning, documentation and the procedure itself saves time and precious resources. The best available imaging devices and user interfaces reduce the need for extensive personnel in the OR and facilitate new minimally invasive procedures. The immediate possibility of post-operative control images in CT-like quality enables the surgeon to react to the problems during the same procedure without the need for later revision.

Transport of the parturient between the IR suite and the obstetric theatre is required where facilities of hybrid OR do not exist and this is pertinent to Indian scenario.<sup>[23]</sup> The patient may be transferred by attending anaesthesiologist from IR suite to theatre for caesarean section. Care should be taken while shifting the patient as there is always a risk of arterial sheath displacement. Arterial sheath displacement can lead to haemorrhage which can worsen the patient's already compromised condition.

The LUD position should be maintained during transport by placing a wedge under the right buttock,

this can make transport of patient and care of the sheath difficult.

## CHOICE OF ANAESTHESIA

Knowledge of the procedure to be performed, its length, likely complications and intra-operative and post-procedure requirements will influence anaesthetic choice.<sup>[24]</sup>

Regional anaesthesia (RA) has a number of advantages over general anaesthesia (GA) in obstetrics, including reduced aspiration risk, better post-operative pain control, improved maternal birth experience and decreased foetal exposure to the depressant effects of GA. RA has been associated with decreased blood loss and decreased need for transfusion in major obstetric haemorrhage.

An epidural technique facilitates placement of internal iliac artery occlusion balloon catheters that can take 45 min. An epidural as opposed to a single-shot spinal is chosen to reduce initial sympathectomy and to allow redosing if the operation is prolonged.

A combined spinal/epidural technique is preferred by some as these procedures can be lengthy and outlast a spinal, especially if a hysterectomy is performed.<sup>[25]</sup>

Placement of epidural catheter before balloon catheter is strongly recommended. If the balloon catheter is placed before the epidural catheter, then hip flexion while positioning the patient for epidural placement may dislodge the balloon, occluding the artery and possibly leading to thrombosis. Since small amounts of heparin are sometimes used during balloon catheter placement, it is preferable to have the epidural catheter in place before heparin use and in the unfortunate event of foetal distress, vessel rupture or other obstetric emergency, the previously placed epidural catheter allows rapid augmentation of the anaesthesia for emergency surgery.<sup>[26]</sup>

For the purists, one might argue that RA is contraindicated in any case where there is potential for haemorrhage, and in many case reports, there is a high conversion rate to GA. An Australian and New Zealand multidisciplinary panel review describes GA as providing optimal surgical conditions.<sup>[26,27]</sup>

GA for caesarean section after balloon catheter placement under local anaesthesia should be used

from the outset in cases of placenta accreta to allow greater control. The added advantage of having an unconscious patient is, it permits easier communication between the specialities at crisis times, removes the possibility of having to convert to GA in a patient with a sympathetic block of RA and should a coagulopathy develop, there is no anxiety about the removal of the epidural catheter.

The use of invasive monitoring is indicated in these cases as is cell salvage, warming and rapid infusor devices and near-patient testing as blood loss is often so rapid and high volume that laboratory results are 'out-of-date' by the time they are obtained.

Eventually, choice of anaesthesia is at the discretion of the anaesthesiologist on the day.

## CONCLUSION

In the Indian scenario, IR suite is almost always remote from the operation theatres and can be challenging for the anaesthetic team as well as the obstetricians and neonatologists. Good communication is paramount to successful outcome, and protocols and checklists are useful when working in environments outside normal practice. A multidisciplinary approach with a team consisting of obstetrician, anaesthesiologist, interventional radiologist, neonatologist and haematologist is imperative for management of this spectrum of patients.

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