SECOND EDITION

Analgesia, Anaesthesia and Pregnancy

A PRACTICAL GUIDE

Edited by
Steve Yentis
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Analgesia, Anaesthesia and Pregnancy

A practical guide

A thoroughly updated edition of this well-established practical guide to obstetric analgesia and anaesthesia. All aspects of obstetric medicine relevant to the anaesthetist are covered, from conception, throughout pregnancy, to after-birth care.

The emphasis is on pre-empting problems and maximising quality of care. The authors have identified over 150 potential complications each covered in two sections: issues raised and management options, with key points extracted into boxes for quick reference. A section on organisational aspects such as record keeping, training, protocols and guidelines makes this an important resource for any labour ward or hospital dealing with pregnant women. Presented in a clear, structured format, this book will be invaluable to trainee anaesthetists at all levels and to experienced anaesthetists who encounter obstetric patients. Obstetricians, neonatologists, midwives, nurses and operating department practitioners wishing to extend or update their knowledge will also find it highly beneficial.

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From reviews of the First Edition:

'This is a book that openly professes to be a ''short practical text'' – and it has achieved its objective very successfully indeed. Clearly set out with discrete well-organized chapters, the text is easy to read and presents a comprehensive overview of a difficult field in a ''user-friendly'' form.'

European Journal of Anaesthesiology

'The diversity of topics and their limited analysis makes it easy to read the text quickly and pick up key points. At the end of each topic is a bullet point synopsis... It is these characteristics of the book that create the practical approach... The book... is certain to be popular given its broad authorship and succinct style.'

British Journal of Anaesthesia

‘The authors have succeeded in producing an excellent book in a style that sets it apart from, and possibly above, recent similar publications . . . . The book achieves its aim of targeting anaesthetists in training at all levels, and would provide a useful handbook for both the experienced and the occasional consultant obstetric anaesthetist.’

International Journal of Obstetric Anesthesia

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Preface

There are now many large and authoritative texts on obstetric anaesthesia and analgesia available to the anaesthetic trainee. With reduced time available for obstetric anaesthetic training, we feel there is a need for a shorter, more practically based text, suitable for both the trainee starting in the maternity suite and the more experienced trainee preparing for anaesthetic examinations. Similarly, such a book may be of use to anaesthetists involved in teaching obstetric anaesthesia. In addition, obstetric anaesthetists of all grades are increasingly involved in the management of sick obstetric patients, and few manuals or handbooks bridge the gap between routine obstetric anaesthesia and analgesia and this challenging area of practice. Finally, the boundaries between obstetric anaesthesia and anaesthesia for certain gynaecological procedures are becoming increasingly blurred as women present for anaesthesia (or anaesthetic advice) before pregnancy as well as throughout pregnancy itself.

We hope this book fulfils these needs and provides useful, practical information and advice to obstetric anaesthetists. Whilst aimed primarily at trainees, we hope it will also be useful to more senior anaesthetists as a ready guide to be supplemented by larger and more comprehensive texts. Other specialties and disciplines are also involved in the care of pregnant women, and they too may find the book helpful. Indeed, we wish to stress the importance of a team approach to maternity care, particularly in the care of complex cases.

We have assumed basic anaesthetic knowledge and thus do not include topics such as anaesthetic equipment and drugs, etc. except where there are areas of specific obstetric relevance. We have tried to base the advice given on our own practice, supported by evidence wherever possible, although we accept that opinions differ amongst obstetric anaesthetists (including amongst ourselves!). Despite this, we hope that we have presented a consistent guide to anaesthesia and analgesia in pregnancy.

We hope the layout of the book is easy to follow and the difficulties we have had classifying some of the topics are not too apparent. There will inevitably be some repetition but we believe this is not necessarily a bad thing.

We have tried to provide a brief list of pertinent further reading where possible; often this has meant that very large topics have been left relatively

unreferenced since there are few journal reviews broad enough in scope. The standard, more comprehensive texts, of which there are several excellent examples, would be good starting points for more comprehensive lists of references.

Section 1 – Preconception and Conception

1 ASSISTED CONCEPTION

There have been rapid developments in the treatment of infertility. The anaesthetist may be involved in many aspects of the patient's treatment, which may be complex. The harvesting of oocytes needs to take place within a defined period of time, or ovulation will have occurred and oocytes will be lost. Couples presenting for infertility treatment are generally anxious and often the women are emotional at the time of oocyte retrieval. It is therefore particularly important for the anaesthetist to understand the couple's anxieties and to be able to explain the effects of the anaesthetic technique that is to be used.

Problems/special considerations

All of the techniques involve extraction of oocytes from the follicles, either laparoscopically or, with the development of transvaginal ultrasonography, via the transvaginal route (ultrasound directed oocyte retrieval, UDOR). The techniques differ in the site of fertilisation and/or replacement of the gamete/zygote:

- *In vitro fertilisation (IVF):* fertilisation occurs in the laboratory and the developing embryo is transferred into the uterus via the cervix, usually 48 hours after oocyte retrieval. Embryo transfer is performed with the patient awake, although there are occasions when the help of the anaesthetist may be required to provide sedation. The success rate is approximately 15–25%.
- *Gamete intrafallopian transfer (GIFT):* the oocytes and sperm are placed together in the Fallopian tube, usually laparoscopically although an ultrasound-guided transvaginal procedure may also be used. The success rate is approximately 35%.
- *Zygote intrafallopian tube transfer (ZIFT):* fertilisation occurs in the laboratory and, before cell division occurs, the zygote is placed in the Fallopian tube as for GIFT. The success rate is approximately 28%.
- *Intracytoplasmic sperm injection (ICSI):* fertilisation occurs in the laboratory via injection of sperm into the oocytes, and the developing embryo is transferred into the uterus as for IVF. This technique is used for male infertility. The success rate is approximately 28%.

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The main considerations for laparoscopy are the type of anaesthesia, the pneumoperitoneum and the effects of the anaesthetic agents on fertilisation and cell cleavage. The length of exposure to the drugs is also important. The effects of nitrous oxide and volatile anaesthetic agents on fertilisation and cleavage rates have been extensively examined. It is generally recognised that all the volatile agents and nitrous oxide have a deleterious effect, although opinion is divided as to the extent of the problem. It is also recognised that the carbon dioxide used for the pneumoperitoneum causes a similar effect, and it is difficult to separate the effects of the anaesthetic agents from those of the carbon dioxide.

Of the intravenous agents, the effect of propofol on fertilisation and cleavage appears to be minimal. Propofol accumulates in the follicular fluid, and the amount in the follicular fluid may become significant if there are a large number of oocytes to retrieve. Propofol decreases the fertilisation rates but there is no significant effect on the cell division rates.

All assisted conception techniques carry the risk of ovarian hyperstimulation (see Chapter 2, Ovarian hyperstimulation, p. 3), and multiple or ectopic pregnancy.

Management options

It would be logical to use regional anaesthesia wherever possible, although this is often not well suited for laparoscopy. The development of the transvaginal route for oocyte retrieval has increased the possibility of using regional anaesthesia.

For patients requiring laparoscopy, it would seem sensible to minimise the use of drugs. This has led to the increased use of propofol as the main agent in total intravenous anaesthesia.

For UDOR, which has become the most common method used for oocyte retrieval, the main anaesthetic techniques are intravenous sedation and regional anaesthesia. It is important to remember that patients requiring UDOR are day cases and the basic principles of day-case anaesthesia apply. There has been a considerable amount of work to date on the use of propofol with alfentanil, and this drug combination would appear to be the technique of choice for intravenous sedation. The propofol may be administered by intermittent boluses or by continuous infusion, with the patient breathing oxygen via a Hudson mask. Many anaesthetists find that they are using levels of sedation close to anaesthesia. It is essential that the sedation is administered in a suitable environment with resuscitation facilities and anaesthetic monitoring. Often the assisted conception unit is some distance from the main theatre suite; therefore it is important for the staff working in an isolated environment to maintain their skills in resuscitation.

The aim of minimising the drugs administered to women undergoing ultrasound-guided techniques has led to the use of regional anaesthesia. The main problem lay in developing techniques that allow the woman to go home the same day. Epidural and spinal anaesthesia have both been used with success, particularly where early ambulation is not essential. The low-dose spinal technique that is used for labour analgesia has been shown to give good operating conditions and to satisfy the

criteria needed for day-case anaesthesia; it may be some way to achieving an ideal in this difficult group of patients.

Post-procedure analgesia may be provided with non-steroidal anti-inflammatory drugs such as diclofenac.

Key points

- Oocyte retrieval may involve laparoscopy requiring general anaesthesia, although intravenous sedation and regional anaesthesia are suitable for transvaginal ultrasound-directed techniques.
- Couples are usually very anxious and require constant reassurance.

FURTHER READING

Tidmarsh MD, May AE. Spinal analgesia for transvaginal oocyte retrieval. *Int J Obstet Anesth* 1998; **7**: 157–60.

Viscomi CM, Hill K, Johnson J, Sites C. Spinal anaesthesia versus sedation for transvaginal oocyte retrieval: reproductive outcome, side effects and recovery profiles. *Int J Obstet Anesth* 1997; **6**: 49–51.

Yasmin E, Dresner M, Balen A. Sedation and anaesthesia for transvaginal oocyte collection: an evaluation of practice in the UK. *Hum Reprod* 2004; **19**: 2942–5.

2 OVARIAN HYPERSTIMULATION SYNDROME

Ovarian hyperstimulation syndrome is associated with the medical stimulation of ovulation necessary for in vitro fertilisation. It occurs 3–8 days after treatment with human chorionic gonadotrophin (hCG), and the effects continue throughout the luteal phase. The active ingredient causing the syndrome via increased capillary permeability is thought to be secreted from the ovaries, and both histamine and prostaglandins have been implicated.

Problems/special considerations

Clinical manifestations of the syndrome are:

- Enlargement of the ovaries
- Pleural effusion
- Ascites.

Additional complications that may occur are:

- Hypovolaemic shock
- Renal failure
- Acute lung injury
- Thromboembolism
- Cerebrovascular disorders.

Table 2.1. Grading of ovarian hyperstimulation syndrome

Grade	Features	Incidence
1	Abdominal distension and discomfort	8–23%
2	Grade 1 plus nausea, vomiting and diarrhoea	
3	Grade 2 plus ascites (detected by ultrasonography)	1–8%
4	Grade 3 plus clinical ascites and shortness of breath	1–1.8%
5	Grade 4 plus clinical hypovolaemia, haemoconcentration, coagulation defects, decreased renal perfusion – therefore urea and electrolyte disturbance, thromboembolic phenomena	

Women undergoing ovarian stimulation who develop ovarian hyperstimulation syndrome can be assessed by placing them in one of five grades according to presenting symptoms and signs (Table 2.1).

Management options

When a large number of eggs (>20) have been retrieved, ovarian hyperstimulation should be suspected and the patient monitored. This may involve hospital admission.

Once suspected, the diagnosis of ovarian hyperstimulation syndrome can be confirmed by:

- A rapid increase in plasma oestradiol concentration
- The presence of multiple ovarian follicles on ultrasound examination
- An increase in body weight.

Immediate treatment is to stop hCG administration and to aspirate the enlarged follicles. Mild forms of ovarian hyperstimulation syndrome will be self-limiting, but those women graded 3 or worse will require intravenous fluids to correct the hypovolaemia and haemoconcentration. The intravenous administration of 1000 ml of human albumin is recommended at the time of oocyte retrieval if hyperstimulation is suspected.

In women graded 4 and 5, dopamine has been given to improve renal perfusion. In addition, it may be advisable to drain the ascitic fluid and to consider anti-coagulation. Ultrafiltration and intravenous reinfusion of ascitic fluid has been used in severe cases.

Monitoring is tailored to the severity of the syndrome, and the following progression is recommended:

- Urea and electrolytes
- Full blood count and packed cell volume
- Plasma/urine osmolality
- Clotting screen
- Chest radiography

- Central venous pressure if large volumes of fluids are needed
- Pulmonary artery catheter if the woman is severely affected.

Key points

- Hyperstimulation comprises ovarian enlargement, pleural effusion and ascites, which may be relentless.
- Severe protein loss may result in shock and renal failure.
- The most severe form occurs in 1–2% of cases treated with human chorionic gonadotrophin.

FURTHER READING

Shanbhag S, Bhattacharya S. Current management of ovarian hyperstimulation syndrome. *Hosp Med* 2002; **63**: 528–32.

Whelan JG 3rd, Vlahos NF. The ovarian hyperstimulation syndrome. *Fertil Steril* 2000; **73**: 883–96.

3 ANAESTHESIA BEFORE CONCEPTION OR CONFIRMATION OF PREGNANCY

Many women will require anaesthesia when they are pregnant and many will be unaware that they are pregnant at the time of the anaesthetic, especially in the first 2–3 months of their pregnancy. The thalidomide catastrophe initiated the licensing arrangements for new drugs and their use in pregnancy; the current cautious stance of the pharmaceutical industry is reflected in the *British National Formulary*'s statement that no drug is safe beyond all doubt in early pregnancy. The anaesthetist should have a clear knowledge of the time scale of the developing fetus in order to balance the risks and benefits of any drug given to the mother. A *teratogen* is a substance that causes structural or functional abnormality in a fetus exposed to that substance.

Problems/special considerations

The possible effect of a drug can be considered against the stage of the developing fetus:

- *Pre-embryonic phase (0–14 days post-conception):* the fertilised egg is transported down the Fallopian tube and implantation occurs at around 7 days post-conception. The conceptus is a ball of undifferentiated dividing cells during this time and the effect of drugs on it appears to be an all-or-none phenomenon. Cell division may be slowed with no lasting effects or the conceptus will die, depending on the severity of the cell damage.
- *Embryonic phase (3–8 weeks post-conception):* differentiation of cells into the organs and tissues occurs during this phase and drugs administered to the

mother may cause considerable harm. The type of abnormality that is produced depends on the exact stage of organ and tissue development when the drug is given.

- *Fetal phase (9 weeks to birth):* at this stage, most organs are fully formed, although the cerebral cortex, cerebellum and urogenital tract are still developing. Drugs administered during this time may affect the growth of the fetus or the functional development within specific organs.

Management options

The anaesthetist should always consider the possibility of pregnancy in any woman of child-bearing age who presents for surgery, whether elective or emergency, and should specifically enquire in such cases. If there is doubt, a pregnancy test should be offered. If pregnancy is suspected, the use of nitrous oxide is now generally considered acceptable, despite its effects on methionine synthase and DNA metabolism, as there is little evidence that it is harmful clinically. Similarly, although the volatile agents have been implicated in impairing embryonic development, clinical evidence is lacking. Some drugs cross the placenta and exert their effect on the fetus, e.g. warfarin, which may cause bleeding in the fetus.

Key points

- The possibility of pregnancy should be considered in any woman of child-bearing age.
- No drug is safe beyond all doubt in pregnancy.

FURTHER READING

Koren G, Pastuszak A, Ito S. Drugs in pregnancy. *N Engl J Med* 1998; **338**: 1128–37.

Section 2 – Pregnancy

I Procedures in early/mid-pregnancy

4 CERVICAL SUTURE (CERCLAGE)

Cervical suture (Shirodkar or McDonald cerclage) is performed to reduce the incidence of spontaneous miscarriage when there is cervical incompetence. Although it can be done before conception or as an emergency during pregnancy, the procedure is usually performed electively at 12–16 weeks' gestation; it generally takes 10–20 minutes and is performed transvaginally on a day-case basis. A non-absorbable stitch or tape is sutured in a purse-string around the cervical neck at the level of the internal os; this requires anaesthesia since the procedure is at best uncomfortable, although the suture can usually be removed easily without undue discomfort (usually at 37–38 weeks' gestation unless in preterm labour); spontaneous labour usually soon follows.

In patients with a grossly disrupted cervix, e.g. following surgery, placement of the suture via an abdominal approach may be required. Delivery is usually by elective Caesarean section in these cases.

Problems/special considerations

Women undergoing cervical suturing may be especially anxious since previous pregnancies have ended in miscarriage. Otherwise anaesthesia is along standard lines, bearing in mind the risks of anaesthesia in the pregnant woman and monitoring of, and possible effects of drugs on, the fetus (see Chapter 7, Incidental surgery in the pregnant patient, p. 12).

Cerclage may be difficult if the membranes are bulging; the head-down position and/or tocolysis may be requested to counter this.

Management options

Many authorities advocate spinal anaesthesia as the technique of choice since only a small amount of a single drug is administered, although epidural anaesthesia is also acceptable. If spinal or epidural anaesthesia is chosen, standard techniques are used. The procedure itself requires a less extensive block than Caesarean section

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(from T8–10 down to and including the sacral roots) and thus smaller doses are required; however, the reduction is offset by the greater requirements at this early stage of pregnancy compared with the term parturient. Thus the doses required for regional anaesthesia are in the order of 75% of those used for Caesarean section. Low-dose techniques have also been used, as for Caesarean section; the women have more sensation (though painless) but have less motor block.

General anaesthesia may also be used; an advantage is the relaxing effect of volatile agents on the uterus, but it does usually involve administration of more than one drug, and the effects on the fetus of many agents in current use are not clear. There may also be an increased risk of regurgitation and aspiration of gastric contents, depending on the gestation and severity of symptoms (see Chapter 56, Aspiration of gastric contents; p. 138).

Paracervical and pudendal block and/or intravenous analgesia/sedation may also be used, but most authorities would recommend avoiding paracervical block because of the potential adverse effects on uteroplacental perfusion.

Key points

- Cervical suture is usually performed at 12–16 weeks' gestation.
- Patients may be especially anxious because of previous miscarriage.
- Standard techniques are used; spinal anaesthesia may be preferable.

FURTHER READING

Drakeley AJ, Roberts D, Alfirevic Z. Cervical stitch (cerclage) for preventing pregnancy loss in women (Cochrane Review). In: *The Cochrane Library*, Issue 4, 2003. Chichester, UK: John Wiley & Sons, Ltd.

5 ECTOPIC PREGNANCY

There are approximately 11 000 ectopic pregnancies per year in the UK (just over 1% of all pregnancies), and the incidence is thought to be increasing as a result of pelvic inflammatory disease. There are many risk factors, with tubal pathology or surgery and use of an intrauterine device the most important; others are infertility, increased maternal age and smoking. About 3–5 women die as a consequence in the UK per year, representing about 3–6% of all direct maternal deaths (~1 per 2500 ectopics). Most ectopic pregnancies occur in the Fallopian tube, but up to 5% occur elsewhere within the genital tract or abdomen. Typically, the tube initially expands to accommodate the growing zygote but when unable to do so any more, there may be bleeding from the site of implantation or even rupture of the tube. Thus the classic presentation is with abdominal pain, which may be sudden in onset, accompanied by a history of amenorrhoea (although there is vaginal bleeding

at presentation in ~80% of cases). There may be sudden collapse if the tube ruptures, caused by reflex vagal activity or hypovolaemia if bleeding is severe, or both.

Problems/special considerations

The main risk of ectopic pregnancy is sudden severe haemorrhage, which may be intra-abdominal and thus concealed until rapid decompensation and collapse occur. A common theme in deaths associated with ectopic pregnancy is the failure to consider the diagnosis before collapse. Ectopic pregnancy may present with non-specific abdominal signs including diarrhoea or constipation, thus mimicking other intra-abdominal conditions (e.g. appendicitis), although with serial measurement of plasma human chorionic gonadotrophin (hCG; doubles every 2–3 days in normal pregnancy) and use of pelvic ultrasonography this should be unusual. The potential severity of the condition is not always appreciated by other hospital staff, the patient herself or her relatives. Ectopics outside the Fallopian tubes are more likely to be associated with massive haemorrhage, with abdominal pregnancies the most hazardous, especially when the placenta is removed.

Most ectopic pregnancies present early in pregnancy and thus many of the physiological changes of pregnancy are absent or mild – the patient may even be unaware that she is pregnant. However, even at this early stage there may be features of the physiological changes of pregnancy.

The implications for the current and future pregnancies pose a great psychological stress on the patient and her partner. There may be a previous history of ectopic pregnancy since its occurrence is itself a risk factor for subsequent ectopics.

Management options

Initial management is directed at treating and preventing massive haemorrhage; thus the patient requires at least one large-bore intravenous cannula and careful observation at least until the diagnosis has been excluded. Similarly, once the decision to operate has been made it needs to occur as soon as possible, since the risk of rupture is always present.

Operative management usually involves laparoscopy unless there is severe haemodynamic instability, in which case laparotomy is performed. Traditionally, laparoscopy was performed purely for diagnostic purposes, but laparoscopic removal of the zygote with or without tubal resection has become routine in many units. Anaesthetic aspects of the procedure itself are as for any laparoscopic operation.

Anaesthetic management is as for any emergency surgery, given the above considerations. Haematological assistance and admission to the intensive care unit should be available if required. In severe cases, anaesthesia must proceed as for a ruptured aortic aneurysm: full preoperative resuscitation may be

impossible and the patient is prepared and draped before induction of anaesthesia, which may be followed by profound hypotension.

In some countries, medical management is increasingly used as the first-line treatment of early ectopic pregnancies, with intramuscular methotrexate. The drug antagonises folic acid and prevents further growth of the trophoblast, which is especially vulnerable at this early stage. Similar outcome to that following surgical management has been claimed. Local injection of hyperosmolar glucose, prostaglandin and potassium chloride have also been used. Finally, expectant management has been used in selected patients, although women whose pregnancies are self-limiting cannot yet be identified reliably.

Key points

- Ectopic pregnancy accounts for 3–6% of all direct maternal deaths in the UK.
- Severe haemorrhage and/or cardiovascular collapse is always a risk.

FURTHER READING

Pisarska MD, Carson SA, Buster JE. Ectopic pregnancy. *Lancet* 1998; **351**: 1115–20.
Tay JI, Moore J, Walker JJ. Ectopic pregnancy. *BMJ* 2000; **320**: 916–19.

6 EVACUATION OF RETAINED PRODUCTS OF CONCEPTION

Evacuation of retained products of conception (ERPC) may be required at any stage of pregnancy, but it occurs most commonly in early pregnancy following incomplete miscarriage or early fetal demise. It is also required during the puerperium following retention of placental tissue (see Chapter 41, Removal of retained placenta, p. 107).

Problems/special considerations

- ERPC following spontaneous abortion at 8 weeks' gestation may be a minor routine gynaecological emergency for the anaesthetist, but the mother may have lost a much-wanted baby.
- The urgency of the procedure varies greatly. The majority of ERPCs are performed as scheduled emergencies in fit young women, and this may lull the inexperienced anaesthetist into a false sense of security. Death may occur from spontaneous abortion; blood loss may be heavy and is frequently underestimated.
- The possibility of coexisting uterine or systemic sepsis must always be considered, especially in postpartum ERPC or in a repeat procedure following incomplete evacuation.

Management options

- Diagnostic ultrasound scanning is frequently used to confirm a non-viable early pregnancy or the presence of retained placental tissue. Transabdominal ultrasonography is facilitated by a full bladder, which is often achieved by asking the mother to drink large volumes of water. Most units now operate a policy of fully assessing mothers on the day of admission in an early pregnancy advisory unit (EPAU), allowing them home and readmitting them the following day for planned ERPC. This facilitates planning of medical and nursing staffing levels, reduces prolonged periods of waiting and starvation for the mother, and can be economically advantageous.
- Medical treatment is increasingly used and this enables women to be allowed home, after treatment with prostaglandin analogues, to await events. Some of these women will need surgical management if the products of conception are not fully expelled.
- Preoperatively, a full assessment is required. Assessment of blood loss may be difficult; fit young women may lose a significant proportion of their blood volume without becoming hypotensive. Tachycardia should alert the anaesthetist to possible hypovolaemia. Signs of sepsis should be sought, and prophylactic antibiotics may be considered.
- General anaesthesia is acceptable although in the absence of uncorrected hypovolaemia or other contraindications, regional anaesthesia is entirely suitable. The puerperal mother in particular may wish to stay awake if offered a choice, and she should be advised to do so if at risk of regurgitation.
- Rapid sequence induction of general anaesthesia is indicated for the non-fasting mother requiring urgent surgery (uncommon) and for the mother who is at risk of regurgitation (see Chapter 56, Aspiration of gastric contents; p. 138). Anaesthesia using a laryngeal mask airway or facemask using any standard day-case anaesthetic technique is appropriate for the majority of women needing ERPC. Sedative premedication is rarely needed. Intravenous anaesthesia e.g. with propofol or inhalational anaesthesia is acceptable, though if the latter is used high concentrations of volatile anaesthetic agents (>1 minimum alveloar concentration) should be avoided because of the uterine relaxation that may ensue.
- Oxytocic drugs may be requested by the surgeon, although there is little evidence for their efficacy at gestations of less than 15 weeks. A single intravenous bolus of 5 U Syntocinon usually suffices. Ergometrine causes increased intracranial and systemic pressure, and nausea and vomiting, and should not be used routinely.
- Spinal anaesthesia produces more rapid and dense anaesthesia than epidural and an anaesthetic level of at least T8 is recommended. Clinical experience shows that the traditionally taught anaesthetic level of T10 is insufficient to prevent pain occurring when the uterine fundus is manipulated or curetted.
- Postoperatively, the aim is rapid recovery and discharge home. Requirement for postoperative analgesia rarely exceeds simple non-opioid drugs. Non-steroidal anti-inflammatory agents may be beneficial in relieving uterine cramps.

Routine administration of antiemetics should be considered since these women are at risk of postoperative nausea and vomiting.

Key points

- A sensitive and sympathetic approach to the mother is necessary.
- Prolonged preoperative waiting and starvation reflect poor communication and inefficiency.

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7 INCIDENTAL SURGERY IN THE PREGNANT PATIENT

Pregnant women may present with the same surgical conditions as the non-pregnant population, or with problems related to their pregnancy. Most pregnant women are relatively young and fit, although there are an increasing number of women with systemic disease who are becoming pregnant because of advances in medical or surgical management of their condition. Points of particular relevance to anaesthetists are therefore any underlying condition in addition to the reason for surgery, the effects of pregnancy on its management and the effect upon the fetus.

Problems/special considerations

- Surgical diagnosis of the acute abdomen may be difficult because of the physical presence of the gravid uterus. Non-specific signs such as white cell count may be unreliable (up to $15\,000 \times 10^6$/l in normal pregnancy). The differential diagnosis may also include obstetric conditions such as placental abruption and HELLP (haemolysis, elevated liver enzymes and low platelets) syndrome. Surgical technique may be hindered by the pregnancy, and the operation itself may be more difficult than in the non-pregnant patient; e.g. laparoscopic procedures may be impossible.
- The risks of aortocaval compression, difficulties with airway management and aspiration of gastric contents are present as for any pregnant woman, and depend to a certain extent on the stage of pregnancy and the reason for surgery (see Chapter 56, Aspiration of gastric contents, p. 138).
- Surgery that normally requires the non-supine position, e.g. back surgery, may pose particular problems.
- Since surgery is generally withheld during pregnancy unless absolutely necessary, patients who do present for surgery tend to be more severely affected; thus careful

preoperative assessment and management are especially important. Problems of emergency surgery include inadequate preparation and investigation and an increased incidence of vomiting and dehydration.

- The fetus is at risk from the primary effects of the mother's illness (e.g. dehydration, sepsis), the possible teratogenic effects of any drugs that are given to the mother, especially during the first trimester (see Chapter 3, Anaesthesia before conception or confirmation of pregnancy, p. 5), alterations in uteroplacental blood flow or oxygenation during anaesthesia and surgery, and possible premature onset of labour provoked by the illness, drugs or surgery itself.

Management options

In general, surgery is delayed until the second trimester if possible, because the major fetal organs will have already developed; in addition, the risk of premature labour is lower and the surgery easier than in the third trimester.

Perioperative management requires attendance by senior surgical and obstetric staff, with investigations and scans as required.

Anaesthetic management includes preoperative assessment of the airway and antacid pretreatment. The supine position should be avoided at all times, although the efficacy of lateral tilt when the uterus is still small is uncertain. Particular attention should be paid to general assessment as for emergency surgery in any patient. The disadvantages of regional anaesthesia (e.g. hypotension, increased peristalsis, problems with managing the block during difficult or prolonged surgery) must be weighed against those of general anaesthesia (airway problems, risk of awareness, etc.). Although general anaesthesia involves administration of more drugs with possible effects on the fetus, it also allows administration of volatile agents that relax the uterus. In general, drugs with good safety records during pregnancy should be used; most anaesthetic drugs do not have licences for use in pregnancy (mainly because of the costs involved in extending their licences), but newer drugs should probably be avoided until more is known about their actions. The only standard anaesthetic drug that has excited controversy in recent years is nitrous oxide, because of its effects on methionine synthase and DNA metabolism. Although there is a theoretical risk of its affecting the fetus, there is no evidence to support this clinically and many, if not most, authorities would now consider its use acceptable. General anaesthetic management would thus usually consist of rapid sequence induction with standard agents, tracheal intubation and ventilation of the lungs with a volatile agent, as for any emergency general anaesthetic. Other drugs would be used as standard, but those that might increase uterine tone (e.g. ketamine, β-blockers) or vasoconstriction should be avoided if possible. Many obstetricians would request prophylactic administration of tocolytic drugs perioperatively. β-Adrenergic agonists are commonly used for this purpose, although their efficacy in this situation is uncertain and they may cause maternal tachycardia and pulmonary

oedema; recent evidence suggests that calcium-channel blockers such as nifedipine may be at least equally effective with a better safety profile. In general, probably the fewer drugs used overall the better. Certain drugs given near to delivery may cross the placenta and affect the fetus, e.g. non-steroidal anti-inflammatory drugs (which can prevent the ductus arteriosus from closing).

Traditional fears about the detrimental effects of high levels of maternal oxygen by causing uteroplacental vasoconstriction are now known to be unfounded, and fetal arterial partial pressure of oxygen increases (up to a maximum of about 8 kPa (60 mmHg)) as maternal arterial oxygen content increases, so long as maternal hypotension is avoided. Maternal arterial partial pressure of carbon dioxide should be kept in the normal (pregnant) range during controlled ventilation.

The fetus must be monitored preoperatively and postoperatively. Intraoperative monitoring is controversial and may be difficult if the surgery is abdominal; it may be possible to use a sterile sleeve over an ultrasonic/Doppler probe. It may be difficult to arrange appropriate midwifery and surgical nursing care both before and after surgery, and the most appropriate area for the mother's postoperative care needs careful consideration.

Key points

- Surgical diagnosis and management may be difficult.
- Maternal risks are those of anaesthesia in the pregnant state.
- Fetal risks are related to the mother's condition, maternal drugs, and the premature onset of labour.

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8 INTRAUTERINE SURGERY

Fetal surgery is an option in cases where an isolated abnormality would be otherwise fatal to the fetus or neonate, and is clearly amenable to correction, e.g. neck tumours with airway obstruction, sacrococcygeal teratomas, obstructive uropathy and diaphragmatic hernia. However, results of intrauterine surgery have

been conflicting and there is no clear consensus on its place. Simpler measures, e.g. intrauterine blood transfusion in haemolytic disease, are more widely accepted.

Problems/special considerations

Each procedure must be assessed on a risk–benefit basis, since there is a risk of up to 50% fetal loss associated with premature labour, haemorrhage, abruption and infection. For open procedures, vertical uterine incision is required, with Caesarean section to deliver the baby if pregnancy proceeds. Maternal thromboembolism has been reported. Thus each lesion must be carefully defined and a chromosomal abnormality or other malformation excluded. For example, intrauterine placement of intraventricular shunts is no longer considered suitable for treatment of hydrocephalus, since the risk–benefit ratio cannot be calculated for individual fetuses because of the difficulty in predicting outcome antenatally. Since most conditions that might be amenable to intrauterine surgery are rare or uncommon and already associated with poor outcome, it is difficult to demonstrate that outcome after fetal surgery is better than that after conventional postpartum therapy, because any expected improvement will be small.

Surgery is technically difficult because of the small size of the fetus and its mobility when small, but leaving the surgery until later may result in increased end-organ damage caused by the malformation. The optimal timing for most procedures is uncertain, although most open ones have been performed at around 18–24 weeks. Percutaneous procedures, e.g. transfusions, may be performed later or at intervals. The EXIT procedure (ex utero intrapartum therapy), for airway obstruction, is also done later and involves delivery of the fetal head through an open hysterotomy and tracheal intubation or tracheostomy while the fetus is oxygenated by the placenta. The fetus may then be delivered and undergo corrective surgery.

After intrauterine surgery, the mother may be confined to bed and receive β_2-agonists, with the risks of deep vein thrombosis and pulmonary oedema respectively.

Management options

Anaesthetic management is along the lines of that for incidental surgery during pregnancy. Local anaesthetic infiltration of the abdominal wall may be adequate for percutaneous procedures, although there may be a need for emergency Caesarean section if fetal bradycardia occurs, and so adequate preparation and facilities are required for this. Regional anaesthesia is a suitable alternative if extensive percutaneous procedures are required.

Fetal and maternal general anaesthesia for corrective surgery is administered by using standard techniques. Fetal injection of a neuromuscular blocking drug may be required to stop fetal movement. Analgesics may also be injected into the fetus – there is increasing evidence that the fetus can ‘experience’ pain, although

the significance of this is disputed. Uterine relaxation has been achieved by using one or more of volatile agents, magnesium sulphate or glyceryl trinitrate. Fetal monitoring may be difficult but pulse oximetry, ultrasonography and cardiotocography have been used. Bleeding may be excessive in prolonged open procedures.

Key points

- The place of intrauterine surgery is uncertain.
- To be suitable, malformations must be clearly defined, fatal if untreated and amenable to corrective surgery.
- General principles of anaesthesia are as for incidental surgery during pregnancy.

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9 TERMINATION OF PREGNANCY

Termination of pregnancy in the UK is undertaken under the terms and conditions of the Abortion Act 1967. For the consideration of anaesthetic procedures and potential problems, patients presenting for a termination of pregnancy broadly fall into two groups:

1. The presence of a maternal problem, the most commonly stated reason being danger to the mental or physical health of the mother
2. Severe fetal congenital abnormality or early fetal death.

Problems/special considerations

When caring for women who are to undergo a termination of pregnancy, it is important to consider the physiological changes of pregnancy, the psychological state of the woman and the need for routine preoperative assessment of the patient.

Those women in the first group above are usually scheduled to have termination of pregnancy on a gynaecological operating list. The second group of patients are often looked after in the maternity unit.

Some members of staff may express conscientious objection to performing or being involved in termination of pregnancy and this must be respected. They cannot be made to participate in such procedures, although they do have a duty to find other staff who will, if that is the patient's wish.

Management options

Termination for maternal indications

Termination of pregnancy is usually a day-case procedure, and routine preoperative assessment is undertaken immediately preoperatively. Assessment should be conducted sympathetically as these women are often very distressed.

Gestation is usually less than 15 weeks and these women can usually be regarded as non-pregnant with respect to gastric emptying and acid aspiration unless they have symptoms of reflux.

An anaesthetic technique suitable for day-case anaesthesia should be employed, e.g. induction with propofol followed by nitrous oxide/oxygen and maintenance with propofol or a volatile anaesthetic agent. There has been concern about concentrations of volatile anaesthetic agents greater than one minimum alveolar concentration causing uterine relaxation unresponsive to oxytocics. For a termination of pregnancy at less than 15 weeks, standard concentrations of volatile anaesthetic agents do not appear to pose a risk and may be used to maintain anaesthesia. Analgesia may be provided by intravenous fentanyl or alfentanil with rectal diclofenac 100 mg.

The gynaecologist may request that 5–10 U Syntocinon is administered to aid uterine contraction. There is no clear evidence that this is helpful at this stage of pregnancy.

Termination for fetal abnormality or death

Women who present for termination of pregnancy because of fetal abnormality or intrauterine death present a difficult clinical problem. Induction of labour is usually required and this may be a long and tedious process involving the use of prostaglandin pessaries and Syntocinon infusion (see Chapter 71, Intrauterine death, p. 170).

Termination of a pregnancy at less than 28 weeks is often associated with the retention of products of conception, for which surgical evacuation and anaesthesia are required. Either regional or general anaesthesia may be offered to the woman, balancing the risks and benefits of each depending on the clinical condition and whether epidural analgesia is already in place. Rapid sequence induction and tracheal intubation may be appropriate.

Key points

- Women may present for termination of pregnancy because of maternal reasons or fetal abnormality/death.
- Such women are distressed and should be dealt with sympathetically.
- Early termination is usually performed as a day-case general anaesthetic procedure.
- Issues surrounding late terminations are as for intrauterine death.

II Normal pregnancy and delivery

10 ANATOMY OF THE SPINE AND PERIPHERAL NERVES

Although not exclusive to obstetric anaesthesia, a sound knowledge of the anatomy pertinent to epidural and spinal anaesthesia is fundamental to obstetric anaesthetists because of the importance of these techniques in this field. In addition, knowledge of the relevant peripheral nerves is important in order to differentiate central from peripheral causes of neurological impairment.

The structures involved in obstetric neuraxial anaesthesia comprise the vertebrae and sacral canal, vertebral ligaments, epidural space, meninges and spinal cord. The important peripheral aspects are the lumbar and sacral plexi and the muscular and cutaneous supply of the lower part of the body.

Vertebrae (Fig. 10.1)

The vertebral column has two curves, with the cervical and lumbar regions convex anteriorly and the thoracic and sacral regions concave. Traditionally, T4 is described as the most posterior part (most dependent in the supine position), although T8 has been suggested by recent imaging studies. L3–4 is the most anterior part (uppermost in the supine position), although this curve may be flattened by flexing the hips. In the lateral position, the greater width of women's hips compared with their shoulders imparts a downward slope from the caudal end of the vertebral column to the cranial end.

There are seven cervical vertebrae, twelve thoracic, five lumbar, five fused sacral and three to five fused coccygeal. A number of ligaments connect them (see below). Vertebrae have the following components:

- *Body:* this lies anteriorly, with the vertebral arch behind. It is kidney-shaped in the lumbar region. Fibrocartilaginous vertebral discs, accounting for about 25% of the spine's total length, separate the bodies of C2 to L5. Each disc has an outer fibrous annulus fibrosus and a more fluid inner nucleus pulposus (the latter may prolapse through the former: a 'slipped disc'). The bodies of the thoracic vertebrae are heart-shaped and articulate with the ribs via superior and inferior costal facets at their rear. The bodies of the sacral vertebrae are fused to form the

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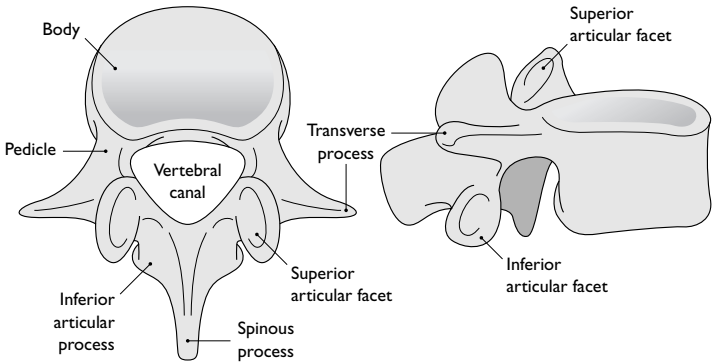

Fig. 10.1 A lumbar vertebra, seen from superior and lateral aspects. Reproduced with permission from Yentis, Hirsch & Smith: Anaesthesia and intensive care A-Z, 2nd edn, Butterworth Heinemann, 2000.

sacrum, which encloses the sacral canal; the coccygeal vertebral bodies are fused to form the triangular coccyx, the base of which articulates with the sacrum.

- *Pedicles:* these are round in cross-section. They project posteriorly from the body and join the laminae. Each intervertebral foramen is formed by the pedicles of the vertebra above and below.
- *Laminae:* these are flattened in cross-section. They complete the vertebral arch by meeting in the midline at the spinous process. The superior and inferior articular processes bear facets for articulation with adjacent vertebrae; those of the thoracic vertebrae are flatter and aligned in the coronal plane, whereas those of the lumbar vertebrae are nearer the sagittal plane.
- *Transverse processes:* in the lumbar region they are thick and pass laterally. The transverse processes of L5 are particularly massive but short. The transverse processes of thoracic vertebrae are large and pass backwards and laterally; they bear facets that articulate with the ribs' tubercles (except T11 and T12).
- *Spinous process:* these project horizontally backwards in the lumbar region; in the thoracic region they are longer and inclined at about 60° to the horizontal. The spinous process of T12 has a notched lower edge.

The cervical vertebrae have a number of features which distinguish them from the others, including the foramen transverarium in the transverse processes, bifid spinous processes and the particular characteristics of C1 and C2.

A line drawn between the iliac crests (Tuffier's line) usually crosses the L3–4 interspace (slightly higher than in the non-pregnant state because of rotation of the pelvis), although this is unreliable, and it has been shown that even experienced anaesthetists can be one or more interspaces lower (or more commonly, higher) than that intended.

Sacral canal (Fig. 10.2)

The sacral canal is 10–15 cm long, triangular in cross-section, runs the length of the sacrum and is continuous cranially with the lumbar vertebral canal. The fused

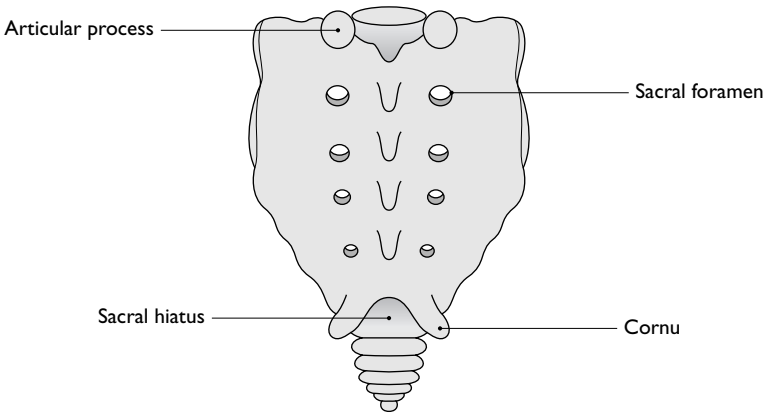

Fig. 10.2 Sacrum. Reproduced with permission from Yentis, Hirsch & Smith: Anaesthesia and intensive care A-Z, 2nd edn, Butterworth Heinemann, 2000.

bodies of the sacral vertebrae form the anterior wall, and the fused sacral laminae form the posterior wall. The sacral hiatus is a deficiency in the fifth laminar arch, has the cornua laterally and is covered by the sacrococcygeal membrane. Congenital variants are common, possibly contributing to unreliable caudal analgesia.

Vertebral ligaments (Fig. 10.3)

- *Anterior longitudinal ligament:* this is attached to the anterior aspects of the vertebral bodies, and runs from C2 to the sacrum.
- *Posterior longitudinal ligament:* this is attached to the posterior aspects of the vertebral bodies, and runs from C2 to the sacrum.
- *Ligamentum flavum (yellow ligament):* this is attached to the laminae of adjacent vertebrae, forming a 'V'-shaped structure with the point posteriorly. It is more developed in the lumbar than thoracic regions.
- *Interspinous ligament:* this passes between the spinous processes of adjacent vertebrae.
- *Supraspinous ligament:* this is attached to the tips of the spinous processes from C7 to the sacrum.

In addition, there are posterior, anterior and lateral sacrococcygeal ligaments. Other ligaments are involved in the attachments of C1 and C2 to the skull.

The ligaments may become softer during pregnancy because of the hormonal changes that occur.

Epidural space

- *Boundaries:* the space extends from the foramen magnum to the sacrococcygeal membrane. It is triangular in cross-section in the lumbar region, its base anterior; it is very thin anteriorly and up to 5 mm wide posteriorly. It lies external to the dura mater of the spinal cord and internal to the ligamenta flava and vertebral

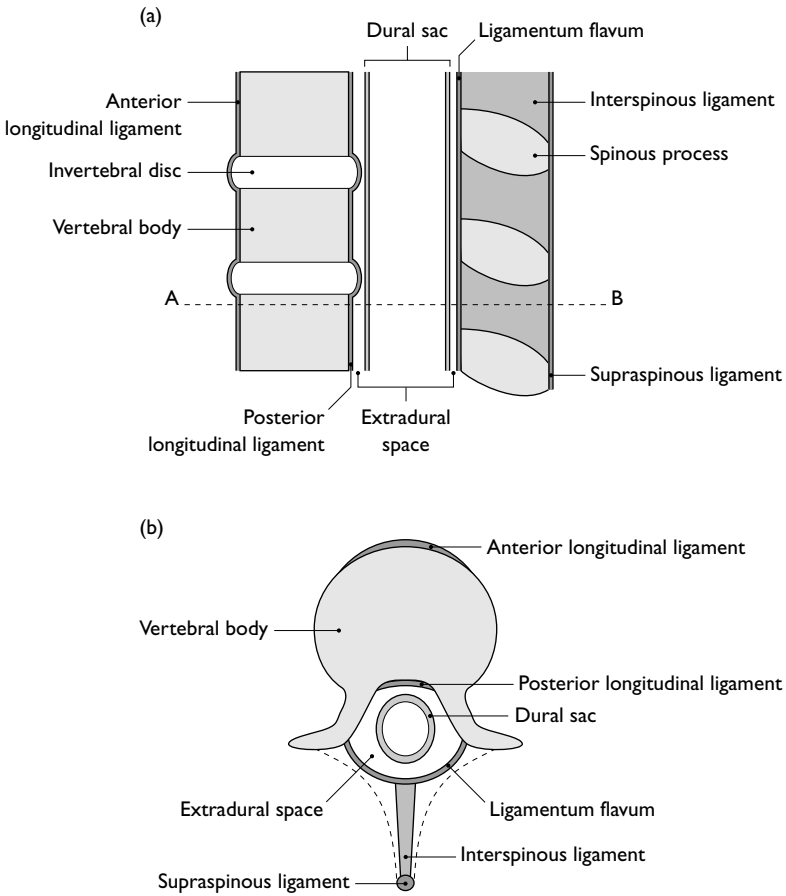

Fig. 10.3 Vertebral ligaments: (a) longitudinal section and (b) transverse section through A–B. Reproduced with permission from Yentis, Hirsch & Smith: Anaesthesia and intensive care A-Z, 2nd edn, Butterworth Heinemann, 2000.

laminae posteriorly; the posterior longitudinal ligament anteriorly and the intervertebral foramina and vertebral pedicles laterally. Magnetic resonance imaging suggests the space is divided into segments by the laminae. The space may extend through the intervertebral foramina into the paravertebral spaces.

- *Contents:* these include extradural fat, extradural veins (Batson's plexus), lymphatics and spinal nerve roots. The veins become engorged in pregnancy as a result of the hormonal changes and any aortocaval compression. Connective tissue layers have been demonstrated by radiology and endoscopy within the extradural space, in some cases dividing it into right and left portions.
- *Pressure:* a negative pressure is usually found in the epidural space upon entering it; the reason is unclear but may involve anterior dimpling of the dura by the epidural needle, sudden posterior recoil of the ligamentum flavum when it is punctured, stretching of the dural sac during extreme flexion of the back, transmitted negative intrapleural pressure via thoracic paravertebral spaces and

relative overgrowth of the vertebral canal compared with the dural sac. Occasionally a positive pressure is found.

Meninges

- *Pia mater:* this delicate and vascular layer adheres closely to the brain and spinal cord. Between it and the arachnoid mater is the cerebrospinal fluid (CSF) within the subarachnoid space containing blood vessels, the denticulate ligament laterally along its length and the subarachnoid septum posteriorly. The pia terminates as the filum terminale, which passes through the caudal end of the dural sac and attaches to the coccyx.
- *Arachnoid mater:* this membrane is also delicate and contains CSF internally. It lies within the dura externally, the potential subdural space containing vessels, between them. It fuses with the dura at S2.
- *Dura mater:* this fibrous layer has an outer component, which is adherent to the inner periosteum of the vertebrae and an inner one that lies against the outer surface of the arachnoid. The dura projects into the extradural space, especially in the midline. It ends at about S2.

Spinal cord

The spinal cord ends inferiorly level with L3 at birth, rising to the adult level of L1–2 (sometimes T12 or L3) by 20 years. Below this level (the conus medullaris) the lumbar and sacral nerve roots (comprising the cauda equina) and filum terminale occupy the vertebral canal. The main ascending and descending tracts are shown in Fig. 10.4.

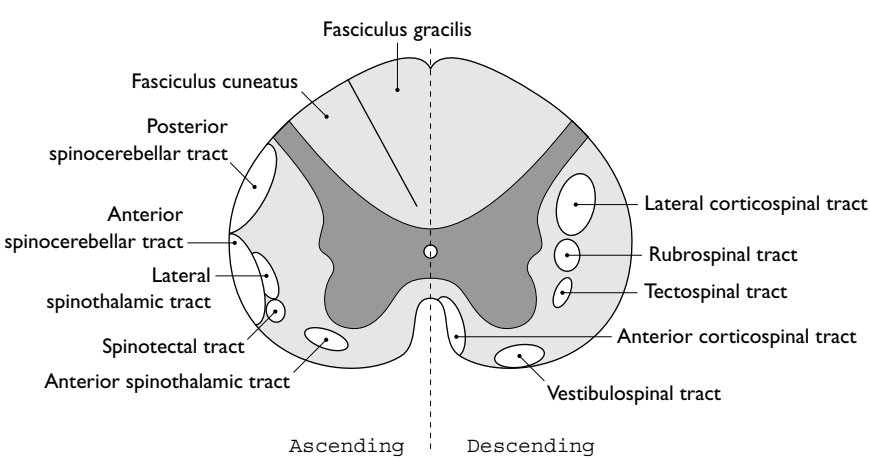

Fig. 10.4 Ascending and descending tracts, spinal cord. Reproduced with permission from Yentis, Hirsch & Smith: Anaesthesia and intensive care A-Z, 2nd edn, Butterworth Heinemann, 2000.

The blood supply of the spinal cord is of relevance to obstetric anaesthetists, since cord ischaemia may result in neurological damage:

- *Anterior spinal artery:* this descends in the anterior median fissure and supplies the anterior two-thirds of the cord. The anterior spinal artery syndrome (e.g. arising from profound hypotension) thus results in lower motor neurone paralysis at the level of the lesion, and spastic paraplegia, reduced pain and temperature sensation below the level and normal joint position sense and vibration sensation.
- *Posterior spinal arteries:* these descend along each side of the cord, one anterior and one posterior to the dorsal nerve roots.
- *Radicular branches:* these arise from local arteries (from the aorta) and feed the spinal arteries. Those at T1 and the lower thoracic/upper lumbar level (artery of Adamkiewicz – usually unilateral) are the most important. The cord at T3–5 and T12–L1 is thought to be most at risk from ischaemia. The conus medularis and cauda equina are supplied by a vascular plexus arising from the artery of Adamkiewicz above and pelvic vessels below. In 15% of the population,

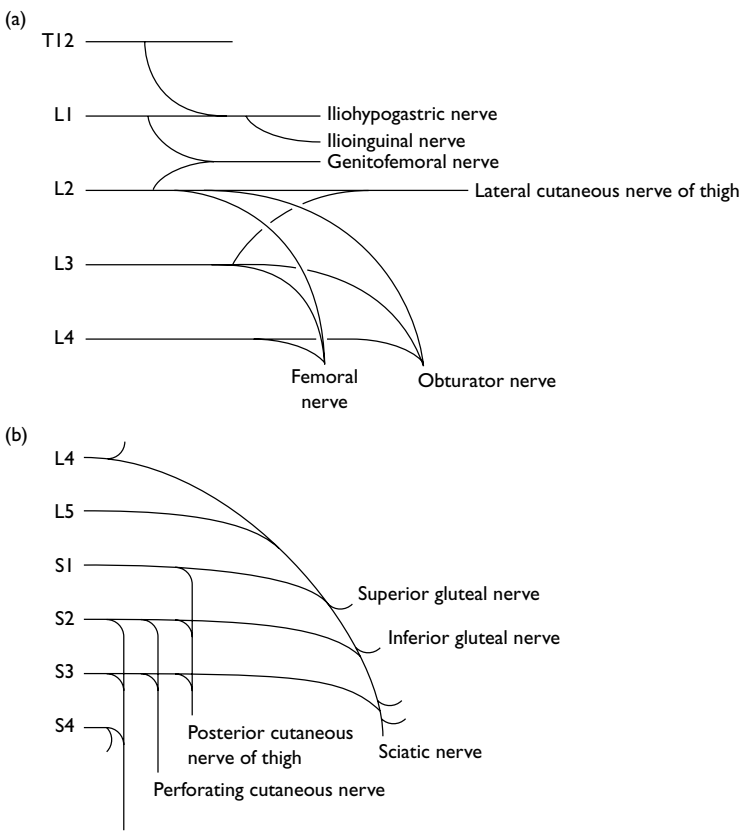

Fig. 10.5 Plan of (a) lumbar and (b) sacral plexi. Reproduced with permission from Yentis, Hirsch & Smith: Anaesthesia and intensive care A-Z, 2nd edn, Butterworth Heinemann, 2000.

the latter are the main source of arterial blood to the conus medularis and cauda equina; compression during delivery may result in permanent paraplegia.

Venous drainage is via the internal iliac, intercostal, azygos and vertebral veins.

Peripheral nerves of the lower body

The lumbar and sacral plexi are shown schematically in Fig. 10.5. They form at the posterior of the pelvis, and their branches pass round the interior of the pelvis where they may be exposed to pressure during labour and delivery (Fig. 10.6; see also Chapter 50, Peripheral nerve lesions following regional anaesthesia, p. 128).

Peripheral cutaneous innervation may be characterised according to the dermatomal distribution or peripheral nerves (Fig. 10.7 and 10.8). Both representations may vary considerably between individuals. Peripheral motor innervation may also be considered according to myotomal innervation or peripheral nerves (Table 10.1).

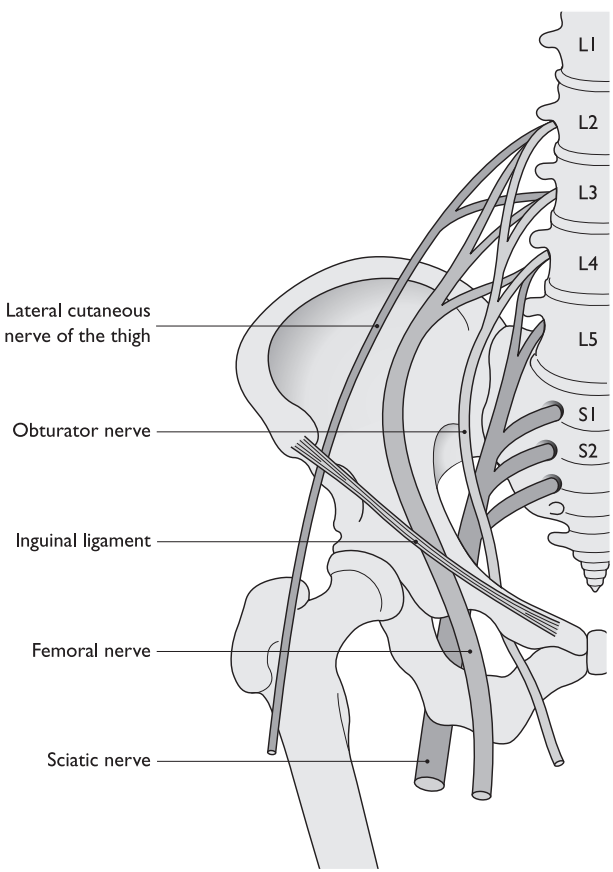

Fig. 10.6 Major nerves of the pelvis. Adapted with permission from Holdcroft & Thomas: Principles and practice of obstetric anaesthesia and analgesia, Blackwell Publishing, 2000.