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LOCAL ANAESTHETIC TECHNIQUES IN OBSTETRICS

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In 1901 the German, Kreiss, used spinal (subarachnoid) analgesia for the first time in obstetrics and the technique was popularized by Pitkin in the U.S.A. in 1928. In 1909, Stoeckel of Marburg reported the use of single injection caudal analgesia in obstetrics, a technique which had been suggested, but not utilized, by Cathelin of Paris in 1901. Analgesia was short lived and often imperfect because of the limitations imposed by the local anaesthetic agents available in the early years of the century. Gellhorn used local anaesthetics for infiltration of the perineum in 1927.

In 1942 Hingson and Edwards first used continuous caudal analgesia during labour. They did this while working as young doctors in a U.S. Navy Hospital on Staten Island, New York. They acted on the orders of their commanding officer, who wished to silence the cries of labouring women which were distressing the burned and injured sailors who occupied adjacent wards! Techniques and agents have been refined since those days and the motivation of anaesthetists has changed.

ANATOMICAL BASIS OF REGIONAL ANALGESIA IN OBSTETRICS

The sensory innervation of the birth canal is now well known and is illustrated in figure 1. The A delta and C afferent fibres from the body and cervix of the uterus pass through the paracervical tissues and travel upwards through the inferior, middle and superior hypogastric plexuses to enter the lumbar and lower thoracic portions of the chain of sympathetic ganglia. Central connection to the spinal cord is by the white rami communicantes of T11, T12 and L1 nerves. The pain of uterine contractions is referred to the areas of skin supplied by these nerves in the lower abdomen, loins and lumbo–sacral region. The vagina and perineum have an entirely separate sensory nerve supply, principally from the pudendal nerves (S2, 3 and 4), with a minor contribution from the ileo–inguinal, genito–femoral and posterior femoral cutaneous nerves and the cutaneous branches of S2, 3 and 4 nerves.

Regional techniques in current use which can relieve the pain of uterine contractions and can be utilized in the first stage of labour are:

Lumbar and caudal extradural analgesia
Spinal (subarachnoid) analgesia
Paracervical block
Paravertebral block of T11, T12 and L1

In practice, only extradural and paracervical block are in regular use and the latter has fallen out of favour.

Techniques which can relieve the pain of vaginal delivery include:

Lumbar and caudal extradural analgesia
Spinal (subarachnoid) analgesia
Pudendal nerve block
Perineal infiltration

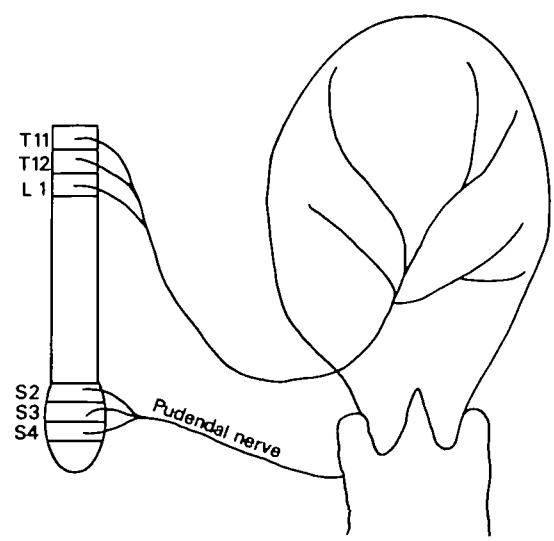

FIG. 1. Schematic representation of the sensory innervation of the birth canal.

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Only extradural and spinal analgesia can relieve the pain of uterine contractions and of vaginal delivery.

SOME PHYSIOLOGICAL AND PHARMACOLOGICAL CONSIDERATIONS

Only a few topics with special relevance to the use of local anaesthetic techniques in obstetrics will be considered. The effects of regional analgesia on utero–placental blood flow, fetal well-being and uterine action are of prime importance.

Aorto–caval occlusion. The significance of compression of the inferior vena cava and the abdominal aorta by the gravid uterus when the mother is in the supine position is now well recognized. Caval compression is the rule in the supine position without lateral tilt (Kerr, Scott and Samuel, 1964). Aorto–caval compression is perhaps the greatest hazard for mother and fetus in association with the extensive sympathetic blockade of extradural and spinal analgesia, and yet is easily avoided.

Compensation for the reduction in venous return which follows caval occlusion would normally include vasoconstriction, but this may be inadequate when the sympathetic outflow is blocked. Cardiac output and systemic arterial pressure decline, especially if there is bradycardia. Compression of the abdominal aorta can cause arterial hypertension above the site of compression and hypotension beyond it. This is termed the Poseiro effect and the analogy with coarctation of the aorta will be obvious. Both aortic and caval compression are likely to reduce uterine artery blood flow, with a consequent reduction in placental intervillous flow and progressive fetal hypoxia and metabolic acidosis (Corke et al., 1982). Myometrial blood flow may also be diminished and uterine contractions may diminish in intensity and frequency, or even cease, if hypotension is severe (Schellenberg, 1977).

Utero–placental blood flow. The placenta is believed to lack an intrinsic sympathetic nervous mechanism for the regulation of its own blood supply (Greiss, 1967). It is, therefore, usually assumed that placental intervillous blood flow is proportional to the inflow in the uterine artery. Measurements are usually made by one of two techniques: (a) measurement of uterine artery blood flow by chronically implanted electromagnetic flowmeters, which is utilized in pregnant ewes or (b) measurement of intervillous blood flow using a xenon-133 clearance method, which is applicable to humans and gives a wide range of normal values which may represent the normal condition or may reflect inaccuracy in the method. The studies in sheep are often, and perhaps rather uncritically, assumed to represent the human situation.

It is probable that intervillous blood flow is unaltered or slightly increased when extradural analgesia is used in normal labour and that the flow tends to decline in the absence of extradural blockade (Jouppila et al., 1978a). Intervillous flow is probably increased by extradural analgesia in pre-eclampsia. During elective Caesarean section, intervillous blood flow is unaltered or marginally increased when extradural or spinal analgesia is used (Jouppila et al., 1978b, 1984). When general anaesthesia is induced, the intervillous blood flow is reduced (Jouppila et al., 1979). It has been suggested that the catecholamine response to painful stimuli during the very light general anaesthesia often used in obstetrics might reduce utero–placental blood flow and cause fetal hypoxia and acidosis (Palahniuk and Cumming, 1977).

Very powerful or tetanic uterine contractions can temporarily reduce intervillous blood flow. The vasoconstrictor action of α-adrenergic vasopressor drugs such as methoxamine which reduces uterine artery blood flow in sheep and agents such as ephedrine, with a mainly positive ionotropic action on the myocardium, are preferred (Ralston, Shnider and de Lorimier, 1974). Extreme hyperventilation may occur in painful labour and may reduce utero–placental blood flow as a result of marked hypocapnia (Levinson et al., 1974). Hyperventilation is prevented or reversed by extradural analgesia (Fisher and Prys-Roberts, 1968).

Uterine action. Hypotension and a reduction in cardiac output may impair myometrial blood flow and cause a diminution in uterine contractility. Noradrenaline can cause inco-ordinate uterine action. Endogenous noradrenaline might have this effect in the woman who is afraid and in pain, thereby prolonging labour and further increasing pain and anxiety. In this type of labour the use of extradural analgesia is often followed by accelerated progress in labour, perhaps as a consequence of the relief of pain and a reduction in catecholamine

concentrations (Moir and Willocks, 1967; Raabe and Belfrage, 1976).

In normal labour, the overall rate of progress in spontaneous and induced labour is not altered by extradural analgesia (Studd et al., 1980, 1982). Adrenaline in high concentrations relaxes the myometrium, but the quantities and concentrations used with local anaesthetics have no clinically important effect (Phillips et al., 1977).

Extradural analgesia and the fetus. In the majority of cases, extradural analgesia has no harmful effects on the fetus and indeed may be beneficial in maintaining placental blood flow and avoiding depressant drugs. Adverse effects are rare, but could result from maternal hypotension or the placental transfer of local anaesthetic agents.

Procaine and 2-chloroprocaine are metabolized rapidly by maternal, fetal and perhaps placental cholinesterase. They are present in negligible amounts in fetal blood and have no effect on fetal heart rate patterns (Abboud et al., 1982). In contrast, bupivacaine is sometimes associated with a reduction in the baseline variability of the fetal heart rate—a probably innocent effect. Late decelerations are occasionally seen and usually disappear after a few contractions. Their significance is less clear, but they probably do not indicate serious fetal hypoxia and are not, of themselves, an indication for immediate delivery (Abboud et al., 1982). They may be evidence of transient fetal myocardial depression. Lignocaine may also cause loss of baseline variability of the fetal heart rate, but the older view that lignocaine might cause neonatal depression is not substantiated by more recent studies (Kuhnert et al., 1979; Abboud et al., 1984) and lignocaine is returning to favour for obstetric extradural analgesia for labour and for Caesarean section. Prilocaine causes maternal and fetal methaemoglobinaemia and is not recommended for continuous techniques.

The fetus and neonate are not harmed by extradural or spinal analgesia for Caesarean section if hypotension is avoided or is swiftly treated if it occurs. The duration of hypotension may be more relevant than its severity, and restoration of normotension within perhaps 4 min may avoid fetal acidosis (Abboud et al., 1982, 1984; Corke et al., 1982). In contrast, opioid analgesics regularly produce depression of neurobehavioural functions in the neonate for up to 48 h (Weiner, Hogg and Rosen, 1977). The tests of neurobehavioural activity are very sensitive and their significance is debated.

The placental transfer of local anaesthetic drugs and their subsequent handling by the neonate is a complex and incompletely understood subject which is also considered elsewhere in this issue (Tucker, 1986). Reduced binding of local anaesthetics to fetal serum proteins influences the action of these drugs and makes simple maternal:fetal concentration ratios open to misinterpretation. For example, the total concentration of bupivacaine in the maternal serum may well be three times the concentration in the fetal serum, yet the diminished binding of bupivacaine to fetal serum proteins may result in approximately equal concentrations of unbound bupivacaine in maternal and fetal serum. As fetal pH decreases there is ion trapping of local anaesthetics in fetal blood and tissues and this could have adverse consequences for the hypoxic, acidotic fetus (Kennedy et al., 1979). Elimination of lignocaine and bupivacaine by the neonate may take from 1 to 3 days (Kuhnert et al., 1979, 1981). The elimination of etidocaine is more rapid in the newborn lamb (Pederson et al., 1982).

Toxicity of bupivacaine in pregnancy. Controversy surrounds the use of 0.75% bupivacaine for extradural anaesthesia for Caesarean section and its use in obstetrics is no longer recommended by the manufacturers or by the Food and Drug Administration in the U.S.A. Cardiac arrest has proved fatal, despite vigorous, prolonged and skilled resuscitation (Albright, 1985). Animal experiments indicate that bupivacaine may be especially toxic in pregnancy (Morishima et al., 1983), that bupivacaine may be more cardiotoxic than lignocaine and that acidosis and hypoxia further increase the toxicity of bupivacaine but not of lignocaine (Kotelko et al., 1984). In our experience 0.75% bupivacaine has no practical advantages over 0.5% bupivacaine for extradural Caesarean section, while the more concentrated solution results in higher maternal and fetal serum concentrations and is, therefore, potentially more toxic (Dutton et al., 1984). Convulsions have been recorded when using unusually large volumes of 0.5% bupivacaine to "extend" extradural analgesia for Caesarean section (Thorburn and Moir, 1984). Convulsions may be the forerunner of cardiac arrest. Hodgkinson (1984) suggested a maximum dose of bupivacaine 2–2.5 mg/kg body weight for extradural Caesarean section and the

manufacturers advise an upper limit of 2 mg kg^{-1}/4 h. An important safeguard is the use of an incremental technique for Caesarean section because peak concentrations are thereby reduced (Dutton et al., 1984; Thompson et al., 1985). The use of cimetidine, but probably not ranitidine, impairs the metabolism of amide-type local anaesthetics and may increase their potential toxicity (Hodgkinson, 1984).

EXTRADURAL ANALGESIA

Extradural Analgesia for Labour and Vaginal Delivery

Most indications for extradural analgesia in obstetrics are now widely agreed. The principal ones are:

Relief of pain
Hypertension
Twins delivery
Premature labour
Inco-ordinate labour
Cardiac and respiratory disease
Diabetes mellitus
Forceps delivery
Caesarean section
Surgery during pregnancy

Extradural analgesia in normal labour

Extradural analgesia is undoubtedly the most effective method of pain relief in labour (Moir et al., 1976). Painful labour, especially if prolonged, has a number of undesirable effects. These include:

Maternal acidosis
Fetal acidosis
Increased catecholamine concentration
Increased cortisol concentration
Increased oxygen consumption
Hypocapnia
Reduced utero–placental blood flow

Some of the consequences of pain in labour are interdependent and the important adverse effect is a reduction in intervillous blood flow. These various adverse effects are to a large extent prevented or reversed by extradural analgesia.

Extradural analgesia requires no prior preparation of the mother, but does require the presence of a skilled anaesthetist. Although analgesia is usually very effective, there is a minority of mothers who will view the overall experience of childbirth with some dissatisfaction when extradural analgesia is used (Morgan, Bulpitt et al., 1984). For these women, pain appears to be a necessary part of an emotionally satisfying labour, but for the majority of women this is not the case.

Extradural analgesia and the forceps rate

As extradural analgesia has become widely used in essentially normal labours, awareness has developed of possible imperfections and drawbacks as well as the undoubted benefits of the technique. A frequent and not always justified accusation is an increase in the incidence of forceps deliveries.

It would be statistically desirable, but ethically unacceptable, to allocate at random a series of mothers to receive or not to receive extradural analgesia in labour. Consequently, any series of women receiving extradural analgesia will almost certainly include an abnormally high number of primigravidae and obstetric abnormalities such as prolonged labour, occipito–posterior positions, hypertension and other conditions which often result in instrumental delivery. Thus extradural analgesia is often associated with a high forceps rate, yet the association may not be one of cause and effect.

May extradural analgesia, *per se*, increase the forceps rate? If older, arbitrary time limits are placed on the duration of the second stage of labour, then it is probable that extradural analgesia may result in unnecessary forceps deliveries. It is now recognized that, provided that the condition of the infant is known to be satisfactory, then the second stage can usually be safely prolonged. Descent and rotation can occur and a spontaneous or outlet forceps delivery may then replace a mid-cavity and perhaps rotational forceps delivery (Bailey and Howard, 1983; Maresh, Choong and Beard, 1983). Another factor which may influence the forceps rate is the concentration and volume of bupivacaine solution used. When 0.5% bupivacaine is used, then the forceps rate is likely to be high and rotational forceps relatively common (Hoult, McLennan and Carrie, 1977). When 0.25% bupivacaine is used analgesia is usually adequate, motor block less marked, and these factors, together with safe prolongation of the second stage of labour, can achieve spontaneous delivery in 75% of mothers receiving extradural analgesia (Thorburn and Moir, 1981). The 0.25% solution of bupivacaine is therefore recommended for normal labour and the 0.5% solution is reserved for operative deliveries and for the occasional woman who gets inadequate relief from the weaker solution. If

analgesia does not reach the sacral nerve roots, then involuntary expulsive efforts should occur.

The practice of allowing extradural analgesia to wear off in the second stage of labour in the hope of encouraging spontaneous delivery is mentioned only in order to condemn it as barbaric. Moreover, the desired objective may not be attained. In the experience of Phillips and Thomas (1983), instrumental delivery was more often required by the distressed and now unco-operative mother suddenly deprived of all pain relief.

The conduct of labour under extradural analgesia

Evidence is accumulating which suggests that the position of the mother during the induction of extradural blockade and the giving of top-up injections has only a very small influence on the spread of analgesia (Apostolou, Zarmakoupis and Mastrokostopoulos, 1981; Merry et al., 1983). The common practices of dividing the top-up injection while the mother changes from one lateral position to the other and sits up before an injection for forceps delivery are probably of little practical value. The maintenance of a lateral position throughout labour can result in unilateral analgesia.

The scrupulous avoidance of the un-tilted, supine position is vital for maternal and fetal welfare. If a supine or dorsal position is necessary, then a wedge must be placed under the right buttock or the table must be tilted to the left. Adequate hydration should be maintained by infusing crystalloid fluids, and "preloading" before each top-up injection has been found to reduce substantially the incidence of hypotension and aberrations of the fetal heart rate (Collins, Bevan and Beard, 1978). Large volumes of 5% dextrose in water have caused water intoxication, especially when used to administer oxytocin (Feeny, 1982). The administration of dextrose to the mother can cause neonatal hypoglycaemia and metabolic acidosis as a result of the production of insulin by the infant (Kenepp et al., 1982). Hartmann's solution is recommended for routine use and the hazards of maternal ketonuria have almost certainly been exaggerated in the past.

If aorto–caval occlusion is avoided and hydration is maintained with a glucose-free solution, the incidence of maternal hypotension should not exceed 2%. If hypotension occurs despite these precautions, then i.v. ephedrine 10 mg should be injected in order to improve cardiac output and uterine artery blood flow (Ralston, Shnider and de Lorimier, 1974).

A full bladder may go unrecognized, and it is helpful to encourage micturition before each top-up injection. Catheterization may be necessary. Post partum retention of urine occurs more often when concentrated solutions of bupivacaine have been used (Thorburn and Moir, 1981).

Continuous monitoring of the fetal heart rate is very desirable and is essential if the second stage of labour is to be safely prolonged and the number of forceps deliveries reduced. As discussed previously, lignocaine and bupivacaine may reduce baseline variability and even cause late decelerations of the fetal heart rate, but in these circumstances are thought to be innocent.

Progress should be assessed at intervals not exceeding 4 h in most patients, and the inexperienced obstetrician or midwife may omit to do this when the mother is free of pain and anxiety.

In the U.S.A. it is sometimes the practice to perform tubal ligation within a few hours of delivery and if this is the intention then the extradural catheter may be left in place. British opinion generally favours sterilization at a later date when the mother is certain of her wishes, hypercoagulability has diminished and there is no excessive risk of regurgitation and aspiration of stomach contents.

Safer maintenance of extradural analgesia

In the United Kingdom and elsewhere there has been a small number of fatalities following upon the administration of an extradural top-up during labour. Typically, the injection has been followed within a few minutes by respiratory inadequacy or apnoea and hypotension. The injection has usually been given by a nurse, midwife or junior obstetrician without special training in cardiopulmonary resuscitation. Attempts at resuscitation have usually been inadequate and may have failed to include the avoidance of aorto–caval occlusion and the passage of a tracheal tube. An anaesthetist has usually not been immediately available.

Most of these tragedies appear to have resulted from the unrecognized placement of the catheter tip within the subarachnoid or perhaps the subdural space (Brindle-Smith, Barton and Watt, 1984). A test dose was sometimes used, but it is recognized that this does not exclude misplacement of the catheter and may consist of an inappropriate volume of an inappropriate solution (Moore and Batra, 1981; Abouleish and Bourke, 1984). When

using a catheter with three lateral eyes, there is the possibility that the distal eye might lie within the subarachnoid space while the proximal eyes are within the extradural space, with a resulting mixed but extensive blockade. There is the possibility of migration of the catheter tip after its insertion (Park, 1984).

The optimal safety precaution is to ensure that a competent anaesthetist is readily available throughout every obstetric extradural blockade. This involves heavy and perhaps unmeetable demands on the staff of smaller anaesthetic departments and there has been a recent interest in the use of infusions rather than top-ups. It has been speculated that extradural infusions might be safer than top-up doses because of the slower rate of upward spread (Li, Rees and Rosen, 1985) and the reduced likelihood of profound motor block when a dilute solution of local anaesthetic is used. Various workers have used 0.0625%, 0.125% and 0.25% bupivacaine infusions and a popular technique uses 0.125% bupivacaine 10 ml h^{-1} after an initial bolus loading dose. Further bolus doses may be required. If the anaesthetist draws a line on the mother's skin at T6 dermatome, then the midwife can make frequent checks on the upper level of loss of cold sensation, using an ice cube in a swab. The safety of such techniques is at present hypothetical and it is not possible, at present, to recommend their use if an anaesthetist is not readily available.

A simple alternative method of potentially improving the safety of extradural analgesia is the use of a fractionated top-up technique. Increments of 3 ml are given at 5-min intervals and each increment is preceded by a simple observation and questioning of the mother concerning motor block and respiratory difficulty. This has been used now for more than 8000 top-up injections in the Queen Mother's Hospital, Glasgow but, in the light of the rarity of excessive spread, this does not constitute an adequate evaluation.

Special Indications for Extradural Analgesia

The principal indication for extradural analgesia is, of course, painful labour. There are also some obstetric situations in which extradural analgesia has special and even therapeutic benefits and some of these have been listed above.

Hypertensive conditions. Pre-eclampsia is a leading cause of maternal death and the mechanism of death is usually a cerebro–vascular accident. Control of hypertension can be life-saving.

The hypertensive mother frequently develops progressive further hypertension during painful labour. Extradural analgesia relieves pain and creates a sympathetic nerve block. Both mechanisms tend to prevent or minimize the progressive hypertension of painful labour and there is often a slight decrease in systemic arterial pressure (Moir, Victor-Rodrigues and Willocks, 1972). Elective forceps delivery is often indicated and can be readily performed under extradural analgesia. Ergometrine can cause a severe and sustained further increase in arterial pressure and should not be used. Extradural analgesia is in no sense a cure for pre-eclampsia. Anticonvulsant and antihypertensive drugs may also be needed, and delivery is the ultimate effective therapy.

Severe pre-eclampsia is often accompanied by thrombocytopenia and intravascular coagulation and these complications should be excluded before performing extradural block.

Breech delivery. Assisted breech delivery is nowadays undertaken in a very restricted and carefully selected population and extradural analgesia is now widely accepted as the technique of choice for vaginal breech delivery. The obstetrician is enabled to perform a careful, controlled delivery of the unmoulded after-coming head if the mother is calm and free of pain, and a hazardous general anaesthetic is not required. The infant is born with a higher Apgar score, less severe acidosis, and is less likely to show evidence of cerebral irritation. The benefits are of even greater significance for the low birth weight infant (Crawford, 1974; Donnai and Nicholas, 1975; Breeson et al., 1978). The incidence of breech extraction is not increased, the first stage of labour is not prolonged and the second stage is prolonged by 10 or 15 min. Recently Confino and others (1985) attributed a higher incidence of low 1-min Apgar scores in infants weighing more than 2.5 kg to prolongation of the second stage. Smaller infants were unaffected and all babies had 5-min Apgar scores comparable to those of babies delivered without extradural analgesia.

When extradural anaesthesia is used for elective Caesarean section in breech presentation, the fetus is likely to be less acidotic than is observed when general anaesthesia is used (Crawford and Davies, 1982).

Multiple births. Extradural analgesia is of special value in the delivery of twins. The second twin is usually at greater risk of intrauterine asphyxia and should be delivered as soon as possible after the first child. Extradural analgesia permits such expeditious delivery whether spontaneously, by forceps or by the breech, and the condition of the child is then more likely to be satisfactory (Crawford, 1975; James et al., 1977). The large gravid uterus increases the probability of aorto–caval compression and particular care should be taken to avoid this complication.

Triplets and greater numbers of siblings are usually delivered by Caesarean section and extradural anaesthesia is recommended for this purpose.

Premature labour. When the immature or growth-retarded fetus is to be delivered vaginally, then it is widely believed that the risk of intracranial haemorrhage is diminished by the controlled delivery and relaxed perineal muscles provided by extradural analgesia.

Cardiac and respiratory disease. Extradural analgesia has advantages for most mothers with heart disease. It offers relief of pain and anxiety and prevents the tachycardia which can itself precipitate cardiac failure. Maternal muscular effort is reduced and oxygen consumption and metabolic acidosis are thereby reduced. Pain is the main cause of the increased oxygen requirements of the woman in labour (Hagerdal et al., 1983). Elective forceps delivery can readily be performed. Aorto–caval occlusion must be rigorously avoided and if hypotension does occur, then it may be treated with small doses of ephedrine. Patients with intracardiac shunts are at grave risk and the increased pulmonary vascular resistance of pregnancy predisposes to reversal of the shunt. Even in hazardous conditions such as Eisenmenger's syndrome, extradural analgesia is probably the method of choice for labour or Caesarean section (McMurray and Kenny, 1982).

Most of the advantages of extradural analgesia for patients with heart disease apply with equal force to those with respiratory disease.

Diabetes mellitus. Extradural analgesia is recommended for most diabetic mothers, whether for labour or for Caesarean section. Intervillous blood flow is often diminished, even in well controlled diabetes (Nylund et al., 1982) and extradural analgesia may improve intervillous flow. The infant is sometimes large, and delivery may be difficult. Extradural analgesia may minimize the extent of fetal acidosis when delivery is protracted (Crawford and Davies, 1982). There is a suggestion that solutions spread more extensively in the extradural space of diabetic mothers and volumes should be somewhat reduced (Datta et al., 1981).

Previous uterine surgery. When the uterus is scarred by a previous Caesarean section or other uterine surgery, then there is a risk of uterine rupture. Labour may be permitted if cephalo–pelvic disproportion is absent and a vaginal delivery is considered feasible. In these circumstances extradural analgesia is not thought to increase further the risk of uterine rupture and is not contraindicated if fetal heart rate, uterine contractions and maternal vital signs are carefully monitored. If uterine rupture does occur, it may cause pain, despite extradural analgesia, and the other signs of rupture such as cessation of uterine contractions, alterations in the fetal heart rate pattern and maternal hypotension and tachycardia will not be obtunded. Uterine rupture may not be diagnosed until after delivery, when the uterus is explored because of vaginal bleeding. Recent reports on the use of extradural analgesia after previous Caesarean sections have been published by Carlsson, Nybell-Lindahl and Ingemarsson (1980) and by Uppington (1983).

Extradural Anaesthesia for Caesarean Section

In many centres a substantial majority of Caesarean sections are performed under extradural anaesthesia and Davis (1982) estimated that this figure could reach 84%. This represents a major change in practice over the past 5 or 6 years and the advantages claimed for extradural anaesthesia include:

- Near elimination of the principal hazards of general anaesthesia (aspiration pneumonitis and failed intubation).
- Avoidance of drug-induced neonatal depression.
- Maintenance of intervillous blood flow (Jouppila et al., 1978b).
- Less fetal acidosis if delivery is prolonged (Crawford and Davies, 1982).
- Maternal and paternal participation in the birth.
- Alert and pain-free postoperative condition of the mother.

Facilitation of early breast feeding (Morgan, Barker et al., 1984).

Extradural anaesthesia has certain disadvantages including:

Maternal hypotension.

Reduction in intervillous blood flow and fetal acidosis if hypotension persists for more than about 4 min (Corke et al., 1982).

Inadequate anaesthesia in about 2% (Thorburn and Moir, 1980).

Delay in establishing adequate anaesthesia to T6, especially with bupivacaine.

The performance of Caesarean section under extradural anaesthesia demands meticulous technique and general anaesthesia may yet be necessary in about 2%. For this reason an H_2-receptor antagonist should be given to patients scheduled for extradural Caesarean section and ranitidine is preferred to cimetidine because it does not delay the metabolism of amide type local anaesthetics. The following are important details of technique evolved from that described by Thorburn and Moir (1980).

Technique for extradural Caesarean section

(a) Analgesia to pinprick must reach T6 dermatome before surgery commences. Analgesia should also extend downwards to the sacral nerve roots. Less extensive block may result in pain, vomiting and vasomotor responses after delivery of the child. Analgesia should be maintained at these levels and a top-up injection is often useful after delivery of the infant.

(b) The choice of local anaesthetic solution for most British anaesthetists lies between 0.5% bupivacaine and 2.0% lignocaine with 1:200 000 adrenaline. The lignocaine solution is recommended for its more rapid onset of adequate analgesia (average 20 min) when compared with bupivacaine (average 40 min). Contrary to older views, it is no longer believed that lignocaine depresses neonatal neurobehavioural reflexes (Abboud et al., 1984). Bupivacaine 0.75% has no clinical advantages over 0.5% bupivacaine and is potentially more toxic. Etidocaine 1.5% often gives inadequate anaesthesia and needlessly prolonged motor block (Dutton et al., 1984). An incremental technique is safer than a single large volume injection and is strongly recommended (Thorburn and Moir, 1980; Dutton et al., 1984; Thompson et al., 1985).

(c) Hypotension is the commonest complication of extradural Caesarean section and is difficult to eliminate. Lateral tilt and preloading with i.v. fluids are the primary preventive measures, with ephedrine in reserve. A case has been made for preloading with colloid fluids (Twigley and Hillman, 1985), but personal experience has revealed that gelatine solutions, although usually effective in preventing hypotension, carry an unacceptable incidence of histamine release phenomena, including bronchospasm and laryngeal oedema, when given to normovolaemic mothers. Hartmann's solution is therefore preferred and a volume of 2 litre is infused before surgery. Dextrose is not used because neonatal acidosis and hypoglycaemia may result (Kenepp et al., 1982). Hydroxyethyl starch may be effective, but its very prolonged elimination from the body is seen as a disadvantage. If hypotension occurs despite lateral tilt and hydration, then ephedrine 10 mg is injected i.v. Prophylactic ephedrine is not generally recommended.

(d) Ergometrine should not be used because it causes vomiting and retching in almost 50% of women delivered under extradural analgesia (Moodie and Moir, 1976) and has prolonged and unwanted alpha-adrenergic effects. An oxytocic drug is not always necessary because uterine retraction is often powerful and sustained under extradural anaesthesia and blood loss is less than is usually observed under general anaesthesia (Moir, 1970). If an oxytocic drug is used, then an i.v. bolus of oxytocin (Syntocinon) 5 units will have a safe but short-lived action and may be followed by an i.v. infusion of oxytocin.

If extradural anaesthesia is to be used for the great majority of elective and emergency Caesarean sections, then it is very useful if the possibility of Caesarean is anticipated earlier in labour. Extradural analgesia can be initiated at that time, or an extradural catheter can be placed so that the anaesthesia can be extended quite rapidly when required. The anaesthetist in the obstetric unit should keep himself informed of such potential problem patients and should constantly keep in mind that it is urgent general anaesthesia in the labouring patient which carries the highest mortality rate.

SPINAL (SUBARACHNOID) ANALGESIA IN OBSTETRICS

The ready availability of pre-sterilized ampoules of plain or hyperbaric solutions of 0.5% bupivacaine has been accompanied by a renewal of

interest in spinal analgesia (Russell, 1983), a technique of which the advantages have for long been recognized by a few British enthusiasts and by many anaesthetists in other countries.

Perhaps the outstanding advantage of spinal analgesia over extradural analgesia is the rapid onset of analgesia, accompanied by profound muscular relaxation. The main disadvantages are a 15% incidence of postspinal headache in obstetric patients, even with 25-gauge needles; an incidence of sudden hypotension of about 20%; an element of uncertainty over the extent of spread of the block, a failure rate of up to 4% and unsuitability for use as a continuous technique. The fear of permanent neurological sequelae has at last been banished by the use of sterile, disposable equipment and drugs and the avoidance of chemical contamination. Continuous spinal analgesia is no longer used and so the flexibility of continuous extradural analgesia is lost. It is, of course, possible to insert an extradural catheter at the time of induction of spinal analgesia and to keep the advantages of extradural analgesia in reserve.

The indications for spinal analgesia in obstetrics include:

Forceps delivery
Breech delivery
Twins delivery
Caesarean section, especially if urgent
Manual removal of placenta
Surgery during pregnancy
Post partum sterilization

It will be appreciated that the procedures listed could also be carried out under extradural analgesia, and the special role of spinal analgesia is fulfilled when time is scarce and an extradural catheter is not already in place.

Spinal analgesia as used in obstetrics can be classified into saddle block, low spinal and mid-spinal analgesia.

Saddle block involves the injection of a small volume of a hyperbaric solution with the patient in a sitting position—a position which is maintained for several subsequent minutes. Analgesia is confined to the vagina, vulva and perineum (the area in contact with a saddle) and systemic upsets are minimal. The technique is now rarely used because the pain of uterine contractions is not relieved and intrauterine manipulations cause pain.

Low spinal analgesia implies a block reaching upwards to T10 dermatome with perineal analgesia and painless uterine contractions. This is a valuable technique in the second stage of labour and permits operative vaginal delivery and manual removal of the placenta.

Mid-spinal analgesia reaches T6 dermatome and is required for Caesarean section.

Solutions of 0.5% bupivacaine can be recommended (Russell, 1983) and a volume of 1.3–1.5 ml will produce low spinal analgesia and 1.8–2.2 ml will suffice for Caesarean section. Experience is accumulating which suggests that hyperbaric solutions of bupivacaine may offer greater control of spread of analgesia, whereas plain solutions can sometimes produce a very high block reaching cervical dermatomes (Russell, 1985).

A hyperbaric solution of 5.0% lignocaine was found to give unpredictable spread in obstetric patients and was considered unsuitable (Bembridge, Macdonald and Lyons, 1985).

Spinal analgesia can spread very rapidly and it is therefore important that preloading with i.v. crystalloid fluids should be carried out before injecting the local anaesthetic solution. Colloid fluids are effective in preventing hypotension but may cause adverse reactions. Prophylatic ephedrine is of value before Caesarean section.

The infant delivered under spinal analgesia is usually in good condition, unless already compromised by obstetric pathology. According to Marx, Luykx and Cohen (1984), spinal analgesia is suitable for emergency Caesarean section in the presence of fetal distress. Neurobehavioural reflexes are usually normal and, if hypotension is avoided, fetal acidosis should not result from the anaesthetic technique and intervillous blood flow should be unaltered (Jouppila et al., 1984). Infants of diabetic mothers delivered by Caesarean section under spinal anaesthesia were sometimes acidotic (Datta et al., 1982), but this acidosis may have resulted from maternal hypotension. If hypotension is rapidly corrected, fetal acidosis is unlikely to be severe (Corke et al., 1982). The quantity of local anaesthetic agent used is small and is unlikely to affect the infant.

Contraindications to extradural and spinal analgesia

The contraindications to these techniques are remarkably few:

Maternal opposition
Coagulation defects (severe pre-eclampsia, drugs, haemorrhage)
Massive haemorrhage
Bacteraemia (possibility of infected extradural haematoma)
Major spinal abnormality

The commonest contraindication is a strong maternal desire to be unconscious during delivery or to experience a natural childbirth.

Existing disease of the nervous system is not an absolute contraindication to spinal and extradural techniques, but nevertheless the anaesthetist may be reluctant to risk possible litigation if the disease should worsen after their use. Previous Caesarean section does not rule out extradural analgesia in subsequent labour if vaginal delivery seems probable and monitoring is available.

OTHER LOCAL ANAESTHETIC TECHNIQUES

The undernoted techniques will receive only brief consideration because they are no longer extensively used or are generally regarded as within the province of the obstetrician.

Caudal analgesia. Although this was the method of continuous extradural analgesia introduced by Hingson and Edwards in 1942, it has been largely superseded by continous lumbar extradural analgesia for first stage pain relief. This is because of a high failure rate resulting from numerous variations in the anatomy of the sacral hiatus, and from obesity. A larger volume of local anaesthetic solution is required and the risk of toxicity is greater. The risk of inadvertent subarachnoid injection exists. The inevitable blockade of the sacral nerve roots results in a high forceps rate and frequent failure of rotation of the fetal head from the occipito–posterior position. A few anaesthetists and obstetricians use caudal analgesia as a single injection technique for forceps delivery.

Paracervical block. In this method of first stage pain relief sensory nerves are blocked as they leave the uterus and traverse the paracervical tissues at the base of the broad ligament. An injection of 10 ml of a suitable local anaesthetic solution is made through each lateral fornix and the injections are repeated when pain returns. Lignocaine 1 % or 0.25 % bupivacaine may be used. Satisfactory pain relief is achieved in 55–90 % of women in labour (Gudgeon, 1968) and analgesia is sometimes unilateral.

The method has been extensively used in North America and in Europe, but was never popular in the United Kingdom. Paracervical block is now used infrequently because of the high incidence of fatal bradycardia, although it has the important advantages of simplicity and of being performed by the obstetrician. Fetal bradycardia occurs in up to 50 % of cases and is sometimes accompanied by metabolic acidosis in a sample of fetal scalp blood (Liston, Adjepon-Yamoah and Scott, 1973). Fetal death has occurred on very rare occasions. Fetal bradycardia has been variously ascribed to depression of the fetal myocardium by local anaesthetic drug (Asling et al., 1970), constriction of the uterine arteries by the local anaesthetic drug or the added adrenaline (Gibbs and Noel, 1977) or to uterine hypertonicity (Liston, Adjepon-Yamoah and Scott, 1973).

The potential wide applicability of paracervical block has resulted in efforts to reduce the incidence of fetal bradycardia by injecting smaller volumes of local anaesthetic solution at a more superficial level, sometimes by the use of a jet injector device (Jagerhorn, 1975; McKenzie and Shaffer, 1978). As extradural analgesia becomes more widely available, the need for techniques such as paracervical block diminishes.

Pudendal nerve block. This nerve block must be bilateral and is usually accompanied by local infiltration of the perineum in the proposed line of episiotomy. Lignocaine or prilocaine in 1 % concentration are suitable agents. Some obstetricians inject up to 40 ml of solution in total and, if lignocaine is used, adrenaline 1:200 000 should be added. Analgesia is complete on both sides in only 50 % of mothers when the transvaginal method has been used and is even less successful when the now almost obsolete transperineal route is used (Scudamore and Yates, 1966). Uterine contractions remain painful and intrauterine manipulations cause pain. Pudendal nerve block is therefore only suitable for outlet forceps delivery and is often unsuccessful, any analgesia resulting as much from perineal infiltration as from the nerve block.

Local infiltration for Caesarean section. This technique is mentioned only because it could offer a solution to obstetrician and anaesthetist when intubation of the trachea has been impossible and extradural or spinal analgesia are inappropriate for whatever reason. Skin, subcutaneous tissues,

muscle and posterior rectus sheath are infiltrated as the abdomen is opened layer by layer and without haste. A 0.5% solution of prilocaine or lignocaine with adrenaline may be used and up to 100 ml of solution may be needed. Intraperitoneal manipulations are likely to cause pain, retching or hypotension and the line of incision in the uterus should be infiltrated. The obstetricians Ranney and Stanage (1975) recommend "pentothal supplemented by gas" after the delivery to cover the inadequacies of the infiltration technique! This recommendation is not endorsed.

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