Spinal anaesthesia for caesarean section: current clinical practice

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Spinal anaesthesia has evolved as the preferred anaesthetic technique for most cases of caesarean section. Having been extensively studied and refined over the years, there are few situations where a spinal is absolutely contraindicated. While general anaesthesia will always have a place in obstetrics, in experienced hands a spinal offers safety, efficacy and an improvement in maternal morbidity.

Administering general anaesthesia to a patient who is more than 20 weeks pregnant has many inherent risks, most notably the potential danger of pulmonary aspiration of gastric contents. Definitive securement of the airway of these patients can be rendered more difficult by soft tissue hypertrophy of the pharynx, neck, and chest which occurs in the third trimester. The most recent triennial Confidential Enquiry into Maternal Deaths in the United Kingdom 1994–96 (Department of Health, 1998) has shown a decline in maternal mortality related to anaesthesia, attributed to a growing preference for using regional anaesthesia for most obstetric surgical procedures.

Compared with general anaesthesia, studies have shown significant advantages of regional anaesthesia, reporting improved neonatal Apgar scores (Evans et al, 1989) and less postoperative maternal morbidity (Morgan et al, 1984). Furthermore, remaining awake to witness the birth of their infant appeals to most pregnant women, and they can be accompanied by a partner or supporter during an awake procedure.

Since the early 1980s, spinal (‘subarachnoid’) anaesthesia has emerged as the preferred regional technique for most surgical cases. Subarachnoid anaesthesia provides a dense and predictable block, since the local anaesthetic agent is injected directly into the cerebrospinal fluid (CSF) that surrounds nerve roots. Hence, it is quicker in onset, and associated with fewer complications when compared with epidural anaesthesia (Riley et al, 1995). Furthermore, it reduces the possibility of a ‘patchy’ block, encountered in approximately 5–10% of epidurals, which is attributable to fatty tissue and fibrous septa within the epidural space hindering the spread of local anaesthetic.

TECHNIQUE

A strict aseptic technique is followed, using spinal needles of less than 24 standard wire gauge to enter the subarachnoid space. After establishing an indwelling intravenous cannula, the patient adopts either the sitting or lateral position and flexes their lumbar spine. The subarachnoid space is accessed by introducing the spinal needle between the spinous processes of two lumbar vertebrae. The ‘solid’ spinal cord usually terminates at the level of the second lumbar vertebra, so it is routine practice to puncture the dura mater below this level (e.g. L2/3, L3/4, L4/5).

The endpoint of the technique is the appearance of CSF in the hub of the spinal needle. A suitable volume of local anaesthetic is then injected over 20 seconds into the CSF, during which the patient may perceive a sensation of warmth in dependent areas (e.g. perineum). After removing the spinal needle, the patient adopts the supine position, usually with some degree of lateral tilt. The local anaesthetic then disperses within the CSF, providing onset of anaesthesia usually within 10 minutes, heralded by both motor and sensory changes.

LOCAL ANAESTHETIC SPREAD

The spread of the local anaesthetic agent within the CSF is determined by various factors, but the baricity of the drug solution has a major influence. Baricity refers to the density of the local anaesthetic solution compared to that of CSF at a temperature of 37°C. A hyperbaric solution is denser than CSF, and its spread within it will be

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determined by gravitational effects. In the supine individual it spreads ‘downhill’ from the apex of the convex lumbar spine, into the concavities of the sacrum and thoracic spine. Other factors that contribute to the spread of the drug are the total mass of agent and the vertebral level at which it is injected (Greene, 1985). Patient variables such as height and weight are thought not to have a significant influence within the scope of ‘normal’ clinical practice (Norris, 1990; Russell, 1995).

PHARMACOLOGY

In the UK, only ‘heavy’ 0.5% bupivacaine solution is licensed for intrathecal use; that is, a plain bupivacaine (hypobaric) solution rendered hyperbaric by the addition of glucose. In common with all local anaesthetics, bupivacaine acts on fast sodium channels to impair neuronal conduction in both nerve roots and within the spinal cord itself. A dose of 12–15 mg (2.4–3.0 ml) of ‘heavy’ 0.5% bupivacaine provides an average duration of 90 minutes’ anaesthesia.

The discovery of spinal opioid receptors has led to the intrathecal coadministration of local anaesthetic and opioid. Diamorphine (300 mg) and fentanyl (20 mg) are popular choices for providing both enhanced intraoperative comfort and prolonged postoperative analgesia (Kelly et al, 1998). Respiratory depression is a potentially serious side-effect and patients receiving these adjuvants need careful observation. This complication appears to be related to both the dose and the lipid solubility of the compound. ‘Hydrophilic’ opioids (morphine) are absorbed by neural tissue to a lesser degree than the ‘hydrophobic’ opioids (fentanyl). The former remain in the CSF longer and can be swept rostrally toward the brainstem, and thus appear more likely to cause respiratory depression.

NEURAXIAL BLOCKADE

The manipulation of somatic, visceral and peritoneal structures during a caesarean section requires interruption of afferent input to the spinal cord extending from T5 to S4. The presence of an adequate neuronal blockade should be established before commencing surgery, but methods of determining this vary considerably. Authorities suggest that a satisfactory block should display evidence of loss of light touch sensation in the relevant dermatomes. In practice, given that pain and temperature sensation are transmitted together (via C fibres), a loss of ‘cold’ sensation (assessed by ethyl chloride spray) in dermatomes T5 to L2 is generally considered as evidence of an acceptable block.

ADVERSE EFFECTS

Severe neurological complications such as myelopathy, radiculopathy or meningitis are fortunately exceedingly uncommon (less than 1:100 000). Occasionally, excessive rostral spread of local anaesthetic in the CSF can precipitate a state of cardiorespiratory collapse known as a ‘total spinal’. Supportive management including, tracheal intubation, ventilation, inotropic therapy, and general anaesthesia (to prevent awareness) are required until the block recedes. More commonly encountered are the issues of hypotension and postdural puncture headache (PDPH).

Hypotension

Pregnant women are more susceptible to hypotensive episodes because of the pressure of the gravid uterus on the inferior vena cava, known as ‘aortocaval compression’. During such episodes, patients experience symptoms of nausea and light-headedness, and there is impaired uteroplacental blood flow. Hence, it is customary to tilt a pregnant woman laterally (usually to the left) at an angle of approximately 15° to the horizontal. However, tilting does not fully eliminate the problem, with evidence that compression effects may not be negated by as much as a 34° tilt (Kinsella et al, 1992).

A central neuraxial block may exacerbate supine hypotension through several physiological mechanisms associated with interruption of sympathetic neural tone. The sympathetic outflow, which extends from T1 to L2, can be disrupted by the action of local anaesthesia. The ensuing vasodilatation in the affected dermatomes and myotomes reduces systemic vascular resistance, leading to decreased systemic blood pressure. Should the sympathetic efferents to the myocardium (T1 to T4) become blocked, both heart rate and stroke volume will decrease, and hypotension will be enhanced by the reduction in cardiac output.

Traditional approaches to minimizing the effects of sympathetic block have included the use of a fluid preload before the spinal anaesthetic, and the incremental intravenous administration of a sympathomimetic (e.g. ephedrine) thereafter. In recent years, however, the value of fluid loading has been contested. Different fluid volumes (Park et al, 1996) and different rates of administration (Rout et al, 1992) have failed to show any significant

reduction in hypotension. Fluid administration may indeed generate problems. Intravascular colloid oncotic pressure is reduced in pregnancy, making obstetric patients more predisposed to pulmonary oedema. Furthermore, the temporary dilutional effects of fluid may exacerbate the existing physiological anaemia of pregnancy, leading to a reduction in fetal oxygen delivery. Finally, fluid loading may induce atrial natriuretic peptide release via atrial stretching (Pouta et al, 1996). This peptide causes a humoral vasodilatation and diuresis, and can potentiate the neurogenic hypotensive effects of spinal anaesthesia.

The use of sympathomimetics to correct hypotension is widespread and has been extensively investigated. Ephedrine is the most popular choice, although methoxamine or phenylephrine may be used less frequently. However, the latter are pure α-adrenoceptor agonists, whereas ephedrine has α- and β-adrenoceptor agonist actions, and is more likely to preserve uteroplacental circulation. Hypotension, defined as systemic blood pressure of less than 100 mmHg (or a 15% drop from baseline value), is the usual trigger for sympathomimetic therapy. Prompt treatment will prevent worsening hypotension (and fetal acidosis), and reduce the concurrent maternal nausea and vomiting (Datta et al, 1982).

Furthermore, it has been suggested that a constant infusion of ephedrine (titrated to effect) is more beneficial than intermittent boluses of the drug (Kang et al, 1982). Some authors have looked at using vasoconstrictors alone and abandoning the use of any fluid preload. Although their results are favourable (Chan et al, 1997; Husaini and Russell, 1998), there are no absolute recommendations relating to the prevention and management of hypotension during spinal anaesthesia.

PDPH

This headache characteristically occurs in the first 3 days after the spinal anaesthetic, and is thought to result from CSF leaking through the hole at the dural puncture site. It is usually, but not exclusively, felt in the fronto-occipital region and becomes worse when the patient is upright. A PDPH can occur in any patient, but is particularly common in young women. The reported incidence and severity varies (0.5–1.5%), but it is more likely when larger gauge needles have been used. In addition, the design of the needle tip is a key factor. A 'pencil-point' (e.g. Sprotte) needle is less traumatic to the dural membrane than needles featuring a cutting bevel (e.g. Quincke). The former tend to split the dural fibres, whereas the latter cut a hole in the dura, resulting in a greater incidence of headache (Cesarini, 1990). Simple hydration and analgesia may suffice as treatment, but definitive management is the injection of 20–30 ml of the patient's blood into the epidural space (at the level of the puncture), in an attempt to seal the dural tear, a procedure known as an 'epidural blood patch'.

VARIATIONS OF TECHNIQUE

A 'single shot' spinal anaesthetic is employed by the majority in clinical practice. Alternatively, 'continuous spinal anaesthesia' has been accomplished by introducing a microcatheter intrathecally through a spinal needle. This enables local anaesthetic dosage to be titrated in conditions where a single dose may act unpredictably. Such patients might include those with severe musculoskeletal disorders or cardiac valvular lesions (Pittard and Vucevic, 1998; Pouta et al, 1996). Disadvantages of the technique include the technical difficulties in handling very fine catheters; several case reports of cauda-equina syndrome have been associated with their use.

TABLE 1.
Contraindications to spinal anaesthesia

Absolute	Patient refusal	
Relative	Coagulopathic states	
	Hypovolaemia	Uncorrected
	Sepsis	Systemic
		Local
	Cardiac conditions limiting stroke volume and heart rate	Aortic stenosis
		β blockade
	Spinal and neuropathology	Spina bifida
		Spinal fusion

Another modification of the technique is the 'combined spinal–epidural', where the epidural space is identified using a Tuohy needle, and a spinal needle introduced through this to puncture the dura. Local anaesthetic solution in injected down the spinal needle, which is then withdrawn. An epidural catheter is then inserted via the Tuohy, to enable the spinal blockade to be augmented by epidural local anaesthetic alone (or with opioid) if necessary (e.g. prolonged surgery). While beneficial in certain circumstances, the technique often involves rotating the Tuohy needle within the epidural space, increasing the risk of accidental dural puncture and consequent headache (Moore and Cowan, 2000). Currently, it has not generally replaced the standard single shot spinal injection.

APPLICABILITY

Spinal anaesthesia is applicable for patients undergoing obstetric interventions, although there are notable contraindications (*Table 1*).

This article has concentrated on the technique of subarachnoid anaesthesia for caesarean section, but it can be adapted for other situations in obstetric practice (e.g. retained placenta, forceps delivery, and labour analgesia). Although most commonly employed for elective caesarean sections, a skilled clinician can institute a block quickly enough to perform the procedure in an emergency. The technique has been refined to such a degree that even procedures on patients with pre-eclampsia (Sharwood-Smith et al, 1999) or placenta praevia (Bonner et al, 1995) may be performed under spinal anaesthesia. As spinal anaesthesia has evolved, it has gained widespread acceptance to both clinicians and patients. The safety, versatility and popularity of the technique has established it as the anaesthetic of choice for almost all obstetric interventional procedures. **HM**

Conflict of interest: none.

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KEY POINTS

- Spinal anaesthesia for caesarean section has a number of benefits, including the airway remaining unjeopardized, reduced maternal morbidity and improved neonatal Apgar scores.
- It is a predictable, effective, rapid technique.
- The drugs used are bupivacaine (heavy) and increasingly opioids.
- Side-effects of spinal anaesthesia for caesarean section include hypotension and headache.