

Obstetric Regional Anesthesia

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History of Regional Anesthesia for Obstetrics

The possible detrimental effects of chloroform and ether on uterine activity were realized at a relatively early stage. John Snow, a pioneer anaesthetist who administered chloroform for labor analgesia to Queen Victoria, wrote "it was said that, in some of the early cases in which chloroform was employed, the uterine contractions were so enfeebled by it that delivery had ultimately to be accomplished by forceps". Since Oscar Kreis (an assistant obstetrician) administered the first spinal for obstetric use at the Women's hospital in Basel in 1900, regional techniques for control of labor pain revealed their advantages. The term "Controllable spinal anesthesia" was used in 1928 by George Pitkin. He popularized spinal anesthesia for labor in the USA by describing the techniques, safety precautions and anatomical considerations. The first use of caudal analgesia for labor pain was studied by Walter Stoeckel in 1909. It was not until 1936 that Charles Odom, a surgeon at the Charity Hospital of Louisiana, reported the first successful use of lumbar epidural analgesia for a caesarean section. Catheter techniques for continuous epidural analgesia were described by Curbelo of Cuba in 1949 but its use for parturient was described by Flowers et al in 1949. Philip Bromage, who played a major role in popularizing the techniques, wrote "Continuous epidural anesthesia is not a technique for the occasional anaesthetist, it does require a degree of skill and judgement which is unlikely to be attained without special training and experience"¹.

Physiology of Labor Pain

Labor pain has visceral and somatic elements. The visceral element is conveyed via A δ and C fibres and is caused by distension of the uterine body and cervix. These fibres run with sympathetic fibres, though different plexuses, to enter the sympathetic chain and from there, they gain access to the dorsal horn of the spinal cord through the white rami communicants entering

is initiated only if intrauterine pressure exceeds 25 mmHg. Early labor pain is referred to T11-T12 dermatomes and thus perceived as lower abdominal and backpain. The somatic pain is caused by distension of the pelvic floor, perineum and vagina and is transmitted by A δ fibres via the pudendal nerve (S2-4)².

Considering these pathways, the following regional techniques have been described for control of labor pain/pain associated with caesarean section (CS)³:

- Central blockades:
 - Lumbar epidural anesthesia.
 - Caudal epidural anesthesia.
 - Spinal anesthesia (subarachnoid block).
 - Combined spinal epidural anesthesia (CSE).
- Pudendal nerve block.
- Paracervical block.
- Lumbar sympathetic paravertebral block.
- Local perineal infiltration.

N.B.: The old debate about using the word "anesthesia" to describe regional techniques no longer exists as the effect of these techniques includes a degree of muscle relaxation as well.

Incidence of Regional Anesthesia

A study looking at the rate of CS and the use of regional anesthesia over the period 1987-2002 in a UK region revealed that the CS rate rose from 12.7% in 1987 to 24.2% in 2002⁴. The rate of regional anesthesia for elective CS rose from 69.4% in 1992 to 94.9% in 2002, when spinal anesthesia was used for 86.6% of cases³. Various factors, all related to improved maternal and foetal safety are responsible for this increase². Interestingly, all 6 deaths attributed directly to anesthesia in the last report of Confidential Enquiry into Mother and Child Health (previously known as Confidential Enquiry into Maternal Deaths) covering the period 2000-2002, were associated with the use of general anesthesia^{4,5}.

Effects of Regional Blockade on Materno-Fetal Physiology³

Pain relief leads to a reduction in serum catecholamines by decreasing physical stress or by denervating the adrenal medulla with subsequent enhancement of uterine blood flow. Hypotension occurring secondary to central

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the dorsal nerve roots of T10-12 and L1. This pain

blockade decreases uterine blood flow as uterine perfusion pressure is dependent on maternal mean arterial pressure with minimum capacity for autoregulation. Avoidance of maternal hypotension prevents any derangement of umbilical artery blood flow². Aortocaval compression is compensated for by sympathetic hyperactivity. Regional blockade may diminish this reflex but on the other hand venous dilatation of vertebral and paraspinal veins draining into the azygous compensates for minor degree of aortocaval compression. Provided prolonged hypotension is avoided, improved foetal outcomes with epidurals are known to occur secondary to improved placental haemodynamics. Reduced perioperative blood loss is associated with regional anesthesia (e.g. for placenta previa)¹. This has been attributed to avoidance of inhalational agents (all have uterine relaxant effects to a varying degree) and reduced pelvic venous plexuses pressures due to venodilatation. Early ambulation is another documented benefit of regional techniques which is caused by both direct effects (avoidance of depressant effects of general anesthesia) and indirect causes (elimination of stress response by the pre-emptive effect of regional blockades). Pain scores postoperatively are much lower postoperatively when a regional technique is used. This is reflected as a decrease in opioid requirements which leads to better somatosensory profiles for the mother and baby³. Avoidance of general anesthetic effects on the baby is reflected as less postpartum interventions and early feeding. This is of particular value when a long predelivery phase (e.g. patients who had previous CS) is expected. Epidural improves incoordinate uterine activity unless severe hypotension ensues².

Central Blockades

The commonest indication for central blockades is maternal request for adequate pain control during labor and/or Caesarean sections³. A list of other indications might also be considered such as pre-eclampsia, cardiorespiratory diseases were graded controlled change in cardiorespiratory reserve provided by an epidural blockade is advantageous¹. In patients with a potentially difficult airway and the morbidly obese patients, despite the known technical difficulties and hazards, a lumbar epidural has its appreciated advantages. Patients with malignant hyperthermia are another group². When it comes to contraindications, patient's refusal is an absolute one. Coagulopathy, induced or acquired, is a matter of great debate. Full anticoagulation with heparin or oral anticoagulants is an absolute

contraindication (this can be confirmed by INR, PTT respectively. Normalisation is essential before central blockade is attempted). Low molecular weight heparin (LMWH) is used extensively for parturients who have history of thromboembolism (TE) or thrombophilia caused by deficiency of naturally-occurring anticoagulants as protein C, S and factor V Leiden. Various protocols exist regarding regional central blockades in these patients. In some centres, a predetermined time interval is required after the last dose of LMWH, 12 hours for instituting a block or removal of a catheter, 2 hours after a block is instituted before the next dose of LMWH can be administered. Other authorities monitor factor anti-Xa (kept between 0.05 and 0.3 U/ml) routinely in these patients as a guide. In vitro coagulation tests are very unlikely to be affected by LMWH and are entirely unreliable for monitoring. Platelet counts of $80 \times 10^6/L$ or above is satisfactory for a central blockade. Thromboelastography (TEG) is recommended for platelet count $50-80 \times 10^9/L$ or when platelet function is a matter of question. The maximum amplitude (MA) is the parameter to consider when TEG is applied. A MA of 60-80 mm is acceptable in the third trimester. Platelet count $<50 \times 10^6$ is considered a relative contraindication to central blockades. Aspirin is no longer a matter of debates when it comes to central blockades as it has a well established safety profile^{1,3}.

Maternal pyrexia was always a question of safety of central blockades. Bader et al observed no cases of CNS infections after a series of epidural blocks in patients with chorioamnionitis⁷.

Other studies documented the same results for patients undergoing central blockades for gynaecological and obstetric procedures associated with bacteraemia. The current recommendation is administration of antibiotics before the central blockades are instituted in such patients. Other classic contraindications include raised intracranial tension (risk of coning), local skin infection, inadequate resuscitation facilities and lack of trained medical staff to provide the care service required³.

Spinal Anesthesia (Subarachnoid Block)

Spinal anesthesia is defined as instillation of local anesthetic solution in the vertebral subarachnoid space. The major advantages this technique provides is related to the close proximity of the site of local anesthetic administered compared to epidural anesthesia where multiple tissue layers have to be penetrated before reaching the site of action². This result in

smaller dosage, more effective and reliable block (solid block) compared to that provided by other techniques which makes it an ideal choice for caesarean sections where good muscle relaxation is required. Spinal anesthesia is usually performed at L3-L4 intervertebral space since the spinal cord ends at L1. Less commonly used is the paramedian approach. A catheter technique is available in some countries for continuous spinal anesthesia².

Epidural Anesthesia

The overall epidural rate in the UK and the USA is between 25-30% with rates up to 80% for primiparae in some centres^{1, 2, 3}. The site of administration of local anesthetics differs greatly from spinal anesthesia as the solution is instilled outside the dura without actual direct mixing with CSF. The local anesthetic solution bathes the nerve roots on their exit from the intervertebral foramina. This process is slowly occurring and incomplete at the same time allowing slower onset, longer duration of action and less haemodynamic consequences with less motor block compared to spinal anesthesia. The width of lumbar epidural space varies between 5-8 mm making it ideal for epidural block. Several techniques are used to detect the space including loss of resistance to air or saline, hanging drop technique and ultrasound-guided localisation of the epidural space. Classically, epidural anesthesia was considered more appropriate compared to spinal anesthesia in pre-eclamptic patients for the controlled haemodynamic response. This point is arguable now as both have shown similar safety profiles in controlled studies in patients with pregnancy-induced hypertension (PEH). Patient-Controlled Epidural analgesia (PCEA) is a new system of drug delivery through the epidural catheter where the patients actively triggers an automated pump to deliver a set dose of local anesthetic at a predetermined time intervals that are adjusted according to the maximum safe dose allowed within a time interval. Improved patient's satisfaction as well as reduced burden on the caring staff is the main advantages⁸.

Caudal Anesthesia

This techniques is essentially a sacral epidural block performed through the sacrococcygeal membrane which is the membrane covering the lower end of the vertebral canal; the sacral hiatus. Despite the simplicity of the technique (easily identified landmarks, less incidence of neurological complications due to the remote

insertion point), the inconvenience of catheters in this area and the potential of contamination from the nearby structures made it much less popular. Caudal Anesthesia is considered more appropriate for gynaecological procedures as a supplementary mode of analgesia by a single-injection technique.

Combined Spinal Epidural (CSE) Anesthesia⁹

The technique is usually performed by a needle-through-needle approach. An epidural needle is used to identify the epidural space then a spinal needle is passed through it to perform the subarachnoid block after which the spinal needle is withdrawn and an epidural catheter is threaded for subsequent use. This approach combines the speed on onset and reliability of the spinal block with the durability and flexibility of epidural block. Care should be taken as further epidural doses should be reduced after the spinal block. Commercially available kits might be used or conventional spinal and epidural needles (compatibility of both needles together has to be verified first)¹. Compared with epidural, CSE provides faster onset of effective pain relief from the time of injection, and increases the incidence of maternal satisfaction. However, CSE women experience more itch. There is no difference between CSE and epidural techniques with respect to: the incidence of forceps delivery, maternal mobility, post dural puncture headache, cesarean section rates or admission of babies to the neonatal unit. It has not yet been possible to reach any meaningful conclusions regarding rare complications such as nerve injury and meningitis.

Effect of Epidural Anesthesia on the Progress of Labor^{1, 6, 10}

This issue has always been controversial, possibly because of bias of selection criteria during many of the researches done in that field. Currently the Cochrane database conclusion is that Epidural analgesia appears to be effective in reducing pain during labor. However, women who use this form of pain relief are at increased risk of having an instrumental delivery. Epidural analgesia has no statistically significant impact on the risk of cesarean section, maternal satisfaction with pain relief and long-term backache and does not appear to have an immediate effect on neonatal status as determined by apgar scores. Further research may be helpful to evaluate rare but potentially severe adverse effects of epidural analgesia on women in labor and long-term neonatal outcomes. There is insufficient evidence

to support the hypothesis that discontinuing epidural analgesia late in labor reduces the rate of instrumental delivery. There is evidence that it increases the rate of inadequate pain relief in the second stage of labor. The practice of discontinuing epidurals is widespread and the size of the reduction in instrumental delivery rate could be clinically important; therefore, a larger study remains to be undertaken to determine whether this effect is real or not, and to provide stronger evidence about the safety aspects.

Complications of Central Blockades

Hypotension occurs due to blockage of preganglionic sympathetic fibres. Incidence varies from 3-17% according to the study protocol. Aortocaval compression is a contributing factor managed by fluid preloading and suitable pharmacological agents². Post dural puncture headache (PDPH) follows accidental dural puncture during citing an epidural block or intentional dural puncture for subarachnoid (spinal) block. The mechanism of headache is not entirely understood but it has been attributed to CSF leak with subsequent traction on the nerves, another view is the reflex cerebral vasodilatation caused by decreased intracranial pressure (this has been documented radiologically)¹. Onset is very variable; from the first hour to the 3rd postpuncture day is the commonest. Clinical picture includes postural headache, photophobia with or without neck stiffness. Double vision due to affection of 6th cranial nerve may occur. The incidence varies greatly with the size of the¹ needle as the headache is related to CSF leak. 16G epidural needles have a PDPH of 75% compared to 1-2% incidence when a 25G spinal needle is used for subarachnoid block. Treatment includes caffeine, sumatriptan and ACTH which have a much lower success rate when compared with epidural blood patch (25% Vs 75%). Epidural blood patch even has a higher success rate on repetition (85% and 95% on second and third patches)¹. Unilateral block/Partial block; these occur due to midline anatomical barriers, deformity of vertebral canal or partial dislodgment of the epidural catheter. Subdural block is another commonly missed factor. Reciting the epidural catheter might be the only solution¹.

Long-term neurological sequelae are extremely uncommon with central blockades. Ranging from subtle reversible sensory loss (1/10,000) to paraplegia (1/450,000), neurological sequelae have been well reported after normal vaginal delivery since 18th century. Mistakenly blamed on central blockades, they are known to occur

after as a consequence of cephalopelvic disproportion or forceps application (lumbosacral trunk compression as it crosses the pelvic brim), Lithotomy position (common perineal nerve, rarely femoral nerve), compression of blood supply of conus medullaris during delivery (paraplegia). Exceptionally, cauda equina syndrome was found to be directly related to the use of spinal microcatheters and lignocaine 5% solution which lead to its withdrawal from the USA market shortly after. Backache is common in pregnancy occurring in 50% of women. MRI studies have demonstrated lower lumbar superficial tissue oedema regardless of the use of epidurals. The importance of backache following a central blockade is that it might be a symptom of more serious complication (abscess, haematoma)¹¹. Misplacement of the block is a known complication of caudal blocks with reports of accidental injection into the rectum, foetal head and subperiosteally. The placement of epidural catheters subdurally occurs with a characteristic clinical picture of patchy block that's higher than expected with minimal motor block and slower onset of action. Local anesthetic toxicity is known to occur following accidental intravascular injection or absolute overdosage with high levels of local anesthetics in plasma². Accidental catheter migration with epidural blocks is known to occur. The low dose of local anesthetic used for spinal anesthesia is very unlikely to cause toxicity. It presents as circumoral numbness, slurred speech, confusion, loss of consciousness, convulsion and cardiovascular collapse. Treatment is mainly supportive and survival rates are more than 90%². Total spinal anesthesia results from either using a high dose of local anesthetic during spinal anesthesia or the undetected migration of an epidural catheter to the subarachnoid space. The clinical picture is caused by blockage of sympathetic outflow from the spinal cord and possibly, in severe cases, from migration of local anesthetic solution into the brain tissue. Supportive measures are all that is required and may include mechanical ventilation, inotropic support¹. Epidural haematomas are rare (1/240,000 following epidurals, 1/170,000 following spinal anesthesia). Backpain and neurological impairment should warrant an immediate CT scan for proper early diagnoses and management in these cases. Spinal decompression is the surgical treatment. Epidural abscesses are quite rare (1/10,000) and reports of spontaneous cases in hospital patients without central blocks exist with same incidence. When opioids are used for epidural blocks along with local anesthetics, they presents their own side effects such as respiratory depression (occurs

more commonly with morphine, detected by studying oximetry during labor and rarely represents a problem in clinical practice), Urinary retention (caused by inhibition of sacral parasympathetic outflow, bladder outlet obstruction by the presenting foetal part is a contributing factor), Pruritis (the most common, caused by interaction with the trigeminal nucleus via the anterior spinal artery, treated by naloxone, antihistamines and subhypnotic dose of propofol)¹

Non-Central Blockade Regional Anesthetic Techniques

These techniques are to be employed when the local facilities for central blockade are not available or in presence of a contraindication.

Paracervical Block

Introduced by Rosenfeld to the USA in 1945, paracervical block gained wide popularity with an incidence of up to 7% reported in 1993. It aims at blocking Frankenhäuser's ganglion which contains all the visceral sensory nerve fibers from the uterus, cervix, and upper vagina¹. It provides analgesia only for the first stage of labor since the perineal somatosensory supply is not affected². The block is performed with the patient in the modified lithotomy position. The obstetrician introduces the needle to the left and right vaginal fornices, near the cervix at 4 o'clock and 8 o'clock positions. The needle is advanced through the vaginal mucosa for a depth of 2-3 mm. careful aspiration is mandatory before 5-10 ml of 0.25% plain bupivacaine is injected. Observing the foetal heart rate for 5-10 minutes is mandatory between the two injections. Despite the variety of maternal complications reported, they are relatively rare. They include; vasovagal syncope, laceration of the vaginal mucosa, systemic local Anesthetic toxicity, parametrial haematoma, postpartum neuropathy and paracervical, retrosoal or subgluteal abscess¹. In contrast, foetal complications tend to be much more common with reported incidence of foetal bradycardia up to 70% in some studies. The exact cause of foetal bradycardia remains unclear. Manipulations close to foetal head may cause reflex bradycardia. Direct foetal central nervous system and myocardial depression as a result of large doses of local Anesthetic injected in close proximity to foetoplacental circulation has also been suggested as a cause. When the block is performed in presence of advanced (>8 cm) cervical dilatation, the incidence of injection into foetal scalp is increased with subsequent systemic local Anesthetic toxicity. Increased uterine activity is

another reported complication. Uterine and/or umbilical artery vasoconstriction may occur. The blind nature of the techniques also exposes the physician to a needle-stick injury².

Considering the wide range of complications associated with paracervical block, it is recommended to perform it only on healthy patients with no evidence of uteroplacental insufficiency¹.

Lumbar Sympathetic Block

Paravertebral lumbar sympathetic block was first described by Dellepiane and Badino in obstetric patients in 1927. It aims at blocking uterine and cervical visceral afferent sensory fibres as they join the sympathetic chain at L2 to L3. Like the paracervical block, it provides analgesia only for the first stage of labor but not the second stage¹. A major advantage of this block is motor sparing and safety in many situations where epidural Anesthesia might be contraindicated or baring a high failure rate (e.g. after complicated back surgery). The main disadvantages are the pain associated with performing the block and hypotension (15%). Other rare complications include systemic local toxicity, total spinal Anesthesia, retroperitoneal haematoma and Horner's syndrome. The technique relies on injection of local Anesthetic just anterior to the medial attachment of the psoas muscle at the level of the second lumbar vertebrae on both sides².

Pudendal Nerve Block

First reported by King in 1916 for pain control during the second stage of labor, pudendal nerve block is commonly performed by obstetrician in patients without spinal or epidural analgesia. The pudendal nerve carries somatic nerve fibres from the anterior primary divisions of the second, third and fourth sacral nerves. The technique aims at blocking the nerve distal to its formation but proximal to its division into its terminal branches (i.e., dorsal nerve of the clitoris, perineal nerve and inferior haemorrhoidal nerve)².

The technique is based on bilateral injection of 10 ml of local Anesthetic solution medial and posterior to the ischael spine after introducing the needle through vaginal mucosa and sacrospinous ligament. Another percutaneous approach has been described but it is less commonly applied. Careful aspiration is a must as pudendal artery lies in close proximity to the nerve¹. Complications include systemic toxicity, laceration of vaginal mucosa, vaginal and ischeorectal haematoma and subgluteal abscess.

As paracervical block, direct injection into foetal tissues and needle-stick injuries are a potential risk.

Pudendal nerve block may provide satisfactory analgesia for spontaneous vaginal delivery and outlet forceps delivery but it is entirely inadequate for mid forceps delivery, cervical repair and manual examination of the uterus¹.

Perineal Infiltration

Despite inadequacy in 40% of patients, perineal infiltration is the most commonly used technique among all the abovementioned ones. Highest serum level of local anesthetic in the mother and foetus are reached with this technique compared to the others. Few cases of injection into foetal scalp have also been reported².

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