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SPINAL ANESTHESIA INDUCED COMPLICATIONS IN CAESAREAN SECTION - A REVIEW

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Abstract:
Spinal anesthesia is a technique of introducing anesthetic drugs into the subarachnoid space to abolish temporarily the sensory and motor functions of several groups of spinal nerves. Spinal anesthesia recently has gained popularity for cesarean section. The change in attitude that has taken place is related to an increased awareness that regional block methods are safer for both mother and infant. Although spinal (subarachnoid or intrathecal) anaesthesia is the most reliable types of regional block methods, the possibility of complications has long been recognized. Dealing with a spinal anaesthetic which is in some way inadequate can be very difficult; so, the technique must be performed in a way which minimizes the risk of regional block. This review has considered some complications: hypotension, post dural puncture headache, vomiting, shivering, total spinal and backache etc. Techniques for minimizing the possibility of complications are dsiscussed, all of them requiring, in essence, close attention to detail. Options for managing the complexities include monitoring of the vitals, choice of an anesthetic, fluid preloading, anesthetist awareness before caesarean section and adherence to the proper procedures and principles in case of complications. Therefore this paper aims to bring out some complications and the management procedures necessary for safe caesarean section.

Keywords: spinal anesthesia, complications, management.

Introduction:

Anesthetic techniques currently available for caesarean delivery are general and regional anesthesia. [1]Regional anesthesia is used for 95 percent of planned caesarean deliveries in the United States. [2] It is the preferred option as far as balancing risks and benefits to the mother and her fetus is concerned. Spinal anesthesia for caesarean section is advantageous due to simplicity of technique, rapid administration and onset of anesthesia, reduced risk of systemic toxicity and increased density of spinal anesthetic block. Both spinal and epidural techniques are shown to provide effective anesthesia for caesarean section. Spinal anesthesia has a shorter onset time, but treatment for hypotension is more likely if spinal anesthesia is used. [3]

The technique of introducing anesthetic drugs into the subarachnoid space to abolish temporarily the sensory and motor functions of several groups of spinal nerves was introduced by Bier fifty years ago. [4] In spite of its usage and advantages since the 1800s, a number of complications led to the decrease in the popularity of this technique.[5] Reasons for high morbidity and mortality associated with spinal anesthesia may include inadequate experience and training of the anesthetist, inappropriate use of the technique in mothers with significant co-morbidity, the performance of both anesthesia and surgery by the same practitioner and neonatal resuscitation by the anesthetist at the expense of dedicated care to the mother Many problems are avoidable or amenable to treatment by attention to details of safe practice, intended to supplement the document on spinal anesthesia.[6]

Search strategy;

For this review 'Google' database was searched using the terms 'obstetric anesthesia' ,'complications of spinal anesthesia', 'side effects of spinal block for a c-section', and 'failed spinal anesthesia: mechanism, management and prevention'. Relevant articles were retrieved as were any possibly relevant papers in their reference lists. Supporting searches were performed on subjects that may not have been otherwise identified, specific examples being anesthesia and resuscitation and preeclampsia.

Preoperative Mechanisms

Anxiety;

The preparation required for RA is stressful for the patient, and can result in anxiety-related physiological changes. Vasovagal episodes are not uncommon and are more severe when the patient is in the sitting than the lateral position. Severe episodes can result in maternal asystole and fetal compromise. Anxiolytic premedication is usually omitted as it causes neonatal depression, but when the mother is very anxious, 1mg of midazolam IV can help in preventing vasovagal episodes. [24]

Preoperative care;

Preoperatively, women should be assessed and given adequate information regarding the regional technique. Antacid premedication and, in elective cases, an appropriate starvation period are mandatory. Regional anesthesia should be established in the operating theatre, with both maternal and fetal monitoring in progress. Single-shot spinal is currently the most popular technique. Before surgery starts, assessment and documentation of the blockade are essential. Sensory block to light touch, and/or cold, should be measured. Surgery should be halted, if there is pain. Analgesic options include Entonox, intravenous opioids or ketamine and local infiltration. All women should be followed up within 24 hours by the anesthetic team. [9]

Positioning of the patient;

The patient should be placed on a firm surface; the lumbar laminae and spines must be 'separated' maximally by flexing the whole spine, the hips, and knees; rotation and lateral curvature of the spine are avoided; these points can be applied to lumbar puncture in both sitting and lateral horizontal positions; the former is usually an easier option in 'difficult' patients, but sometimes the reverse is true. The role of the assistant in achieving and maintaining the patient in the correct position cannot be underestimated. [33]

Needle insertion;

Accurate identification of needle insertion can be difficult using clinical land-marks, as third lumbar inter-space is usually used, but examination may indicate that another is preferable. However, care should be taken not to venture too cephalad and risk damage to the spinal cord. With the midline approach, insertion should start precisely in the mid-line, mid-way between the posterior spines, with the needle shaft at right angles to the back. Small, incremental changes in needle angle should be made only if there is resistance to advancement; if resistance is met, cephalad angle should be tried first, and such angulation may be appropriate from the start if the patient is unable to flex fully (e.g. the obstetric patient). Caudad angle is sometimes needed, with a slight lateral direction being required very rarely.

It is recommended that the anaesthetist should have a good knowledge of spinal anatomy and relate these to changes in tissue resistance as the needle is advanced. The above points apply specifically to the midline approach; especially if the mid-line ligaments are heavily calcified. However, in the face of difficulty, the same basic rules apply: make sure that the patient is in the correct position and that the correct angles and insertion technique are used.

Solution injection errors;

Although the appearance of CSF in the needle hub is an essential pre-requisite for spinal anaesthesia, but the successful blockade is not guaranteed and therefore requires an effective dose and its actual deposition in the CSF. [10]

Anesthetist awareness;

Those responsible for providing anesthesia for caesarean section must be fully aware of the basic principles involved. When selecting the type of anesthetic to be used, the anesthetist must take into consideration

his or her own experience and that of the surgeon, the condition of the patient, the degree of urgency, the availability of equipment and drugs, [3] maternal preference, coexisting medical problems and the indication of the operation. [8]

Anesthetic used and dose selection;

The actual dose chosen will depend on the specific local anaesthetic used, the baricity of that solution, the patient's subsequent posture, the type of block intended, and the anticipated duration of surgery. Thus, knowledge of the factors influencing intrathecal drug spread and clinical experience with any particular local anaesthetic preparation are important guides to choosing an effective dose. [34]

However, hyperbaric bupivacaine is most widely used in obstetric surgery because of its rapid onset and predictable duration of sensory blockade. The correct dose and volume of subarachnoid bupivacaine should be injected at the appropriate level. Most units administer 9 - 12 mg of hyperbaric 0.5% bupivacaine (1.8 - 2.4 ml) with 10 - 20 μg of fentanyl at the L3/4 interspace, using a 25G pencil point spinal needle. Injection at or above L2/3 may rarely result in damage to the conus medullaris of the spinal cord, with the development of a syrinx and permanent neurological injury. [7] Moreover, dosage per height is given in table below.

Table 1. Local Anesthetics Commonly Used For Cesarean Section Delivery with Subarachnoid Block

Dosage per height of patient(cm)	**Bupivacaine 0.75% in 8.25% dextrose (mg)**	**Bupivacaine 0.5% (isobaric) (mg)**
150-160 cm	8	8
160-180 cm	10	1o-12.5
>180 cm	12	12.5-15
Onset of action	2-4min	5-10min

Injectate Leakage prevention;

The Luer connection between syringe and needle provides a ready opportunity for leakage of solution. A particular variant of this problem being a leak through a defect at the junction of needle hub and shaft.Given the small volumes involved, the loss of even a few drops may cause a significant decrease in the mass of drug reaching the CSF, and thus in its effectiveness. To avoid this, it has long been conventional teaching that the syringe containing the injectate must be inserted very firmly into the hub of the needle, and that a subsequent check is made that no leakage occurs. [10]

Complications (intraoperative and postoperative) of SA for Caesarean Section and Management

Complications associated with spinal anesthesia may be classified as minor or major. Minor complications consist of limited, transient (if treated) alterations in physiological status of the patient. Minor complications include arterial hypotension (autonomic block) [35],nausea and vomiting, excessive cephalad spread leading to respiratory insufficiency, post-lumbar puncture headache (PLPH; more common with larger needles and younger patients),[6] and back pain. Major complications include isolated nerve injuries, meningitis, cauda equine syndrome and other neurological dysfunctions, but these occur infrequently. Although minor complications occur more commonly, they are in general, easily managed.[35]Some complications may result from the introduction of needles, drugs or foreign material into the subarachnoid space.[4]Complications of spinal anesthesia are discussed below:

Hypotension;

Hypotension is the most common problem during caesarean section associated with maternal nausea and vomiting and the risk of fetal and neonatal acidosis. Crystalloid pre-loading confers no benefit, whilst

colloid [11] or 500ml of balanced salt solution [12] pre-loading is beneficial. The vasopressor of choice, according to most contemporary experts, is phenylephrine. Lowering the intrathecal dose of bupivacaine seems to be a useful technique as well to reduce the incidence of hypotension. However no prophylactic technique can successfully eliminate hypotension. A combined approach using colloid pre-loading, vasopressors and a low dose CSE is probably the best option to provide anesthesia for caesarean section. [11] Monitor the blood pressure and heart rate. The mother should be positioned with a wedge under her right hip to achieve 15 degrees of left lateral tilt in order to minimise aorto-caval compression. [12]

However the incidence of hypotension, as defined by a 30% decrease in mean BP, is less in patients with severe preeclampsia undergoing spinal anesthesia for caesarean delivery, as compared with healthy parturient . In addition, the magnitude of the decrease in mean BP is smaller in severely pre-eclamptic patients. [13] Moreover hypertension is not a complication or hazard as it can be successfully managed with volume loading, vasopressors and left uterine displacement. When transient, it is without effects on the fetus. [14]

Nausea and vomiting;

Nausea and vomiting during regional anesthesia for cesarean section are very common and unpleasant events. They cause significant distress to the patient and also interfere with the surgical procedure. They have multiple etiologies, which include hypotension, vagal hyperactivity, visceral pain, i.v. opioid supplementation, uterotonic agents and motion.

Intraoperative nausea and vomiting can be best prevented by controlling hypotension, optimizing the use of neuraxial and i.v. opioids, improving the quality of block, minimizing surgical stimuli and judicious administration of uterotonic agents. Although prophylactic antiemetics have been advocated during cesarean sections, strict adherence to these practices can effectively lower the incidence of intraoperative nausea and vomiting without the requirement of antiemetic agents. Antiemetics, therefore, should be reserved for the prevention of intraoperative nausea and vomiting in high-risk patients. [15]

Backache;

Backaches related to spinal anesthesia may result from tissue trauma during insertion of the spinal needle through the layers of skin, fat, muscles and ligaments. It's unclear whether spinal anesthesia specifically causes back ache. Patients usually describe pain as mild soreness or aching. In rare cases, back ache can signal the presence of more serious problems such as a localized collection of blood, known as a hematoma, or a localized collection of pus, known as an abscess.

Once hematoma and abscess have been ruled out, patients can manage pain with warm or cold compresses or acetaminophen. Most cases resolve within a few weeks.

High spinal block or total spinal;

The medication used to induce spinal anesthesia travels higher than intended within the spinal cord, a condition refer to as high neural blockade, high spinal block or total spinal. This condition occurs most often in obese or short women, and in women who are sensitive to anesthesia. [16] This may result in hypotension, bradycardia and difficulty in breathing. [17] Patients often complain mild shortness of breath and numbness or weakness in the arms, shoulders and trunk, followed by nausea, with or without vomiting.

High spinal block may be frightening, but it is not life threatening. [16] Hypotension is due to venous and arterial vasodilation resulting in a reduced venous return, cardiac output and systemic vascular resistance. It should be treated with volume infusion and

vasopressors. Bradycardia can be treated with anticholinergic agents, like atropine, or ß-adrenergic agonists, like ephedrine. Cardiac arrest may occur due to hypotension and hypoxaemia. Prevent this by adequate ventilation and use of vasopressors. [17]

Management consists of supplemental oxygen, volume infusion and intravenous drugs like ephedrine that rapidly correct heart rate and blood pressure. Hence management is supportive and dependent on degree and height of block. Early recognition is vital as block progression may be mitigated. Typical features can be managed as follows: [16]

Loss of Consciousness;

This is usually due to severe hypotension from a high spinal block. On occasion a patient can lose consciousness while haemodynamically stable, and this has been attributed to subdural spread of anaesthesia. Here the signs of cephalad extension of the block are usually slower than with an immediate total spinal block, and patients may complain of dyspnoea, weakness of the arms or dysarthria. There may be no warning before the loss of consciousness (LOC) suddenly occurs some time after the block has been inserted. Other causes of LOC during CS include air or amniotic fluid embolism, pulmonary embolism, inadvertent sedative drug administration or hysteria. These require systematic exclusion. [24]

Post-dural puncture headache (PDPH);

Another problem with spinal anesthesia in obstetrics has been the high incidence of postdural puncture headache (PDPH). The leak of cerebrospinal fluid through the puncture site and the resultant traction of intracerebral contents is a reasonable aetiology. [18] The smallest pencil point needle (27 to 25G) should be used. On using a cutting needle, the bevel should be aligned parallel to the fibres of the dura. This reduces the risk of headache. Bupivacaine (plain or hyperbaric) .The use of an opioid allows for the reduction of the dose of local anesthetic and provides early post-operative analgesia. [12]

The management of the headaches consists of rest in bed in the supine position, analgesics, adequate hydration, improved needles, aseptic techniques, psychotherapy, tight abdominal binders, patient selection and injection of normal saline is necessary. [19,20,21] The definitive treatment of the spinal headache is the epidural blood patch (EBP).[22] The amount of blood which should be used for patch has been widely debated. It appears that 12-20 ml should be injected and injection should be stopped if the patient complains of back or leg pain. [23]

Shivering;

This can be a troublesome side effect of RA for CS for both the mother and the anesthetist. It interferes both with maternal comfort and monitoring. Moreover, shivering increases maternal oxygen consumption and particular efforts should be taken to avoid shivering when other pathology resulting in maternal or fetal hypoxaemia is present. The aetiology of shivering associated with SA is complex and poorly understood. It occurs in women who have both low core temperatures (thermoregulatory shivering) and core temperatures greater than 38.0°C (nonthermoregulatory shivering). Skin warming with a forced-air warmer, maintaining an adequate environmental temperature and avoidance of prolonged skin exposure and cold intravenous fluids can help in reducing shivering. [24]

Neurologic Complication;

Regional anesthesia can lead to serious neurological complications but fortunately they are rare. Permanent transient neurologic complications are estimated to be 1/1,000 and 1/1,000,000. The spinal needle may touch the spinal cord, nerve root or peripheral root and can direcly injure the

spinal cord. [25] Pressure exerted by a needle on spinal nerve roots produces immediate pain and necessitates repositioning. [26] Cauda equine syndrome is another complication. Rigler and others postulated that neurotoxic injury may be resulted due to the combination of trauma, maldistribution and a relatively high dose of local anesthetic given.[25]

Moreover, Schneider et al reported transient neurological symptoms in 1993 involving the development of severe radicular backpain after administering lidocaine spinal anesthetic. [27] Zoric et al analyzed that the risk of developing TNS can be increased by the use of lidocaine in spinal anesthesia. However there was no evidence that this condition was associated with neurologic pathology and that the symptoms disappeared by the fifth postoperative day. The risk of developing TNS was higher with lidocaine than with bupivacaine, prilocaine or procaine.

Hence early intervention is the key to success in managing these potentially devastating complication prompt diagnosis and early surgical management is indicated. [28]

Infective complications;

Meningitis and abscesses occur infrequently. Strict aseptic techniques should always be used when administering RA, including wearing face masks, as Streptococcus viridians from the oropharynx of anesthetists has been associated with meningitis. There is often concern about introducing spinal infection when a patient has another infection such as chorioamnionitis. If the patient is haemodynamically stable, the fever low-grade and antibiotics have been administered for safe abministration of spinal anesthesia. [24]

Hearing Loss;

Low-frequency hearing loss has been reported after SA. Usually this is minor and transient, but it can be permanent and disabling, particularly when associated with vertigo and tinnitus. [29] This problem has been attributed to CSF leakage, causing a reduction in perilymph pressure in the cochlea. [30] Cutting type needles of larger gauges (22G) are associated with a higher incidence of this complication than when finer gauge Quincke needles (25G) or pencil point needles are used. [31]

Cardiac arrest;

Cardiac arrests during spinal anesthesia are described as "very rare," "unusual," and "unexpected," but are actually relatively common. Because the cardiac arrests that occur after spinal anesthesia are not closely linked with sedation or known effects of spinal anesthesia on respiratory drive, alternative mechanisms should be considered. If cardiac arrest after spinal anesthesia is the far end of a spectrum that begins with minor slowing of the heart rate, then factors that have been linked with bradycardia during spinal anesthesia may help predict which patients are at risk for cardiac arrest during spinal anesthesia.

Although multiple factors may lead to cardiac arrest during spinal anesthesia, a common mechanism is vagal predominance. Atropine may be recommended to treat bradycardia during spinal anesthesia because glycopyrrolate is ineffective in this setting .Treatment of bradycardia with atropine may decrease the morbidity of the arrests that occur during spinal anesthesia. Unfortunately, not all of the arrests that occur during spinal anesthesia are successfully treated, and fatal arrests still occur in healthy patients.

When a spinal anesthetic is selected, maintaining preload should be a priority, and prophylactic preloading with a bolus of IV fluid should not be omitted before initiating spinal anesthesia. Standard regimens for volume preloading may not be sufficient to maintain adequate preload, so a low threshold for administering additional

fluid boluses, using vasopressors or repositioning the patient to augment venous return, may be appropriate. For severe bradycardia or cardiac arrest, full resuscitation doses of epinephrine should be promptly administered. With the popularity of spinal anesthesia and the reported frequency of these arrests, the potential impact of these interventions on further improving the safety of spinal anesthesia could be substantial. [32]

Anesthetic failure;

Failure of a spinal anesthetic is an event of significant concern for both patient and anesthetist even when it is immediately apparent, but it can have serious consequences if the problem only becomes evident once surgery has started.

The management of the failed block will depend on the nature of the inadequacy and the time at which it becomes apparent. Thus, some monitoring of the onset of the block and correct interpretation of the observations are both vital. The slower the onset of either motor or sensory block, the more likely is the block to be inadequate. While the onset of spinal anaesthesia is rapid in most patients, it can be slow in some; so, 'tincture of time' should always be allowed. However, if the expected block has not developed within 15 min, some additional manoeuvre is almost certainly going to be needed. The possibilities and suggested immediate responses are given as follows:

(1) No block: the wrong solution has been injected, it has been deposited in the wrong place, or it is ineffective. Repeating the procedure or conversion to general anaesthesia are the only option.

(2) Good block of inadequate cephalad spread: the level of injection was too low, anatomical abnormality has restricted spread, or some injectate has been misplaced. If a hyperbaric solution was used, flex the patient's hips and knees and tilt the table head down. This straightens out the lumbar curve, but maintains a cephalad 'slope' and allows any solution 'trapped' in the sacrum to spread further. A variation with the same aim, but perhaps better suited to the obstetric situation, is to turn the patient to the full lateral position with a head down tilt, reversing the side after 2 – 3 min.

(3) Good, but unilateral block: this is most likely because of positioning i.e. turning the patient onto the unblocked side if a hyperbaric solution was used (or the reverse for plain solutions) may facilitate spread.

(4) Patchy block (This term is used to describe a block that appears adequate in extent, but the sensory and motor effects are incomplete.): causes of inadequate block are numerous and include all those discussed above, the options are to repeat the spinal injection or to use a greater degree of systemic supplementation than, the latter being the only option after skin incision.

(5) Inadequate duration: systemic supplementation or infiltration of local anaesthetic may tide matters over, but often the only option is to convert to general anaesthesia. [10]

Adverse effects related to intrathecal opioids;

Fentanyl and/or morphine are frequently administered in combination with intrathecal bupivacaine, to enhance and prolong intra- and postoperative analgesia. Intrathecal (IT) morphine is clinically useful for postoperative analgesia, but is associated with significant side effects.Even the currently recommended dose of 0.1mg, which provides good analgesia for up to 11 hours postoperatively, will result in an estimated incidence of 43% for pruritus, 10% for nausea and 12% for vomiting. Using this low dose, delayed respiratory depression is very uncommon in the obstetric population, although its exact incidence is unknown. Higher doses may be associated with a higher incidence of clinically significant respiratory depression

after CS. Rarely, IT morphine for CS may cause postoperative shivering, hypothermia and excessive sweating. The mechanism probably involves a disturbance of hypothalamic thermoregulatory mechanisms after cephalad spread of morphine, since naloxone antagonised these effects. Intrathecal fentanyl for CS provides better intraoperative analgesia than IV fentanyl, with fewer side-effects such as nausea, vomiting and hypotension. However fentanyl provides little benefit in terms of postoperative analgesia. Pruritus is dose-dependent, and the incidence is higher when given IT (26%) than IV (8%).[24]

Follow-up

As with any anaesthetic complication, the details should be documented fully in the notes, and the patient provided with a full explanation after operation. Giving the patient a written summary of events for presentation to a future anaesthetist can be very helpful, although care should be taken to prevent medico-legal recourse. Therefore, it may be appropriate to look for symptoms and signs of post operative complications, and involve an anesthetist if there is any suspicion of these being present. As has already been noted, much wider consideration of the possibilities, supported by very detailed investigation, is needed.

Conclusion:

Regional anesthesia is safe for caesarean section, provided that the anaesthetist is aware of the complications associated with the various techniques, takes precautions to prevent complications where possible, carefully monitors the patient, and manages complications timeously and appropriately.

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