

Neurological Complications of Regional Anesthesia

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*“The man with ideal education not necessarily is the wise man,
but that who loves the correct things”.*

Lin Yutang: Importance of life

1. Introduction

The difference between a complication and an adverse event is that a complication can occur directly or indirectly as a result of the procedure; whereas an adverse event must have three conditions: it is an injury not related to the patient's illness, it occurs involuntarily, and happens during medical care of the patient.

According to Philip R. Bromage, neurological complications and its sequels can be divided into three classes (1, 2):

- Neurological complications produced by non-anesthetic causes
- Complications related to underlying pathology in which regional anesthesia can be a contributing factor
- Neurological complications related to regional anesthesia

Nonanesthetic causes: a pre-existing condition can coincide with the administration of regional anesthesia; like neurological injuries caused by abnormal medullary circulation like diabetes mellitus, atherosclerosis, and cervical injury which can lead to the infarction of the anterior two thirds of the spinal cord producing flaccid paralysis of the lower limbs (3). A case report of an intervertebral disc prolapse has been described after labor in obstetric patients that had received epidural analgesia with subsequent paresthesia in the legs (4). Arterial cerebrovascular events during labor or puerperium can also produce neurological injuries (5). Cerebral venous thrombosis secondary to pregnancy hypercoagulability and stasis have been described most commonly in the first week postpartum (6). Neoplasia, tumors or medullary

metastasis of breast or lung cancer can produce medullary compressions with an incidence of 70% of thoracic, 20% of lumbar and 10% of cervical level (7).

The occurrence of spontaneous epidural abscess attributed to bacteremia or a neighboring infectious process, although very infrequent (1/50.000 patients) (8) can coincide with a regional anesthesia or analgesic procedure.

Rare cases like viral infections of the spinal cord like Guillain-Barré syndrome, multiple sclerosis, etc. can occur insidiously in these patients (8).

The recommendation of many authors when an unusual neurological deficit appears (motor deficit of only one limb, fever and severe pain of the spine, general well-being compromise, etc.), is to perform an exhaustive exploration emphasizing the central nervous system to exclude a pre-existing or co-existing neurological disease along with the anesthetic procedure (9,10).

Causes in which anesthesia can be a contributing factor: epidural hematomas can happen in obstetric patients with abnormal coagulation or low platelets (11). Two axioms should always be considered in medicine: always consider the risk-benefit analysis, as not all procedures are indicated for all patients; and second the anesthetist should titrate all medications and therapeutic options.

There are other case reports of epidural hematomas in chronic renal failure (12), hepatic cirrhosis (13), and liver failure (14).

Peltola et al (15) emphasize that bleeding in the epidural, subdural or subarachnoid space as a result of a vascular injury with the needle or the catheter can worsen to become a compressive hematoma even though the coagulation tests of the patient are within normal limits.

The American Society of regional anesthesia (ASRA) (16), have made these recommendations (available online at www.asra.com) in patients with antiplatelet or anticoagulant therapy that require neuraxial regional anesthesia:

- Aspirin and NSAIDs do not increase the risk of spinal hematoma in neuraxial blocks
- Cox-2 inhibitors do not alter platelet function and do not contraindicate neuraxial regional anesthesia
- The risk of spinal hematoma in patients receiving thienopyridines (clopidogrel and ticlopidine) and GP IIb/IIIa platelet receptor antagonists like (abciximab, eptifibatide and tirofiban) is unknown. It is recommended that clopidogrel be suspended 7 days, ticlopidine 14 days, abciximab 24-48 hours, and eptifibatide 4-8 hours before neuraxial puncture
- The insertion of epidural or spinal catheters who are receiving at the same time anticoagulants and antiplatelet agents is contraindicated
- The prophylactic doses of low molecular weight heparins (LMWH) (enoxaparin 40 mg SC/day or dalteparin 5000 units/day) should be administered at least 12 hours before spinal or epidural puncture
- When full anti-coagulation is required with low molecular weight heparins (enoxaparin 1 mg/kg bid or dalteparin 120 units/kg bid) the neuraxis should not be accessed until after 24 hours of its last administration

- Removal of the epidural catheter should be performed at least 12 hours after the last dose of prophylactic LMWH. The administration of the next dose of LMWH should be administered at least two hours after removing the catheter
- If a single dose of LMWH is administered the epidural catheter can be kept in the postoperative period
- Cancel the prophylactic administration of two doses of LMWH per day or anticoagulant doses is not recommended when an epidural catheter is in place
- When the spinal or epidural puncture has been traumatic the next dose of LMWH should be delayed 24 hours
- In patients receiving warfarin, neuraxial blocks should not be performed unless it has been suspended and the INR is below 1.5. This is the INR recommended to remove an epidural catheter
- And INR should always be obtained when a single dose of warfarin has been administered 24 hours before surgery or if the patient has received a second dose
- Herbal medications do not seem to increase the risk of spinal hematoma in neuraxial anesthesia
- The new thrombin inhibitors and fundaparinux currently exert an unknown risk and the insertion of epidural catheters should be avoided when the patient is receiving these medications.

Among the distinct factors associated with increased risk of spinal hematoma with neuraxial blocks are: female sex, older age, patient and anesthesia related factors, traumatic insertion of the needle or catheter, epidural versus subarachnoid puncture, LMWH dose, twice a day LMWH, use of epidural catheter with LMWH, immediate preoperative, intraoperative or immediate postoperative LMWH administration, concomitant use of anticoagulants or antiplatelet agents in patients whose neuraxis is accessed (16).

Neuraxial hematomas usually locate in the epidural space because of the dilated epidural venous plexus, the absence of vessels in the subarachnoid space, and the fact that if there is subarachnoid bleeding the blood is diluted with the CSF and drained in the segmental vessels along the exiting spinal nerves. (17)

Chronic adhesive arachnoiditis is another condition with poor prognosis and multifactorial in nature (18). It presents as a severe meningeal inflammatory response to different agents (trauma, surgery, infections, tumors, etc.). Its prognosis depends on the extent and formation of septums and adhesions that can trap and collapse the spinal blood vessels, which compromise the spinal cord circulation. Some researchers have associated the appearance of this complication with the use of chemicals substances present as preservatives of anesthetic agents like benzyl alcohol, methylparaben, and sodium bisulfite (19). This author established epidemiologically that the arachnoiditis that occurs after a subarachnoid anesthesia is an extremely rare complication, and no direct association between this pathology in the use of local anesthetic has been proved; and currently with the asepsis, antisepsis, disposable equipment use, absence of preservatives in subarachnoid medications, and worldwide standardized doses and concentration of anesthetics, this complication has virtually disappeared (20).

The incidence of back pain with regional anesthesia is not different from that in patients with general anesthesia (2 %). Obstetric patients with or without regional analgesia or

anesthesia have an incidence of up to 40% of back pain that can last 24 hours, and which worsens with ambulation (2).

Obstetric nerve palsies can happen with the positions maintained during labor and delivery, specifically compromising the nerves crossing the pelvic rim; many others are associated with cephalopelvic disproportion, difficult or instrumented deliveries. Up to 25% can occur in normal deliveries with an incidence between 1: 2100 to 1: 2600 births (2).

Neurological complications related to regional anesthesia: these complications range from superficial, transient and minor injuries to serious and severe injuries that can be permanent or even compromise the patient's life. In general these type of complications are very infrequent and it is important to recognize them to prevent them and treat them promptly in an appropriate way to guarantee more safety and comfort to the patient. Highlighting Dr. Bromage's words: "no anesthetic is completely safe and many failed to provide the unique set of conditions that epidural analgesia can provide" (2).

2. Failure in blocks or analgesia

Failed blocks are the most frequent cause of immediate and minor complications in regional anesthesia, up to 15% in epidurals in teaching hospitals, or 2.35% of failure among all regional anesthesia techniques as reported in Fundación Santa Fe de Bogotá (21). In world literature, the incidence ranges from 2.8% overall for all regional anesthesia techniques, up to 5 to 25% with techniques other than subarachnoid puncture (22).

Generally, the approach and technique of these procedures is considered easy, but it must be considered that it not only consists of placing a catheter in a specific position and injecting the anesthetic; the anesthesiologist must also be capable of deciding the type, concentration an adequate dose of the anesthetic, individualizing each patient according to the time, anesthetic level and surgical procedure to be performed. Failure in the block or analgesia is an event that is immediately identified as the patient will refer pain and the surgical procedure cannot be performed. Failed blocks should not be dealt by repeating the technique, as the injection of more anesthetic in the subarachnoid space can lead to morbidity because of the high concentration in a subarachnoid space (22).

Failure of block has not been well defined as some describe it as the inability to locate the space, and obtain cerebrospinal fluid (CSF) after three punctures, which suggests incapability of the anesthesiologist to identify the space and impossibility to administer a dose of anesthetic. Others extend the concept, including every case that requires the use of general anesthesia at any point during the anesthetic or the surgery (23).

The causes can be divided in three groups (23):

1. **Technical factors:** related to the selection of the needle in terms of type and gauge, the position and localization of the space by the anesthesiologist. Among these factors in anesthesia or analgesia it is important to consider that identifying the epidural space with air can produce outcomes as serious as tetraplegia; because of high doses of air injected in the subarachnoid space. In adult patients, this can produce headache, multiradicular or compressive medullary syndrome. When fluid is used instead of air, the main complication is the increase in anesthetic level (24). Other key issue in this

technique is the final location of the catheter, as it determines the distribution of the injected medications in the desired site so that complications like total spinal anesthetic, epidural venous puncture or spinal myoclonias do not happen, which represent 6.2% of all inserted catheters (25). In the obstetric patient usually the spinal catheter is not left in place in cesarean section and does not represent greater risks

a. Total spinal anesthetic

It is produced by the administration of the epidural anesthesia medication (20 to 30 ml in volume) in the subarachnoid space because of poor positioning of the catheter or the epidural needle rupturing the dura, which can extend desired lumbar block to an inadvertent cervical, brachial plexus and sacral roots block which produce clinical symptoms depending of the level reached. As the level is more cephalad, motor and sensitive block increases until the patient develops unconsciousness, respiratory arrest, severe hypotension and pupillary dilation which can lead to cerebral ischemia in total amnesia of the event (26). These events happen within a period of one to 5 min.

The treatment for this type of complication is to secure the airway with an orotracheal tube or supraglottic device, in case of unconsciousness and loss of airway reflexes; to provide immediate thoracic compressions and intravenous hemodynamic support including intravenous fluids like crystalloids (at least 1000 ml); the use of vasoconstrictors like ephedrine initially with 10 to 30 mg and then with a continuous infusion to maintain a systolic blood pressure about 100 mmHg and incremental doses of 0.3 mg of atropine to treat bradycardia; while the patient recovers from the anesthetic overdose. One maneuver that can help is to use a head down position 10 to 20° with minimal lateralization to improve venous return (26).

b. Epidural venous puncture (27)

This represents 9% of the complications related to catheter positioning and produces a dramatic effect on obstetric patients. There are five technical factors which reduce the incidence of this complication: the introduction of the catheter in lateral position decreases the risk from 11.9% to 6.7%; distending the space with air reduces it from 12.9% to 6.7%; using single hole needles reduces it from 10% to 6.8%; avoiding introducing the needle more than 6 cm reduces it from 12.9% to 6.4%; and using catheters lined with polyurethane instead of polyamide. These catheters not only decrease the risk of venous cannulization but also have a decreased incidence of paresthesias. The position and previous distention of the space with air are the most effective measures. The median or paramedian techniques, or the needles gauge 16 or 18 G have not demonstrated any protection.

c. Spinal myoclonus

These are focalized involuntary movements muscle groups in a patient with a spinal catheter. With myelography it has been shown to be produced by the persistent stimuli of the catheter on a nerve root or in the medullary conus, and is corrected with the repositioning of the catheter away from these nerves (28).

To avoid this type of complication that catheter's position can be verified with fluoroscopy which allows the detection of the spread of the fluid with anterior posterior

or lateral projections and thus reposition it in the correct space (29); this can also allow the detection of internal knots and posterior complications like rupture within the space that require surgical treatment.

2. **Patient factors:** basically related with anatomical abnormalities during pregnancy or obesity which make these procedures more difficult because of changes in the spinal canal's anatomical conformation, tissues, skin, internal CSF distribution, etc.
3. **Factors of the anesthetic solution:** there are multiple factors related to these agents ranging from the adequate choice by the anesthesiologist individualizing each patient and procedure, to the production technique of the solutions by the different manufacturing companies and the storage methods throughout the time for an optimal effect. It is important to verify expiration date, administration route, and contraindications of these medications before used in the different techniques. An example of such happened in the case of dermatitis after the erroneous infusion of potassium chloride through a subarachnoid catheter for postoperative analgesia with serious impact on the patient's health like hemodynamic abnormalities, motor activity changes and a dramatic increase in blood pressure (30).

As each anesthetic procedure is individualized for each patient, the management of block or analgesia failure should be personalized according to the situation or to painful stimuli control achieved.

3. Traumatic puncture

3.1 Post dural puncture headache (PDPH)

It is one of the most common neurological complications in patients subject to regional anesthesia with a median incidence of 3% between epidural and spinal (31,32). It is more common in patients under 40 years old, basically in children under 10, with a difference in gender more commonly in women, mainly in obstetric patients (33,34), in whom the complication is more common producing an increase in hospital stay up to 49% (34). This complication depends on factors like the gauge and design of the selected catheter. There is currently a debate regarding the design of the needles, and it is believed that atraumatic needles could produce less injury in the dura mater (33) which can decrease PDPH, however some studies using electronic microscopy found that pencil point needles produced more trauma in the dura with more irregular borders and more edema which accelerates the closure of the orifice and thus reduces its incidence (33).

The headache can also appear after the insertion of the epidural catheter when it accidentally ruptures or injures the dura. Different studies have been done to decrease its incidence, among them one reveals that the use of fluid to verify the loss of resistance compared to air decreases the incidence. The risk difference was 0.015. In addition and according to this metanalysis, among obstetric patients, there were no significant differences between mediums (35). Pathophysiologically this phenomenon is explained by the loss of CSF which drains faster than produced, generating a difference in pressures and traction of the intracranial contents in upright position (36). The imbalance is generated from the orifice of the dura after the puncture, and depends on its shape and size (36). It occurs in the first 15 to 48 hours after the puncture (33).

The main characteristic as its name suggests is the severe headache observed mainly with positional changes, and other symptoms that can occur are vomiting, nausea as well as sixth cranial nerve palsy which produces diplopia. It is important to perform an appropriate diagnosis as prolonged and intense headache after spinal anesthetics has been related to intracranial hemorrhage, meningitis, and subdural hematoma (37), for which it is important to identify any change in symptoms or the appearance of alarming signs like meningeal stigmata, photophobia, fever, focalization and seizures (34,35).

The development of new needles with smaller gauges has decreased its incidence (37). Different studies have shown that the incidence of this complication decreases clearly and statistically significant with both the decrease in gauge of the needle as well as the selection of needles that produce lesser trauma to the dura during insertion (Table 1) (36).

Needle	Gauge	Incidence PDPH
Quincke	22G	40%
Quincke	25G	25%
Quincke	26G	2-12%
Quincke	27G	2.7%
Whitacre	27G	0.37%
Punta de lapiz	27G	0.01 - 1.7%
Quincke	29G	< 2%

Source: table made by authors from data of: Mordecai M, Bruell S. Spinal anesthesia. *Current Opinion in Anaesthesiology*. 2005; 18: 527-33.

Table 1. Incidence of PDPH with needle gauge

The initial treatment of PDPH is conservative based on adequate hydration, intravenous boluses of normal saline, rest, anti-inflammatory analgesics, methylergonovine and caffeine in doses of 300 to 500 mg IV or ingestion of caffeinated beverages (33,34). However, it has been described that this syndrome can correct spontaneously up to 50% of the cases in five days, and 90% at 10 days (33). If this conservative treatment fails and the headache either is steady or is severe, an epidural blood patch can be applied in the puncture site. The volume described is of 10 to 20 mL of autologous blood injected in the same intervertebral space where the traumatic puncture was performed (33). Jeskins determined in a retrospective study, that the blood patch has a short term benefit, as in longer terms it did not reduce the pain symptoms. He determined that the success rate of the first blood patch was 33%, and of the second blood patch required by 29% of the patients who did not improve was 50% in treating long-term pain (37). It is important to recognize that if this treatment is ineffective, or if the headache worsens and other alarming signs appear, it is important to extend the studies to exclude other type of complications or basal conditions of the patient (34).

3.2 Nerve and root injury

This important complication is produced when the anesthesiologist inserts the catheter for the administration of anesthetic solutions through the nervous fibers, or nerve bundles or performs a high puncture (above L1) injuring spinal cord. When advancing too much a catheter in children, complications like pneumothorax or serious vascular injury can result (24). The studies revealed that the estimate of the intervertebral level by the anesthesiologist

compared to MRI is poor, as only 29% was in the desired space, whereas 68% were 1 to 4 spaces above the level desired (38). During the insertion of the catheter to provide regional anesthesia it is not uncommon that patients complain of paresthesias or severe radicular pain. Cheney et al (39) reviewed the complaint database of the American Society of Anesthesiologists finding that 92% of the injuries were related to the technique and that patients complained about paresthesias and pain during insertion. This is why it is recommended to perform this type of anesthetic in awake patients, capable of communicating any anomaly or complaint that occurs during the anesthetic procedure (40). It is important to be aware of these complaints and to do an appropriate follow-up, as these are the symptoms associated with nerve injuries that can lead to sequelae if not treated appropriately. Auroy et al (41) found that two thirds of the patients with neurological complications described these symptoms during different periods of the anesthetic, and even though many anesthesiologists stopped the procedure when the symptoms appeared, the complication still happened, which do not allow the identification of when to stop the procedure.

It is difficult to calculate its incidence as the report of these cases is not very frequent (1), however some estimate an incidence of this 0.3 among 2500 (42). Other study revealed that the incidence of paresthesias during epidural catheter insertion increases with each additional dose, and the postoperative neurological deficit increased from 0.13% with a single dose to 0.66% with a continuous catheter, explained by the evidence of demyelination and inflammatory process adjacent to the catheter (43,44).

To avoid this type of complications an appropriate puncture site should be selected avoiding spaces where intervertebral discs protrusions could happen which can produce a tight canal (44), and to never puncture above L1 to L2 (45). Giebler et al. (46) noticed an incidence of 0.2% of postoperative radicular pain in patients with thoracic catheters. In obstetric patients difficulties are common, and identification of the puncture site is commonly erroneous as they cannot flex their knees on the abdomen which generates cephalization of the Tuffier line; in addition their hips are wider than their shoulders which alters the horizontal spine line (47). A new anatomical reference point for the identification of the intervertebral space has been radiologically described showing that the 10th intercostal arch is aligned to L2's spinous process. Others have used other imaging tools during puncture and regional anesthesia including fluoroscopy, with the disadvantage of subjecting the patient to radiation, to ultrasound, both demonstrating a reduction in complications as there is less needle manipulation to reach the desired space and performance of the puncture avoiding injuring any vascular or neurological structure (36,47).

The incidence of back pain after epidural anesthesia has been observed to be between 18 and 19% in rich retrospective studies (48, 49, 51) and between 21 and 53% in prospective studies (50, 51)

3.3 Lumbar pain and sacral numbness

There are multiple studies in obstetric patients that demonstrate that there is no real association between back pain and regional anesthesia, and have probably the same incidence of the obstetric population without any neuraxial intervention with a 63% risk of developing back pain during the first year postpartum (48-51).

Many reports have described patients presenting non specific dull back pain after neuraxial procedures for C-section that improve spontaneously within eight weeks without associated

abnormalities like dysesthesias or motor abnormalities. This type of pain is known as sacral numbness. The etiology of this type of pain is unknown (40).

4. Chemically related injury related

The susceptibility of the different nervous fibers is determined by their location, myelination and blood supply, as when they are exposed to a foreign substance in more perfused and higher degree of myelination areas, it is easier for it to be cleared. The nerves of the subarachnoid space are more prone to pharmacological neurotoxicity than those of the of the epidural space as the latter are covered by the pia matter, to a degree that case reports have been made where substances as thiopental, potassium chloride or antibiotics injected into the epidural space have not produced any neurological injury or sequelae. Sacral roots are also at risk from local injury because of their poor myelination. That is why when instilling foreign substances into space so well protected against infections and other antigens, it can be presumed that local anesthetics, catheter debris, glove talcum, etc. can generate immune responses that can produce direct allergic reactions both locally or systemically, like in the cauda equina syndrome, transient neurological syndrome, adhesive arachnoiditis and epidural fibrosis.

4.1 Cauda equina syndrome

The incidence of cauda equina syndrome is in general terms very low, 0.73 per 10,000 subarachnoid anesthetics (40). This syndrome is described after the administration of intrathecal lidocaine, after repeat administrations of anesthetic in failed spinal blocks, after unique doses or infusions during combined spinal anesthesia, or even with a single dose during the administration of a regional anesthesia because of very high concentrations medication in a small area of the medulla. It has also been associated with the very slow injection of medications, like what happens with the administration through microcatheters (33). This syndrome is characterized by bladder atony, loss of micturition control, and injury of the lower motoneuron including paraplegia (41).

4.2 Transient neurological syndrome (TNS)

Reported for the first time in 1993 by Schneider et al., it is characterized by transient pain in the lumbar area related more to intrathecal lidocaine rather than bupivacaine, happening after 12 hours of the complete resolution of an uncomplicated spinal anesthetic. The patient has a normal neurological examination and the main characteristic is that there are no sequelae. The pain is typically described as neural localized in the gluteal area and can extend to both inferior limbs, worsening at nights, improves with ambulation and NSAIDs, with a complete resolution in 90 % of the cases between the second and fifth postoperative day. Its incidence is lower in obstetric patients comparing to the general surgical population, (0 to 7% versus 10 to 30% respectively (44)), with a 1 to 7 ratio in patients who are administered lidocaine for spinal anesthesia (41). Its cause is still unknown, and is usually related more to the position during surgery and lidocaine administration (11.9%) independent of its concentration, than to bupivacaine (1.3%), prilocaine, procaine, or tetracaine (1.3%) (33). A randomized prospective study reported an incidence of 16% of TNS both in patients who received 5% hyperbaric lidocaine with epinephrine, and received 2%

isobaric lidocaine (*Pollock J.E., 1999*) (33). A higher incidence of TNS has been reported in patients undergoing arthroscopy or genitourinary surgery with hip flexion (24.3%) than in those operated supine position (3.1%) (52) (Table 2)

Transient neurological symptoms (TNS)			
Agent	Presentation	Position	Approximate TNS incidence
Lidocaine	Hyperbaric 2%-5%	Lithotomy	30%-40%
	Hyperbaric 0.5%-5%	Knee arthroscopy	20%-30%
	Hyperbaric 5%	Supine/not specified	5%-10%
Bupivacaine	Isobaric/Hyperbaric	Lithotomy / others	Rare
Tetracaine	Hyperbaric	General use	Rare
	Hyperbaric + Fenilefrina	Lower limbs/ perineum	12%
Procaine	Hyperbaric 5%	Knee arthroscopy	6%
	Isobaric 5%	Supine/not specified	1%
Mepivacaine	Hyperbaric 4%	Lithotomy / others	30%-40%
	Isobaric 1.5%	Knee arthroscopy	Rare
Ropivacaine	Hyperbaric 0.25%	Supine volunteers	Rare*
* 30% of the volunteers reported persistent back pain but denied extended symptoms			

Taken from: Hodgson PS, Liu SS. New Developements in Spinal Anesthesia. *Anesthesiology Clinics of North America*. 2000;18(2):235-49. Reproduced with permission.

Table 2. Transient neurological symptoms

Some anesthesiologists believe TNS is the beginning of a cauda equina síndrome, but there is no literature supporting this. The management is individualized for each patient (44).

4.3 Epidural fibrosis

Is a common complication associated with the prolonged use of infusion of epidural medications. Epidurography has demonstrated that this fibrosis produces an encapsulation, stenosis and deviation of the epidural space. It can be suspected in patients resistant to the analgesic effect when referring lumbar pain. JA Aldrete suggested that the etiology instead of being a direct reaction to the medications, corresponded to direct meningeal injury from the catheter (53).

5. Infections

Epidural anesthesia or analgesia comprise 5.5% of the patients with epidural spinal abscesses (54). The incidence of meningitis and spinal abscesses occur more frequently in patients with interventions injuring the dura and less in obstetric patients than the general population (*Sweden 1990-1999*). In fact it happens more in women after delivery with spinal analgesia, than with C-section. The incidence of meningitis in obstetric patients is estimated at one every 39,000 after neuraxial procedures compared to the global epidural abscesses incidence standing at one every 302,757 patients (55).

Two access routes can explain the infections: endogenously from the normal flora of the patient, or exogenously by colonization of microorganisms through the breach of the blood brain barrier after dural puncture (33). Schneeberger et al reported four cases of iatrogenic meningitis by the same anesthetist with recurring pharyngitis and who did not use facemask during the procedures (33). Reynolds reported in 2008, 16 epidural abscess all related to the use of epidural catheters observing higher risk with prolonged duration, poor asepsis and traumatic insertions (56). Holt et al. reported an epidural catheter colonization rate of 6%, with the *Staphylococcus* being the most common microorganism, which was confirmed by Steffek et al. (26).

5.1 Spinal abscess

Spinal abscesses have a mortality of 18% and an incidence of 1/250,000 healthy patients, which increases to 1/2000 in patients with diabetes or immunodeficiency. Epidural abscess symptoms appear 4 to 10 days after the insertion of the catheter. The most common symptoms are severe back pain which increasing intensity and general weakness associated with fever, nuchal rigidity, headache or local symptoms like rash, erythema and pruritus, with increasing white blood cell count, and erythrocyte sedimentation rate in the initial phases of the disease, or associated with radicular pain, sacrum numbness, reflects loss, and bladder dysfunction as late symptoms of the disease (44). The symptoms can progress as rapidly as weakness becoming paralysis of the lower limbs in less than 24 hours (33). Fluid may ooze from the catheter insertion site. The most common microorganism is *Staphylococcus aureus* from direct contamination of the skin or blood borne from the vagina. Treatment success is based on early suspicion and identification of the symptoms. The gold standard for diagnosis is magnetic resonance imaging with gadolinium, although either a myelogram or CAT scan can confirm the diagnosis. Lumbar puncture is contraindicated when an epidural abscess is suspected. The American Society of Regional Anesthesia and Pain Medicine recommend the use of chlorhexidine and alcohol as the best antiseptic technique for regional anesthesia, accompanied by hand wash, jewelry watches and pendants removal, use of sterile gloves, gown and sterile drapes (41,45). In 1991, Du Pen et al determined the relative risk of infection related to the catheter use in cancer patients with chronic pain at one every 1702 days of catheter use, which decreases in half with the use of external percutaneous catheters (De Jong, 1994) (41). The management is basically the immediate removal of the catheter and the initiation of an aggressive antibiotic scheme. The recovery of neurological function depends on the severity and progression of the symptoms like with epidural hematomas (33).

5.2 Meningitis

The mortality of this type of infection can be as high as 30%. Teele et al showed 15% of meningitis in children with bacteremia who underwent lumbar puncture against 1% in those without it (56). The most common microorganism is *Streptococcus viridans* type *salivarius*, *sanguis* and *uberis* which colonize the upper respiratory, the female genital and gastrointestinal tract, and which grow rapidly in aqueous media like cerebrospinal fluid but not in conventional laboratory culture media. The main mechanism of transmission is poor antiseptic technique and saliva particles when not using facemask. Common symptoms are: fever, headache, photophobia, nausea, vomiting and nuchal rigidity. Other symptoms are confusion, lethargy, and positive Kernig sign. Laboratory diagnoses is made with a lumbar

puncture which reveals an increase in proteins and white blood cells in the cerebrospinal fluid and a decrease in the glucose levels compared with blood levels and with special cultures for *S. viridans*. The first-line treatment is the use of vancomycin with third-generation cephalosporin, begun immediately with clinical suspicion, not waiting for laboratory confirmation. Even though some authors have reported antibiotic treatment with infusion pumps or intrathecal catheters to limit the infection without their removal after suspicion of an epidural abscess (Boviatsis, 2004), this is not true in meningitis where the removal of infectious pockets is mandatory. Another cause of meningitis is chemical agents which is difficult to differentiate from bacterial infection (41).

Patients with confirmed bacteremia or septicemia benefit much more from an epidural than a spinal technique, only if an antibiotic scheme has begun before the block with an adequate clinical response. An example of such is the study of Bader et al. sin 1990 who used regional anesthesia in 293 women with chorioamnionitis without any infectious complication, even though only 43 had antibiotic treatment (33).

There is not contraindication for regional anesthesia among HIV- infected obstetric patients. There is no evidence of accelerated disease progression in the rate of infectious or neurologic complications in the neuraxial anesthesia. In HIV patients 40% of patients have neuropathic symptoms, the neurological symptoms as aseptic meningitis, headache, or polyneuropathy are indistinguishable and not related with the regional anesthetic technique used (33). Antibiotic prophylaxis is recommended against *Staphylococcus* in this type of patients, as well as patients with cancer, myelodysplastic diseases, low white blood cell count, diabetes and other immunodeficiency scenarios. The identification of infections in these patients can be delayed because they do not develop general symptoms like fever or leukocytosis (56). In patients infected with herpes virus no increase in infections has been demonstrated (55).

5.3 Discitis

It is a rarer complication reported after injection of steroids in L2 L3 level as well L4-L5. It is related to an infection with *Pseudomona aeruginosa*. Specific intravenous treatment with antibiotic is recommended with good results (57).

5.4 Arachnoiditis

This complication can happen days, weeks, or months after anesthesia. It produces a progressive weakness until paraplegia, caused by meningitis, spinal trauma or neurotoxic chemicals. Most are idiopathic and can occur by medication errors during administration (58).

5.5 Epidural collection of CSF

There are case reports of symptoms similar to epidural hematoma where the cause of compression has been the collection of cerebrospinal fluid in the epidural space, initially presenting as a post puncture headache from the loss of subdural CSF that is collected in the epidural space. It is difficult to diagnose because the imaging techniques cannot differentiate between CSF, blood or pus. It is mainly a clinical diagnosis and can be managed conservatively without any neurological sequelae with the same treatment as a post dural puncture headache (33).

5.6 Intrathecal granuloma

It consists basically in the formation of a mass of inflammatory characteristics around insertion point of the catheter, believed to form from the activation of the mitogen activated protein kinase cascade triggered from high concentrations of opioid infusions.

The prevalence is not well known and is estimated at 0.1 to 5%.

The symptoms are severe pain that can be accompanied by neurological symptoms depending on its size. The gold standard for diagnosis MRI, diagnosed usually .5 to 72 months after the opioid infusion. If symptoms of neurologic compression appear the clinical suspicion increases (33).

6. Miscellaneous

6.1 Palsy of cranial nerves VI and VII

This can happen before or after a post dural puncture headache, and has been related to the Tuohy needle (24), with similar etiology, as it is produced by the traction of the nerve that occurs from a deficit of CSF. The most common palsy is of the sixth and seventh cranial nerves showing diplopia or hearing loss. It usually resolves spontaneously. A blood patch may be useful if administered before symptoms, afterwards it does not show any efficacy (58).

7. Conclusion

All procedures demand maximum patient care, for which international organizations like the WHO and PAHO recommend the surgical checklist and safe anesthetic for a safe patient (59).

Complications and associated injuries will continue to occur as there are many factors to consider, some of them as previously reviewed, depend on conditions not related to medical care; however, it is essential that the anesthesiologist have a role in the postoperative care when any incident, complication or adverse event occurs, that he reports it and practices an effective follow-up to improve the patient's recovery.

The obstetric patients with diabetes and obesity are increasing every day (60), for which the anesthesiologists should be prepared to face these challenges with the availability of proper equipment and supplies, surgical tables, medications, infusion pumps, specialized care units, etc. in order to provide proper and professional care to these patients.

The interest and respect of care provided will determine the patient's evolution both physically and mentally with the implications for or against the people who cared for him.

Many neurological sequelae are the result of a delayed diagnosis and treatment (61), and in some cases there is poor follow-up and induced healthcare requirements.

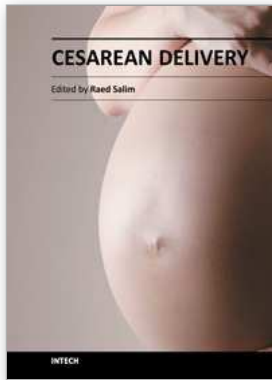
It's worth adding that in spite of the several complications described, their incidence is relatively low and hence, regional anesthesia as compared to general anesthesia, still the preferable anesthetic option among pregnant women undergoing cesarean section

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This book provides broad, science-based information regarding the most common major surgical procedure performed, i.e. Cesarean Delivery. The book provides relevant scientific literature regarding epidemiology and rates of cesarean delivery in low and high income countries and the impact of the disparities in the rate of cesarean delivery between countries. In addition, the book systematically reviews the relevant scientific literature regarding all perioperative considerations with a broad cover of anesthetic techniques, drugs and difficulties that anesthesiologists may encounter during cesarean delivery. Care of the neonate after cesarean and crucial guidelines for obese women undergoing cesarean are also provided. The book was written by distinguished experts from different disciplines to ensure complete and accurate coverage of the recent scientific and clinical advances and to bring care providers and purchasers up to date including essential information to help improve health care quality.

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