PERMANENT NEUROLOGICAL DAMAGE AFTER SPINAL ANAESTHESIA

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ABSTRACT:
Background: *The use of subarachnoid block for various surgeries is becoming common and it is without complications. There many complications of spinal anaesthesia but one of the devastating of such complications that can lead to permanent disability and psychological trauma for the anaesthetist is permanent neurological damage.*

METHOD: *This is a review article of various works on neurological damage following spinal anaesthesia using different search engines such as PubMed and Google.*

CONCLUSION: *Permanent neurologic damage can occur after spinal anaesthesia but its incidence is low.*

Key Words: *Spinal, Anaesthesia, Permanent, Disability.*

INTRODUCTION

Spinal anaesthesia is the procedure of introducing a short acting anaesthetic agent into the subarachnoid space to effect anaesthesia [1]. Regional anaesthesia is a safe and widely utilised method of analgesia for labour [2,3]. The tremendous increase in the number of regional anaesthesia procedures has increased and can be linked to the perception that regional anaesthesia is associated with numerous advantages and with very few severe complications[4]. Over the last decade, methods and practice of anaesthesia have changed considerably in favour of regional techniques whenever applicable [5]. Spinal anaesthesia has evolved greatly since its introduction in 1899 to clinical use by august bier [6,7.] The technique has been refined since that time and has evolved into the modern concept of intrathecal, spinal or subarachnoid block [7]. Spinal anaesthesia is now practised widely [8]. Spinal anaesthesia remains a popular technique for surgery to the abdomen, pelvis and lower limbs 8. It is currently the most common technique for non-emergency obstetric, urologic and orthopaedic anaesthesia [6]. Most infra umbilical procedures can be done under spinal anaesthesia [6]. There is a demonstrable reduction in morbidity and mortality with regional techniques [6]. It is best reserved for operations below the umbilicus such as herniorrhaphy, gynaecological and any operation on the perineum or genitalia. Its use for orthopaedic procedures but may be an unpleasant experience for amputation with the patient awake or caesarean section for foetal demise.

Neuraxial techniques have proved to be extremely safe when managed well, however there is a risk for complications. Neuraxial blocks may reduce the incidence of venous thrombosis and pulmonary embolism, cardiac complications in high risk patients, bleeding and transfusion requirements, vascular graft occlusion and pneumonia and respiratory depression following upper abdominal or thoracic surgery in patients with chronic lung disease [9]. Neuraxial blocks may also allow earlier return of gastrointestinal tract function following surgery and has had a great impact in obstetrics [7,9.] It extends access to patients who would normally be excluded for general surgery for example because of obesity or cardiorespiratory disease and high patient satisfaction rates [7].

ANATOMY OF THE SPINAL CANAL

In the adult, the spinal cord usually ends at the level of the first lumbar, vertebrae. However, it may end as far distally as the second or even third lumber vertebrae [10]. Spinal needles inserted for diagnosis or anaesthetic reasons should not therefore be introduced above the L3/L4 interspace except in exceptional circumstance [10]. The spinal canal contains the spinal cord with its coverings (the

meninges) fatty tissues and a venous plexus. The meninges are composed of three layers. The meninges are composed of three layers namely the pia mater, the arachnoid mater and the dura mater [1].

Cerebrospinal fluid is contained between the pia and arachnoid maters in the subarachnoid space. In children, the spinal cord ends at l3 and moves up as they grow older [9]. The meninges surround the spinal cord from the foramen magnum as far down as the second sacral segment [11]. The subarachnoid space contains the spinal cord and nerve roots surrounded by the cerebrospinal fluid. An injection of local anaesthetic will mix with the cerebrospinal fluid and rapidly block the nerve roots which it comes in contact with. During the administration of a spinal anaesthetic, the needle passes through the skin, subcutaneous fat, supraspinous ligament, interspinous ligament, ligamentum flavum, epidural space and dura. Dura puncture above the level of the end of the spinal cord is associated with a slight risk of damaging the spinal cord.

SPINALANAESTHESIA

Majority of regional anaesthetic techniques requires formal sterile procedures [11]. Spinal anaesthesia is used for a variety of both elective and emergency surgical procedures below the level of the umbilicus for surgery above the umbilicus; high spinals are now rarely used because of the associated difficulties of maintaining spontaneous ventilation and abolishing the painful stimuli from traction of the peritoneum and pressure on the diaphragm [11].

Spinal anaesthesia requires the injection of a small volume of local anaesthetic gent directly into the cerebrospinal fluid in the lumbar region below the level of L1/L2, where the spinal cord ends [11]. Spinal anaesthesia is usually performed with the patient in the lateral or sitting position [10]. Some experienced anaesthetists have done it in the knee chest position especially for caesarean section for cord prolapse. Whichever position is chosen, the patient should be asked to flex the spine as much as possible, thereby widening the gaps between the lumbar spinous processes [10]. The line that joins the top of the iliac crests (the intercristal or tuffers' line) usually passes through the body of the fourth lumbar vertebrae and is therefore a useful landmark [10].

The choice of the interspace to use is important as the spinal needle should be introduced at a level that may cause it to enter the spinal cord [10]. The lumbar puncture is normally performed in the midline, after infiltration with the local anaesthetic; the spinal needle passes through the following structures: skin, subcutaneous tissue, supraspinous and interspinous ligaments, ligamentum flavum and dura mater. On puncturing the dura, a characteristic 'give' is often appreciated. On removal of the stylet from the needle, cerebrospinal fluid should appear at the hub of the needle [10]. Performing a lumbar subarachnoid puncture below L1 in adults and L3 in a child avoids potential needle trauma to the cord [9].

Drugs injected into the subarachnoid space numb the nerves to give pain relief in certain areas of the body. When performing a spinal anaesthesia, the injection should occur below the level of the conus medullaris. Cases of conus damage following spinal anaesthesia have been reported as the conus medullaris does not always terminate at the lower border of L1 in 2-20% of individuals it ends at the lower border of L2 more commonly in women [12].

Tuffers line may cross the midline at L3/L4 not L4/L5 and is not a reliable indicator therefore before attempting spinal anaesthesia, it is prudent to choose the lowest possible interspace and avoid using the L2/L3 interspace (or higher) [12]. Spinal anaesthesia has the advantage that profound nerve block can be produced in a large part of the body by the relative simple injection of a small amount of local anaesthetic. However, the greatest challenge in spinal anaesthesia is to control the spread of the local anaesthetic through the cerebrospinal fluid to provide a block which is adequate for the proposed surgery without unnecessary extensive spread and increased risk of complications [13].

COMPLICATIONS OF SUBARACHNOID BLOCK [9]

The absolute contraindications of subarachnoid block are:

- Infection at the site of the injection
- Patient refusal
- Coagulopathy or other bleeding diatheses
- Severe hypervolemia
- Increased intracranial pressure
- Severe aortic stenosis
- Severe mitral stenosis

Relative contraindications of subarachnoid block

- Sepsis
- Uncooperative patient
- Pre-existing neurologic deficit

- Stenotic valvular heart lesions
- Severe spinal deformity
- Lack of consent

Controversial contraindications of subarachnoid block are:

- Prior back surgery at the site of the injection
- Inability to communicate with patient
- Complicated surgical procedures such as anticipated prolonged operation anticipated major blood loss and manoeuvre that compromise respiration.

COMPLICATIONS OF SPINAL ANAESTHESIA

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 vent must have three conditions. It is an injury not related to the patients' illness; it occurs involuntarily and happens during medical care of the patient [14]. Although serious complications are uncommon with regional anaesthesia, they should be considered and discussed with the patient [3]. Regional anaesthesia is associated with multiple benefits compared to general anaesthesia including reduced morbidity and mortality, superior postoperative analgesia and enhanced cost effectiveness [15]. Complications after spinal anaesthesia are minimal and these have been further reduced by advances in needle design. Also, with the introduction of the newer local anaesthetic agents has reconfirmed the need for hyperbaric, glucose containing solutions in order to provide predictably reliable clinical block patterns [8]. All regional anaesthetic techniques have associated complications and local anaesthetic drugs have potentially toxic properties. Airway and resuscitation skills are therefore essential to the practice of regional anaesthetic [11]. The adverse reactions and complications range from self-limiting back soreness to debilitating permanent neurological deficits and even death. Some clinical studies suggest that postoperative morbidity and possibly mortality may be reduced when Neuraxial blockade is used either alone or in combination with general anaesthesia [9]. The complications of spinal anaesthesia can be thought of as resulting from exaggerated physiologic side effects, placement of the needle and drug toxicity.

Complications of spinal anaesthesia due to exaggerated physiologic side effects

- Hypotension
- Bradycardia
- High neural block
- Total spinal
- Urinary retention
- Nausea
- Hypoventilation
- Cardiac arrest

Complications of spinal anaesthesia due to needle placement

- Inadequate anaesthesia or analgesia
- Intravascular injection
- Subdural injection
- Backache
- Postdural puncture headache
- Neurologic injury
- Spinal haematomas
- Meningitis or arachnioditis

The symptoms of inadvertent intravascular injection are hypotension, arrhythmias, cardiovascular collapse, seizures and unconsciousness. Some of the causes of high neural blockade are excessive dose of local anaesthetic administered, failure to reduce dose in patients susceptible to excessive spread that is the elderly, pregnancy, obese or short patients, unusual sensitivity and unusual excessive spread.

Trauma

- Trauma from the spinal needle leads to backache, dura puncture and leak of cerebrospinal fluid leading to post dural puncture headache, diplopia and tinnitus.
- Nerve injury leading to nerve root and spinal cord damage.
- Bleeding leading to intraspinal and epidural haematoma.
- Misplacement: no effect and inadequate anaesthesia, subdural block, inadvertent intravascular injection.

Complications Due To Drug Toxicity

- Systemic local anaesthetic toxicity.
- Transient neurological syndrome.
- Cardiac arrest.
- Drug side effects such as nausea and vomiting, respiratory depression, anaphylaxis, toxicity including intravascular injection pf local anaesthetic.

Complications of spinal anaesthesia can also be classified as early and late. The early or immediate complications are:

- Hypotension and cardiac arrest
- Total spinal block leading to respiratory arrest

- Urinary retention
- Epidural bleeding and haematoma

The late complications of spinal anaesthesia are:

- Post dural puncture headache
- Backache
- Focal neurologic deficit
- Bacterial meningitis

NERVE ROOT DAMAGE

Nerve root damage is caused by direct needle trauma or by intraneural injection of local anaesthetic [16]. It usually presents with skin hypaesthesia in the dermatome supplied by the nerve root and occasional muscle weakness. The area of the sensory deficit differs depending on whether there is damage to a nerve root or to a peripheral nerve. A spinal needle may traumatise a nerve root [16]. Some neurological deficits following nerve root trauma are when the L2 is affected, there is sensory loss to the upper anterior thigh and motor weakness of the hip flexion. When L3 is affected, sensory loss of the lower anterior thigh and medial aspect of the thigh with motor weakness of adduction oft het high. When L4 is affected, there is sensory loss of the lateral thigh knee and medial aspect of the leg with motor weakness of leg extension. When L5 is affected, there is sensory loss of the lateral aspect of the leg and dorsum of the foot with motor weakness of the ankle dorsiflexion. When S1 is affected, there is sensory loss of the lateral aspect of the foot with motor weakness of ankle flexion [16].

PERMANENT NEUROLOGICAL DAMAGE FOLLOWING SPINAL ANAESTHESIA

Neurological complications may complicate regional anaesthesia [16]. Almost most resolve spontaneous, while some are permanent [9]. Serious neurological injury is extremely rare but widely feared complication of spinal anaesthesia [11].

However rare, neurological injury after regional anaesthesia can be distressing to patients and their families [15]. Neurologic injuries from Neuraxial procedures are rare, but it remains a fervently held fear among many patients [18]. The incidence of neurologic complications after spinal anaesthesia is higher with lidnocaine than with bupivacaine [4]. The incidence has been reported as 35 per 10 000 blocks after spinal anaesthesia [16]. And serious permanent neurological damage id extremely rare less than 1:10 000 [11]. Neurologic injury may result from direct needle trauma to the spinal cord or spinal nerves or spinal cord ischaemic. Inadequate patient positioning and /or non-cooperative patients, insufficient physician experience, insufficient patient information on the procedure are critical factors that increase the risk of neurologic complications [4]. The most common complication is a reversible neuropathy due to direct needle trauma or intraneural injection of local anaesthetic presenting as a radiculopathy involving s single spinal nerve root. There is generally under reporting of neurologic complications following regional anaesthesia due to litigation [16]. Many neurologic sequences are the result of a delayed diagnosis and treatment and in some cases there is poor follow up and induced healthcare requirements. In spite of the several complications, there incidence is relatively low and hence regional anaesthesia as compared to general anaesthesia. Potential mechanisms of neurologic injury following Neuraxial anaesthesia include direct needle trauma, neurotoxicity of injected substance infections complications, haemorrhagic complications or spinal cord ischaemic. The majority of perceived injuries are related to persistent paraesthesia or motor weakness [18]. The nerve roots or spinal cord may be injured postoperative peripheral neuropathies can be due to direct physical trauma to nerve roots.

Some studies have suggested that multiple attempts during a technically difficult block are risk factors for neurological sequence after spinal anaesthesia [9]. Direct injury into the spinal cord can cause paraplegia; damage to the conus medullaris may cause isolated sacral dysfunction including paralysis of the biceps femoris muscle, anaesthesia in the posterior thigh, saddle area, or great toes and loss of bowel or bladder function [9]. Needle trauma to the epidural veins often causes minor bleeding in the spinal canal though this usually benign and self-limiting. A clinically significantly spinal haematoma can occur following spinal anaesthesia, particularly in the presence of abnormal coagulation or bleeding disorder. The incidence of such haematomas has been estimated to be about 1: 220 000 for spinal anaesthesia [9].

Epidural haematoma is a rare but potentially devastating complication [12]. Haematomas or abscess formation in the spinal cord after subarachnoid anaesthesia results in weakness and sensory below the level of the spinal cord compression [19]. It is associated with intense back pain and is a neurological emergency which demands immediate decompression to avoid

permanent disability [19]. Neuraxial haematomas are usually located 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 cerebrospinal fluid and drained in the segmental vessels along the existing spinal nerves [13]. Complications and associated injuries will continue to occur as there are many factors to consider. It is essential that the anaesthetist have a role in the postoperative care when any incident, complication or adverse event occurs [13]. Many neurological sequelae are the result of a delayed diagnosis and treatment [13].

In spite of the several complications, the incidence of Neuraxial haematomas is relatively low and hence, regional anaesthesia as compared to general anaesthesia [13]. Bleeding into the spinal canal is the most serious complication associated with spinal anaesthesia as the spinal canal is a concealed and non-expandable space [20]. Despite surgical decompression and aggressive rehabilitation the majority of reported neurological deficits have been permanent if not treated on time [20]. Spinal subarachnoid haematoma is extremely uncommon [20]. The safety of Neuraxial blocks has been well established and acknowledged over a series of studies and trials, even with anticoagulation and antiplatelet therapy [20]. Intraspinal haematoma though rare, is an established complication of lumbar puncture and a source of concern for the anaesthetist because it can cause permanent neurological deficits [20]. Spinal haematoma should always be considered early in the differential diagnosis of patients who present with motor and sensory deficits with a history of Neuraxial intervention and should be diagnosed and treated aggressively [20]. Though magnetic resonance imaging confirms the presence of a large mass compressing the spinal roots, the exact localisation can be confirmed on surgical exploration [20]. When haematoma is suspected, neurological imaging such as magnetic resonance imaging, computed tomography or myelography must be obtained immediately and neurosurgical consultation should be requested [9]. Early diagnosis and timely intervention will result in improved outcome [20]. Early surgical intervention and evacuation is indicated however in some patients with minimum symptoms, conservative treatment may play a role. Results are poor in patients with subarachnoid haematoma, severe preoperative deficits and in those where surgery has been delayed. Early diagnosis and urgent surgical treatment improves the possibility of neurological recovery. It is known that surgical decompression more than 8 hours after the beginning of the symptoms is associated with a worse prognosis [20]. Subarachnoid haematoma, the prognosis is worse as in addition to the mass effect of the haematoma separated from the subarachnoid space, there is also rupture of the internal membrane. When the collection of blood is large, there may be local pain, flaccid paralysis, paraparesis, impairment of sensation in the lower limbs and sphincter disturbances. Prompt evacuation of the haematoma is mandatory to prevent a permanent neurological deficit [20]. There is an increased risk of haematoma formation in patients with a bleeding tendency therefore before a regional block is sited, it is important to assess the potential risks and benefits. Regional blockade should never be performed in the presence of full anticoagulation or within ten hours of an injection of a low molecular weight heparin. Although spinal anaesthesia may occasionally be prolonged, delayed recovery should always be followed up. The presence of a bilateral distribution of motor and sensory abnormalities and/or disturbance of bowel or bladder function should arouse suspicion of a catastrophic lesion. Urgent imaging is required and if a haematoma is present, emergency decompression is indicated as soon as possible. Any delay increases the likelihood of permanent neurologic sequelae [12]. The symptoms of needle trauma are sharp back and leg pain with a progression to numbness and motor weakness and/or sphincter dysfunction. In many cases good neurological recovery has occurred in patients who have undergone surgical decompression within 8-9 hours [9].

When performing a spinal anaesthetic, the injection should occur below the level of the conus medullaris. Cases of conus damage following spinal anaesthesia have been reported as the conus medullaris does not always terminate at the lower border of l1. In 2-20 % of individuals it ends at the lower border of L2, more commonly in women. Even senior anaesthetists may underestimate the interspace where the pace where to inject the local anaesthetic agent. Tuffers line may cross the midline at L3\L4 not L4\L5 and is not a reliable indicator. Therefore before attempting spinal anaesthesia, it is prudent to choose the lowest possible interspace and avoid using the L2\L3 interspace or higher [16].

CONCLUSION

Neuraxial anaesthesia is best avoided in patients with coagulopathy, significant thrombocytopenia, platelet dysfunction or those who have received

fibrinolytic/thrombolytic therapy. Neurological damage after administration of spinal anaesthesia could result from needle damage, to the spinal cord or nerve roots, spinal haematoma, meningitis, arachniodinitis and neurotoxicity of the local anaesthetic. Spinal cord injury can be best avoided by performing the block below L1 in adults and L3 in paediatric patients. Direct injection into the spinal cord can cause paraplegia. Damage to the conus medullaris may cause isolated sacral dysfunction with lower extremity muscle weakness and loss of bowel or bladder function. Needles can cause direct physical trauma to the spinal nerve roots as well. Multiple attempts of a difficult block raise the chances of needle trauma significantly. An anaesthetist should never be a hero or shy to call for help and another pair of hands if block cannot be established after two to three trials. Spinal and epidural haematoma can lead to permanent neurological damage after spinal anaesthesia if it is not evacuated as soon as possible. The symptoms of this haematoma formation typically appear suddenly and include sharp back pain and leg pain with a progression in numbness, motor weakness and sphincter dysfunction. Magnetic resonance imaging, computed tomography scan or myelography must be obtained as soon as the possibility of a haematoma is considered as well as neurology consultation as soon as possible. The haematoma leads to compression resulting in ischaemic and subsequent injury. Presence of blood in the subarachnoid or epidural space will result in the compression of neural tissues. There is no way to apply pressure and stop the bleeding due to anatomy. Direct injection into the spinal cord can lead to paraplegia.

Neurological injury following spinal anaesthesia can be transient or permanent. This is prevented by avoiding trauma to the nerve roots or spinal cord. Identification of appropriate land marks is essential. Pre-existing neurological deficits should always be documented. In the pre-operative visit, history of any neuropathy, acute and chronic low back pain and motor deficits should always be inquired. Concurrent conditions that may contribute to postoperative neurological deficits should be documented such as vascular disease, diabetes mellitus, intervertebral disk injury or spinal disorders. Multiple attempts increase the risk of trauma therefore this can be avoided to some extent by proper positioning, identification of landmarks. During administration of spinal anaesthesia, if paraesthesia is encountered, the needle should be redirected.

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