

Epidural anaesthetics are another group of drugs implicated in causing arachnoiditis. Vandermeulen ( [ii](#) ) includes arachnoiditis as a

"mishap"... "solely due to ... epidural anaesthesia".

Haisa et al ( [iii](#) ) state that lumbar adhesive arachnoiditis should be considered for differential diagnosis of back and leg pain after epidural anaesthesia.

Furthermore, epidural anaesthesia may cause subarachnoid cysts or cavities, which are also recognised complications of arachnoiditis.

Over a century ago, Koller first used cocaine to anaesthetise his eyes.

In 1865, Halsted used cocaine anaesthesia. Corning pioneered the epidural local anaesthetic block, whilst Bier reported on subarachnoid local anaesthetic in 1899. (Bier also reported the first spinal headache).

Lemmon in 1940 started using a continuous spinal technique; later intraoperative spinal anesthesia came into use; however, it was not until the 1990s that infusions of post-operative analgesia became widespread. ( [iii](#) )

Epidural and spinal administration of anaesthetic agents is used for:

- childbirth
- post-operative pain relief
- regional anaesthesia : e.g. for knee operations

Aldrete, an anaesthetist with considerable experience with arachnoiditis patients, has recently written a paper about arachnoiditis following regional anaesthesia. ( [\[iv\]](#) )

He begins by stating:

"Of late, regional anaesthesia has enjoyed unprecedented popularity; this increase in cases has brought a higher frequency of instances of neurological deficit and arachnoiditis."

He notes that in the early stages this may manifest as transient radicular irritation, cauda equina syndrome and conus medullaris syndrome, whereas later, it cause radiculitis, nerve root clumping, scarring, dural sac deformities, pachymeningitis, pseudomeningocele, and syringomyelia.

With regard to regional anaesthesia in particular, arachnoiditis arises as a result of traumatic puncture (blood, damage to neural structures), the toxicity of the anaesthetic agents themselves, detergents/antiseptics, and epidural abscesses or meningitis.

Aldrete points out that the old adage 'all anaesthetics are neurotoxic' and Pizzolatto's prediction to that effect, seem to be proved correct by experience. Even lower concentrations of anaesthetic agent such as 2% lidocaine, have been reported as neurotoxic. ( [\[v\]](#) )

High dose, high concentration or prolonged exposure are all risk factors in neurotoxicity. Weighting with dextrose (to provide hyperbaric solutions) or use of vasoconstrictors such as epinephrine, are further causes for concern.

Burm ([\[vi\]](#)) states that epidural anaesthesia results from the interactions of local anaesthetics with nerves within the subarachnoid space, which they reach by uptake into the epidural fat and via systemic absorption, and that consequently, epidural doses need to be much higher than spinal doses.

Bearing this in mind, it is unsurprising that there is evidence that epidural anaesthetic agents such as those used in childbirth also carry a risk of neurological damage.

In 1996, Gallo et al, in Italy, ([\[vii\]](#)) compared the use of 1% and 0.5% hyperbaric bupivacaine administered intrathecally for Caesarean section.

The authors reported little difference in the efficacy of the two concentrations and remarked:

"In view of the possible relationship between the neurotoxicity of local anaesthetics and the concentration of the solution used for spinal anaesthesia, it is to be hoped that less concentrated solutions of hyperbaric bupivacaine will be introduced."

As Malinovsky and Pinaud noted (also in 1996 [\[viii\]](#)), neurotoxicity of anaesthetic agents can be due to:

- Reduced neuronal blood supply
- High concentrations
- Long duration of exposure
- The use of adjuvants.

They reported Cauda Equina Syndrome following continuous spinal anaesthesia using hyperbaric lidocaine and tetracaine. The authors clearly recommended the use of preservative-free solutions.

Meanwhile, Ganem et al ( [\[ix\]](#) ) had studied the neurotoxicity of subarachnoid hyperbaric bupivacaine in dogs.

They found that "Increasing doses of hyperbaric bupivacaine solutions increased the incidence of nerve tissue damage, which did not occur using hypobaric solutions."

A study published in the British Journal of Anaesthesia in 1995( [\[x\]](#) ) by Tarkkila et al found that with 5% lidocaine, there was a 10% incidence of transient radicular irritation, which was not however seen with bupivacaine.

Ginther and Zamanian, in an Internet publication, "Toxicity, Local Anaesthetics from Emergency Medicine/toxicology" ( [\[xi\]](#) ) noted:

"Very high doses of anesthetics can produce irreversible conduction block in less than 5 minutes. Peripheral neurotoxicity, such as prolonged sensory and motor deficits, has been documented. It is hypothesized that a combination of low pH and sodium bisulphite in the mixture can be partially responsible for these changes."

Lidocaine and tetracaine appear to have a greater potential for neurotoxicity than bupivacaine at clinically relevant concentrations.

Hodgson et al. ( [\[xii\]](#) ) listed a number of different studies in which spinal anaesthesia caused transient neurological symptoms (TNS).

In particular, it is worth noting the findings of Hampl ( [\[xiii\]](#) ), with gynaecology patients; 31% experiencing TNS after 5% lidocaine, 40% after 2% lidocaine and in a separate study ( [\[xiv\]](#) ), 33% with 5% lidocaine plus 7.5 glucose, and 31% with 5% lidocaine plus 2.7 glucose (cf. 0% with 0.5 % bupivacaine which is now in wider use).

Yamashita et al. ( [\[xv\]](#) ) recently published the results of a rabbit study looking at the comparison of neurotoxic effects on the spinal cord of 2% tetracaine, 10% lidocaine, 2% bupivacaine and 2% ropivacaine administered intrathecally.

They found "sensory and motor functions in the lidocaine group were significantly worse than in the other groups,"

significantly raised glutamate concentrations and characteristic histopathological changes: vacuolisation of the dorsal funiculus and chromatolytic damage of motor neurons.

They concluded:

"The margin of safety may be smallest with lidocaine.

Horlocker wrote in 2001( [\[xvi\]](#) ) about neurological complications of neuraxial blockade. She noted that incidence of transient neurologic symptoms (TNS), first described in 1993, has ranged between 0 and 37%,

"and is dependent on anesthetic, surgical and, possibly, undefined patient factors."

Freedman et al. ( [\[xvii\]](#) ) in a large study, found incidence of TNS with lidocaine (11.9%) was significantly higher than that with tetracaine (1.6%) or bupivacaine (1.3%). Pain was described as severe in 30% of patients and resolved within a week in over 90% of cases.

Obesity and lithotomy position were noted as particular risk factors. Horlocker noted:

"The clinical significance of TNS is unknown. While many anesthesiologists believe that the reversible radicular pain is on one side of a continuum leading to irreversible cauda equina syndrome, there are currently no data to support this concept."

She also remarked

"The blood supply to the spinal cord is precarious due to the relatively large distances between the radicular vessels. Systemic hypotension or localized vascular insufficiency with or without a spinal anesthetic may produce spinal cord ischemia resulting in flaccid paralysis of the lower extremities, or anterior spinal artery syndrome."

Birnbach ( [\[xviii\]](#) ) writing on Controversies in Obstetric Anesthesia, devoted the last section of his article to the question:

"Should we still be using 5% spinal hyperbaric lidocaine?"

He argues that one of the reasons we are seeing

"an increased incidence of lidocaine-related neurologic sequelae" is that these problems always existed but are only now being looked for and thus recognised. He notes a "heightened awareness"

of this problem due to the literature on cauda equina syndrome caused by lidocaine and microcatheters.

ASTRA USA, acknowledging reports of transient radicular symptoms, has advised all US anesthesiologists to use caution with hyperbaric spinal lidocaine 5%, as follows:

1. Dilute 5% lidocaine with equal volumes of CSF or preservative free saline.
2. Limit the dose to a maximum of 100mg
3. remove and replace the needle if an additional dose is necessary
4. use a needle of sufficient gauge to allow adequate withdrawal of CSF before and after spinal administration.

If the epidural space is already compromised by disc herniation, stenosis or epidural fibrosis, the risk is greater.

Yuen et al ( [\[xix\]](#) ) state that neurological complications

"may be more severe in the presence of spinal stenosis".

The presence of a preexisting neurologic condition may predispose the nerve to the neurotoxic effects of local anaesthetics. ( [\[xx\]](#) )Rocco et al ( [\[xxi\]](#) ) in a study of pressure gradients in the epidural space, concluded that as resistance to inflow of fluid was significantly higher in the diseased epidural space, "spread of anesthetics might be difficult to predict".

Whilst a British paper published in February 2001 ( [\[xxii\]](#) ) refuted the impact of epidural anaesthesia on long-term backache for up to a year post-procedure, there are questions that remain to be answered as to the risk of long-term neurological sequelae, which seem not to have been addressed as yet (studies to date concentrating on back pain but not necessarily on neurological problems).

The Patient Injury Act in Finland in 1987 initiated a scheme where patients can claim damages

on a no-fault compensation basis via the Patient Insurance Association (PIA).

Aromaa et al. ( [xxiii] ) looked at severe complications associated with epidural and spinal anaesthetics between 1987 and 1993 in Finland, based on insurance claims. Out of 86 claims, 25 involved serious complications of spinal anaesthesia.

These included one case of permanent cauda equina syndrome, 7 of neurological deficits and 4 infections. 9 cases of serious complications of epidural anaesthesia were reported, including paraparesis (1), permanent cauda equina syndrome (1), peroneal nerve paresis (1), neurological deficit (1), bacterial infections (2), acute toxic reactions related to the anaesthetic solution (2), and overdose of epidural opioid (1).

Using these results, the authors proposed incidence figures of serious complications: 0.45:10,000 following spinal and 0.52:10,000 following epidural anaesthesia.

Swedish authors Moen, Irestedt and Raf ( [xxiv] ) reviewed claims from Patient insurance between 1997 and 1999, noting that

“These occurred more frequently after epidural anaesthesia (1:4,000) than after spinal anaesthesia (1:13,000) with the exclusion of obstetric epidural anaesthesia (1:40,000)”

Epidural haematoma occurred in 1:30,000 after epidural anaesthesia, in 1:200,000 after spinal anaesthesia. One epidural abscess occurred in 60,000 epidural anaesthetics, while five cases of meningitis occurred after spinal anaesthesia (1:40,000). Out of 65 claims, 29 involved serious neurological complications.

Chiapparini et al. ( [xxv] ) looked at the outcome of severe complications of lumbar epidural anaesthesia in 16 patients. 4 had symptoms immediately after the procedure. 1 developed subacute flaccid paraparesis. 2 others had infectious spondylodiscitis at lumbar puncture level.

8 patients had a delayed progressive spastic paraparesis, which was found to be due to "subarachnoid cysts and irregularities of the surface of the spinal cord consistent with arachnoiditis"; of these, 6 had an "extensive, complex syrinx within the cord". 1 patient had a severe lumbar polyradiculopathy, as a result of cauda equina adhesive arachnoiditis revealed on MR.

The authors noted what they termed a

"relentless progression of the disease and a poor outcome"

for the patients with arachnoiditis; 5 were wheelchair bound, one bedridden.

They remarked:

"Although epidural anaesthesia is generally considered safe, rare but severe complications, such as radiculopathy, infectious disease, myelopathy from ischemia and arachnoiditis with a syrinx may occur."

In conclusion, the Italian authors stated:

"Complications of epidural anaesthesia are easily recognised when they develop immediately; their relationship to the anaesthesia may be ignored or underestimated when they appear after a delay. Awareness of the possibility of delayed complications is important."

The problem with many cases of arachnoiditis is that there can be a considerable delay between the triggering procedure and onset of the symptoms.

One of the causes for these complications might be skin particles: Reina Perticone et al. ([\[xxvi\]](#)) discussed the drawing of epithelial (skin) cells into the vertebral canal during spinal injections.

They mentioned early complications such as meningitis and later ones such as epidermoid tumour.

Using cats, they conducted postmortem analysis of meninges after subarachnoid anaesthesia using 0.7-1ml bupivacaine 0.5%.

Whilst no epidermal cells were found on the meninges' surface, an epithelial cell was observed inside a sectioned epidural vessel towards the systemic circulation.

The authors suggested that subarachnoid anaesthesia using a 22G Quincke needle might allow skin fragments to enter the spinal canal.

In patients who have experienced paraesthesia during administration of epidural anaesthesia, there is a risk of neurological complications. Aldrete remarked (267):

“Direct trauma to nerve roots or the spinal cord may be manifested as paraesthesia that has not been considered an injurious event; however, it usually implies dural penetration, as there are no nerve roots in the epidural space posterior.”...

“it has been realized that paraesthesia provoked in peripheral nerve trunks not only implies nerve contact but frequently represents a puncture.”

Selander ( [xxviii] ) reported a 2.8% incidence of neurological complications in patients in whom painful par aesthesia was deliberately induced. If the perineurium integrity is compromised, herniation, loculation and scarring of the intraneural structures may result.

In addition, one must consider the effects of a neurotoxic substance on a damaged and therefore susceptible, nerve: Aldrete commented:

“Furthermore, the persistent pursuit of the anesthetic technique by injecting the local anaesthetic upon and around a nerve root with a perforated myelin sheath may turn an otherwise usually innocuous concentration of LA into a neurotoxic agent.”

Indeed, he recommended:

“Reassessment of the impact of paraesthesia as generator of a potential neurological deficit when LA is injected into or around it, includes the consideration to immediately discontinue the procedure rather than attempt another puncture at a different intervertebral space, as a hole in the dura has already been made.”

Aldrete also mentioned an important point:

the increasing trend for performing regional anaesthesia on patients who are unconscious, having already been given a general anaesthetic. He cited Bromage and Benumof ( [\[xxviii\]](#) ) who reported on paraplegia following accidental intracord injections.

He noted that many paediatric anaesthetists practice regional and general anaesthesia together in infants and children.

Pleym and Spigset ( [\[xxix\]](#) ) surveyed 21 cases of peripheral neurological deficit related to subarachnoid or epidural anaesthetic. The patients experienced:

Pain in the lower extremities reported in 12 (57%), paraesthesias/hypoaesthesias reported in 11 patients (52%), low back pain or abdominal pain from T9-T10 downwards in 7 (33%), urinary incontinence in 3 patients, faecal incontinence in 2 patients, and erectile dysfunction, loss of sensation of full bladder and quadriceps muscle paresis were each reported in one patient.

There was a group with reversible symptoms and another group who had persistent symptoms after 1 month to 4 years. 50% of the latter group had motor deficits.

Although the authors concluded:

“causal relationship between subarachnoid or epidural administration of local anesthetics and neurologic deficits therefore remains uncertain,” they also pointed out the increase in the number of reports on lidocaine after the introduction of very fine-bore spinal needles, which they noted as being “consistent with the suspicion that lidocaine at the concentration 50 mg/ml is neurotoxic and that it may not be diluted rapidly enough in the cerebrospinal fluid when injected through these needles”.

Mateo et al. ( [xxx] ) reported on a rare complication: pneumocephalus. They had 2 cases, after “loss of resistance” technique (using an air-filled syringe) was used for epidural injection; one was an epidural collection of air, the other subarachnoid.

Previously, Saberski et al. ( [xxxi] ) reviewed the complications related to the use of air in determining the loss of resistance in order to identify the epidural space for injections. There were few studies comparing saline with air during the review period (1966 to 1995) but a number of case reports.

The authors noted:

“Complications associated with the use of air for the loss of resistance technique included pneumocephalus, spinal cord and nerve root compression, retroperitoneal air, subcutaneous emphysema, and venous air embolism. Additionally, inadequate analgesia and paresthesia have been associated with the loss of resistance technique using air. Transient and permanent

neurologic sequelae have been attributed to some of the complications.&quot;

They concluded:

&quot;The potential complications associated with the use of air for identifying the epidural space with the loss of resistance technique may outweigh the benefits. The use of saline to identify the epidural space may help to reduce the incidence of these complications.&quot;

Vartis, Collier and Gatt ( [\[xxxii\]](#) ) in Australia, discussed the potential intrathecal leakage of drugs injected as a bolus via an epidural catheter during combined spinal anaesthesia (CSE). CSE involves a deliberate multicompartiment block across a breached dural membrane.

Whilst in their study, they did not observe evidence of this leakage, the authors counselled caution during administration of a bolus dose of drug, especially hydrophilic opioids.

Di Tommaso et al. ( [\[xxxiii\]](#) ) recently reported: &quot;Severe complications such as spinal epidural haematoma and an array of adverse neurological events leading to temporary or permanent disability have been ascribed to central neuraxial blocks.

Infections (meningitis, abscesses), chemical injuries and very rarely cerebral ischaemia or haemorrhage, or both, have also been ascribed directly or indirectly to spinal and/or epidural anaesthesia. Some case reports, and very few retrospective studies, have focused their attention on the fact that central nerve blocks can cause, albeit rarely, permanent damage to the spinal cord or nerve roots, or both.&quot;

Butamben is a local anaesthetic that provides extended sensory blockade, which has led to the use of 5% butamben administered epidurally in cancer patients to relieve pain uncontrolled by systemic opioids. ( [\[xxxiv\]](#) )

However, once again, we need to consider possible adverse effects.

(Many drugs used in chronic non-malignant pain were originally developed for patients with terminal illness where longer-term effects were less relevant).

Shulman, Joseph and Haller ( [\[xxxv\]](#) ) looked at the effect of 10% butamben on dogs.

They found that if it was injected intrathecally (a single injection), the dogs developed arachnoiditis, whereas epidurally (given 3 times) appeared to be safe.

The authors also reported on 2 cancer patients who at autopsy were not found to have significant pathology in the spinal cord, meninges or spinal nerves.

They concluded:

"Epidural butamben does not appear to cause any local tissue damage provided that subarachnoid needle placement has been ruled out. Subarachnoid butamben should be avoided."

**Conclusion:** The Cochrane review in February 2000 ( [\[xxxvii\]](#) ) commented, "Epidural analgesia appears to be very effective in reducing pain during labour, although there appear to be some potentially adverse effects. Further research is needed to investigate adverse effects and to evaluate the different techniques used in epidural analgesia."

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