Complications from peripheral nerve blocks have been well documented.

Multiple review articles have been published with the rate of complications being averaged etc.

The incidence of neurological symptoms following PNB depends on the anatomical location:

a. 0.03% for supraclavicular blocks (3/10000)
b. 0.3% with femoral nerve blocks (3/1000)
c. 3% with interscalene blocks (3/100)

Types of complications:
NERVE INJURY:
1. Mechanical trauma from the needle
2. Nerve edema and/or hematoma
3. Pressure effects from local anesthetic
4. Neurotoxicity of solution
5. Preexisting neuropathies
6. Surgical manipulation
7. Prolong tourniquet pressure
8. Compression from postoperative casting
COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

The majority of neural injuries are temporary and not permanent. They are usually self resolving in weeks to months.

It is well established that a direct injection into a peripheral nerve can result in nerve injury.

New studies indicate that this is not always true, but never the less we attempt not to inject directly into a nerve.

Peripheral nerve injury

- In the early postoperative period, mild paraesthesia may be present in up to 15% of patients that undergo peripheral nerve block.
- Most of these symptoms resolve within days to weeks, with over 99% completely resolving by 1 year.
- Serious neurologic injury reported in a large prospective study occurred in 2.4 per 10,000 peripheral nerve blocks.

COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

We need to be familiar with the anatomy of a nerve.

1. Perineurium
2. Epineurium
3. Fascicle
4. Axon
5. Schwann Cells
6. Endoneurium
7. Myelinated nerve
8. Unmyelinated nerve
Peripheral Nerve Injuries can be classified in terms of Degree of functional disruption.

NEURAPRAXIA: This is where a mild insult has occurred, but the axons and connective tissue have remained intact. Usually indicating a focal demyelination and reversible over weeks to months.

AXONOTMESIS: This is Axon disruption with connective tissue remaining intact. Recovery is usually complete but not always with regeneration of axon at a rate of 1-2 mm/day.

NEUROTMESSIS: Complete interruption of fascicle, including the AXON and CONNECTIVE TISSUE. The nerve is completely severed so surgery is indicated in an attempt to reapproximate the ends. RECOVERY is poor even with surgery.
COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

The problem today is we try to place local anesthetic adjacent to the nerve but not in the nerve, but there have been several studies that demonstrate no harm when some injections are placed in the nerve.


Bigeleisen PE. Anesthesiology 2006;105(4):779-783.

COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

The results of these studies suggest that injection into the connective tissue of the nerve will not result in a permanent injury to the nerve.

An injection into the fascicle of a nerve will result in permanent injury.

COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

Injection in the perineurium – a tough multilayer epithelial sheath that does not distend with increase pressure but ruptures. This rise of increase pressure can result in disruption “rupture” of the nerve anatomy. This can lead to permanent injury or damage.

The brachial plexus in area of the interscalene, the ratio of loose connective tissue to neural tissue is 1:1; not a lot of room for intraneural injection of local anesthetic.
COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

MECHANISMS OF NERVE INJURY FOLLOWING INTRANEURAL INJECTION

Once the perineurium is ruptured or breached the spectrum of subsequent injury is wide and multifactorial.

NERVE TRAUMA

Trauma to the perineurial sheath may result in injury to the axons and/or the leakage/herniation of endoneurial content. The may be by the needle or catheter. Again this is multifactor problem. Injection of Normal Saline into the fascicles does not cause damage or permanent injury.

Insertion of IV catheter into nerve or EEG needle has resulted in permanent injury without any injection of substances.

A variety of cellular changes occur because of needle trauma: alteration in membrane channel, activation of signal transduction, neuropeptide production and overall increase in excitability at the dorsal horn.
If you attempt to do intraneural injection you will find it hard to get into the fascicles. They move. The sharper the needle (15 degree vs. 30 degree is more likely to penetrate the nerve fascicle.

If you are really lucky and you can get your 18 gauge blunt tip needle to puncture nerve fascicle that will cause more damage than 15 degree sharp needle. Sala-Blanch X, Anesthesia Pain Med. 2009;34(3):201-205.

Regardless of the needle size or type once nerve is penetrated it leads to inflammation and cellular infiltration whether clinical injury occurs or not.

TOXICITY OF LOCAL ANESTHETICS AND ADDITIVES:

All local anesthetics are potentially neurotoxic. The mechanism of injury by LA is unclear.
COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

Here are the Theories: (educated guesses)

1. Increase in intracellular calcium concentrations.
2. Disturbances in the Force.
3. Disturbances in the mitochondrial function.
4. Interference with membrane phospholipids.
5. Cell Apoptosis (programmed cell death by not eliminating fragmentation of DNA.)

COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

TOXICITY OF LOCAL ANESTHETICS AND ADDITIVES:

Intraneural administration of local anesthetics exposes the axons to a higher concentrations of drug than extraneural application.
We know injection of LA into the FASCICLES results in widespread and immediate AXONAL injury.

COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

TOXICITY OF LOCAL ANESTHETICS AND ADDITIVES:

Local anesthetics alone can cause decrease in neural blood flow. Lidocaine 2% can reduce blood flow in rat sciatic nerve by 20-40%.
COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

TOXICITY OF LOCAL ANESTHETICS AND ADDITIVES

EPINEPHRINE is a common adjuvant, it can decrease blood flow by 20-35%.

The effects of Lidocaine and Epinephrine are additive and can reduce neural blood flow up to 80%.

Prevention of Peripheral Nerve Injury

There have been many different methods analyzed to add safety doing peripheral nerve blocks.

1. Pain on injection
2. Electrical Stimulation
3. Ultrasonography
4. Injection pressure monitoring

Prevention of Peripheral Nerve Injury:

Pain on Injection – Traditionally pain on injection means stop the injection or you will cause neural damage.

Problem one: pain is subjective and difficult to quantitate (intensity and quality)

Problem two: pre-existing disease such as Diabetes Mellitus or peripheral neuropathy or premedication for the block may interfere with subjective complaints.
COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

Prevention of Peripheral Nerve Injury:

Problem three: There is no correlation between pain and symptoms or injuries. The overall rate of neurological injuries is 1.7%.

Problem four: The transmission time of “that hurts” to anesthesiologist maybe all the time needed to completely disrupt a nerve - damage done!

COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

Problem five: Performing blocks while patient is asleep/heavily sedated. This maybe necessary in certain types of patients-child, mentally incompetent, traumatically injured etc.

COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

Electrical Nerve Stimulation:

Can use electrical nerve stimulation to locate nerve and also detect intraneural (intrafascicular) needle location. Motor response at <0.2mA, readjust the needle, indicates intraneural placement of needle tip.
COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

Ultrasonography:

Imaging the needle should help prevent intraneural injection. Ultrasound may not prevent nerve injury because depend on skill of person doing the procedure, the ability to obtain a good clear image with ultrasound, the needle used to do the block. Again, by the time the changes of inter or intraneural takes place the damage may already be done.

COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

Injection Pressure Monitoring:

Pressure >20psi is associated with neural injury. If pressure >20psi then needle needs to be relocated from intraneural injection to extraneural injection. Pressure of >20psi can result in severe neural injury. Pressure of <20psi indicates extrafascicular needle tip placement.

COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

Injection Pressure Monitoring

High pressure can be caused by PNB needle obstruction, attempted injection into a tendon, or tissue compression by the ultrasound transducer.

There is a move to have pressure monitoring of injection as standard part of the procedure.
COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

Monitoring during nerve blocks: Combining Ultrasound, Nerve Stimulation and Injection Pressure Monitoring.
COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

Practical Management of Postoperative Neuropathy:

A postoperative sensory or motor deficit can happen with the best of providers. The vast majority of neuropathies resolve spontaneously over weeks to months. Patients need to be reassured. Observe patient and keep open mind other things maybe going on and need further evaluation and specialty care.
Managing postoperative neuropathy:

1. Develop and maintain good communication with the patient.
2. Approximately 95% of postoperative sensory changes will resolve within 4-6 weeks, most will resolve the first week. 99% will resolve in first year.
3. Early diagnosis of postoperative nerve injury can be challenging due to:
   - Residual sedation and/or PNB.
   - Pain that limits the examination

4. Neuropathies can be caused by prolonged tourniquets, casting, excessive intraoperative traction, or a misplaced surgical clip. Early involvement with a surgeon is necessary.

5. The presence of motor deficits is reason to refer to a neurologist and/or neurosurgeon.
6. Neuropathies that are evolving need to be sent to a neurologist/neurosurgeon immediately.

REFERRAL FOR ELECTROPHYSIOLOGICAL TESTING WHEN SYMPTOMS NOT PURELY SENSORY, OR NEUROPATHY IS SEVERE AND/OR LONG LASTING.
COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

ELECTROMYOGRAPHY: This is to determine which muscle unit is affected by this denervation lesion.

NERVE CONDUCTION STUDY: A characteristic waveform is generated following stimulation of the nerve, which may allow the neurologist to pinpoint a conduction block.

When to do these tests: Initial exam within 2-3 days of injury or recognition of problem. Prognosis can be determined by what is found. This initial exam is considered baseline and test will need to be repeated in 4 weeks.

Table 3 is algorithm for management of postoperative neuropathy.
COMPLICATIONS OF PERIPHERAL NERVE BLOCKS

Hip and knee surgery

- Hip replacement (performed under general anesthesia) is associated with a 0.5% to 2% incidence of sciatic nerve lesion.
- Sciatic and/or femoral nerve blocks are associated with nerve injury in 2:1000 anesthetic procedures (almost 10 times less common).
- In difficult-to-diagnose cases, a surgery-induced lesion should be considered first.