COMPLICATION OF REGIONAL ANAESTHESIA

(IN COLLABORATION WITH SIGRA, MALAYSIA)

Dr Ling Kwong Ung,
Anaesthetist,
Department of Anaesthesiology,
Sime Darby Medical Centre Subang Jaya,
1, Jalan SS 12/1A.
47500 Subang Jaya, Selangor , Malaysia.
lingkupisces@yahoo.com

Sime Darby Medical Centre Subang Jaya, Selangor, Malaysia.

UNIVERSITY OF MALAYA

The Leader in Research & Innovation

Campus: 750 acres

Hospital: 1,200 beds

Complication of Regional Anaesthesia

- Nerve injury
- L.A. toxicity
- Infection
- Hematoma
- Vascular puncture
- Pneumothorax

Complication of Regional Anaesthesia

- Nerve injury
- L.A. toxicity
- Infection
- Hematoma
- Vascular puncture
- Pneumothorax

Nerve Injury

- Anatomy
- Classification
- Causes of nerve injury
- Incidence
- Mechanism
- Sign & symptom
- Evaluation
- Investigation
- Management
- Prevention

Nerve Injury

- Anatomy
- Classification
- Causes of nerve injury
- Incidence
- Mechanism
- Sign & symptom
- Evaluation
- Investigation
- Management
- Prevention

Anatomy of nerve

- Epineurium

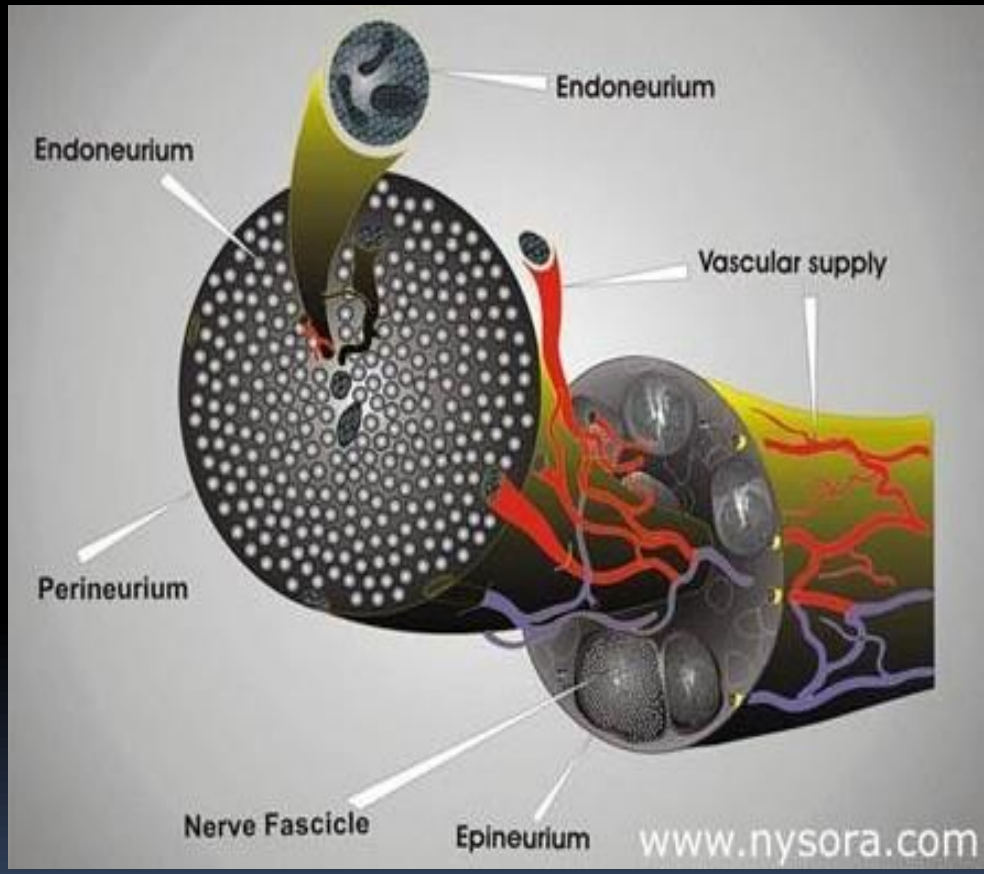
  -external connective tissue enveloping the nerve

- Perineurium

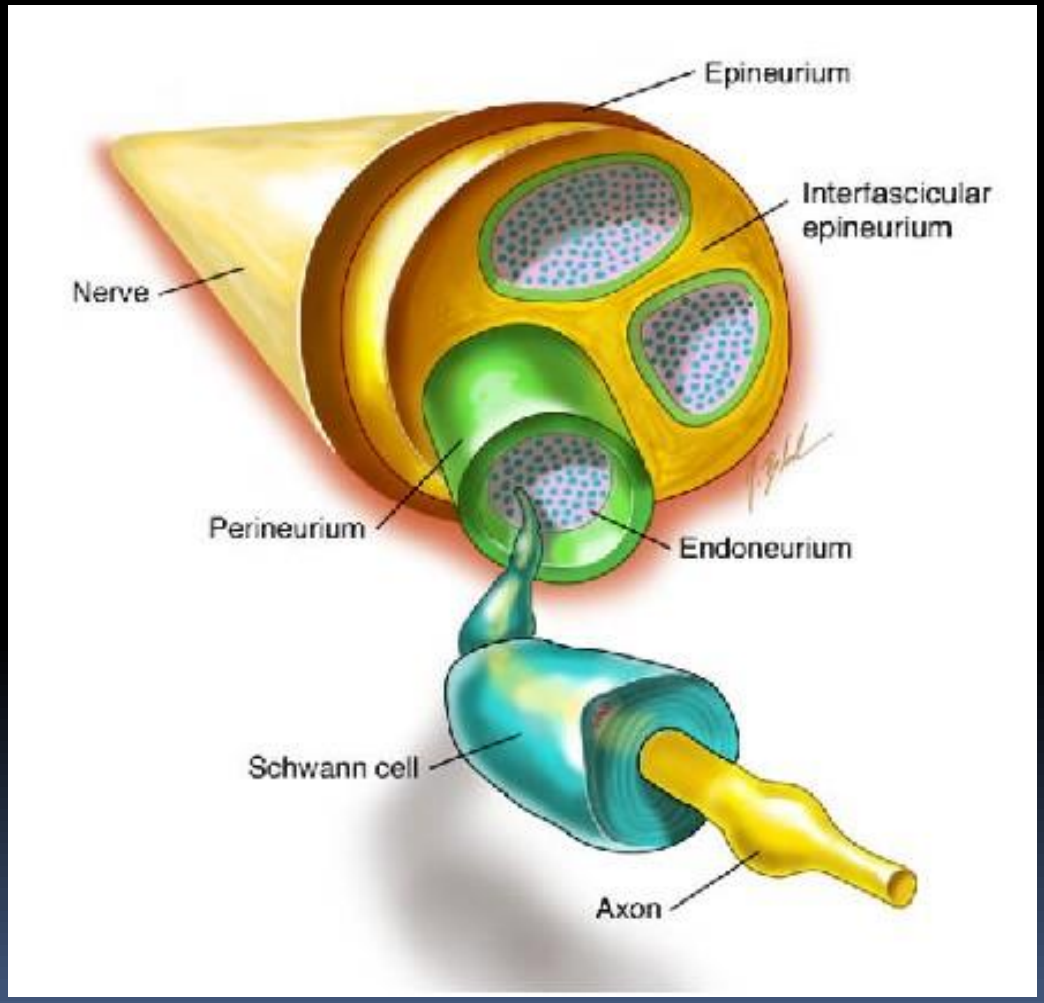
  - multilayered epithelial sheath that surrounds individual fascicles

- Fascicles

  - contain many nerve fibers & capillary blood vessels embedded in a loose connective tissue, the endoneurium



Anatomy of nerve



Nerve Injury

- Anatomy
- Classification
- Causes of nerve injury
- Incidence
- Mechanism
- Sign & symptom
- Evaluation
- Investigation
- Management
- Prevention

Important of Classification of nerve injury

- Based on microscopic & macroscopic
- Seddon Class.(1943)

  - useful to understand the anatomic basis of injury
- Sunderland Class.(1978)

  - useful for prognosis & treatment strategies

Classification of nerve injury

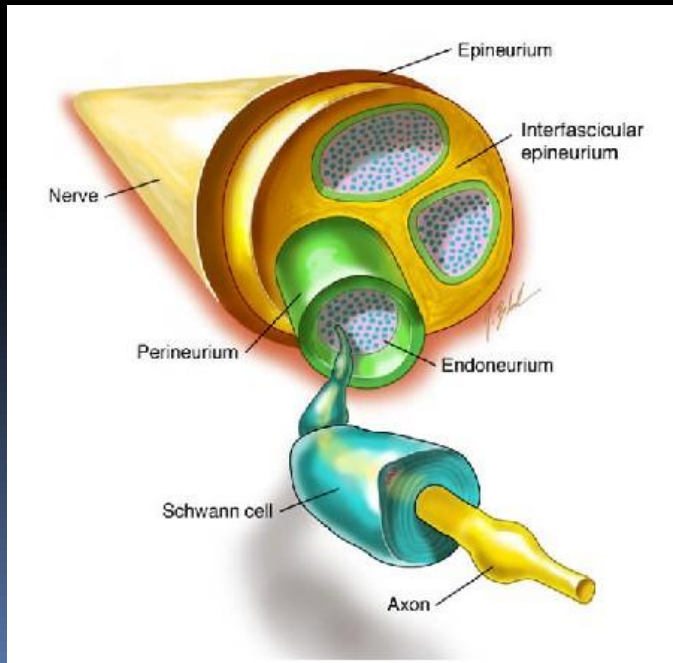
Table 2. *Classification of nerve injuries**

Seddon	Sunderland	Structural and functional processes
Neurapraxia	1	Myelin damage, conduction slowing, and blocking
Axonotmesis	2	Loss of axonal continuity, endoneurium intact, no conduction
Neurotmesis	3	Loss of axonal and endoneurial continuity, perineurium intact, no conduction
	4	Loss of axonal, endoneurial, and perineurial continuity; epineurium intact; no conduction
	5	Entire nerve trunk separated; no conduction

Based on data from Seddon[11], Sunderland[12], and Lundborg[13]

Seddon Classification

- 1) Neuropraxia
  - focal demyelination
  - axon & all connective tissue (endoneurium, perineurium, epineurium) are all intact
  - disruption of conduction
  - motor > sensory deficit
  - autonomic function is rarely affected
  - nerve conduction velocity (NCV) is normal
  - EMG- absent MAPs (motor action potentials)
  - full recovery in days to weeks & rarely months



Seddon Classification

- 2) Axonotmesis (tmesis= cutting)

  - axon is interrupted

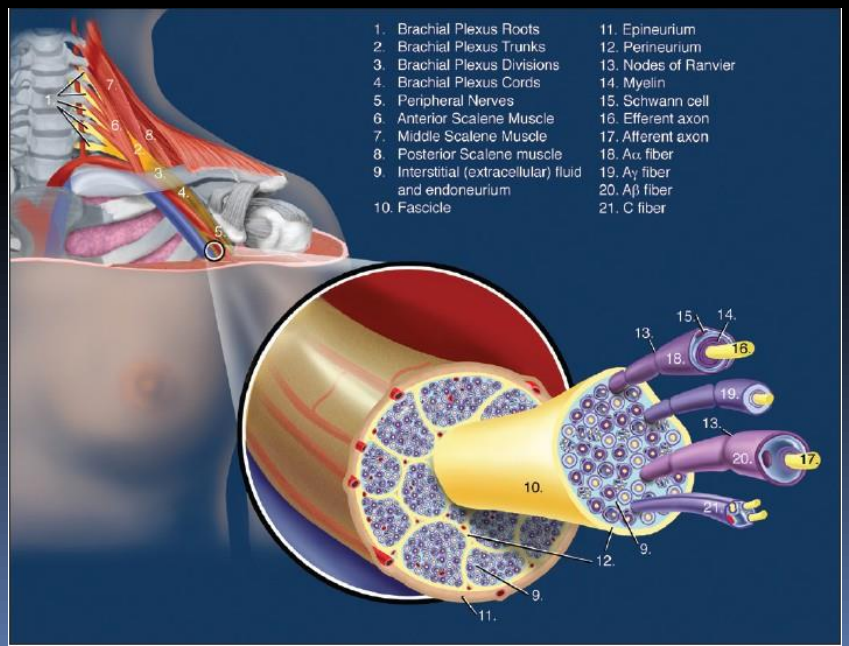
  - intact Schwan cell & all connective tissue (endo,epi, perineurium)→ provides a good guide for axonal regeneration

  - motor, sensory & autonomic all affected

  - NCV : no conduction

  - EMG: fibrillation potentials & absent MAPs

  - variable recovery



Seddon Classification

- 3)Neurotmesis

  - complete disruption of the entire nerve

  - total nerve dysfunction (sensory, motor & autonomic)

  - EMG & NCV : absent

  - incomplete & variable recovery

  - usually need surgical intervention

Sunderland Classification

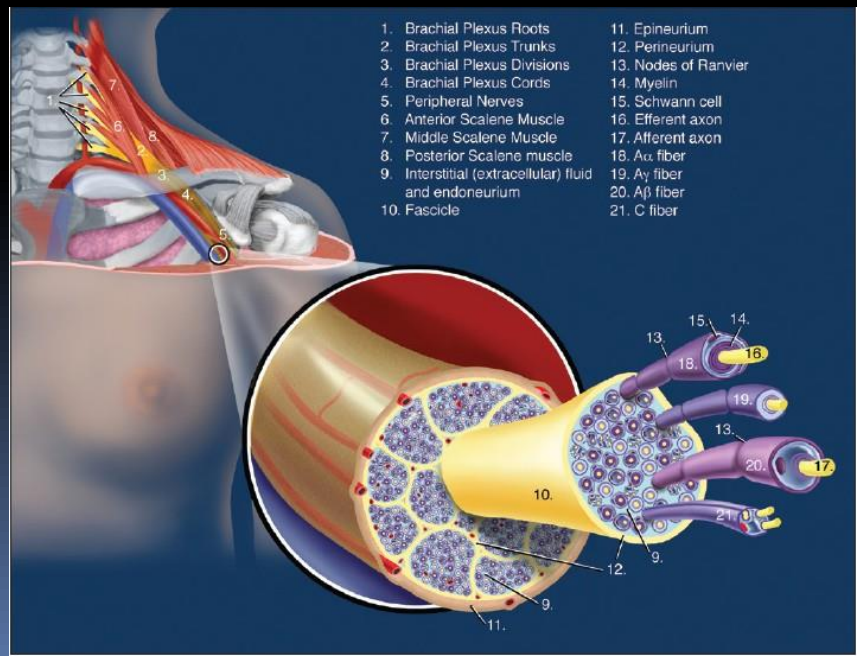
- Grade I : same as Seddon's neurapraxia
- Grade II : same as Seddon's axonotmesis
- Grade III :

  -neurotmesis with preservation of the perineurium

  -endoneurium is disrupted

  -axonal growth is disrupted

  -60-80% recovery



Sunderland Classification

- Grade IV

  -neurotmesis with the preservation of the epineurium, everything else is disrupted

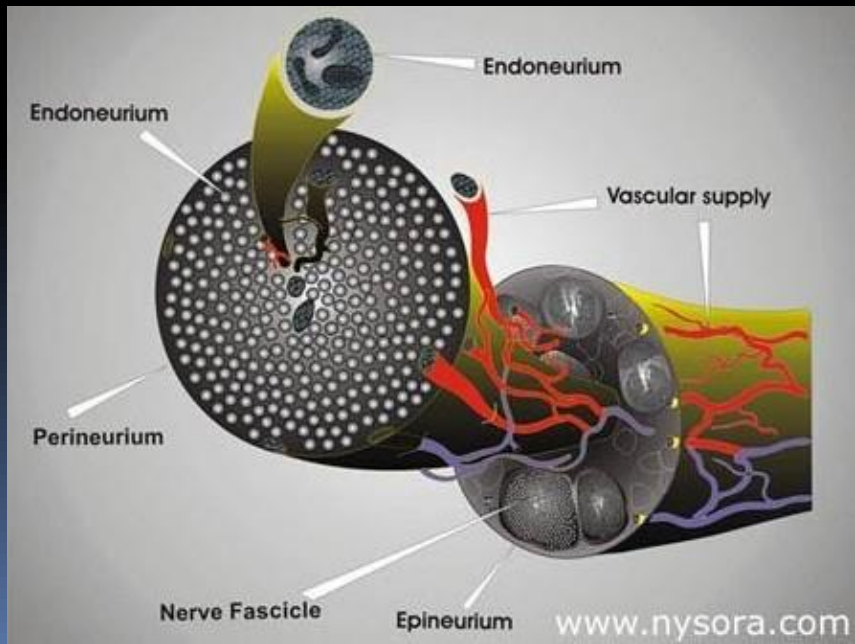
  -grossly edematous nerve

  -nerve grafting is required

- Grade V

  -complete nerve transection

  -by pass/ jump grafting is required



Nerve Injury

- Anatomy
- Classification
- Causes of nerve injury
- Incidence
- Mechanism
- Sign & symptom
- Evaluation
- Investigation
- Management
- Prevention

Causes of nerve injury

A) ANAESTHETIC TECHNIQUE

- Mechanical trauma

  - needle trauma

  - intraneuronal/ intrafascicular inj.
- Neuronal ischemia
- Neurotoxicity of L.A.
- Wrong drug
- Hematoma
- Infection

Causes of nerve injury

B) INTRAOPERATIVE FACTORS

- Surgical trauma
- Join distension
- Extravasations of fluid (arthroscopy surgery)
- Surgical retractor/ excessive traction
- Tourniquet (ischemia)
- Patients positioning

  - compression & stretching of the nerve

Causes of nerve injury

C) OTHERS

- Compartment syndrome
- Patient with preexisting neurological disorders

- Often multifactorial
- Consequence of different factors
- Preexisting deficits ↑ the risk of injury

Nerve Injury

- Anatomy
- Classification
- Causes of nerve injury
- Incidence
- Mechanism
- Sign & symptom
- Evaluation
- Investigation
- Management
- Prevention

Incidence of nerve injury

- Varies from 0-5%
- Severe nerve injury : 0.4% (may be under reported)
- UL > LL, (because more block performed on UL)
- Axillary block has the highest incident (1.9%)
- Interscalene block

  -0.4% (Borgeat et al, 2004)

  -3% (Brull et al, 2007)
- Fem. Nerve block : 0.04-2.81%

Nerve Injury

- Anatomy
- Classification
- Causes of nerve injury
- Incidence
- Mechanism
- Sign & symptom
- Evaluation
- Investigation
- Management
- Prevention

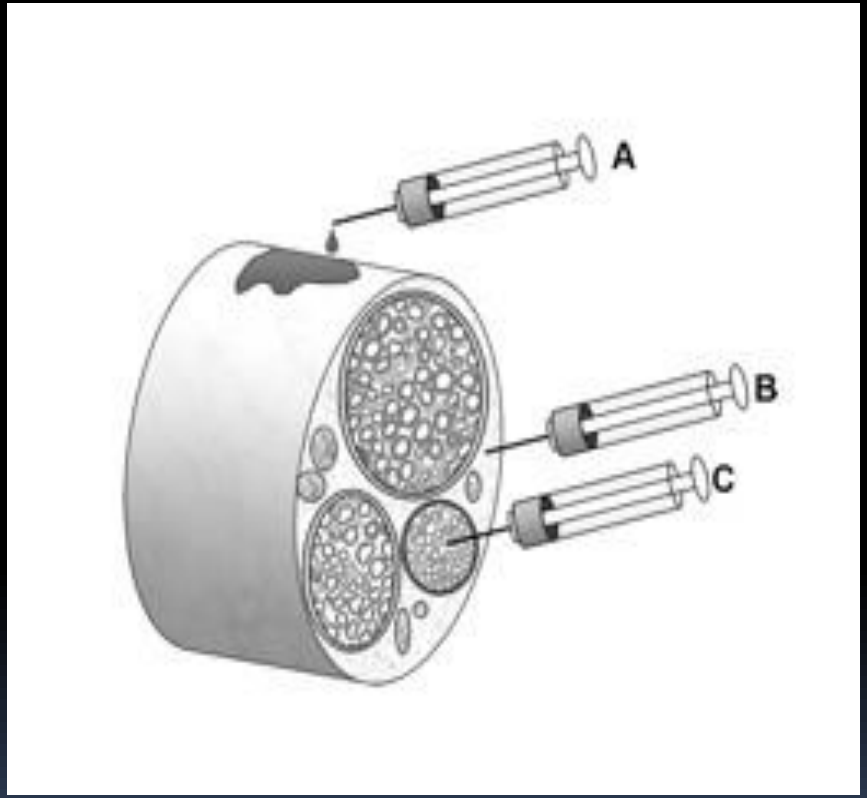
Mechanism: Mechanical trauma

A - extraneural

B - intraneural,

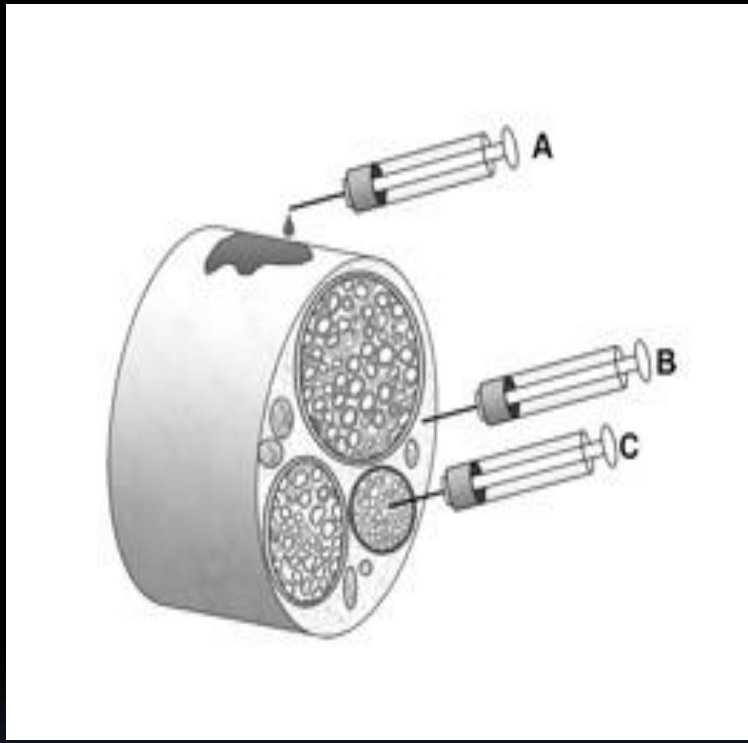
- subepineurium ,
- extrafascicular,
- interfascicular

C - intrafascicular



Mechanical trauma

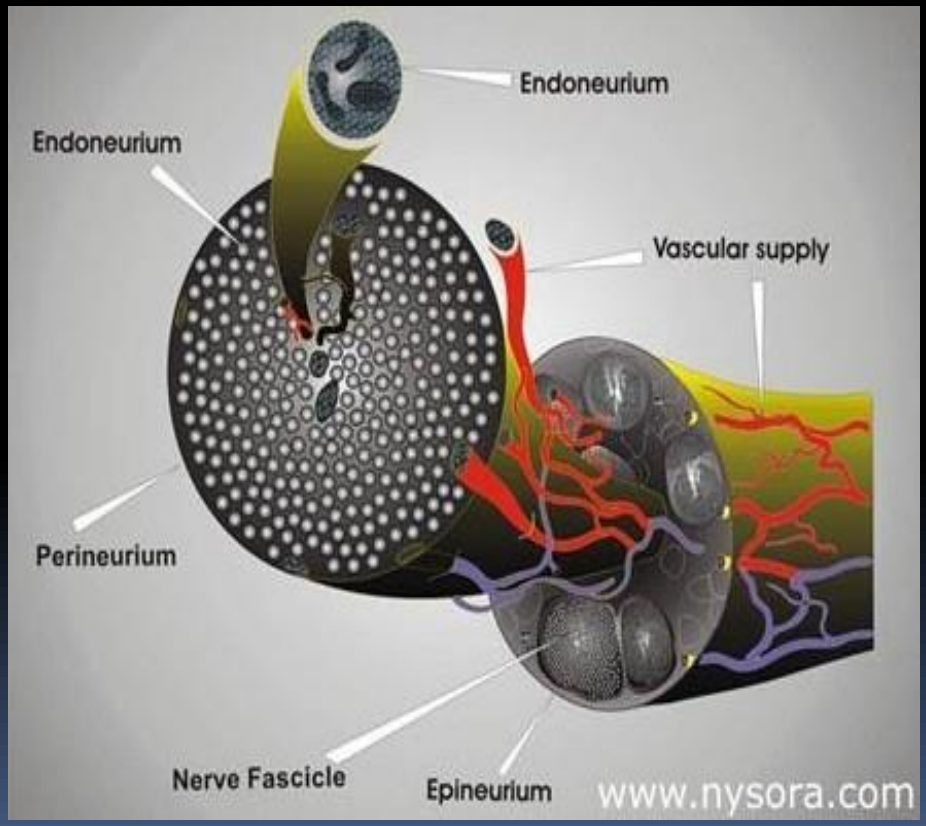
- INTRAFASCICULAR INJ. (c)
  - can be painless
  - ass. with high pressure
  - rupture of the fascicles and the perineurium
  - axonal & myelin degeneration
  - intrafascicular haematoma



Mechanical trauma

- INTRAFASCICULAR INJ.

  - prolonged ↑ in endoneurial pressure, exceeding the capillary perfusion pressure, →endoneural ischemia



Mechanical trauma

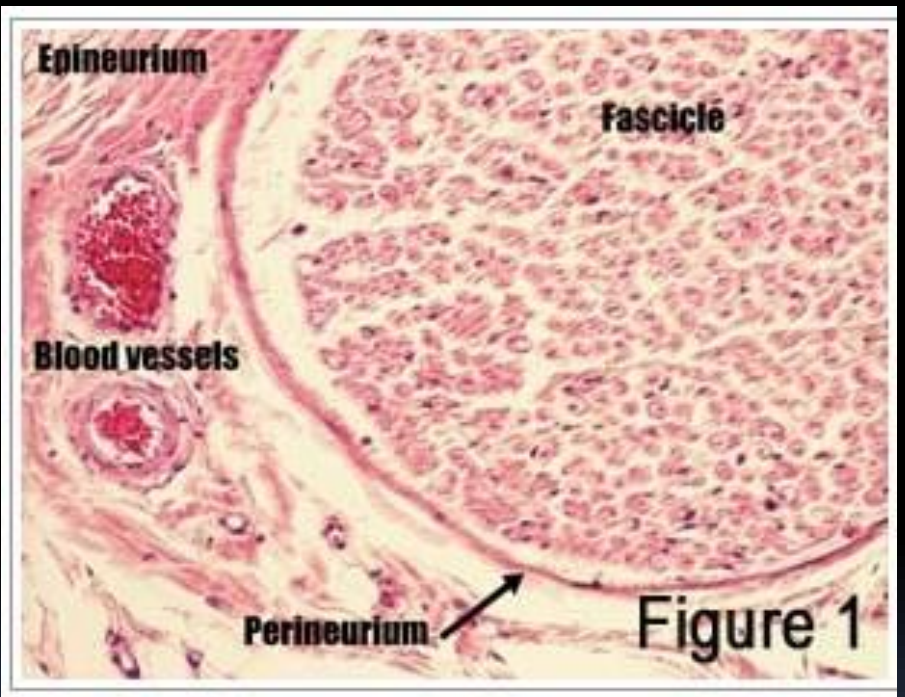


Figure 1. *Histology of the peripheral nerve. Shown are a large fascicle of the peripheral nerve with its axons, surrounded by perineurium, epineurium and nourishing blood vessels.*

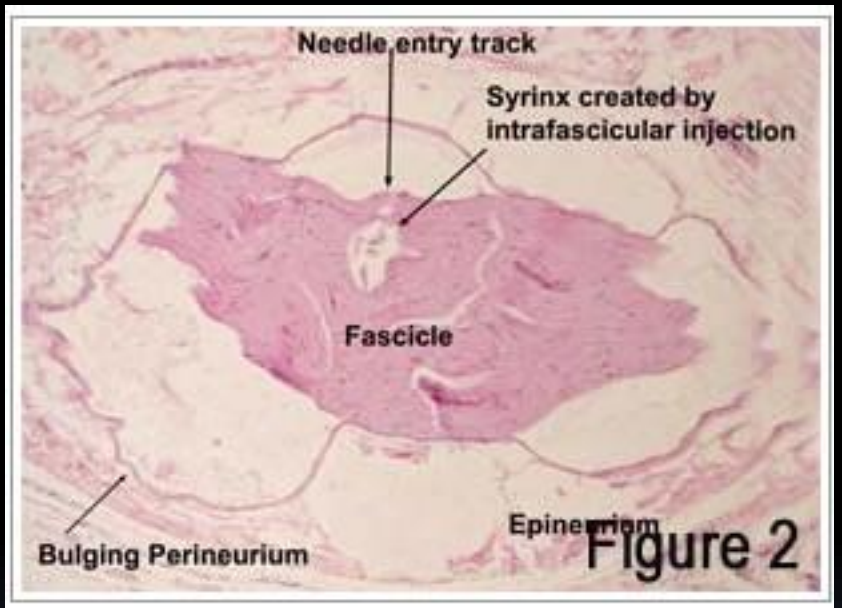


Figure 2. *An example of mechanical injection injury to the peripheral nerve. Shown is a large fascicle, with a needle track, syrinx created by hydrostatic pressure of the injectate, as well as the needle track into the fascicle. Perineurium is seen bulging off the surface of the fascicle.*

Mechanism: Neuronal Ischemia

- Intrafascicular inj
- + Use of vasoconstrictor
- + Tourniquet

↓

Reduced blood supply to the nerve

Mechanism: Needle bevels

- Short bevel needles 30-45^0 is safer
- Lower risk of nerve penetration

Most experts would agree that short-bevel needles (i.e., angles 30 to 45 degrees) carry less risk of nerve injuries during peripheral nerve blockade than sharp needles with longer beveled tips. The recommendations on needle designs are largely based on the work of Selander and colleagues, who clearly showed that the risk of perforating a nerve fascicle was significantly lower when a short-bevel (45-degree) needle was used, as compared with a standard long-bevel (12 to 15 degrees) injection needle. The results of their work certainly make clinical sense and resultantly, short bevel needles are nowadays used most commonly for nerve blocks (excluding cutaneous blocks and local infiltration). In contrast, the work of Rice and McMahon suggested that the shorter bevel needles may cause more mechanical damage than the long beveled needles. In their experiment, after deliberately penetrating the largest fascicle of rat sciatic nerves with 12- to 27-degree bevel injection needles, when the needle was actually inserted into the nerves, the degree of neuronal trauma was greater with short-bevel needles. Naturally, the sharp needles produced clean cuts and the blunt needles produced messy cuts on the microscopic images. The debate that ensued neglected that fact that blunt-tip needles are much less likely to be inserted into the non-fixed and exposed nerves in the clinical setting. Thus, while their finding may hold true when the fascicle is indeed penetrated, short bevel needles are much less likely to penetrate the nerves, thus, reducing the risk of nerve penetration altogether. Unfortunately, this research study caused considerable confusion and debate in the field.

Needle bevels

- However, sharp bevel, small gauge needles is still routinely used in:

  - axillary transarterial BP block

  -wrist & ankle block

  -cutaneous nerve block

Mechanism: Nerve stimulator

- Caution when stimulation is obtained with current of < 0.2mA
- Safe margin is 0.2-0.5 mA (0.1-0.2ms), however this does not exclude the possibility of nerve damage (Auroy & colleagues)

Nerve stimulator

- Motor respond may be absent even when the needle is inserted intraneurally

  -not stimulating on motor nerve fb

  -needle tip-nerve fb may has high resistance

- Need accurate & reliable nerve stimulator
- Tested by biomedical dept.

Mechanism: Nerve toxicity of injected solution / wrong drug

-worst if injected into the fascicle

Most damaging drugs

- Benzylpenicilin
- Diazepam
- Paradelhyde (sedative & antiepileptic)

Other drugs

- Antibiotic
- Analgesics
- Sedatives
- Antiemetic

Mechanism: Neurotoxicity of L.A.

- L.A. itself produce a variety of cytotoxic effects
- Proportionate to the concentration & duration
- Usually in intrafascicular inj., but high conc. of extrafascicular anesthetics may produce axonal injury

Neurotoxicity of L.A.

- Johnson & colleagues

LA

↓

mitochondria depolarize

↓

Stop producing ATP

↓

Electrolyte imbalance

↓

Cell degradation & loss of axonal transport

Neurotoxicity of L.A.

- Lab test: 5% lignocaine caused immediate cell death or necrosis
- Lidocaine & tetracaine > bupivacaine
- Epinephrine increase the toxicity of lidocaine & bupivacaine
- Intrathecal > epidural & PNB

Neurotoxicity of L.A.

- 4 factors causing L.A. neurotoxicity
  -concentration
  -duration of exposure
  -site of action
  -specific LA agent used

Nerve Injury

- Anatomy
- Classification
- Causes of nerve injury
- Incidence
- Mechanism
- Sign & symptom
- Evaluation
- Investigation
- Management
- Prevention

Sign & symptom of nerve injury

- Manifest < 48 Hr
- Tingling sensation
- Numbness
- Pain
- Paraesthesia
- Neuropathic pain
- Sensory loss
- Motor weakness

- Intermittent / persistent
- Light to severe
- Weeks, months or years

Nerve Injury

- Anatomy
- Classification
- Causes of nerve injury
- Incidence
- Mechanism
- Sign & symptom
- Evaluation
- Investigation
- Management
- Prevention

Evaluation of nerve injury

- Detail history

  - identify the complication

  - prolonged L.A. effect?

  - pathologic event?

  - preexisting condition

  - surgical events (surgery, positioning, tourniquet, retractor, traction, etc)

  - anesthetic events (technique of PNB)

Evaluation of nerve injury

- Careful clinical examination

  - localize the lesion to the appropriate region

  - determine the severity of the deficit

  - assessment of motor weakness is more important than sensory lesion

    → boundaries of dermatomes are not precise, clearly defined line

Nerve Injury

- Anatomy
- Classification
- Causes of nerve injury
- Incidence
- Mechanism
- Sign & symptom
- Evaluation
- Investigation
- Management
- Prevention

Investigation in nerve injury

- US & MRI : especially in suspected compression injury (hematoma)
- Nerve conduction study (NCS) / Electromyography (EMG)

Investigation in nerve injury

NCS / EMG

- Provide information on:

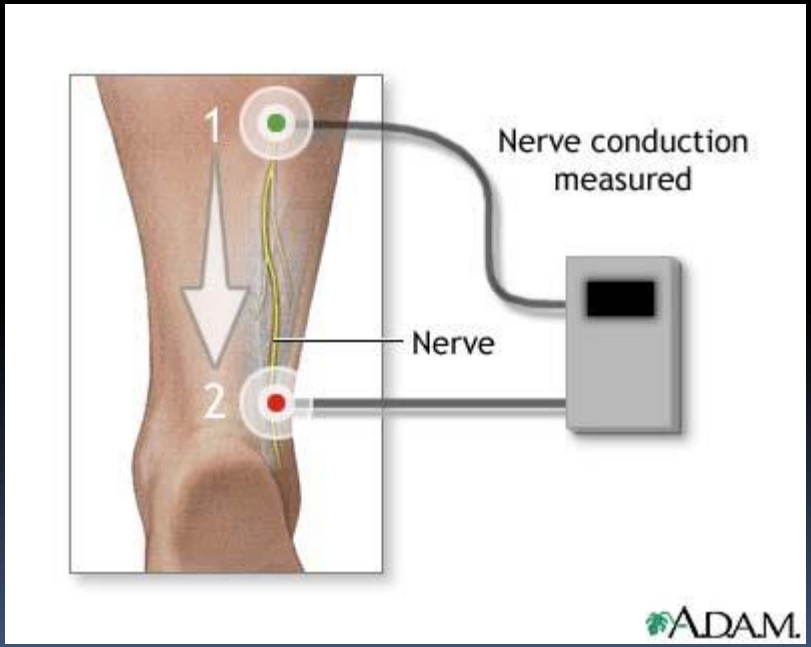
  - preexisting status of the nerve

  - prognosis of the new lesion

  -clue on underlying pathology

  - localize the site of injury

- NCS may be normal or near normal in the 1st few days of injury



Investigation in nerve injury

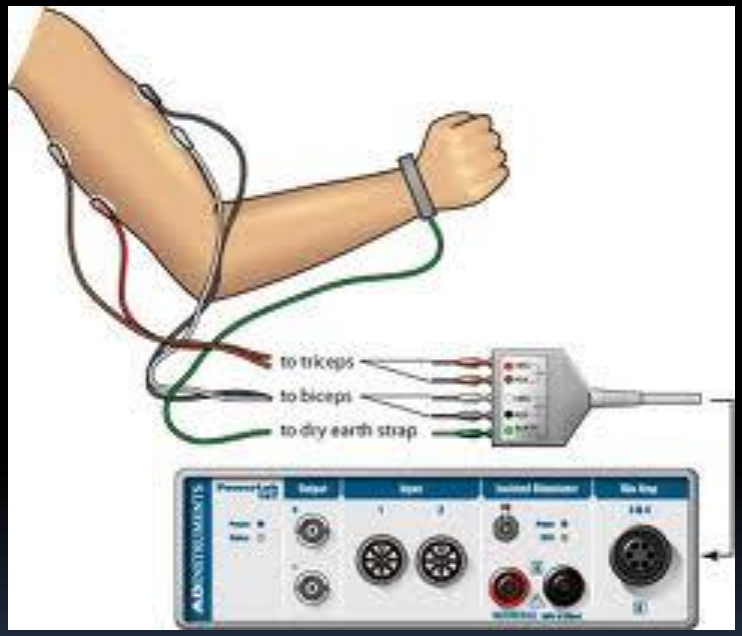
NCS

Investigation in nerve injury

- EMG performed < 72 Hr inform about any preexisting neurologic injury
- Rpt EMG 3-4 wk later

  - full blown nerve conduction abnormality occur at this time, or

  - assess the recovery



Nerve Injury

- Anatomy
- Classification
- Causes of nerve injury
- Incidence
- Mechanism
- Sign & symptom
- Evaluation
- Investigation
- Management
- Prevention

Management of nerve injury

A) Minor Nerve Deficit

- Conservative
- Reassurances
- Telephone follow up-

  weekly / bi-weekly

Management of nerve injury

B) Major Nerve Deficit

- Early neurologist/ neurosurgery consultation
- Diagnostic test
- Early pain treatment to prevent nerve sensitization
- Physical & occupational therapy consultation

  - strength training

  - range of motion exercise

  - to minimize contracture , muscle atrophy & prolonged disability

Management of nerve injury

B) Major nerve Deficit

- Social services referral

  - if patient unable to perform daily activity

- Close follow up by neurologist & anaesthetist until injury is completely resolved or is stable
- Repeat **EMG** at 6 wk, 3 mth & 6 mth
- If no improvement after 3-4 months, may consider neurolysis / neurotization

Management of nerve injury

C) Drug Therapy

- Under chronic pain specialist supervision
- Multiple drug are needed to treat neurally mediated pain
- Need consistent follow up

Management of nerve injury

C) Drugs:

- Tricyclic Antidepressants

  - amitriptyline 10-25mg O.D upto 100 mg/day

- Selective serotonin reuptake inhibitors

  - paroxetine

- Anticonvulsants

  - Gabapentin 300mg O.D upto 1800 mg/day in divided dose

  - carbamazepine

Management of nerve injury

C) Drugs:

- Opiods

  - oxycodone

  - oxycontin

  - fentanyl patches

- Tramadol

- Capsacion ointmemnt

  - for cutaneous hyperalgesia

Nerve Injury

- Anatomy
- Classification
- Causes of nerve injury
- Incidence
- Mechanism
- Sign & symptom
- Evaluation
- Investigation
- Management
- Prevention

Prevention of nerve injury

- Avoid neuronal ischemia

  -avoid neuronal injury

  - avoid epinephrine

  - avoid prolonged tourniquet

    - pressure no more than 150mmHg in LL
    - deflation every 90-120 min
    - tourniquet neuropathy : 1 in 5000
    - tourniquet paralysis: 1 in 8000

Prevention of nerve injury

Aseptic technique

Prevention of nerve injury

Short bevels insulated needles (30-45^0)

- short bevels prevent nerve penetration

- insulated needles → more precise needle placement

Prevention of nerve injury

- Needles of appropriate length for each and every block procedure
- Slow needle advancement & withdraw

  - fast insertion & withdrawal of the needle may result in failure to stimulate the nerve

Prevention of nerve injury

- Fractionated injections
  - 3-5 ml with intermittent aspiration
  - negative aspiration of blood does not exclude intravascular injection

- Accurate nerve stimulator
  - operational & correct current
  - 0.2-0.5 mA, 0.1-0.2ms, 2 Hz

Prevention of nerve injury

- Avoidance of forceful & fast injection

  - prevent channeling of L.A. to the unwanted tissue layers, lymphatic vessels or small veins

  - avoid intrafascicular injection

  - recommended speed : 15- 20 ml/ min

Prevention of nerve injury

- Avoidance of injection under high pressure

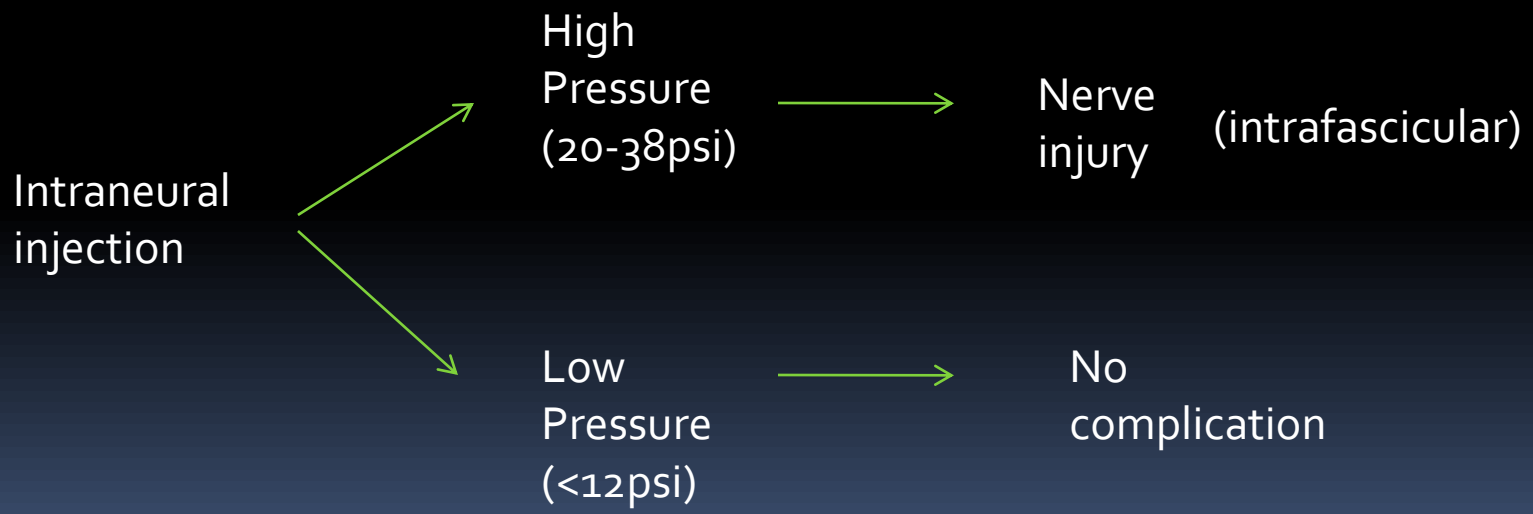
  - intrafascicular needle placement results in higher resistance

  - always use the same syringe and needle size to develop a 'feel' during injection

  - pressure should not exceed 20 psi

Avoidance of injection under high pressure

- Canine sciatic nerve study



Injection Pressure Monitor

Prevention of nerve injury

- Avoidance of paraesthesia on injection

  - pain on injection may signify intraneuronal inj.

  - however, absence of pain on injection alone does not exclude intraneural inj.

Controversial of Pain as monitor

- Most neurologic complication reported after PNB & even central neuraxial block have not been associated with pain on injection

  - Only 10% of them reported pain on injection

Controversial of Pain as monitor

- Cheney & coworkers

  - when patients reported pain on injection, the anesthesiologist stopped the injection, but patients still went on to develop nerve injury

  - in animal models studies, nerve fascicles become injured/ ruptured at the very onset of the injection even with small volume of LA

Controversial of Pain as monitor

- Pain is difficult to assess

  -? Discomfort/paraesthesia on inj, (which is normal)

  - ? Abnormal pain d/t intraneural inj.

  - variable patients' pain thresholds

  - patients' ability to describe the pain sensation

  - anesthesiologist's subjective interpretation of patients' respond

Controversial of Pain as monitor

- Borgeat et al

  - 21% of the interscalene block reported transient, burning pain, but none dev. nerve injury

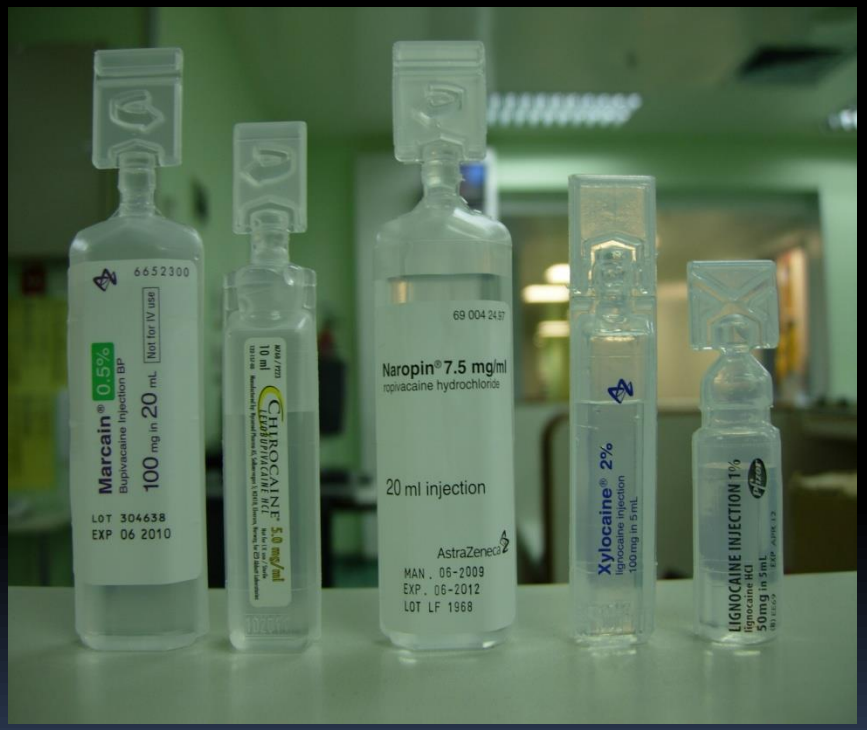
- Current practice: avoid pain on injection

Prevention of nerve injury

- Choose your L.A solution wisely

  - always choose a safer agent (eg: lignocaine over bupivacaine)

  - use short acting (& less toxic) L.A. for short procedure where long lasting postoperative analgesia is not required.



Prevention of nerve injury

- Avoid repeating blocks after a failed block

  - pain on injection cannot be detected

  - when indicated, should be done by experienced hand, & under USG.

Prevention of nerve injury

- Avoid perform block in anaesthetized patients (G.A / S.A.B /heavily sedated)

Controversial of RA in anesthetized patient

General believe:

- Awake patients allow monitoring of CNS toxicity
- GA/ heavily sedated pt prevent the detection of early sign & symptom of LA toxicity

- however, almost all the LA toxicity cases occur in awake or sedated pt.

- no report of LA toxicity in adult pt under GA

Controversial of RA in anesthetized patient

- Possible explanation:

  -premedication offers protection because of its anticonvulsion effects

  -anesthetized patients who dev LA toxicity may survive better because they already have:

  - secured airway
  - ventilated or may be hyperventilated
  - receiving high conc of O_2
  - in an environment that is ideal for resuscitation

Controversial of RA in anesthetized patient

- Bogdanov & Loveland

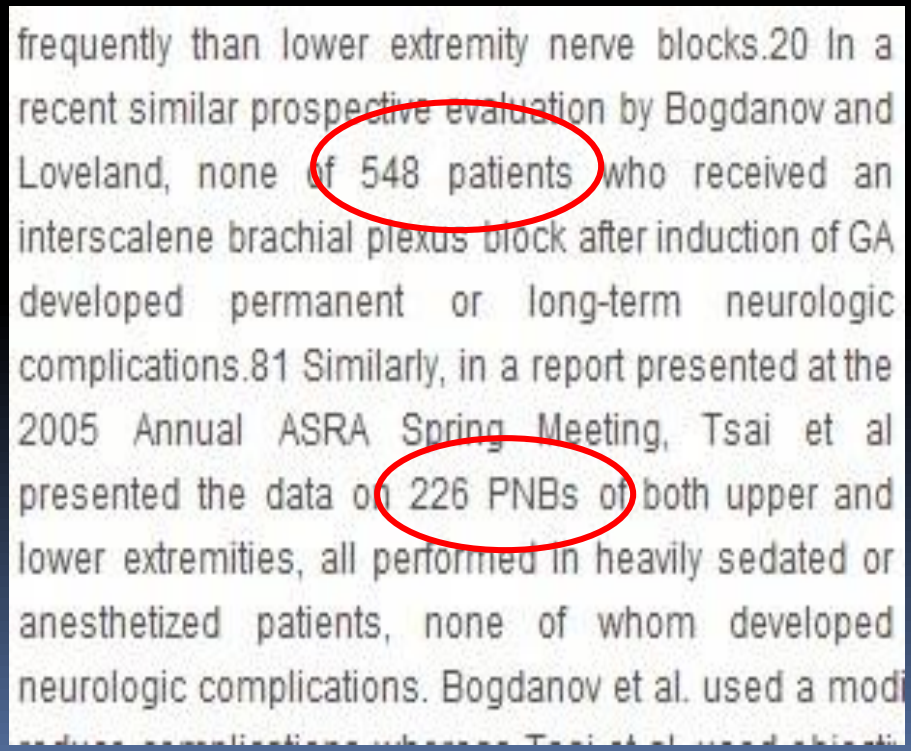
-548 interscalene block under GA

-no complication

- Tsai et al

-226 UL & LL block under GA / heavily sedated pt

-no neurologic complication



frequently than lower extremity nerve blocks.20 In a recent similar prospective evaluation by Bogdanov and Loveland, none of 548 patients who received an interscalene brachial plexus block after induction of GA developed permanent or long-term neurologic complications.81 Similarly, in a report presented at the 2005 Annual ASRA Spring Meeting, Tsai et al presented the data on 226 PNBs of both upper and lower extremities, all performed in heavily sedated or anesthetized patients, none of whom developed neurologic complications. Bogdanov et al. used a modi

Controversial of RA in anesthetized patient

- Pediatric anesthesia- RA is commonly performed under GA/ heavily sedated & the complications are rare

  - however, PNBs are not routinely used in pediatric

  - & usually performed by senior anesthetist

- however, no study has been done to compare awake vs anaesthetized pt.(and it is unlikely that such studies will ever be done)

Controversial of RA in anesthetized patient

- The belief of GA predispose to a greater risk of severe systemic LA toxicity is purely theoretical

  - no data to firmly support this belief

Conclusions

- Regardless, the practice of RA in anesthetized pediatric pt is universally accepted
- Adult:

  - in the absence of adequate evidence, blocks in anesthetized patients should still not be a common practice

  - should be appropriately sedated for block performance and patient acceptance

Prevention of nerve injury

USGRA

- Theoretically may reduce the risk
- Image resolution of US is insufficient to visualize nerve fascicle & prevent intrafascicular inj.

- remain debated

- need more evidence

Prevention of nerve injury

- Cautious in anticoagulated patients

  - follow the guideline on neuraxial anaesthesia & systemic anticoagulation therapy published by ASRA

Nerve Injury

- Remember:

1)Nerve damage after R.A. is unusual & recovery is generally favorable

2)R.A. is not the 1st cause of nerve damage

Guideline for R.A.(University Malaya)

- Consent
- Indication
- Contraindication
- Emergency drug
- G.A machine & airway equipment.
- IV drip
- Full monitoring (+ CNS)
- Pt. Positioning
- Landmark/ anatomy
- Aseptic technique
- Light sedation
- L.A. to skin
- Appropriate Needle
- Familiar Technique
- End point
- Correct Dosage
- Complication
- Anesthesia assessment

Management of L.A. Toxicity

- ACLS
- ABC /CAB
- Call for help
- O_2
- CPR
- Intubation & hyperventilation
- Atropine ?/Adrenaline
- Abort seizure(eg: STP)
- Amiodarone for VT
- 20% Intralipid (1.5ml/kg over 2 min., follow by ivi 0.25-0.5ml/kg/min)
- Treat acidosis
- Defib.

UNIVERSITY OF MALAYA

The Leader in Research & Innovation

REGIONAL BAY

Intra lipid 20%

R.A. website

- www.usgraweb.hk
- www.asra.ca
- www.nysora.com
- www.sono-nerve.com
- www.lipidrescue.org
- www.usra.ca
- www.rapm.ca
- www.neuroaxim.com


Safety First!
Lots of Practice!
Lots of Patience!

52 Kg Giant Trevalley, off shore of Bintulu, South China Sea, June 2010

NYSORA asia, KL, 2009

NYSORA asia , Bangkok, 2010

NYSORA asia, Bangalore, 2011

References

- Mechanism of neurologic complication with peripheral nerve blocks, NYSORA, A.P Admir Hadzic, Alain Borgeat, Stephen Blumenthal.
- Practical issues in Regional Anaesthesia: patient cannot move leg20 hour after single dose femoral block. S. Bloc,
- USGRA and the prevention of neurologic injury; fact or fiction? Hebl, James R,M.D, Anaesthsiology, Feb 08, vol 108-Issue 2, pg 186-188
- Nerve conduction study-Medical disability guideline, www.mdguidelines.com/nerve conduction study, Cachel-Similar
- www.arapmi.org/maraa-book-project/chapt25
- Morphological and physiological aspect of peripheral nerves and prevention of nerve injury in peripheral nerve blockade, J. De Andres, M.A. Reina, F.Maches
- Classification of nerve injury, wiki.cns.org/wiki/index.php/injury-classification
- Complication of peripheral nerve blocks, C.L.Jeng, T.M.Torillo and M.A. Rosenblatt, BJA, vol 105,issue suppl 1.

Thank You !

(in collaboration with SIGRA, Malaysia)

Dr Ling Kwong Ung,
Anaesthetist,
Sime Darby medical Centre,
Selangor, Malaysia.
lingkupisces@yahoo.com