



North West Seminars – Topics in anesthesia.  
Grand Cayman, June 2019. Fri 7h30 AM. 60 minutes

## PBLD – 90 year old lady with severe aortic stenosis, anticoagulation, needs emergency femur surgery.



Robert M Raw MD

MBChB, MPraxMed, MFGP, DA, FCA  
Professor of Anesthesia to 2016.  
Editor of the Journal of Regional-Anesthesia.Com (JRAC)

No conflicts to declare.

Problem Based Learning  
Discussion (PBLD).

## Patient details

1. Age = 90y. Fell off a eight foot high balcony.
2. The femur shaft was fractured. The bone had pierced the flesh.
3. Severe aortic valve stenosis.
4. She is anticoagulated with coumadin for her atrial fibrillation.
5. Her granddaughter is her legal guardian.
6. She was previously slow but ambulant, modestly orientated, and knew her grandchildren's names.

What are the anesthesia concerns?

## List the anesthesia concerns.

1. Concerns relate to (i) aging physiology, (ii) co-morbid chronic diseases, (iii) chronic medications, and (iv) the pathology requiring surgery.
  - Physiological changes
    - ENDOCRINE – possible undiagnosed hypothyroidism = severe opiate sensitivity.
    - RENAL – likely 75% loss of glomerular clearance despite normal creatinine levels.
    - LIVER – Liver clearance reduced due to lowered cardiac output. Affects liver dependent anesthesia drugs; examples B-blockers, long acting opiates, LA infusions.
    - RESPIRATORY –prone to post-op hypoxia. Increased V/Q mismatch, lower closing volumes.
  - Medications – coumadin - anesthesia concerns
    - Avoid neuraxial blocks ++++++
    - Avoid peripheral nerve blocks +
    - Improve coagulation; stop coumadin, Fresh Frozen Plasma
      - Aim for INR absolutely to be under 2.0 and desirably under 1.6 for the surgery.

## Describe the physiological parameters that determine cardiac output.

- Cardiac Output (CO) is blood flow per minute that the heart pumps.  $CO = SV \times HR$
- It is = stroke volume (SV) x heart rate (HR)
- Stroke Volume (SV) depends on
  - (1) Pre-load
  - (2) Myocardial contractility
  - (3) Afterload or Peripheral resistance.
- Peripheral resistance depends (i) cross sectional area of the aortic valve, and (ii) systemic vascular resistance.
- Systemic vascular resistance is measure of the state of arterial vasoconstriction.

### With severe aortic stenosis (AS)

- Aortic valve cross sectional area  $< 1 \text{ cm}^2$
- Severe falls in blood pressure result from;
  - Decrease in systemic vascular resistance (e.g. spinal block)
  - Decrease in pre-load (bleeding)
  - Loss of contractility (anesthetic drug myocardial depression)
  - Coronary perfusion pressure is a balance between
    - End Diastolic Ventricular Pressure (EDVP is high with AS)
      - (Opposes coronary blood flow).
    - Arterial diastolic pressure (is low with severe AS)
      - Drives coronary blood flow.
    - Myocardial ischemia develops very easy – worsening contractility – worsening cardiac output and blood pressures.
- A downward blood pressure (cardiac output) spiral after spinal anesthesia or blood loss usually leads to rapid death.

### What are the risks of delayed surgery, or no surgery?



### What are the risks of delayed surgery, or no surgery?

- Osteomyelitis → amputation and death.
  - DVT and pulmonary embolus.
  - Pneumonia.
- ➔ **The priority is to MOBILIZE the patient.**
- Estimated unoperated death risk in 1 month = 40%.
  - Estimated unoperated death risk in 1 year = 90%.

### Would anybody suggest no surgery at all? Give reasons for your answer.



### Would anybody suggest no surgery at all? Give reasons for your answer.

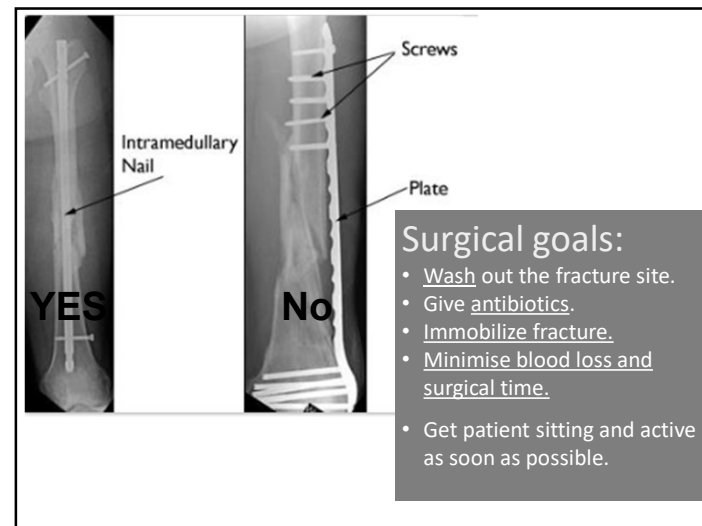
- *In general, if a patient enjoyed a good quality of life and “was a joy unto others, and others were a joy unto her” one should very strongly consider doing all reasonable things to restore them to that former state of good life quality life.*
- *In general, if a patient was bed ridden living a lonely life in a facility and the patient had no interaction of value with anyone she could love or who loved them, then palliative care or “comfort care” is advised. There is little to argue for making big efforts to extend suffering.*
- *This lady is good candidate to attempt relatively small surgery which should have a relatively fast good outcome.*
  - BIG priorities; (1) MOBILIZE out of bed, (2) pain-free.
  - Death sentence = lying in bed with untreated fracture, on opiates.

### How long could one delay the surgery to “optimize” this patient?

- Operate as soon as possible (ASAP) – operate within 6 hours of injury is a relatively arbitrary rule, but close to the truth.
- Patient optimization may continue into the operating room and during surgery.
  - No need to wait for INR results after the first FFP.
- Pre-resuscitate only sufficiently to tolerate the anesthetic.

### List the anesthesia cardiac objectives.

1. Avoid afterload reduction.
  - Avoid spinal anesthesia.
    - Sudden severe afterload reduction = instant death.
2. Avoid pharmacological suppression of myocardial contractility. (thiopentone, propofol, volatiles)
3. Avoid hypovolemia (loss of preload).
  - Modify surgery to minimize blood loss
    - Smaller surgery, tourniquet.
  - Aggressively correct fluid losses.
    - What is the lowest Hb you will tolerate?
      - Lecturer's choice Hb > 11 to 12
    - Use a lot of 5% albumin,
  - Balanced salts solutions IV just for maintenance fluids.



### What monitoring would you want?

- Standard ASA monitoring (EKG, Oximeter, NIBP)
- Urine catheter.
- Central line (for critical drugs, and cardiac monitoring)
- Arterial line. (establish prior to anesthesia)
  
- LIDCO? Swan Ganze catheter? TEE?
  - There are big and small surgeries.
  - There are not big and small anesthetics.

If the patient were not anticoagulated how would you perform neuraxial anesthesia?



If the patient were not anticoagulated how would you perform neuraxial anesthesia?

- A gradual setup segmental epidural anesthetic is better than a dramatic sudden non-segmental spinal block.
- What segments need to be blocked for this surgery?
- Establish a working phenylephrine infusion prior to initiating the epidural block.
- Have inotropic bolus injections at hand;
  - (1) ephedrine, (2) adrenaline (epinephrine), (3) Calcium Chloride 10%
- Expand the intravascular volume with 250 ml 5% Albumin after the 1<sup>st</sup> epidural bolus.

### What general anesthetic technique would you use?

- My personal choice would be
  - INDUCTION - Etomidate
  - LMA - if airway suitable (but never for old males)
  - INTUBATE - relaxant free. (Remifentanil 1 mic/kg, 3 min)
  - MAINTENANCE
    - Remifentanil doses 0.1 to 0.3 micg/kg/min
    - Desflurane 1% on dial setting.
- Good geriatric principle is the **KISS** principle.
  - (Keep It Simple Stupid)
  - The less drugs the better.

Can this surgery be done under peripheral nerve blocks only?



Can this surgery be done under peripheral nerve blocks only?

- YES. This would be my personal preference;
  - Least effect on cardiovascular system.
  - Potential for extending analgesia beyond the operating room.
- Two blocks;
  - Psoas compartment block with postop infusion.
  - Parasacral sciatic nerve block single shot.
- Sedation during case
  - Preceding the first incision by 2 minutes give ketamine 25 mg, midazolam 0.5 mg. Then nothing else.

You visit the patient three hours before surgery and meet a new person.

- They claim to be a family member, and are trying to get the old lady to sign a will.
- What should you do?
- Eject the person from the ward, claiming you need to provide urgent pre-anesthetic care.
- Notify the hospital attorney, the patient's guardian, and the surgeon.
- Once any of those persons is present or involved – get out of the way.
- Inject the patient 0.125 mg midazolam pre-med.

Would you personally decline to anesthetize this patient, based upon your limited in expertise?



Would you personally decline to anesthetize this patient based upon limitations in expertise?

- *Insufficient culture of referring patients in anesthesia.*
- *Best for the patient may be another anesthesiologist.*
- *In a large institution it is a bit easier, but not entirely so.*
- *Such referrals are harder at night or on weekends.*
- *At least “share” the case and consult with a colleague.*
- *WISDOM: The biggest opponents to the use of regional anesthesia are anesthesiologists who can't do the nerve blocks.*
- *WISDOM; The way an anesthetic technique is handled is as important, as the actual choice of technique.*

## The patient's outcome.

- Great surgery;
  - Femur pin, inserted via 5 cm incision at the hip.
  - Fracture site 8 cm incision for washout.
  - Blood loss 150 ml. Surgical time 50 minutes.
- Anesthetic = Psoas compartment block and sciatic nerve block
  - Largely uneventful and uncomplicated.
- Patient sat in a chair the following day.
  - Could extend knee and flex hip.
  - She smiled with slight bewilderment at everyone.
  - Discharged 7 days later to a step-down facility

## Concluding comments.

- Use peripheral regional anesthesia as much as possible in such patients.
- Be the boy / girl scout motto – “*Be prepared*”
  - The more you are thinking ahead about the potential cardiovascular crises the better you will prevent them.







## Anesthesia for Geriatric Emergency Orthopedic Surgery. June 2018

Robert Raw MD,

MBChB, MPraxMed, MFGP, DA, FCA

Professor of Anesthesia to 2016

Editor Journal of Regional-Anesthesia.Com (JRAC)

---

### INTRODUCTION

Earlier in the author's career while performing peripheral nerve blocks it sometimes seemed much harder to locate a nerve confidently in octogenarians and nonagenarians when using only electro-stimulation guidance, than in younger patients.

Mentors also instructed that the aged once they are blessed with the placidness of agedness need no more perioperative sedative medication than a warm confident and friendly hand touch and one should be conservative with opiates. Mentors also taught that one should not be intimidated by "numbers" when having to anesthetize a very aged person. Often the octogenarians and nonagenarians are genetically selected survivors. "Better a perky 85-year-old than a smoky 55-year-old", they often said.

This overview tries to establish the validity and the meaning of this tentative observation and teaching.

---

### INDEX

- A. OUTLINE of PERTINENT GERIATRIC CONCEPTS.
  - A1. Definitions.
  - A2. Major Reference sources.
  - A3. Pain in the aged.
  - A4. Pain diagnosis and measurement in the aged.
  - A5. The nervous system changes of aging.
  - A6. What does an aged peripheral nervous system mean in regional anesthesia?
- B. GENERAL HEALTH CHANGES OF AGING.
  - B1. Organs
  - B2. Pharmacology
- C. ANESTHESIA FOR EMERGENCY GERIATRIC ORTHOPEDIC SURGERY.
  - C1. Introduction
  - C2. Types of anesthesia
  - C3. Special post-surgical problems
- D. ANESTHETIC MANAGEMENT.
  - D1. OVERVIEW
  - D2. SPINAL or GENERAL ANESTHESIA
  - D3. DELIRIUM AS SPECIAL PROBLEM
  - D4. PERIPHERAL NERVE BLOCKS
- E. CHAPTER CONCLUSION

---

## A. OUTLINE of PERTINENT GERIATRIC CONCEPTS.

### A1. DEFINITIONS

**Aging** is the normal process starting immediately after maturation is completed. Aging is typified by a loss of function in tissues or organs and invariably matched with



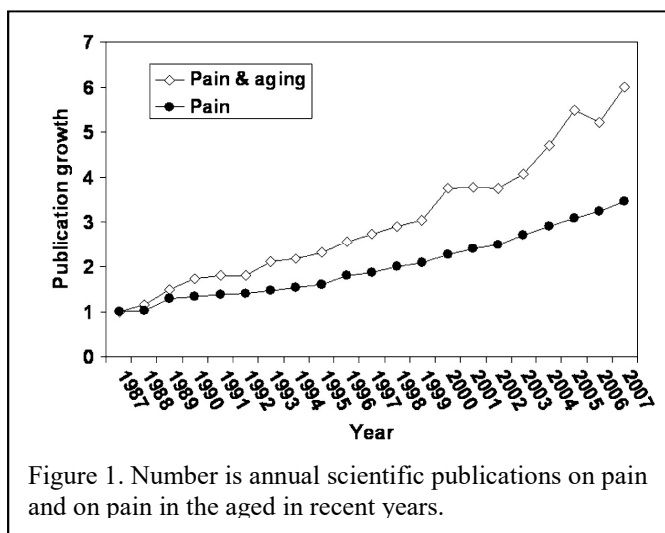
macroscopic and microscopic loss of tissue or morphologic changes in the tissues. These aging changes are per definition not associated with identifiable disease. These tissue and organ changes alter the way aged person react to surgery and medication.

**Agedness** refers to the late phase of life when aging changes are apparent. It refers to the loss of former vitality or performance ability due to aging. The precise definition of Agedness differs in physical definitions, social definitions, political definitions and in cultural definitions and even in a personal definition. One may be considered aged at 60, or 65 or 70 or 75 years of age depending on the definition and context of discussion. Pop culture tries to defer the attainment of the status of agedness and may say things like “The new sixty is forty” meaning, for example, a woman of sixty should live life as vibrantly as if she were forty. Agedness despite being a normal condition is socially considered as an undesirable condition and an inferior condition.

**Gerontology** is the multidisciplinary study of the (1) social, (2) psychological, and (3) medical aspects of aging. It is more than **Geriatrics** which is the medical branch of medicine devoted to the disease of aging.

## A2. MAJOR REFERENCE SOURCES ON AGEDNESS AND PAIN, AGEDNESS AND REGIONAL ANESTHESIA, AND AGEDNESS AND THE NERVOUS SYSTEM

A. A pioneering and critical **journal review on Pain and Aging**, was written in 2009 by Gagliese<sup>1</sup>. This review emphasizes that studies in this field are limited and handicapped due to the fact that the subject is an overlap area between two independent fields of Gerontology and Pain therapy. There has however in the years since 2000 been a dramatic increase in publication relating to pain and regional anesthesia in the aged as seen in graph 1.



B. The two volume **text book** titled by “**Peripheral Neuropathy**” by Dyck and Thomas, 4<sup>th</sup> ed (Chap 22, pages 483-507) (and other “age” related comments in various chapters) provides a vast tabulation of the chemical and histological research on the nervous system changes with aging<sup>2</sup>. This is the major source of information for following discussion. The information is however poorly correlated with functional changes, and much more gerontology research is needed.

C. An **overview** article titled “**Regional anesthesia in the aged**” by JR Bone in Curr Res Anesth Anal 1950 Jan-Feb 29(1):51-3, states that regional anesthesia in the aged can greatly reduce morbidity and especially mortality<sup>3</sup>. The article reflects the





author's personal experiences and summates general opinion of that time. This article also emphasizes the realization that the aged are at higher risk for perioperative morbidity and mortality is very old. Although the safety of general anesthesia has advanced greatly since the pre-1950 era few would say the general opinion of Dr. Bone that regional anesthesia offers benefits to the aged surgical patient is invalid. Subsequent large modern meta-analyses of hundreds of outcome studies all support some better outcomes with regional anesthesia for some surgeries to say the least<sup>4</sup>. In this modern era increasingly critical review of meta-analyses makes it harder to prove regional anesthesia improves any outcome other than analgesia. That does not however state that there is no improvement in serious outcomes including mortality. It possibly only states the appropriate data simply has not been collected yet for logistical reasons. One thing can however also be stated. There has been no suggestion or even a trend to suggest that opposite, namely that regional anesthesia worsen outcomes. This author considers that regional anesthesia on a case specific basis can offer the aged many benefits expected to improve outcomes.

### A3. PAIN IN THE AGED

Gagliese<sup>1</sup> states there are three common beliefs, namely that;

- (1) Aged persons experience pain more often than younger persons.
- (2) Aged persons are less sensitive to pain than younger persons, and
- (3) Aged persons complain more than younger person about a pain they may experience.

She admits there is likely truth in all of those, but that the exact truth is very complex.

Evidence and experience suggest the aged overall experience less intense acute pain than younger persons<sup>5</sup>. Aged persons tend to have less intense musculo-skeletal pain once they reach advanced age, for example 85 years of age, after such pain peaks in the early old age, for example at 65 years of age. Aged persons tend to have specifically less visceral pain, like abdominal pain with acute abdomen and chest pain with myocardial infarction. This can cause a critical delay in diagnosis of, for example, a bowel perforation, and a delay in emergency lifesaving surgery. It can also result in the missed diagnosis of a myocardial infarction due to it being silent (devoid of pain).

Types of pain based on central inflammatory mechanisms can be increased in old age, and specifically post-herpetic neuralgia is often more severe in old age than when it occurs at younger age. This makes it a pressing priority to treat post-herpetic neuralgia maximally and optimally in the aged. Gagliese<sup>1</sup> also states that severity of pain is a risk factor for chronicity of pain and seemingly in particular for neuropathic type pain in the aged. The mechanism for this can be the altered responses at central nervous system level to inflammatory factors. Aging is associated with prolonged and impaired nervous system recovery from inflammatory events associated with hyperalgesia. Aged persons are also more susceptible than younger people to temporal summation of inflammatory pain and prolonged hyperalgesia.

The fact that an aged person may experience less severe pain than younger person does not diminish the necessity to treat pain in the aged. Undertreated pain in the aged may have more detrimental consequences than undertreated pain in a young person.

### A4. THE DIAGNOSIS AND MEASUREMENT OF PAIN IN THE AGED



When a patient is incapable of expressing that they have pain, three serious consequences can occur;

1. Missing the diagnosis of pain.
2. Making a wrong diagnosis of pain when there is none.
3. Over assessment of the severity of the pain.

The mistakes of over-diagnosis or wrong diagnosis of pain can lead to inappropriate treatment and over treatment of pain. This can lead to administration of drugs with dangerous respiratory depressant effects, and undesirable mental status clouding and sedative effects. The patient's inability to express pain, as seen in babies and demented aged person, forces the clinician to rely on indirect signs of pain, such as crying, screaming, loss of appetite, tachycardia, hypertension, restlessness, confusion agitation, strange vocalization etcetera. All of those signs can have many causes other than pain and are highly non-specific. The diagnosis of undertreated pain in aged postsurgical patient who has had some analgesia already requires great astuteness, good clinical judgment and caution of the clinician. It is easy to choose the supposed safe path of erring on the side of under treatment. This may be wrong. Furthermore, the fact that administration of an opiate restores a patient to silence and stillness does not confirm pain was treated. The effect can be purely from the sedative and anesthetic effects of the drugs. It is dangerous in any patient to use an opiate principally as a sedative. This fact makes the use of regional anesthesia a much bigger priority in aged patients because of its inherent lack of sedative and respiratory depressant effects.

The above considerations also make the very few available studies of perioperative analgesia in the aged questionable when they utilize visual analogue pain scores or verbal numerical rating scores. The score will have inherent severe inaccuracy when any study group member has an underlying post-operative cognitive dysfunction or dementia. Subjective reporting and grading of pain require a patient to be (1) capable of verbal communication, (2) have good intelligence and (3) have intact cognitive function. Determining of the presence of pain and grading its severity is very challenging in demented aged persons.

There are some other differences in the pain experience between young and old patients. Young person with higher blood pressure experiences less pain than patients with normal blood pressure, but this phenomenon is not observed in the aged. Also, young females experience more post-operative pain than young males but this gender difference is not seen in aged male and female patients. Thus, the impact of aging is different in different types of clinical pain. This likely reflects the different physiological mechanisms for different pains.

Aged persons also tend to accumulate co-morbid diseases over the decades of life, including neurological diseases. This discussion is primarily about aging of the aged peripheral nervous system and not about other neurological disease in the aged.

Plooij showed that **reduced physical activity** in demented and non-demented patients may indicated the onset or presence of otherwise unrecognized pain<sup>6</sup>. This metaanalysis of 15 studies also suggested that the very inactivity resulting from the pain could worsen the pain. **Autonomic responses to pain** are attenuated in both demented and non-demented aged persons<sup>7</sup>. Because determining whether pain is present and quantifying it can be so difficult in aged person, particularly if they are clinically demented as well it was studied in a meta-analysis whether autonomic responses to pain would assist in evaluating pain. The study confirmed that the aged do get autonomic cardiovascular responses to pain but the responses are attenuated and to the same degree whether the subjected was demented or not. This attenuated autonomic response to pain makes evaluating pain in the aged even more difficult.

- The aged may have reduced local anesthetic needs than younger patients, thus needing smaller doses<sup>8</sup>.
- The question of what chronic pain does to the aging process was also asked. One study suggested that chronic pain, particularly when combined with depression increased one's cellular markers of aging<sup>9</sup>. This **increases the priority to treat**



**pain well in the aged**, despite the difficulties thereof. Another study showed chronic pain increased brain gray matter atrophy is specific brain parts associated with pain sensation<sup>10</sup>. It can be speculated that better pain treatment may help prevent this brain trophy, and until this speculation is disproven it stands as an added reason to other reasons to treat pain well in the aged.

- The type of analgesia influences the risk for post-operative cognitive dysfunction in the aged. One study showed using oral opiates caused less post-operative cognitive dysfunction than using IV Patient Controlled Analgesia (PCA)<sup>11</sup>.

#### A5. NERVOUS SYSTEM MICROSCOPIC AND PHYSIOLOGICAL AGING CHANGES.

Overall there is a loss of neurons, both in the peripheral and central nervous systems. The central nervous system neuron loss is however of much the greater magnitude than that of the peripheral nervous system. There is great variability between individuals in the development of nervous system aging. Not all individuals will develop nervous system aging. Some changes start from 20 years of age and deteriorate in slow linear fashion throughout life. Some changes are undetectable until the age of 50 years or much older. Life-time high exposure to high levels of neurotropic factors provides protection against aging changes. This mean exercising one's full mental and physical abilities maximally regularly delays the nervous system aging. Wear and tear with repetitive healing are a likely major factor in aging of the nervous system. This seems to be an unavoidable matter.

The **autonomic nervous system** degenerates with aging. Thin autonomic fibers atrophy or reduce in numbers more than thicker ones. This is opposite to the pattern of somatic nerve fibers (axons). It is also in particular the enteric and visceral sympathetic fibers that are vulnerable to aging changes. This results in diminished visceral pain with agedness. This may manifest in an aged person as (1) when a myocardial infarction occurs that it is SILENT (painless) causing missed diagnosis and (2) when an acute abdomen occurs like a bowel perforation or a bowel obstruction it be may be painless causing a delay in diagnosis.

The **somatic peripheral sensory nervous system** aging phenomena affect axon fibers. The aging changes are generally seen more in;

- Longer myelinated sensory fibers than in shorter sensory fibers. This translates into more aging phenomena are seen in lower limb nerves than in upper limb nerves and more in the sciatic nerve than in the femoral nerve.
- Myelinated fibers more than in unmyelinated fibers
- Distal parts of an axon fiber more than in its proximal part.

The changes in peripheral nerves that can be seen are;

- Dying back of neurons. This affects the terminal neuron which retracts and undergoes also loss of dendritic branches. This disconnects the axons from their terminal sensory organs with loss of those senses.
- The blood vessels supply nerve trunks also undergo aging changes. They experience thickening of their basal lamina in an identical fashion to that seen with diabetic neuropathy. This correlates with a loss of vasodilating capacity to Nitric-Oxide. These nerve arteries also show reduced vasoconstrictor responses



and reduced ability to react to inflammatory agents via a reduction in the receptors for those agents on the small arteries.

- Sensory receptor bodies reduce in numbers. The greatest loss of sensory receptors, are of the mechano-receptor type in muscles and skin whose axons are A-Alpha and a-Beta axons, the thickest axons. This gives significant loss of tactile sensitivity, and balance and locomotion coordination. Clinically these changes translate into loss of balance control through raised threshold to perceive exteroceptive, proprioceptive, and vibratory sensations. Exteroceptive sensing is the ability to understand some external event or structure by touching and feeling. Between ages of 70 years and 85 years of age 20% of patients have significantly reduced senses of vibration (Tuning fork) and reduced patella reflexes. Ankle reflexes are absent in 5% of patients at the age of 50 years and this increases to 30% at the age of 70. These are the reasons aged persons are more fall and injury prone.
- Axonal performance deteriorates. Action potential transmissions slow down. Sensory axons loose both conduction speed and amplitude of action potential. Speed reduces by 2m/se per decade from 20 to 50 years of age and thereafter at 3m/sec. Normal A-Alpha axon conduction speed is 80+m/sec and normal A-Delta conduction speed is 3-30 m/sec. The thickest fibers conduct fastest. The action potential amplitude at 70 years of age is half of what it was at 20 years of age.
- Peripheral neurotransmitters decrease in amounts. Peripheral neurotransmitters that diminish are in particular aminergic, cholinergic and peptidergic neurotransmitters. This reduces the ability to vasoconstrict peripherally as well as to sweat.
- Some neural receptors decrease in numbers. The neural receptors that most notably decrease with aging are dorsal root ganglion CGRP (CalcitoninRelated GenePeptide), and substance-P receptors. This likely decreases the aged persons' ability to experience amplification of pain from central sensitization and to learn from pain and also the extent with which they suffer emotionally with pain.
- Myelinated Axon numbers are slightly decreased, and mores so of the thicker myelinated fibers. As hyperalgesia and chronic pains tend to involve recruitment of the thick A- $\beta$  fibers this may explain why acute pain tends not to undergo the increase in intensity via sensitization in aged persons that is seen in young persons. This may also explain the reduced incidence of chronic pain seen in very aged persons compared to middle aged persons.
- Unmyelinated axons are not decreased. This correlates with preservation of near normal initial acute pain perception in aged persons which is transmitted by A-Delta and unmyelinated fibers.
- There is a decrease in perineural compliance with age. This contributes to a secondary increase in Endoneural Hydrostatic Pressure (EHP). This probably is due to an associated reduced porosity of the perineurium and resistance to fluid perfusion or diffusion across the endoneurium. This may result in decreased capillary blood flow with a fascicle and diminished ability of fascicle to restore increased intrafascicular pressure to normal after it becomes edematous. This is analogous to the situation where a segment of nerve finds itself experiencing with in and entrapment zone segment.
- Schwan cells encasing unmyelinated axons degenerate. The Schwann cell collapse into characteristic flat sheet like appearance as un-myelinated axons reduce in number. Some evidence suggests that total un-myelinated axons





increase in number, and this may be due to degeneration of large axons attempting regeneration via sprouting out thin axons.

- Axons undergo degenerative changes. Axons showing degenerative changes can form up to 75% of the axon count in an aged person. Within a nerve these changes are greater in the distal axons than in the proximal axons. The two biggest factors contributing to axonal degeneration is (1) increasing age of the subject, and (2) length of nerve with longest nerve being most affected distal axon sites within a nerve being more affected than proximal sites within the same nerve. These degenerative changes have many forms;
  - There is **axon dystrophy**. Dystrophy is characterized by accumulation of intracellular matter, and swelling of the terminal endings.
  - **Axon atrophy**. Atrophy is reduction in axonal diameter.
  - **Axon demyelination**. This slows axon conduction speed. This results in loss of connection to peripheral targets (muscles and receptors). The process of demyelination of aging starts nearly immediate that growth is completed. With aging myelin fibers become more irregular without-pouchings and in-folding of myelin sheaths. This is seen proximally in peripheral nerve s at the level of nerve roots. Complete loss of myelinated axons is however only seen from 60 years of age onwards
  - **Glycogenosome accumulation** occurs within axons. These are membrane bound collections of glycogen. Increased glycogenosomes are also known to increase with poisoning by cadmium, thallium and cyanate. The presence of glycogenosomes parallels an increase of degenerated mitochondria and is linked to altered cellular energy processes.
  - Other **particles of cellular degeneration** accumulate within axons.
  - **Node of Ranvier interspaces become irregular** with aging and probably results and accumulates from a life time process of demyelination and remyelination.
  - **Myelin atrophy** occurs associated with irregular node intervals. This mainly a nerve root phenomenon is unrelated to axonal atrophy which develops in the distal nerve.

**Motor axons** loose conduction speed too but less severely than sensory axons. Motor conduction speed is 30% less at age 70 years than at age 20 years. Motor axons studied in human and animal cadaver studies consistently show greatest loss in the lower limbs (or hind limbs) than in the upper (fore-) limbs. There is also evidence of reduced muscle mass secondary to the axonal loss. This neurogenic muscle loss is greater in the lower limb than the upper limb.

From about 60 years of age onwards muscle strength declines related to three factors.

1. Reduced muscle mass overall.
2. Reduced number of muscle fibers.
3. Muscle fiber atrophy of type II (fast twitch) muscle fibers.

Biopsies of aged muscle frequently show fiber type grouping or grouped atrophy which reflects low-grade denervation and re-innervation. With needle EMG studies the amplitude and duration of motor unit potentials increase with aging, but motor unit numbers decline.



Although the histology of the aging peripheral nervous system is well studied, the correlation between the observed changes and function is less completely described. That is due to most studies require post mortem analysis.

## A6. WHAT DOES AN AGED PERIPHERAL NERVOUS SYSTEM MEAN IN REGIONAL ANESTHESIA?

The very aged may experience milder injury pain than younger person with the same injury. Untreated or undertreated pain in the aged can critically affect their recovery and outcome.

Firstly, it requires good clinical judgment to determine if any aged patient has any pain. Pain should be assumed after surgery. Second grading the pain in aged person is difficult and one should avoid inappropriate use of opioids. It seems that use of regional anesthesia is safe as it near guarantees complete freedom of pain at least for a substantial period. Use of regional anesthesia frees the patient of the sedative effects and respiratory depressant effects of opiates.

Performance of regional anesthesia is however technically challenging, similar to that seen performing peripheral nerve blocks in the presence of a neuropathy, like Charcot Marie tooth disease. The aged nerve is physically smaller and harder to “hit”. The same motor response of a particular nerve stimulation at a given current may result in full limb movement in a younger person and bare flicker in a very aged person. In these cases, it is practical to use **visual nerve localization** using an ultrasound rather than depend on electro-stimulation dependent blind nerve localization.

The question can be asked whether peripheral nerve blocks affect aged peripheral nerves in a detrimental way. No evidence or reasonable logic suggests peripheral nerve blocks are injurious in the aged and general safety can be assumed. There is some suggestion from general experience and very limited studies that suggest aged peripheral nerves may be more sensitive to local anesthetics for both duration of effect and density of nerve block. Accordingly, local anesthetic doses in volume and concentration could be reduced from that customarily used in younger patients and still achieve therapeutic nerve block goals.

Performing peripheral regional anesthesia in the very aged is very desirable to do for acute pain conditions and can be lifesaving. Performing peripheral regional anesthesia in the very aged can be very technically challenging, but is feasible particularly when ultrasound guidance is used.

---

## B. Other General Health Changes with Aging

### B1. THE ORGAN CHANGES OF AGING.

There is substantial inter-individual variation in the aging process. The following events tend to occur;

- B1.1. **Cardiovascular.** They have a reduced resting cardiac output, fortunately paralleled by reduced oxygen consumption from reduced vitality. They have impaired ability to increase heart rate, slower heart rates, reduced chronotropic responses to adrenergic drugs (probably due to Beta receptor down grading), and higher systolic blood pressures (due to loss of artery compliance). The cardiac rhythm system degenerates, and sinus node cell numbers at 75 years old are 80% less than at 20





years old, and conduction pathways become fibrotic. Aged patients are then at heightened risk of developing a heart block. All in all, they compensate poorly for acute blood volume changes. Their Frank Starling curve is short with a narrow summit and they maintain cardiac output with changes of fluid overload or fluid deficit only within a small range of changes. These cardiac changes are much less severe in patients with high levels of day time activity and with exercise programs.

- B1.2. Nervous system.** There is loss of neurons, particularly in the cortex. Peripheral axons reduce both in numbers and conduction speeds. Nerve blocks may be slightly different during electro-nerve location. Elderly patients are very susceptible to developing acute delirium with any physical illness, including surgery and anesthesia. Elderly tolerate phase shifts in time, such as jet lag, very poorly. Their nocturnal breathing is altered and especially males are prone to snoring and obstructive sleep apnea.
- B1.3. Respiratory system.** There is reduced lung and chest wall elasticity revealed, as a stiff chest wall, especially in men. There is lung parenchymal loss which will manifest in slower elimination of volatile gasses. Vital capacity and tidal volume reduce while closing capacity increases causing a reduced PaO<sub>2</sub> (from airway closing, and increasing  $V/Q$  mismatch from reduced cardiac output). Aged patients are more prone to develop severe hypoxia after surgery and anesthesia.
- B1.4. Renal function.** Renal blood flow diminishes inducing reduced glomerular filtration. There is also reduced urine concentrating ability. The aged kidney is thus like a neonatal kidney in that it is less able to accommodate for fluid overload (can't diurese well and eliminate excess IV fluids) and hypovolemia (can't concentrate urine well, and retain IV fluids). This impaired renal function is deceptively concealed due to the reduced muscle mass producing less creatinine. The serum creatinine value then appears normal (similar to a young person creatinine). Renal dependent drugs as most muscle relaxants, many antibiotics, and digoxin tend to accumulate. Aged persons conserve sodium poorly, and easily become hyponatremic if illness reduces their normal eating patterns.
- B1.5. Hepatic function.** There is decreased hepatic flow which alters liver dependent drug clearance and may delay elimination of drugs such as long acting opiates,  $\beta$ -blockers, vecuronium, and local anesthetics. These drugs may seemingly behave normally with first dose but have propensity to either have prolonged effects or accumulate with ongoing administration.
- B1.6. Endocrine system.** Subclinical hypothyroidism may be concealed due to symptoms being attributed to normal aging. These patients may then manifest exaggerated opiate sensitivity for respiratory depression, and delayed recovery from anesthesia.

## **B2. PHARMACOKINETIC AND PHARMACODYNAMIC CHANGES WITH AGING.**

Pharmacokinetic effects are what the body does to the drug. Pharmacodynamic effects are what the drug does to the body. There is no uniform affect for all drugs and classes of drugs.

The pharmacokinetic changes are largely delayed elimination explained by the above-mentioned aging organ changes. Obesity may increase volumes of distribution of drugs but this has little influence in anesthesia as most anesthesia drugs are confined to vascular rich tissues (fat is vascular poor) during their short active phases. Highly fat-soluble drugs like thiopentone and fat-soluble volatile anesthetics like halothane when sequestered in large fat stores, may have minor lingering effects contributing to post anesthesia delirium. Accordingly, "SAFE" (short acting fast elimination) drugs are preferred in geriatric anesthesia.



There are pharmacodynamic effects due to any of reduced receptor numbers in some cases, due to heightened receptor sensitivity, or sometimes diminished receptor sensitivity. Adrenergic receptors seem normal in number but reduced in sensitivity. The MAC for volatile anesthetics is about 50% reduced at 75 years of age compared to age 25 years. Doses for benzodiazepines (compared to the doses that induced a target effect at age 20 years) should be reduced by a 1/3 at 65 years, a 1/3 again for 75 and a third again for 85 years of age; e.g. 3 mg (20 y), 2mg (65 y), 1.3 mg (75 y), and 0.8 mg (85 y) . Opiate doses should be similarly reduced with age.

The neuromuscular junction seems to be the same at all ages and similar “lean mass” weight-based doses give similar relaxation at all ages. It is just drug elimination considerations that influence individual muscle relaxant choices and timing and size of repeat doses. The organ independent muscle relaxants such as cisatracurium are the best long acting relaxants in the aged as they demonstrate best predictability for duration of effect.

Local anesthetics are safe in standard doses, but theoretically infusion rates should be in the mid to lower known safe ranges. No age-related toxicity with infusions has ever been reported.

Volatile anesthetic concentrations as reflected in end tidal monitoring have a greater lag behind brain values than in younger person. Accordingly, there is significant under-reading during emergence and a steady slow wake up plan with early reductions, is better than “sudden all off” plan in aged persons when using volatile anesthetics.

### **B3. THE DISEASES OF OLD AGE.**

The co-morbid diseases of likeliest particular concern are hypertension, Diabetes Mellitus, ischemic heart disease, congestive heart failure, chronic pulmonary disease, degenerative arthritides, subclinical hypothyroidism, and obstructive sleep apnea. These diseases are chronic, and accumulate additively with increasing age.



## C. Anesthesia in the Geriatric Patient for Emergency Orthopedic Surgery.

### C1. INTRODUCTION

This is a relevant topic because there is an increased mortality amongst aged patients presenting for any surgery, especially emergency surgery. Furthermore, in the first world the geriatric group is the fastest growing demographic group as life expectancies increase and especially as family sizes also reduce (diminishing young group sizes relatively). Of the USA population the aged (over 65 y) are 13% of the population, consume 33% of all drugs, and are 700% more likely than a 20-year-old to experience a drug adverse reaction or drug interaction.

These patients represent a concurrence of four groups of anesthesia concerns;

1. Physiological changes of aging.
2. Accumulating chronic co-morbid disease.
4. Multiple drug therapy.
3. Surgery.

Emergency orthopedic surgery may be for;

- (a). **Isolated limb fractures** resulting from unstable patients falling with typical fractures at the wrist, the humerus, the lower leg or the femur.
- (b). **Femur neck fractures**, associated with osteoporosis.
- (c). **Major trauma** with multiple injuries.

This talk will concern mainly femur neck fractures. There are 280 000 “hip” fractures annually in the USA, and they form around 7.2% of all trauma seen in first world hospitals<sup>51</sup>. There is a significant burden on society and these cases cost \$10 billion in total health care<sup>52</sup>. Of these patients 4.9% are bed ridden before injury, 11.5 % are bed-ridden at 1 month after surgery and 22.6% bed-ridden at 12 months after surgery. Fifty percent of these patients use permanent daily help before the injury and that increases to 80% after surgery<sup>12</sup>. This is clearly an injury placing great challenges on health care. In hospital mortalities are about 12.5% for patients over 60 years old, with an exponential increase each increasing decade<sup>13</sup>. One-year mortality is about 15 to 20% but patients return to age-based mortality after that, provided the fracture remain uncomplicated (Campbell’s Operative Orthopedics, 10<sup>th</sup> edition). Femur neck fractures represent 2.6 % of all surgery (including minor surgery) done in patients over 65 years old, and form 30% of all surgery done over 80 years of age<sup>14</sup>. Females out number males four to one.

It is interesting that extreme old patients (over 90 years) although likely to stay longer in hospital, less likely to die in hospital, and less likely to remain bedridden 1 year after surgery

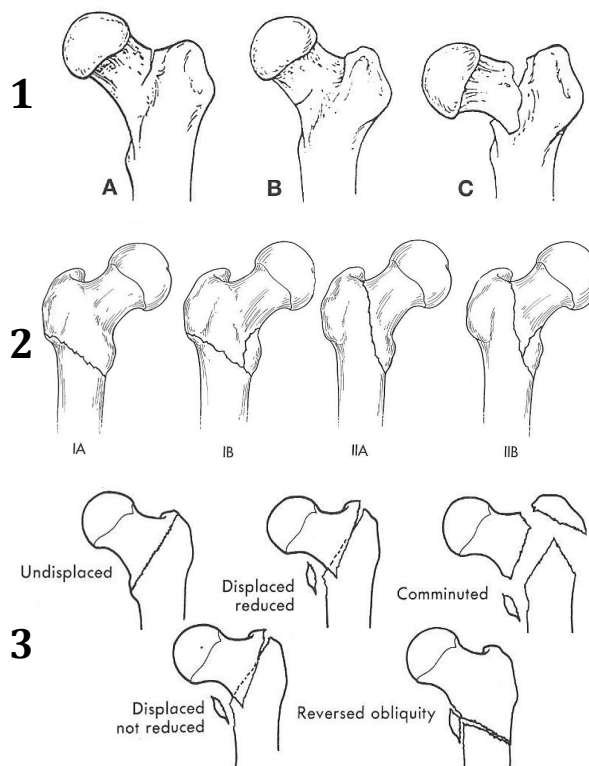


## C2. TYPES OF FRACTURES

Orthopedic injuries in this group are predominantly hip fractures. A modest number are ankle, knee, hand, elbow or shoulder fractures related to ambulatory falls. Major fractures in a context of major trauma is very rare as such patients seldom survive long enough to reach the operating room in most countries. Only in communities with excellent emergency medical care, best medical transport, and close by tertiary or quaternary care emergency rooms and surgical care transport does the rare geriatric major trauma patient reach the operating room.

The more common geriatric hip fractures are (1) femur neck fractures, (2) intertrochanteric fractures, and (3) subtrochanteric fractures. See figure number 1. As opposed to young person who only get such fractures with speed trauma and multiple injuries, in aged person this is usually an isolated injury. Intertrochanteric fractures heal well with good surgical reduction and fixation although non-union can occur. Femur neck fractures are intracapsular, and femur head avascular necrosis mostly occurs eventually. Subtrochanteric fractures have very high nonunion rates, as well as prosthetic fracture rates if arthroplasty arises. Fractures are further classified into impacted ones and non-impacted ones for treatment purposes. Less invasive surgery is possible in some impacted fracture cases.

Falls mostly result from clumsy falls or stumbles, but a modest number result from syncope due to cardiac dysrhythmia which needs medical investigation, and a small minority is spontaneous fractures from severe osteoporosis.



**Figure number 1.** Geriatric hip fractures. Group no. 1 are femur neck fractures. Group no. 2 are subtrochanteric fractions. Group no. 3 are intertrochanteric fractures.

## C3. SPECIAL POST-SURGICAL PROBLEMS

Dementia and post-operative cognitive dysfunction (POCD). Are very common. Dementia is the acute loss of cognitive function, while POCD is a more subtle loss of selected intellectual domains such as concentration ability and memory. It seems that pain is the most identifiable and treatable factor, and it is the patient with preoperative pain in particular who should be targeted for optimal analgesia therapy. There are however more factors and variable to manage and understand to eliminate Dementia and POCD entirely. Acute dementia (lasting





under 6 weeks) significantly diminishes the likelihood that patient after hip fracture surgery will achieve independence existence<sup>15</sup>.

Deep venous thrombosis is another problem and the likelihood of it developing corresponds with the delay between initial injury and post-surgical immobilization. Anti-coagulation therapy is restricted in the presence of a major fracture, especially before surgery.

## D. ANESTHETIC MANAGEMENT.

### D1. OVERVIEW

“Regional anesthesia is a reasonable alternative to general anesthesia in aged patients”, says Stoelting, p 743 of his book. This is probably understated. Over a 30-year period there has been a steady and very large swing from general anesthesia to spinal anesthesia. Spinal anesthesia is seen to have both advantages and disadvantages, and the current swing is to use peripheral nerve blocks, occasionally as sole anesthetic, but usually combined with either of spinal or GA.

### D2. SPINAL or GENERAL ANESTHESIA?

The majority of publications relating to anesthetic management of hip fractures choices were performed 20 to 50 years ago, preceding many newer drugs, modern understanding in disease, latest surgical options and better modern general patient care. These studies often were small, and outcomes were crude, and there was too much GA and spinal technique variation to reach any generic conclusion on technique superiority. The overall results however mostly showed that any “well” managed technique gave seemingly similar results with respect perioperative mortality, morbidity, and short-term outcomes<sup>16</sup>. In virtually no study was regional anesthesia ever inferior to the comparator general anesthesia techniques. A 1993 meta-analysis of 13 randomized trials existing to that time, showed only a small difference favoring regional anesthesia over general anesthesia (GA). The GA group had 31% more DVTs and an odds ratio likelihood of death 1.5 times higher. As a percentage the spinal groups had an insignificant 2.7% lesser mortality. The conclusion is that there is insufficient evidence at that time to unequivocally prescribe one anesthetic technique over the other. A 1999 New York studied randomized 642 patients between spinal or general anesthesia<sup>17</sup>. The overall hip fracture surgery mortality rate in hospital was 3.1% and at one year after surgery 12.1%. Significant post-surgical complications occurred in 12.1% of patients and there were no patient demography differences between the GA and spinal groups.

A 1978 study showed a higher mortality in the general anesthesia group compared to a spinal anesthetic group<sup>18</sup>. Sixty patients divided in three groups getting one of a psoas compartment block, a spinal anesthetic, both groups WITH general anesthesia, or the third group getting general anesthetic, all had similar outcomes in 1980<sup>19</sup>. Thirty patients divided between a ketamine-diazepam technique group and spinal anesthesia had no mortality, whilst the spinal anesthetic group had one death and two strokes in 1983<sup>20</sup>. When 148 patients were followed up for 12 months it seemed the spinal anesthetic group did best initially<sup>21</sup>. The GA group had significantly more deaths than the spinal group at 14 days after surgery, but the mortality was similar in the phase beyond that. Peak death rate was between days 6 and 16 and pulmonary embolism was the speculated (undocumented) cause of death overall. The same group repeated their study identically in another 40 patients, but doing post-surgical venography<sup>22</sup>. Deep venous thrombosis (DVT) was 76.2% in the GA group and only 40% in the spinal group. Five hundred and seventy-eight



patients were randomized to either spinal anesthesia or a GA group using neurolept or enflurane anesthesia and studied in 1986<sup>23</sup>. Similar to the 1985 McKenzie study above, the spinal group did best initially with respect to mortality, but ultimately at 2 years the overall mortalities were identical. Discharge dates and ambulation days were similar. The spinal group lost less blood. Conceivably this reduced blood loss could be explained by differences in blood pressure, use of vasoconstrictors, alterations in coagulation and other unconsidered effects, if any of these existed.

The O'Hara review of 2000 looked retrospectively at 9 425 hip fracture patients retrospectively at 20 USA hospitals<sup>24</sup>. Regional anesthesia (spinal anesthesia) increased from use in 5.2% of patients in the 1980s to use in 50.4% of patients in the 1990s. No significant difference in mortality could be found between spinal and GA cases, but the trial was severely limited (underpowered) by its retrospective nature. Only 1.5% received epidurals.

Another study looked at the out of hospital FUNCTIONAL outcomes (independence) and found in 631 patients after femur neck fracture surgery<sup>25</sup>. Spinal or general anesthesia was compared, and anesthetic technique had no influence on those outcomes at 3 to 12 months after surgery.

### D3. DELIRIUM

Delirium is a serious problem causing significant morbidity<sup>26</sup>. Delirium occurred in 445 of patients studied and it lengthened their hospitalization 400% and increased post-surgical complications greatly. The three biggest predictors of post-surgical delirium were use of anticholinergics, prior history of mental depression, and early post GA hypoxia.

Post anesthetic acute delirium was studied in 40 patients divided into groups receiving either a spinal anesthetic or a "balanced anesthetic" ("neurolept") technique popular in 1984 (no volatile, diazepam N2O, fentanyl, relaxant)<sup>27</sup>. Mortality and serious complication incidences were similar between groups, the spinal group ambulated earlier, and detailed mental studies but no neither early nor persistent mental change difference were seen between the groups. A Japanese study of 40 patients in 2003 found no difference between general or spinal anesthesia, with respect to the postoperative delirium incidence<sup>28</sup>. A 2004 meta-analysis found no difference in acute dementia looking at 24 trials, between neuraxial anesthesia and GA<sup>29</sup>.

### D4. PERIPHERAL NERVE BLOCKS;

Peripheral nerve blocks in hip fracture patients are experiencing growing interest. Peripheral nerve blocks have been used for analgesia before or after surgery for hip fractures, sometimes as sole anesthetic, and sometimes combined with spinal or general anesthetic.

#### **Isolated femoral nerve blocks.**

When an isolated femoral nerve block is used for analgesia it is reported to both provide good analgesia, and to provide nearly no noticeable analgesia<sup>30, 31</sup>. It seems insufficient on its own for the fracture pain preoperative and offers nothing generally for the surgical incision. The surgical pain benefits from addition of an obturator nerve block, and the surgery benefits from addition of subcostal nerve, lateral femoral cutaneous and sciatic nerve blocks.

#### **The cutaneous nerve blocks for surgery**

The two cutaneous nerve of interest are the subcostal nerve supplying the lateral skin immediately inferior to the iliac crest and the lateral femoral cutaneous nerve both of which cover the usual surgical incisions. The addition of a subcostal nerve block and a





large volume femoral nerve block (attempted 3-in-1 block) adds no morbidity, but reduced morphine consumption 48%<sup>32</sup>.

### **Plexus blocks**

There are case reports of patients undergoing hip surgery entire under peripheral nerve blocks, such as psoas compartment block, sciatic block and subcostal (or iliac crest block) only.

Fifteen patients in one study were administered both a femoral nerve block and lateral femoral cutaneous nerve block with general anesthetic Morphine 2 mg SC was administered at the end of surgery<sup>33</sup>. All patients were hemodynamically stable except one who needed ephedrine, and all were comfortable after surgery except one who needed an additional diclofenac.

One impressive case report group had four patients all with severe cardiac failure and valve disease, aged 83, 93, 91, and 97 years. All underwent successful surgery under psoas compartment block and parasacral sciatic nerve block, with minimal propofol sedation<sup>34</sup>. An 87-year-old lady with severe aorta stenosis had her hip fracture repaired with psoas and parasacral sciatic nerve blocks<sup>35</sup>.

The most recent Cochrane database report of 2002, found the various peripheral nerve blocks in various combinations mostly offered substantial analgesia and morphine savings with geriatric hip surgery, but other outcome benefits are undetermined due to only having 328 patients in the meta-analysis.

When spinal anesthesia was compared to combined psoas and parasacral plexus blocks in 29 aged patients undergoing hip fracture surgery, better hemodynamic stability was seen in the peripheral nerve block group, and no patient needed GA although one nerve block patient had an unsatisfactory result although but GA was not needed<sup>36</sup>.

### **The sciatic nerve in hip fractures.**

Anatomical review suggests this nerve has no contribution to the femur itself in pain relief, but it does supply the muscles (hamstrings immediately behind the femur and hematoma into them and surgical dissection of them will clearly require nerve blockade for analgesia via this modality. A pre-operative sciatic nerve block would theoretically seem to offer little analgesia, but this has not been studied. A sciatic nerve block for awake surgery seems essential and for post-surgical analgesia, desirable.

### **Epidurals for hip fractures.**

Epidurals have never achieved great popularity with hip fractures, although they offer potential pre-surgical analgesia, anesthesia for surgery, and post-surgical analgesia. This may reflect reluctance to face the technical challenges of epidural catheter placement in very aged backs. A relatively recent study compared three British hospitals of different staffing and care levels<sup>37</sup>. Interesting observations were that sickest patients had the highest mortalities, and leading predictors of death were co-morbid disease, mental impairment, and low pre-fracture levels of daily activity, increasing age, and extracapsular fractures. One hospital dominantly did most epidurals, had the highest surgical complications but lowest medical complications. When the surgeon was the consultant at any hospital, the highest surgical complications occurred, but least medical complications and no hospital deaths. No theory was posed for last observations. Overall females outnumber males 4 to 1, there were 492 patients studied, with an age range of 60 to 101 years old. The only practical conclusion is that femur neck fractures cause significant morbidity and mortality amongst such patients and good care is needed. Anesthetic technique was not evaluated.



### Spinal anesthesia for aged hip fractures; technical aspects

Performing spinal anesthesia can be difficult in aged backs due to (1) loss of ability to flex the spine, (2) due to calcific changes in ligaments, (4) osteophytes, and reduced distance between spinous process due to loss of patient height from the aging process shrink (desiccating) the intervertebral discs<sup>38</sup>. It seems wisest not to doggedly persist in performing spinal anesthesia if unsuccessful, as well neuraxial hematomas can be caused from the repeated needle trauma, as was reported<sup>39</sup>. They used 24 G pencil point type needle. It is wiser, in the author's opinion, to use a 22 g Quincke point needle, as the risk of PDP headache is near zero, but the technical challenges of neuraxial anesthesia in aged backs is very high and the consequences of needle trauma are potentially catastrophic. A policy of when to abandon spinal anesthetic procedure is needed, e.g. abandon after 3 needle insertions in three different positions.

In DL Brown's "Regional Anesthesia" textbook an unreferenced statement is made that aged persons are more sensitive for local anesthetics than younger persons and that neuraxial blocks "go higher" unless techniques are modified.

Spinal anesthesia, especially in the aged, is associated with hypotension, sometimes severe. Some think that it is possible to reduce this spinal anesthetic associated hypotension (SAAH) by reducing local anesthetics doses.

#### A. MICRODOSE SPINAL ANESTHESIA;

There has been interest in low dose spinal anesthesia to reduce blood pressure changes. In a study comparing 7.5 and 12.5 mg of hyperbaric bupivacaine, where the smaller LA dose group additionally received 20 microgram fentanyl subarachnoid to compensate for the small LA dose<sup>40</sup>. The population studied was 42 patients, and no hypotension difference was seen, there were uncomfortable patients in each group. The fentanyl group also suffered from nasal pruritus. Results have been variable. Ben-David used 4mg bupivacaine with 20 microgram of fentanyl and had satisfactory results in the tiny group of 10 patients<sup>41</sup>.

#### B. UNILATERAL SPINAL ANESTHESIA;

Unilateral spinal anesthesia however looks promising in minimizing hypotension with spinal anesthesia. Casati, and Fanelli studied hyperbaric bupivacaine for this purpose in a general orthopedic group, with the surgical side downwards<sup>42</sup>. They compared 8mg bupivacaine in either a 0.5% solution or a 1.0 % solution. They found that turning the patient at 15 minutes resulted in some loss of the unilateral nature of the block and that the 1% group had higher blocks. This was likely due to shifting of the drug both to contralateral as well as upward to the thoracic kyphotic trough. This hyperbaric technique would clearly be limited in femur neck fractures as it would require the patient to lie on their injured sides. Casati could not recommend the hyperbaric unilateral spinal as a technique for anesthesia if pure unilateral block was a goal, although he did not report hemodynamic outcomes. Conversely gross clinical satisfaction has been reported specific for femur neck fractures where a hyperbaric unilateral spinal technique was associated with minimal hemodynamic disturbances, in a descriptive study<sup>43</sup>. A French study used a hypobaric technique, with the femur fracture side upwards, injecting 4.2 mg bupivacaine in a 0.12% solution and maintaining lateral position 15 minutes. The results by patients and surgeons were rated highly satisfactory and no significant blood pressure changes occurred from the pre-spinal to post-spinal period. In 52 5 of patients there was no evidence of contralateral block at all.

#### C. CONTINUOUS SPINAL ANESTHESIA.

Compared to a 7.5 mg dose oh hyperbaric bupivacaine, a titrated dose of bupivacaine (2.5 mg per 15 minutes) via a spinal catheter produced less hypotension<sup>44</sup>.



*Author's experience;* Hypobaric spinal anesthesia has been the author's favored technique for femur fractures for 20 years. The patient is placed with the injured side upwards. Most patients can be so positioned with minimal analgesia supplementation above that which they arrive in the operating with. Use a standard spinal anesthesia using 22g Quincke point needle. Inject slowly (avoid injection CSF turbulence) and avoid barbotage to reduce CSF drug mixing. Drugs used are 25 micrograms of fentanyl to accelerate onset of analgesia, and 10 mg of 0.5% Bupivacaine (2 ml) and the patient is kept in the lateral position 5 minutes. Numerous studies have shown that 0.5% bupivacaine at 37 C is modestly hypobaric compared to human CSF. The result is a fast onset of high-grade block on the surgical side. Usually a mild block on the contralateral side also results after turning, which is good as it helps the patient tolerate the boot-traction device often used on that leg, as well it reduces spontaneous patient movement of the leg which is very distracting for the surgeon. Hemodynamic disturbances typically range from zero to minimal.

### **ANALGESIA BEFORE SURGERY**

Twenty-seven patients were studied who received fascia iliaca blocks using 20 ml of local anesthetic at the time of ambulance collection<sup>45</sup>. The attraction of this technique is that it can easily be learned by inexpert regionalists and also performed without a nerve stimulator. A 7.4% failure rate occurred, but most patients achieved good analgesia if not total analgesia.

In one study 68 patients were randomized between opiates and epidural analgesia before surgery<sup>46</sup>. The epidural group had dramatically less subsequent cardiac events (20% events versus 0% events).

### **ANALGESIA AFTER SURGERY**

Sixty patients were administered either epidural analgesia with bupivacaine and morphine or placebo, after hip fracture surgery<sup>47</sup>. Marked better analgesia was achieved, but this did not translate to more cases getting to independent ambulation nor earlier discharge. Significantly higher nausea was seen in the drug epidural group which may have limited the group's performance.

### **PERIPHERAL NERVE BLOCKS AND FEMUR NECK FRACTURES: SURGICAL OPTIONS.**

There is an increasing trend to treat the healthier mentally competent patients with displaced femur neck fractures, with total hip replacements. A Baltimore retrospective study of 1998 into 367 femur neck fractures showed number of different outcomes associated with surgical technique choices, reviewed up to 8 years after surgery<sup>48</sup>. For displaced fractures a much higher revision rate was seen with internal fixation patients compared to THR in patients older than 80 years, but not for those under 65- 80 years of age. With undisplaced fractures no difference was seen between surgical techniques at any age group. Mortality paralleled the surgical results. When unipolar versus bipolar arthroplastic prostheses were compared, and anterior versus posterior approaches, no revision or medical complications rate differences were seen.

In a prospective randomized study of 122 patients randomized between THR and internal fixation, there was a 25 % final mortality in both groups by 48 months, but only 4% hip complication rate in the THR group versus the 42% of the internal fixation group,



with necessary re-operation<sup>49</sup>. The THR groups had significantly better hip function and less health deterioration.

Reviews in 2004, 2005 and 2006 concluded as follows<sup>50, 51, 52</sup>.

The most practical classification before surgery are displaced and non-displaced (impacted) fractures. In patients with good health and under 70 years of age impacted fractures tend to heal well with non-operative treatment. Some surgeons still use prophylactic internal fixation for this group, while other will mobilize them without surgery. Over 80 years of age impacted fractures do best with prosthetic replacement. Patients less than 65 years with displaced fractures do best on closed reduction and internal fixation. Those with displaced fractures over 80 years do best with THR. In the 65 to 80 years old group there is no consensus with both displaced and undisplaced fractures. Factors encouraging more invasive therapy are older physiological age, and sicker patients.

### TIMING OF SURGERY

The best timing for surgery seems to be one following a brief period of medical health assessment, optimization and early surgery at first convenience within one day of admission<sup>52</sup>. It seems surgery immediately on admission to hospital may be disadvantageous in patients who are dehydrated and metabolically suboptimal. No proof of disadvantage can be shown from brief delays before surgery. Long delay of numerous days results in a growing rate of immobility associated complications such as pneumonia and DVT.

One study showed that heightened medical care by the addition of a geriatrician to the healthcare provider team before surgery, reduced dementia incidence from 50% in the standard care group to 32% in the geriatrician aided group<sup>53</sup>. This seems to support some degree of medical optimization beforehand.

---

## E. Chapter CONCLUSION

As conclusive data guiding clinical practice is not available, recommendations on anesthetic management has to be based on;

1. First logic principles.
2. The suggested care in the published scientific literature.
3. Empiric general experience.

Anesthetic management needs also consider;

1. Individual surgeon's skills and anticipated blood loss and duration of surgery.
2. Anesthesiologist's personal skills and management options available.
3. Patient individual health considerations.
4. Patient's choice of anesthetic from presented options.

Anesthetic goals need to be;

#### A. Primary;

1. Facilitate surgery.
2. Reduce peri-operative mortality.

#### B. Secondary goals likely to serve primary goals;

1. Minimize post-surgical dementia.
2. Reduce opiates requirements.





3. Reduce suffering (good analgesia).
4. Prevent cardiovascular instability.
5. Optimize fluid status.

Although clear advantage of general anesthesia over regional anesthesia has not been satisfactorily studied and shown, the limited evidence there is does suggest disadvantage for GA. Some studies show limited disadvantage to general anesthesia techniques. However, it is widely recognized that analgesia is easily and often under managed in aged persons both from fear of drug related side effects and from the aged person's diminished ability to demonstrate or express pain. It is also generally recognized that pain contributes greatly to excess immobility and the complications of pneumonia and DVT. Regional anesthesia techniques offer all of avoidance of sedative drugs (opiates, and profound analgesia and this modality needs to be utilized more and be validated with more investigations.

It seems spinal anesthesia has more advantages than GA for reduced dementia, and DVT. GA is however acceptable if spinal anesthesia cannot be offered to the patient. More use of peripheral nerve blocks should made, both before and after surgery and they can be combined with GA or spinal anesthesia. There are also catheter techniques to maintain the nerve blocks. Performing the surgery entirely under peripheral nerve blocks is feasible and the blocks are technically relatively easy.

#### *Bibliography*

1. Anesthesia and co-existing disease. Robert Stoelting. Churchill Livingstone. 3<sup>rd</sup> and 4<sup>th</sup> editions.
2. Regional Anesthesia and Analgesia. DI Brown. Saunders. 1969. 1<sup>st</sup> edition.
3. ASA Refresher course lectures 2006. Lippincott, Williams & Wilkins.

<sup>1</sup> Gagliese Lucia. Pain and Aging: The emergence of new subfield of pain research. The J of Pain. 2009;10(4):343-353.

<sup>2</sup> Book. Peripheral Neuropathy. Editor Dyck and Thomas, 4<sup>th</sup> ed. Publisher Elsevier and Saunders. 2005

<sup>3</sup> Bone JR. Regional anesthesia in the aged. Curr Res Anesth Anal. 1950 Jan-Feb;29(1):51-3

<sup>4</sup> Rogers A, Schug S et al. Need for an updated overview to assess the benefits of epidurals. Anesth Analg 2003 Sep 9;97(3):923-4

<sup>5</sup> Marini I, et al. Aging effect on pressure pain thresholds of head and neck muscles. Aging Clin Exp Res. 2011 Oct 3; (epub)

<sup>6</sup> Plooi B, et al. Physical inactivity in aging and dementia: a review of its relationship to pain. J Clin Nurs. 2012 Mar 28; (epub)

<sup>7</sup> Plooi B, et al. Autonomic responses to pain in aging and dementia. Rev Neurosc. 2011;22(5):583-9

<sup>8</sup> Fujii Y, et al. Influence of aging on lidocaine requirements for pain on injection of propofol. J Clin Anesth. 2006 Nov;18(7):526-9

<sup>9</sup> Sibille KT, et al. Chronic pain, perceived stress, and cellular aging; an exploratory study. Mol Pain. 2012 Feb;12:8;12

<sup>10</sup> Moayed M, et al. Abnormal gray matter aging in chronic pain patients. Brain res 2012 May 25; (epub)

<sup>11</sup> Wang Y, et al. The effects of post-operative pain and its management on postoperative cognitive dysfunction. Am J Geriatr Psychiatry. 2007;15:50-59

<sup>12</sup> Risk and prognosis of hip para-articular fractures. A comparison of treatment results of femoral neck and pertrochanteric femoral fractures. Wissing H. Unfallchirurgie. 1996 Apr. 22(2):74-84

<sup>13</sup> Postoperative course and endocrine stress reaction of geriatric patients with para-articular hip fractures. Prospective randomized study comparing spinal anesthesia and halothane intubation narcosis. Adams HA. Anesth Intensiv Ther. 1990 aug;25(4):263-70



- <sup>14</sup> Anesthesia for the youngest and the oldest: pediatric and geriatric practice in Catalonia, Spain. Med Clin (Barc). Escolano F. 2006 May;126 suppl 2:62-7
- <sup>15</sup> Brief postoperative delirium in hip fractures patients affects functional outcome at three months. Zakriya K. anetheAnalg.2004;98:1798-1802
- <sup>16</sup> An application of multiple logistic regression analysis to an outcome study on surgery for patients with femoral neck fractures. Morita s. Masui. 1993 Mar;42(3):412-6
- <sup>17</sup> Hip fracture in the elderly: the effect of anesthetic technique. Koval KJ. Orthopaedics. 1999 Jan;22(11):31-4
- <sup>18</sup> Anesthetic techniques for surgical correction of fractured neck of femur. A comparative study of spinal and general anesthesia in the elderly. McLaren AD. Anesthesia. 1978 Jan;33(1):10-14.
- <sup>19</sup> Anesthesia for surgical correction of fractured femoral neck. A comparison of three techniques. White IW. Anesthesia. 1980 Nov;35(11):1107-10
- <sup>20</sup> Forum. Femoral neck surgery using a local anesthetic technique. Howard CB. Anesthesia. 1983 Oct;39(10):993-4
- <sup>21</sup> Long term outcome after repair of fractured neck of femur. Comparison of subarachnoid and general anesthesia. McKenzie. Br. J Anesth. 1984 Jun;56(6):581-5.
- <sup>22</sup> Effects of anesthetic technique on deep vein thrombosis. A comparison of subarachnoid and general anesthesia. McKenzie PJ. Br. J Anaesth. 1985 Sep;57(9):853-7.
- <sup>23</sup> Spinal or general anesthetic for surgery of the fractured hip? A prospective study of mortality in 578 patients. Valentin N. Br. J. Anaesth. 1985 Mar;58(3):284-91.
- <sup>24</sup> The effect of anesthetic technique on postoperative outcomes in hip fracture repair. O' Hara Dorene. Anaesthesiol. 2000 Apr. 92(4):947-957
- <sup>25</sup> Functional outcomes after hip fracture. Effect of general versus regional anesthesia. Koval KJ. Clin Orthop Relat. Res. 1998 Mar;348:37-41
- <sup>26</sup> Postoperative confusion after anesthesia in elderly patients with femoral neck fractures. Berggren D. Anesth analg.1987 Jun;66(6):497-504
- <sup>27</sup> Mental function and mortality after acute hip surgery during spinal and general anesthesia. Bigler D. Anesthesia. 1985 Jul;40(7):672-6
- <sup>28</sup> Postoperative delirium after general anesthesia versus spinal anesthesia in geriatric patients. Kamitani K. Masui. 2003 Sep;52(9):972-5
- <sup>29</sup> Postoperative cognitive function as an outcome of regional anesthesia and analgesia. Wu c. RAPM.2004 May;29(3):257-268
- <sup>30</sup>
- <sup>31</sup> Continuous femoral block in elderly patients with hip fractures. Antonopoulou E. Regional Anesthesia and Pain Medicine. September 2006 (Vol. 31, Issue 5 (Supplement), Page 92)
- <sup>32</sup> Postoperative analgesia after triple nerve block for fractured neck of femur. Hood G. Anaesth. 1991 Feb;46(2):138-40.
- <sup>33</sup> Anesthetic management of the elderly patient with femoral neck fracture by sevoflurane and femoral nerve block. Fugimoto T. Masui 2000 Jul;49(6):630-3
- <sup>34</sup> Combined paravertebral lumbar plexus and parasacral sciatic nerve block for reduction of hip fracture in four patients with severe heart failure. Asao Y. Masui 2005 Jun;54(6):648-52
- <sup>35</sup> Combined paravertebral lumbar plexus and parasacral sciatic nerve block for reduction of hip fracture in a patient with severe aortic stenosis. Hi AM. Can J Anesth 2002 Nov;49(9):946-50
- <sup>36</sup> Combined lumbar and sacral plexus block compared with plain bupivacaine spinal anesthesia for hip fractures in the elderly. DeVisme V. Reg anes Pain med.2000 Mar;25(2):158-62
- <sup>37</sup> Outcome following fractured neck of femur – variation in acute hospital care or case mix? Withey C. J Public Health Med. 1995 Dec;17(4):429-37
- <sup>38</sup> The performance of spinal anesthesia is marginally more difficult in the elderly. Tessler M. RAPM. 1999 Mar;24(2):126-130.
- <sup>39</sup> Acute spinal subdural hematoma after attempted spinal anesthesia. Likar R. Anaesthetist (German). 1996 Jan;66-9
- <sup>40</sup> Hypotension in elderly patients undergoing spinal anesthesia for repair of fractured neck of femur. A comparison of two different spinal solutions. Martyr JW. Anesth. Intens Care. 2002 Oct;29(5):501-5
- <sup>41</sup> Minidose bupivacaine-fentanyl spinal anesthesia for surgical repair of hip fractures in aged patients. Ben-David. B Anesthesiol 2000 Jan;92(1):6-10





- 
- <sup>42</sup> Low dose hyperbaric bupivacaine for unilateral spinal anesthesia. Casati A. Can J Anaesth 1998 Sep;45(9):850-4.
- <sup>43</sup> Hemodynamic effects of unilateral spinal anesthesia in high risk patients. Chohan U. J Pak Med Assoc. 2002 Feb;52(2):66-9.
- <sup>44</sup> Spinal anesthesia using single injection small-dose bupivacaine versus continuous catheter injection techniques for surgical repair of hip fractures in elderly patients. Minville V. Anesth analg 2006;102:1559-63
- <sup>45</sup> Fascia iliaca compartment block for femoral bone fractures in Prehospital care. Lopez s. RAPM 2003;28(3):203-207
- <sup>46</sup> Pre-operative cardiac events in elderly patients with hip fracture randomized to epidural or conventional analgesia. Matot I. Anesthesiol. 2003 Jan.98(1):156-163
- <sup>47</sup> Effect of postoperative epidural analgesia on rehabilitation and pain after hip fracture surgery. Bang Foss N. Anesthesiol. 2005 Jun.102(6):1197-1204
- <sup>48</sup> Eight-year outcome associated with clinical options in the management of femoral neck fractures. Hudson JI. Clin Orthop Relat Res. 1998 Mar;(348):59-66
- <sup>49</sup> Comparison of internal fixation with total hip replacement for displaced femoral neck fractures. Randomized controlled trial performed at 4 years. Blomfeldt R. J Bone Joint Surg Am. 2005 Aug;87(8):1680-8
- <sup>50</sup> Total hip arthroplasty; optimal treatment for displaced femoral neck fractures in elderly patients. Healy WL. Clin Orthop Relat Res. 2004 Dec;(429):43-8.
- <sup>51</sup> Operative management of displaced femoral neck fractures in elderly patients. An international review. Bhandari M. J Bone Joint Surg Am. 2005 Sep;87(9):2122-30
- <sup>52</sup> Fractures of the femoral neck: a review and personal statement. Raaymakers EL. Acta Chir Orthop Traumatol Cech. 2006;73(1):45-59.
- <sup>53</sup> Reducing delirium after hip fracture: a randomized trial. Marcantonio ER. J am Geriatric Soc. 2001 May;49(5):516-22