Perioperative pain in thoracoscopy and thoracotomy

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Why is this subject relevant?
Introduction

- Thoracic surgery can cause significant pain and suffering
- Poor pain relief can lead to pulmonary complications and mortality
Introduction

- Appropriate analgesia is important:
  - For humanitarian reason
  - To allow early mobilization
  - To allow pulmonary rehabilitation
Introduction

Inadequate Analgesia
Introduction

- Adverse effect of inadequate analgesia
  - Decreased patient satisfaction
  - Decreased quality of life
  - Decreased patient’s ability to cooperate with physiotherapy
  - Increased post-operative pulmonary complications
Pathophysiology of thoracic surgery pain
Pathophysiology of thoracic surgery pain

- Pain after thoracic surgery is generated from multiple structures and is transmitted via a number of pathways
Pathophysiology of thoracic surgery pain

- Pathogenesis is complex
- Pain receptors are stimulated from
  - Skin incision
  - Division of muscles
  - Retraction of muscles
  - Fracture of ribs
  - Stretch of ligaments
  - Costochondral joints dislocation
  - Intercostal nerve injury
  - Pleural irritation from surgical stripping, chest drains or pleural blood
Pathophysiology of thoracic surgery pain

Nerves involved?
Pathophysiology of thoracic surgery pain

- Nerves involved in the transmission of thoracic surgery pain
  
  A- Intercostal nerves
  - Chest wall
  - Ribs
  - Peripheral diaphragmatic pleura
Pathophysiology of thoracic surgery pain

B- Phrenic nerve
- Pericardium
- Mediastinum
Pathophysiology of thoracic surgery pain

C- Vagus nerve

D- Sympathetic nerves:
- Lung
- Mediastinum
Pathophysiology of thoracic surgery pain

E- Brachial plexus involved

- Shoulder distraction
- Stretch intraoperative or during positioning
Pathophysiology of thoracic surgery pain

• The pain is not only severe but continuous and gets amplified

• **Continuous:**
  • Surgical wound’s continuous movement due to breathing plays a major role in increasing pain sensation

• **Amplified**
  • Central sensitization through amplification of pain transmission plays a major role in pain perception
Pathophysiology of thoracic surgery pain

Thoracic surgery pain pulmonary implication
Pathophysiology of thoracic surgery pain

• Inspiration stretches the injured structures resulting in:

- A reflex contraction of the expiratory muscles (splinting)

- Splinting of the affected hemithorax limits the distraction of the structures
Pathophysiology of thoracic surgery pain

- Expiration becomes active
- FRC decreases below closing capacity leading to airway closure
- Effective cough and sputum clearance affected
- Atelectasis, shunt, hypoxemia
Pathophysiology of thoracic surgery pain

• However, there are many causes other than pain involved in post-thoracotomy pulmonary dysfunction

• The relative importance of pain in the etiology of pulmonary dysfunction is not yet determined
Factors influencing thoracic surgery pain

- Factors affecting perioperative pain in lung surgeries include:
  - Patient’s factors
  - Analgesic technique
  - Surgical approach
Factors influencing thoracic surgery pain

Patient’s factors

"Are you sure I’m getting enough fiber?"
Factors influencing thoracic surgery pain

- Pre-operative preparedness
  - Well-informed patients may experience less pain
Factors influencing thoracic surgery pain

- **Opioids tolerance:**
  - Increases requirements due to a rightward shift in opioids dose response curve.
  - This is due to:
    - Decreased receptor sensitivity
    - Upregulation of cAMP
    - Neural adaptation
    - NMDA receptors activation
Factors influencing thoracic surgery pain

- **Sex**
  - Meta-analysis 1998: women less tolerant to noxious stimuli than men (catastrophization)
  - Difference decreases with age
  - Confounding social factors
Factors influencing thoracic surgery pain

- **Age**
  - Elderly are more sensitive to analgesics
  - Theory of blunting of peripheral nociceptive function
Factors influencing thoracic surgery pain

- Psychological factors:
  - Anxiety increases post op pain (decreased by communication or anxiolytics)
  - Depression increases also thoracatomy pain
Factors influencing thoracic surgery pain

Surgical approach
Factors influencing thoracic sugery pain

- **Sternotomy:**

  Intense stimulus during sternotomy
  Afterward analgesic requirement are modest

  Bone is fixed, bone movement is decreased => moderate post-op pain
Factors influencing thoracic surgery pain

- VATS (thoracoscopy)

A- Smaller incision => less incisional pain

B- Large diameter instruments => more intercostal nerves injury
Factors influencing thoracic surgery pain

• Open technique:

A- Posterolateral incision:
- Good surgical access
- Can be easily extended
- Chest wall muscles involved
- Most painful
Factors influencing thoracic surgery pain

- Open technique:
  
  B- Muscle sparing incision:
  - Axillary muscle sparing incision:
  - No reduction in acute post-op pain
  - Reduced incidence and intensity of chronic pain
  - Higher risk of rib or costal nerve injury due to retraction
Factors influencing thoracic surgery pain

• Open technique:

C- Anterior incision:
- For cardiac and anterior mediastinal procedures
- Limited exposure on the left
- More rib resection => same pain as posterolateral

- Intercostal nerve blocks are effective (no posterior wall involvement)
Factors influencing thoracic surgery pain

- Open technique:

D- Transverse sternothoracotomy:
  - Excellent surgical exposure for lungs and mediastinum
  - Indications include: lung or heart transplant, complex mediastinal tumors
  - Severe post-op pain
Factors influencing thoracic surgery pain

Analgesic technique
Factors influencing thoracic surgery pain

- **Pre-emptive analgesia:**
  - Suggested by Crile to prevent central sensitization
  - Systemic review 2002 for acute postop pain relief found little evidence of benefit only for thoracic epidurals
Analgesic drugs
Analgesic drugs

- **Systemic opioids:**
  - In the past, the mainstay for thoracotomy pain
  - Poor analgesia
  - Titration of systemic opioids is needed to balance between:
    - Analgesia, Passive expiration, Prevention of splinting
    - Sedation, Depression of ventilation, coughing, sighing
  - In a meta-analysis 1998, epidural local anesthetics reduced post op pulmonary complications compared to systemic opioids
  - In 2008, this was not supported in a systematic review.
  - This may be due to improved systemic opioid regimens
Analgesic drugs

• NSAIDs

• Block the synthesis of prostaglandins by inhibiting cyclo-oxygenase.
• Reduce the inflammatory response to surgical trauma
• Act centrally and peripherally

• Side effects:
  - GI mucosal damage
  - Renal tubular dysfunction
  - Platelets dysfunction
  - Increased bleeding (minimal risk in thoracotomy)
  - Renal failure in elderly and hypovolemic patients
  - May affect the result of pleurodesis
Analgesic drugs

• NSAIDs

• They improve pain control if systemic opioids are used
• They don’t have significant effect if epidural is used

• They decrease shoulder pain
Analgesic drugs

- Cox-2 Inhibitors
  - Lower risk of GI side effects
  - Less platelets inhibition
**Analgesic drugs**

- **Acetaminophen**
  - The safest of the non-opioid analgesics.
  - Act centrally by inhibiting prostaglandin synthesis and the serotonergic system.
  - Metanalysis in 2005 by Remy et.al found acetaminophen decreases morphine consumption by 20%.
  - Acetaminophen and NSAIDs have additive effects.
Analgesic drugs

• NMDA Antagonists

• Limit central neural sensitisation.
• Enhance opioid-induced analgesia
• Have opioid sparing effect
• Limit opioid tolerance.
• The effect of ketamine is pronounced in patients on chronic high dose of opioids

• Adding IV ketamine to epidural analgesia improve intraoperative and post-thoracotomy analgesia
Analgesic drugs

- **Gabapentin**
  - Acts on voltage-dependant calcium channels.
  - Effective in neuropathic pain.
  - “off-label” in perioperative pain.
  - Effective for the first 24 hrs after surgery.
  - 300-1200 mg
Analgesic drugs

- **Glucocorticoids**
  - Dexamethasone has analgesic effect. (dynamic movement)
  - Inhibits phospholipase and COX-2
  - Onset of analgesia is slow but can last up to 7 days
  - Maximal effect 10-40 mg
  - Side effect: gastric irritation, impaired wound healing, impaired glucose homeostasis and sodium retention
Procedures
Transcutaneous nerve stimulation

- 7 studies were done to assess its effect on thoracotomy pain.
- Not blinded
- Not randomized
- No significant benefit
Continuous wound infiltration catheter

- Can decrease post-operative opioid use
- Reduce wound edema
- Risk of local anesthetics toxicity
- Can be used if other techniques are contraindicated
Intercostal nerve blocks

- Each intercostal nerve gives off a lateral cutaneous branch that pierces the intercostal muscles proximal to the posterior axillary line
- For success of this technique we should block the nerve posterior to this line
- However the dorsal rami are not blocked by the intercostal nerve block
Intercostal nerve blocks

• These nerves can easily be blocked when the chest is open.
• However the limited half-life of local anesthetics limit the effectiveness of the block
Intrapleural blocks

- In the healthy human, the two layers of the pleura are separated by 10-20 µm.
- Previously this block was considered to be effective.
- However new randomized studies for thoracotomies showed intrapleural blocks to be ineffective.
- High toxicity
Paravertebral blocks

• Continuous thoracic paravertebral blocks can provide excellent post-thoracotomy analgesia

• Comparable to epidural analgesia

• Fewer complications

• Easy to be placed by the surgeon when the chest is open
Paravertebral blocks

• **Anatomy**

• The paravertebral space is a potential space
• Wedge shaped area bounded by:
  - Costa-transverse ligament
  - Transverse process
  - Intervertebral foramina
Paravertebral blocks

• Methods

• Earson and Wyatt technique
  - Needle is inserted 3 cm lateral to the cranial edge of the spinous process until it hits the transverse process
  - Then process is walked cranially
  - Click : costotransverse ligament
  - Loss of resistance
  - Failure rate 10%
Paravertebral blocks

- Management of paravertebral catheter

- The appropriate management has not yet been established
- Review by Kotze et.al 2009 found that a higher bupivacaine dose (890-990mg/24hrs) predicted lower pain score and faster recovery of pulmonary function than lower dose (325-472.5mg) without difference in local anesthetic toxicity.
- Continuous doses were better than intermittent boluses
- Adjuvants (fentanyl, clonidine...) didn’t affect analgesia
- Recommended dose:
  - Initial dose: 0.3 ml/kg 0.25% bupivacaine followed by 0.1 ml/kg/hr
Paravertebral blocks

• **Limitations**
  - To provide adequate analgesia for thoracotomy, it usually takes several hrs for the local anesthetic to spread along the paravertebral space.
  - No benefit intraop

• **Complications**
  - Pleural puncture
  - Hypotension
  - Nerve hemorrhage
  - Dural puncture
  - Nerve injury
  - CNS local anesthetic toxicity
Paravertebral blocks

- Conclusion
- Simple technique
- Easy to learn
- Few complications
- Relatively safe in patients with anticoagulation
- Earlier mobilization than epidural
Thoracic epidural analgesia

- Introduced for thoracotomy in the mid-1970s
- Effective reliable analgesia
- Few post-thoracotomy pulmonary complications
Thoracic epidural analgesia

- **Technique**
- Lateral or sitting position

- The vertebral spinous processes are at their most oblique angle in midthoracic region
- The spinous process of a vertebrae is a landmark for the next vertebrae
Thoracic epidural analgesia

- In midline approach, tuohy needle is inserted above the palpable tip of the lower spinous process and advanced oblique cephalad.

- In paramedian approach, entry point is 1 cm lateral to the tip and the needle is inserted perpendicular to all planes. When there is contact with the lamina the needle is oriented 45 degree cephalad and 10 medial and walk the lamina.
Thoracic epidural analgesia

- **Solutions**

  - High concentrations => hypotension
  - Low concentration less effective analgesia

- Mixing epidural local anesthetics and opioids is beneficial (synergy)

- The effect is improved with epinephrine, however chronic use was associated with potential cord ischemia

- Clonidine reduces pain score without opioids related side-effect.
Thoracic epidural analgesia

- Factors affecting efficacy
  - Level of insertion
    - If high thoracic level => spread caudal
    - If low thoracic level => cephalad spread
    - If midthoracic spread equidistant.
  - Little evidence for the effect of the patient’s height
  - Same for weight
  - Positive correlation between the patient’s age and thoracic spread (elderly require up to 40% less volume)
Thoracic epidural analgesia

- Benefits

  - Excellent analgesia (gold-standard)
  - Decrease in the diaphragmatic dysfunction after thoracotomy
  - Increase in functional residual capacity
  - Better mucociliary clearance
  - Less nausea vomiting
  - Reduction of cardiac related morbidity and mortality (decreases angina, dilate coronary vessels, reduce incidence of supraventricular arrhythmias)
  - Finally patient is able to cooperate with physiotherapy
Thoracic epidural analgesia

- Limitation
  - Technique placement failure rate <1%
  - 15% failure rate afterward
  - Less dural puncture than lumbar (0.9% vs 3.4%) but technically more difficult
  - National Audit Project found that major complications occurred at a rate of 0.007%
  - Urinary retention due to inhibition of sacral parasympathetic outflow
  - Delay gastric emptying (effect on T6-T10)
Thoracic epidural analgesia

- **Shoulder pain**

- Common with thoracic epidural, rare in patients with paravertebrals and almost nonexistent in patients without block
- Incidence: 42%-86%

- Suprascapular block didn’t affect the incidence of pain but decreases its intensity (controversy)
- Blocking the ipsilateral phrenic nerve decreased the incidence from 85 to 33% => pain from irritation of mediastinal pleura, pericardium

- Effective treatment: acetaminophen, NSAIDs, phrenic nerve block,
Thoracoscopy

- The extent of pain and need for analgesia depend on the nature of the surgery
- Large variation of analgesic requirements in studies for thoracoscopy (nature of the surgery is not considered a variable for most of them)
- Thoracic epidural/ Paravertebral block recommended for lung reduction surgery
- No neural block needed for biopsy or sympathectomies
Thoracic epidural analgesia VS Paravertebral blocks

• Both provide excellent analgesia with lower pulmonary complications with paravertebral blocks
Thoracic epidural analgesia VS Paravertebral blocks

- Factors favoring epidurals
  - Poor PFT’s (FEV1 <60%)
  - Extensive lung resection
  - Chest wall involvement
  - NSAIDs contraindicated
  - Patient preference
Thoracic epidural analgesia VS Paravertebral blocks

- Factors favoring paravertebral block
  - Good PFT’s
  - Limited lung resection
  - Sepsis
  - Impaired coagulation
  - Fixed spinal deformity
  - Patient under anesthesia
  - Patient preference
Chronic post-thoracotomy pain
Chronic post-thoracotomy pain

• Definition:
Pain that extends at least 3 months

• Areas affected:
  - Scar
  - Ipsilateral pectoral
  - Subcostal
  - Scapula
  - Shoulder
Chronic post-thoracotomy pain

The most common locations of pain marked by patients after surgery.
Chronic post-thoracotomy pain

• Incidence:
  5-65% (mostly 50%) at 3 months and 2-5% at 1 year

• Intensity:
  Minor to very severe
  Intermittent or constant
Chronic post-thoracotomy pain

- Type:
  - Burning
  - Numbness
  - Cutting

- Affected by weather changes
Factors influencing chronic post-thoracotomy pain

• Genetic factors
Factors influencing chronic post-thoracotomy pain

• Surgical factors

- Posterolateral incision had the worst pain

- Thoracoscopy showed less acute pain but similar neuropathic pain at 1 year (role ribs spreader, paracostal sutures on neurovascular bundle)
Factors predicting chronic pain

- Acute perioperative pain
- Numbness
- Younger age
Influence of anesthesia technique

- No studies of paravertebral blocks on chronic pain
- Thoracic epidural:
  - Some studies showed less chronic pain but meta-analysis done by Bong et.al in 2005 found no sufficient evidence that pre-emptive analgesia prevents chronic pain in thoracotomies. (studies underpowered)
Management of post-thoracotomy chronic pain

• Search for recurrence of the tumor

• Anti-epileptic medications
• Tricyclic antidepressant
• Opioids
• SNRI
• Topical lidocaine
• Transcutaneous electrical nerve stimulation
Thank You!