Pathophysiology of Postoperative Pain

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Pain explains a great deal of human conduct, but the fear of pain even more.

— Neil Abramson —
I have no financial disclosures.
Goals

- Define “pain”
- Understand how pain is transmitted
- Identify targets for pain control
- See how acute pain can become chronic
What Is Pain?

“An unpleasant sensory and emotional experience associated with actual or potential damage.”

International Association for the Study of Pain
What Pain Is Not...

An Opioid Deficiency

Quote by Dr. Brian Ginsberg, Duke
Physiologic Processing of Pain

- Transduction
- Transmission
- Modulation
- Perception
Physiologic Response to Pain
Transduction

- **Nociceptors**
  - Different types
  - Encode intensity by increasing discharge rates

- **Neurotransmitters**
  - Excitatory: substance P, glutamate, CGRP…
  - Inhibitory: endorphins, NE, 5HT3, GABA…
Transmission

- **Aδ fibers**
  - Myelinated
  - Fast transmission
  - Sharp
  - Well-localized

- **C fibers**
  - Unmyelinated ("UNC")
  - Slower transmission
  - Dull, aching
  - Poorly localized

Adapted from Jarvis C: *Physical examination & health assessment*, ed 6, St. Louis, 2011, Saunders. Illustration by Pat Thomas, CMI.
Nerve Injury

Normal nerve
- VSSC
- VSSCs at node of Ranvier

Severed nerve
- Axon sprouting
- Degenerating cut nerve ending

Ectopic activity
- Accumulation of VSSCs on tangled nerve endings
- Neuroma

Normal nerve
- VSSC

Injury or disease

Demyelination
- Loss of Schwann cell insulation
- VSSCs continue to be transported from the cell body

Ectopic activity
- Accumulation of VSSCs
Second Order Neurons

- Nociceptive Specific
- Wide Dynamic Range
  - Noxious and non-noxious stimuli
  - Large receptive fields
  - Wind-up phenomenon
Central Sensitization

- **Wind-up**
  - Increasing discharges with same stimulus
  - Discharges after stimulus ended

- **Receptor field expansion**
Modulation

- Dampening or amplifying signals
- Peripheral modulation- histamine, serotonin, bradykinin
- Central modulation- spinal and supraspinal mechanisms
Supraspinal Inhibition

- Periaquaductal gray matter
- Reticular formation
- Nucleus raphe magnus (NRM)
- Send fibers to inhibit pain in the dorsal horn

It's Complicated

Single
In a relationship
Married
Separated
Divorced
Third order neuron projects from thalamus to cerebral cortex which results in perception and discrete localization.
Perception

• **Cognition**
  » Recognize, discriminate, memorize, judge
  » Relate a painful experience to another event

• **Attention**
  » Only a fixed number of afferent signals can reach cortical centers
  » Biofeedback, hypnosis
We’ve Got Lots of Targets!

Perception: opioids, alpha_2-agonists, TCAs, SSRIs, SNRIs
Modulation: TCAs, SSRIs, SNRIs
Transmission: LAs, alpha_2-agonists
Transmission: LAs, opioids
Transduction: LAs, capsaicin, anticonvulsants, NSAIDs, ASA, acetaminophen, nitrate

Ascending input
Spinothalamic tract
Dorsal horn
Dorsal root ganglion
Peripheral nerve
Peripheral nociceptors
Pain
Descending modulation
Trauma
But what are you giving me for pain?
The P Words

- Preemptive analgesia
- Preventive analgesia

Persistent Pain After Surgery

Preventive Analgesia
Blood Brain Barrier

It's not my problem, the hole is in their side of the boat!

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