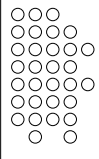


Pain Modulation via Thermotherapy

An Analysis of Current Theories


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Goals

- Synthesize literature
- Explain theories
- Determine which are most supported by literature regarding pain modulation
- Determine where more study is appropriate



Theories


- Gate Control Theory
- Descending Inhibition Mechanisms
- Counterirritation



Neurophysiology of Pain Transmission


Classifications of Nerve Fibers in Mammalian Skin

Fiber Type	Fiber Function	Fiber Size (µm)	Average Fiber Conduction Speed (m/s)	Fiber Myelination
Aβ	Afferent conduction of cutaneous touch and pressure stimuli	8	50	Well myelinated
Aδ	Afferent conduction of cutaneous, thermal and pain (pin-prick) stimuli	3	5 – 30	Thinly myelinated
C	Afferent conduction of cutaneous pain (pin-prick), chemical stimuli and some thermal stimuli	0.5	0.5 – 2	Unmyelinated



Neurophysiology of Pain Transmission

Images available at www.lupcanatomy.com/images/Picture%201176.jpg




Neurophysiology of Pain Transmission

LTM Neurons
Innocuous stimuli
Laminae III, IV'

NS Neurons
High threshold
Noxious, semi-noxious
Laminae I

WDR Neurons
innocuous stimuli
near noxious stimuli
Laminae I, II



Gate Control Theory
Melzack & Wall, 1965

- Large diameter afferents
- Dorsal column/Medial Lemniscus
 - A-beta fibers
 - First order neurons
 - Second order neurons
 - Third order neurons
- Rexed's Laminae
 - A-delta fibers
 - C-fibers
 - A-beta fibers
- A-beta fibers' collaterals

Gate Control Theory
Melzack & Wall, 1965

- Mechanisms of Action
 - Integration of thermal & non-thermal signals
 - A-beta collaterals
 - Presynaptic inhibition
 - LTM neurons vs WDR/NS neurons
- Modalities
 - E-stim
 - Hot pack

Gate Control Theory
Melzack & Wall, 1965

- Research needed
 - To demonstrate practicality of the integration of non-thermal and thermal stimuli
 - To demonstrate activation of A-delta and C fibers by A-beta afferents, presynaptic inhibition
 - To demonstrate stimulation of LTM cells via non-thermal stimuli and override of NS/WDR cells

Descending Inhibition Mechanisms
Reynolds, 1969

- Peri-aqueductal gray matter (PAG)
 - Ventrolateral column
 - Opioid analgesia
 - NRM in medulla
 - Serotonergic (thermal effects)
 - Lateral column
 - Non-opioid analgesia
 - Nucleus gigantocellularis pars alpha
 - Noradrenergic (mechanical effects)
 - Nucleus paragigantocellularis lateralis
 - Noradrenergic (mechanical effects)

Descending Inhibition Mechanisms
Reynolds, 1969

- Opioid Analgesia
 - Endogenous Opioids
 - Endorphins, dynorphins, enkephalins
- Pathway
 - Ascending pain afferents
 - PAG
 - Enkephalinergic interneurons
 - Second laminae
 - Synapse with A-delta, C-fibers

Descending Inhibition Mechanisms
Reynolds, 1969

- Mechanism of action
 - Thermal stimuli approach noxious levels
 - Stimulate PAG
 - More enkephalin released
 - Stimulate anterior pituitary
 - More endogenous opioids released
- Modalities
 - No practical options

Descending Inhibition Mechanisms

Reynolds, 1969

- Research needed to determine means of administering modalities without having to sustain high temperatures for long periods of time



Counterirritation

- Masking/inhibiting pain with another sensation
- Chemical counterirritants
 - Ingredients
 - Menthol
 - Methyl salicylate (peppermint)
 - Camphor (camphor wood)
 - Capsaicin
- Mechanical counterirritants
 - Sensory input
- Thermal counterirritants
 - thermotherapy



Counterirritation

- C-fibers
- Temperature Gated Ion Channels
 - Transient receptor potential family (TRP)
 - TRPV (heat only)
 - TRPV1, TRPV2, TRPV3, TRPV4
 - TRPM, TRPA (cold only)



Counterirritation

- Peripheral effects
 - Inflammatory response propagates thermal sensation to brain
 - Substance P
 - TRPV1 channels open, stay open
 - Pre-synaptic inhibition
- Spinal segmental effects
 - A-delta fiber & C-fiber interference
- Supraspinal effects
 - Descending inhibition mechanisms
 - Endogenous opioids



Counterirritation

- Mechanisms of action
 - Mechanical counterirritants
 - Integration of thermal and non-thermal signals, presynaptic inhibition, LTM neurons vs NS/WDR neurons
 - Chemical counterirritants
 - Inflammatory response leading to presynaptic inhibition
 - Calcium ions cause cell death
 - WDR cells > NS cells




Summary

- Gate Control Theory
 - Effective pain reliever
 - Lack of evidence to substantiate theory
- Descending Inhibition Mechanisms
 - Effective pain reliever
 - Extreme temperatures, time required to elicit pain relief
- Counterirritation
 - Effective pain reliever
 - To what degree does it relieve pain? How long?




Strengths/Limitations

- **Strengths**
 - Includes many available resources
 - Pools most current research
 - Valuable reference for clinicians
- **Weaknesses**
 - More theories to discuss
 - Pain spasm cycle
 - Effects of chronic pain
 - Placebo Effect
 - Lack of scientific studies, RCTs, etc.



Conclusion

- What is the value of this as a publication?



Questions? Suggestions?

References available upon request.

