Anatomical Substrates of Somatic Sensation

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Dorsal Column-Medial Lemniscal System
• Mediates mechanical sensations
  - touch, limb position sense, vibration sense
• Well established; clinical & experimental

Anterolateral System
• Mediates protective sensations
  - Pain
  - Temperature (cold & warmth)
  - Itch
• Not as definitively established as is the DC-ML system for touch
Why?
  • Pain w/o tissue trauma
  • Trauma w/o pain
  • Cultural; pathological

Perspective:
• Peripheral somatic sensory receptors are sensitive to different stimulus qualities
  - Mechanical
  - Noxious (mechanical, thermal, polymodal)
• Different receptor classes provide input to different somatic sensory pathways
• Differential thalamic and cortical localization

Dorsal column-medial lemniscal system: Mechanical sensations
1. Mechanoreceptor
2. Dorsal column nuclei
3. Thalamus: Ventral posterior nucleus
Peripheral nerve
Dorsal root ganglion
1° somatic sensory cortex

Anterolateral system: Pain, Thermal, Itch
1. Nociceptor
2. Anterolateral system:
  • Spinothalamic tract
  • Spinoreticular tract
  • Spinomesencephalic tract
Peripheral nerve
Dorsal root ganglion
Dorsal horn
2. Anterolateral system: Spinothalamic tract
3. Thalamus: Ventral posterior
Cingulate cortex
Medial dorsal nuclei
1° somatic sensory cortex
Insular cortex
Nociceptors, thermoreceptors, & itch receptors are bare nerve endings.

Mechanoreceptors are encapsulated.

Mechano-receptor receptive fields:
- Rapidly adapting
- Slowly adapting

- Meissner's
- Pacinian
- Merkel's
- Ruffini

Fiber Histogram: Sensory axon innervating the skin
- II (A-β)
- III (A-δ)
- IV (C)

Fiber Histogram: Sensory axon innervating a muscle
- II (A-β)
- III (A-δ)
- IV (C)

Dermatomes:
- Area of skin innervated by all sensory fibers within single dorsal root

Dermatomes overlap:
- Pain dermatomes overlap < touch dermatomal boundaries vary

Dermatome facts:
- Dorsal root ganglion
- Dorsal root
- Ventral root
- Spinal nerve
- Dorsal horn
- Intermediate zone
- Ventral horn
- "Anterolateral" column
- Lateral column
- Ventral column
Lamina 5

NTA 5-6

Mechanoreceptor

Ipsilateral loss of touch

Contralateral loss of pain

(2-3 segments caudal to injury)

Spinal Hemisection

Syringomyelia

• Bilateral loss of pain & thermal senses
• Preservation of mechanosensations

Somatotopy of spinal paths

Anterolateral system

Dorsal column-medial lemniscal system
Summary

- Early morphological specialization of DRG neurons sets stage for separate mechanosensory and pain/temp/itch systems
- Different ascending pathways to distinct subcortical and cortical sites
- Single thalamic mechanosensory nucleus and 1° ctx
- Multiple thalamic pain nuclei and cortical areas
- Parietal lobe projections may play role in stimulus localization, esp. for touch
- Cortical pain representations closely tied to emotions