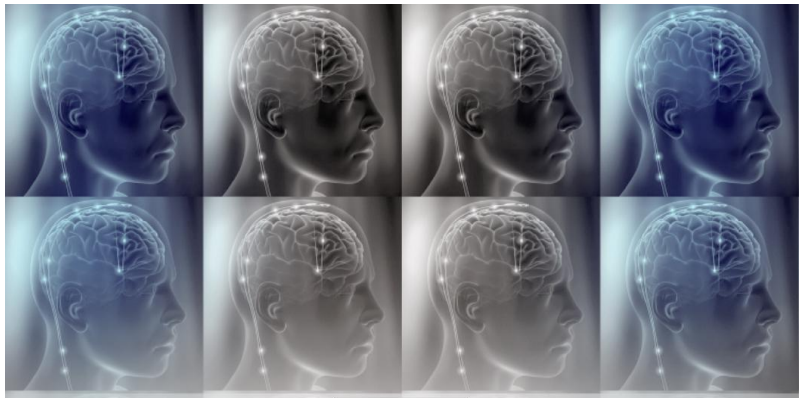

# 431

# CNS Central Nervous System

# Block

## Physiology Team

Female Side Male side

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Revised By:

- **Pain**

**Pain** is unpleasant sensation and emotional experience associated with actual or potential tissue damage or described in terms of such damage. It is characterized by the following:-

1. It has a protective function.
2. All pain receptors are free nerve endings of unmyelinated C fibers & small diameter myelinated A **delta δ** fibers.
3. Pain receptors are the most widely distributed.

- Pain sensation can be produced by various types of stimuli i.e. mechanical, thermal & chemical, hence the existence of mechanoceptors, thermoceptors, & polymodal pain receptors (nociceptors).
- Pain receptors adapt very little, if not at all.
- Localization of pain stimuli is less exact than that of other modalities.
- Pain receptors are high threshold receptors i.e. painful stimuli must be strong & noxious to produce tissue damage.
- Pain is perceived at both the cortical & thalamic levels.

**Effects associated with pain sensation**

1- Motor reactions, these may take the form of:-
   - Reflexes e.g. withdrawal reflex.
   - Muscle rigidity ( stiffness).
2- Autonomic reactions
   - Mild pain stimulates post. hypothalamic N→ sympathetic changes e.g. tachycardia.
   - Sever pain stimulates anter. hypothalamic N→ parasympathetic changes e.g. bradycardia.
3- Emotional reactions as anxiety, crying……..etc.

**Mechanism of stimulation of pain receptors (nociceptors)**

- Pain receptors are depolarized either directly or through the production of pain producing substances that are produced from damaged tissues as a result of inflammation ( also called inflammatory mediators e.g. bradykinin, serotonin, histamine, interleukins, substance P, K+, Ach, proteolytic enzymes.
- Prostaglandins & interleukins lower threshold of pain receptors.

# Qualities of pain

| | Fast pain (immediate, first) | Slow pain (delayed or second) |
|---|---|---|
| **Called** | Pricking, acute, sharp or electric pain. | Burning, aching or chronic pain. |
| **Occurs** | Skin | In skin, deep tissues & viscera |
| **Transmitted via** | Type Adelta fibers, | Type C fibers |
| **Conduction velocity** | 3-30m/s | < 2m/s, |
| **Percentage** | Account for 20% of nociceptors primary afferents | Account for 80% of nociceptors primary afferents |
| **Arise from** | All types of nociceptors. | Polymodal nociceptors. |
| **Appearance and duration** | It appears very rapidly within 0.1 sec., and lasts for short time | It appears slowly, after one sec. Or more, and lasts for longer duration. |
| **Localization** | Well localized | It is diffused (poorly localized). |
| **Neurotransmitter** | Glutamate | Substance P. |
| **E.g** | E.g. The type of sensation felt when skin is cut with a knife | |

# Types of pain

- Pain can be classified according to the **site** of stimulation into:-

| | Somatic pain | | Visceral pain |
|---|---|---|---|
| | **Superficial** | **Deep** | **Visceral** |
| **Arises from** | Skin or other superficial structures | Muscles, joints, periosteum, tendons & ligaments | There are few pain receptors in most viscera; some viscera are pain insensitive e.g. Liver parenchyma, lung alveoli, brain tissue, visceral layer of peritoneum, pleura and pericardium. |
| **Quality** | It occurs in 2 phase of fast pricking followed by slow burning pain. | It is slow prolonged conducted by type C fibers. | It is slow pain conducted by C fibers (pain arising from parietal peritoneum, pleura and pericardium is sharp, pricking type). |
| **Localization** | Well localized | Diffuse | It is diffuse, the patient feels pain arising from inside but he cannot pinpoint it exactly. |
| **Associations** | Associated with motor, autonomic, emotional reactions. | It can initiate reflex contraction of nearby muscles. | It is often associated with autonomic reactions.<br>It can be associated with rigidity of nearby muscles. |
| **Referred pain** | No, cutaneous pain is not referred | It may be referred to other sites. | It may be referred to other sites. |
| **Cause** | | It is caused by, trauma, bone fracture & inflammation, arthritis, muscle spasm & ischemia. | 1.Distension of a hollow organs<br>2.Inflammation of an organ.<br>3.Ischemia e.g. Pain due to myocardial ischemia. |

# Referred pain

- This is pain that is felt away from its original site.
- It is most frequent with visceral pain & deep somatic pain but cutaneous pain is not referred.
- Pain is referred according to dermatomal rule.

**Mechanism of referred pain**

- Convergence theory
  - Afferent nerves from somatic structure & viscera that develop from same embryonic segment converge on same spinothalamic tract.
  - Since brain is accustomed to receiving impulses from skin than viscera, so pain impulses carried to cortex along spinothalamic neurons shared by afferents from skin & other from diseased viscus are misinterprited by the brain as coming from skin.
- Facilitation theory
  - Pain fibers from skin are always carrying impulses, but they are not enough to produce pain. Impulses from diseased viscus pass through afferents which give collaterals to ST neurons receiving pain fibers from skin. As a result, ST neurons' excitability is raised (they are facilitated) to reach a threshold level. The signals reaching the brain are projected to skin area and pain is felt in skin dermatome

| Organ | Site of referred pain |
|---|---|
| Meninges | Back of head &neck |
| Heart | Central chest, left arm |
| Diaphragm | Shoulder tip |
| Esophagus | Behind sternum |
| Stomach,duodenum | Epigastrium |
| Kidney | Loin |
| Ureter | Testicles |
| Trigone of bladder | Tip of penis |
| Hip | knee |
| Appendix | Umbilicus |
| Uterus | Low back |

## Pathway of pain

Pain sensation is carried by lateral spinothalamic tracts which includes 2 separate pathways:-

| | The neospinothalamic pathway | The paleospinothalamic pathway |
|---|---|---|
| | This transmits fast pain & thermoceptive sensation. | This transmit slow pain sensation & thermoceptive sensation |
| First order neurons | Are mainly A delta afferent nerves. They ascend few segments in Lissauer' tract & terminate at lamina I & V of D. horn. | They are mainly type C fibers. They enter spinal cord via dorsal roots, ascend a few segments in Lissauer' tract & terminate at substantia gelatinosa in laminae II & III of dorsal horn. |
| Second order neurons | These constitute the tract. They start at dorsal horn, cross to opposite side and ascend in lateral column of spinal cord. The fibers ascend in brain stem to terminate in ventrobasal complex of thalamus. | They start at SGR, cross to opposite side in front of central canal, ascend in lateral column of SC & terminate at:-<br>*Reticular formation of brain stem.<br>*Intralaminar nuclei of thalamus.<br>*Hypothalamus & adjacent region of basal brain.<br>Impulses arriving these regions have strong arousal effects and can be perceived. |
| Third order neurons | These start at thalamus & project to somatosensory cortex. | These start at thalamus, Project to all parts of cerebral cortex. |

## Role of cerebral cortex in pain perception

- Full perception of pain occurs when signals enter RF of brain stem, thalamus & basal regions.
- Somatosensory cortex plays important role in topognosis i.e. localization & interpretation of pain quality.
- Fast pain is localized better than slow pain because signals carried in neospinothalamic tract reach somatosensory cortex, while a small propotion of paleospinothalamic pathway reach there.