Visceral Sensation
&
Referred Pain

By
Dr. Nourelhuda A. Mohammed
Associate Professor Of Physiology
Faculty Of Medicine, Mutah University
2024-2025

About viscera

* the viscera doesn't have much specific receptor for pain free nerve endings like skin
* the only sensation that comes from the viscera is pain
the viscera doesn't have touch or pressure receptors

- Free nerve endings in viscera are less than that in skin. However, pleura (especially the parietal layer) and peritoneum are rich in pain receptors. (so sensitive to pain)
- liver parenchyma & lung alveoli are devoid of free nerve endings.
- Sensory cortex (most of the sensations come from the skin) is poorly aware by the visceral pain.
- The stimuli which cause severe cutaneous pain may even not cause any visceral pain e.g., cutting the viscera with a knife or cauterization of cervical erosion is not painful. On the other hand, some stimuli which cause visceral pain like bacterial toxins may not cause any cutaneous Pain.

* one of the critera of the characteristics of the viscera :· referred to a other site (it's orgin is in a specific place but the cortex refers it to another place cutaneously) ↓ not deep or visceral

charecteristics of

Visceral pain

شوفوا السلايد اللي بعده

common between deep and visceral pain

deep and slow pain aren't localized also → at cutaneous

- Dull aching, not well localized it doesn't reach a specific area in the somatic sensory cortex
- It is transmitted by afferent sympathetic (1) or parasympathetic (2) nerves and sometimes by somatic afferent (3)

Somatic يعني autonamic يعني
Symp
Parasymp

Visceral pain is produced by:

- overdistension of hollow organs (stomach). or the bladder
- Spasm of intestine or ureters.
- Toxins or chemicals in contact with mucosa. → Severe visceral Pain
- Ischemia.
- Traction on peritoneum or mesentery by a big tumor.

important for blood vessels

↳ this will cause ischemia to the organ

- Visceral pain is usually accompanied by nausea, vomiting , bradycardia and shows phenomenon of referred pain as

only in visceral pain

Sensory cortex is poorly aware of the visceral pain

Visceral pain will give a parasympathetic reaction (just like the deep Pain)

مهم جدًا جدًا جدًا

* the thoracic line → from the end of esophagus and trachea till the begining of the stomache

* the pelvic line → at the level of iliac crest at the hip bone (in the intestine it takes the proximal two thirds of the colon)
the last level of the rectum is under the line

* any structure between the 2 lines the afferent is sympathetic

* any structure above them (like esophagus) → parasymp

* any structure below them (rectum, genitalia) → parasympath

* the gallbladder (found in the gallbladder fossa in the liver), the irration of the gall bladder will cause the irratation of the central part of the diaphragm (since it's located above the liver. afferent → phrenic nerve c3,4,5 (Somatic)

* ال Visceral pain بتتميز عن كل أنواع ال afferent بال Pain

Referred pain

- **It is pain** which is felt in a site other than the diseased one that it originate from.
- It is pain which is felt in a **(cutaneous)** site rather than the **(visceral)** diseased one that it originates from.

بكون الألم مصدره من الـ Viscera بس الشخص بشتكي من ألم بالـ skin

- **Examples:**

1) Anginal pain (cardiac ischemia)	Retrosernum, medial side of left arm with little finger, jaw or root of the neck.
2) Gall bladder pain	Right shoulder.
3) Appendicular pain	Umbilicus & epigastrium.
4) Uterine & labor pain	The back.
5) Renal pain	Testis & loin.
6) Headache	Surface of the head.

Mechanisms of referred pain

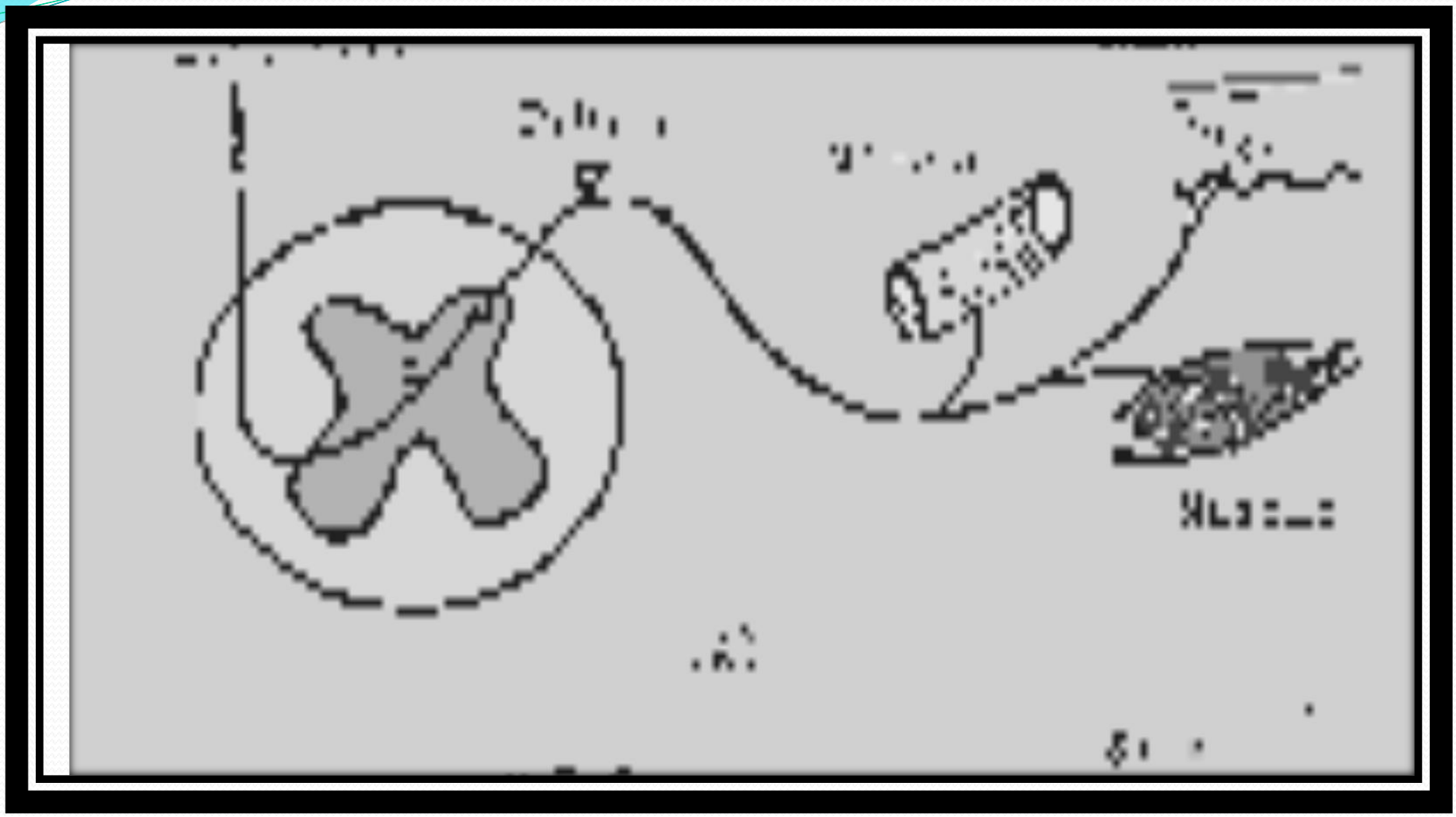
1. Branching dorsal root theory

- Pain from viscera enters the spinal cord in a certain ***dorsal root***.
- Also pain from skin enters the spinal cord through the ***same dorsal root***.

Because the **2 sites** have same embryological origin.

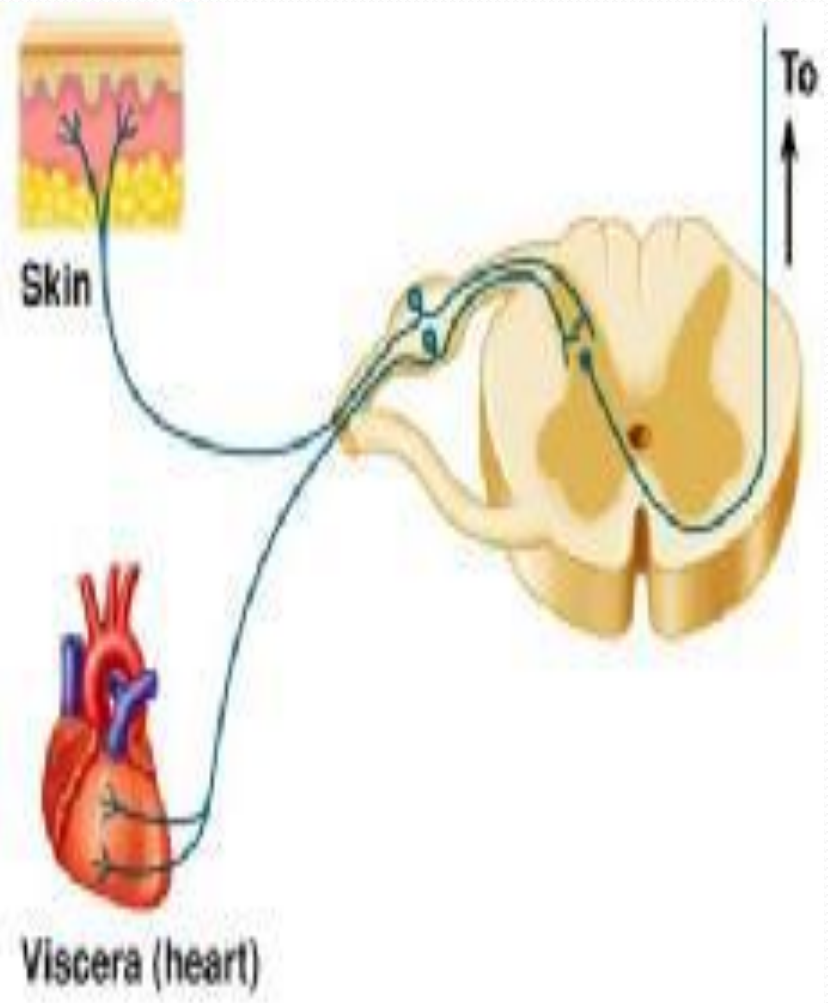
- The sensory cortex is adapted that if pain comes from this ***dorsal root*** it means that it comes from the skin not from viscera **Because**

- a) Skin is usually exposed to trauma (or environmental changes). Since it covers the extrior surface of the body
- b) Sensory cortex is poorly aware by the visceral pain.

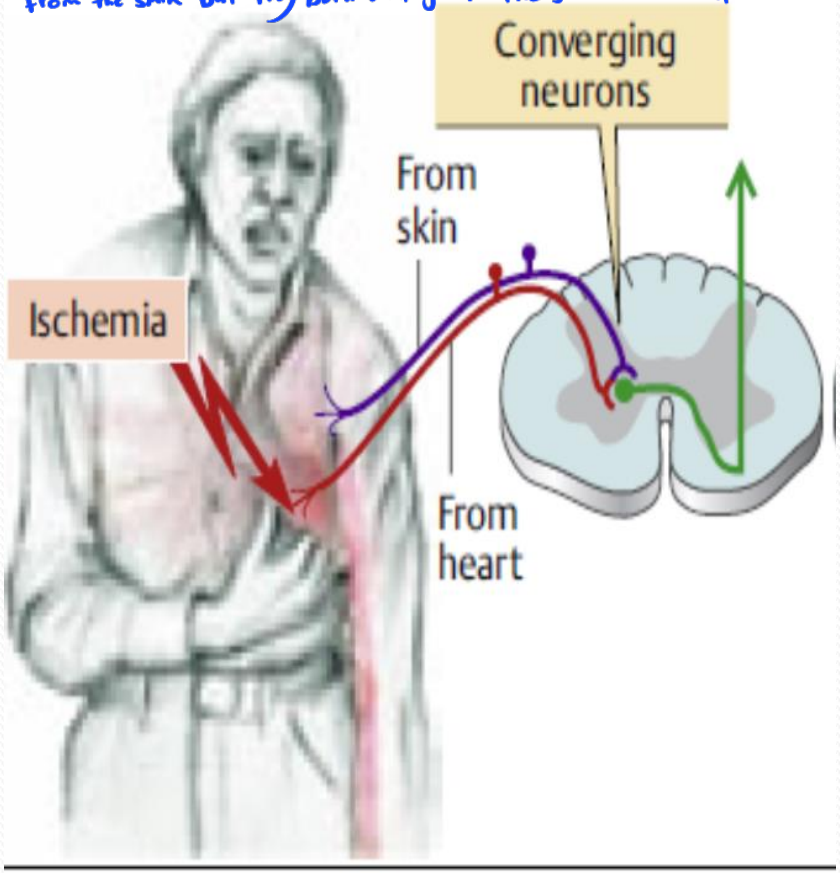


2- Convergence -projection theory

- Pain from the viscera enters the spinal cord and converge on the dorsal horn cell.
- Sensations from certain area of the skin (that originate from the same embryonic segment as that viscera) enter spinal cord and converge on **the same dorsal horn cell**.
- Now pain sensation reach sensory cortex from this neuron, the cortex will project pain sensation as if it originate from the skin and not from the viscera because usually the skin is that organ which is always exposed to trauma and most pain that reach the cortex is coming from it.



if there was ischemia in the heart the Pain sensations are going to be transmitted by a dorsal horn seperate from the dorsal horn that will transmit the sensation from the skin but they both will go to the same dorsal cell



Pain control system

1- Analgesia system

targets slow Pain + C fibers and substance P that is secreted from the nerve terminals of C fibers

(An = no & Algesia = pain)

- It is a physiological system composed of group of neurons at different levels in CNS stimulate each other by chemical transmitters to minimize the pain.
- This system is composed of :

* the stimulation keeps on going until it reaches the Substantia gelatinosa of rolandi (which is the 2nd order neuron of the slow Pain)

Nucleus	Site	Transmitter released
1. Peri ventricular nucleus	Hypothalamus (higher center of emotion; there will be a collateral going to the hypothalamus which will initiate the emotional reaction the analgesic system will then activate)	β Endorphin (will activate PAG)
2. Peri aqueductal gray matter (PAG)	Mid brain	Enkephalin (Will activate Rmn)
3. Raphe magnus nucleus (RMN)	Mid line of upper medulla	Serotonin (5HT) (Will activate PIC)
4. Pain inhibitory complex (PIC)	Dorsal horns of the spinal cord	Enkephalin
5. Interneurons	Substantia Gelatinosa of Rolandi (SGR)	Enkephalin or GABA (inhibitory chemical transmitter)

Mechanism of analgesia cascade

Exposure to pain leads to:

- Stimulation of peri ventricular nuclei of the hypothalamus ➡ release of **β-endorphin.**
- Stimulation of the periaqueductal gray matter (PAG) ➡ *release of* **Enkephalin.**
- Stimulation of raphe magnus nucleus (RMN) in medulla oblongata ➡ release of **Serotonin.**
- Stimulation of pain inhibitory complex (PIC) in posterior horns of the spinal cord.
- Stimulation of interneurons in SGR ➡ release of **Enkephalin or GABA**
- **Enkephalin or GABA** causes **C**losure of **C**a++ channels of nerve terminals carrying pain sensations .

It is called **Presynaptic inhibition** which **P**revent release of substance **P** from nerve fibers that carry pain so, inhibit transmission of pain impulses (Slow) (flow Presynaptic to postsynaptic)

2- opiate system

It was discovered inside C.N.S and other many tissues in the body a certain type of receptors called **"opiate receptors“ ,** they are called so because they are **stimulated by opium and its derivatives.**

Also, inside the body it was discovered that **a group of chemical transmitters** can stimulate these **opiate receptors** and they are called **"Opioid peptides"** and they are widely distributed inside **C.N.S** and in **G.I.T**.

Combination of these **opioid peptides** with their **receptors** leads to marked **inhibition of pain** sensations **by both pre and post synaptic inhibition.**

by closing Ca^{+} channels

by blocking the NT at the receptor

The most important types of **opioid peptides** are:

they stimulate each other by cascades (locally)

1-Enkephalines 2-Endorphins as **B-Endorphins**

3 - Dynorphins.

-Opiate receptors are Mu- Delta -kappa – Sigma **(μ-δ-κ-θ).**

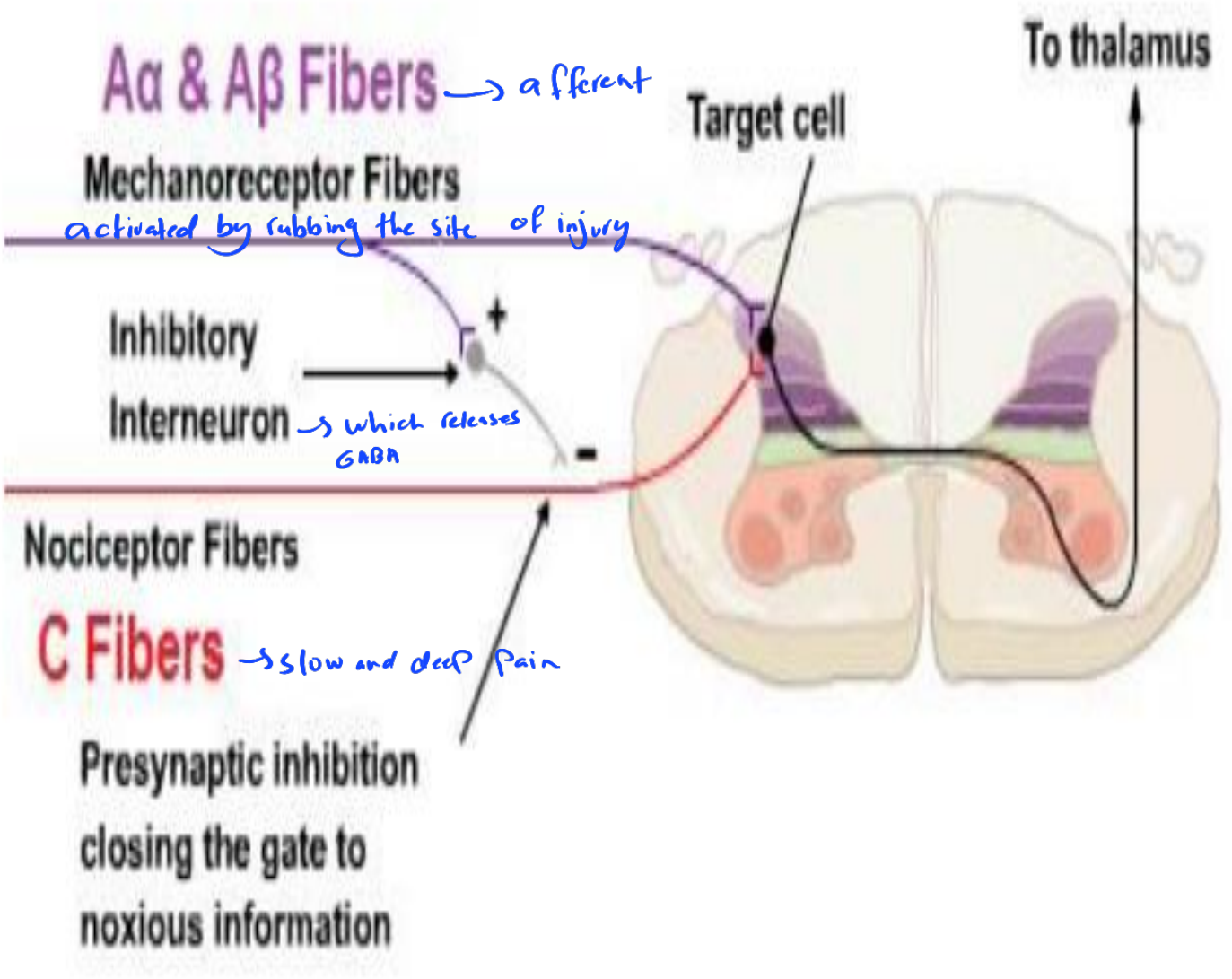
Gate theory of pain inhibition

It is known that the **first gate** of pain sensation is the **S.G.R in laminae II & III of dorsal horn cells.** The pain impulses can be **inhibited at this level** before reaching the spinothalamic tract by many ways :

A- By proprioceptive impulses that are carried by group **"A" fibers** from deep structures during rubbing the site of injury or inserting the specific needles of **acupuncture.**

B- From the descending fibers that come from **raphe magnus nucleus (RMN)** in medulla oblongata **(analgesic system)** through releasing of **Serotonin** , these fibers cause **inhibition to S.G.R** through activating specific interneuron in the spinal cord to **secrete GABA** or **Enkephalin** causing **presynaptic inhibition.**

C- Circulating opioids peptides like endorphins which are secreted from hypothalamus


Aα & Aβ Fibers → afferent
Mechanoreceptor Fibers
activated by rubbing the site of injury
Inhibitory
Interneuron → which releases GABA
+
-
Nociceptor Fibers
C Fibers → slow and deep pain
Presynaptic inhibition
closing the gate to
noxious information
Target cell
To thalamus