Pain Modulation

Objectives

1-Describe the control of pain perception including:

The gate theory of pain control.

The pain control analgesic system.

2-The role of brain opioid peptides

Certain mechanism in CNS can suppress transmission & perception of pain by ascending & descending fibers.

Pain suppression is explained by:

a. The gate theory

b. Special pain control analgesic system.

The gate theory of pain control

Special neurons located in the grey matter of the spinal cord (the dorsal horn of spinal cord SGR) form the gate through which pain impulses must pass to reach brain.

Three variables control this gate:

1- A-Delta fibres (fast pain).

2- C- fibres (slow pain).

3- A-Beta fibres (light touch).

This gate has the ability to block the signals from the A-delta and C fibres preventing them from reaching the brain.

Gate opened or closed by 3 factors:

1- Activity in the pain fibres - opens the gate.

2- Activity in other sensory nerves - closes the gate.

3- Messages from the brain - concentrating on the pain or trying not to think about it.

Impulses coming along type C pain fibers cause the release of substance P from these fibers and tend to open the gate.

While impulses coming along Aβ fibers tend to keep the gate closed by process of presynaptic inhibition of C fibers and postsynaptic inhibition of secondary neurons in dorsal horn.

If impulses in the C and A-Delta Fibres are stronger than the A-beta Fibres the gate opens.

If impulses in the A-beta Fibres are stronger than the C and A-Delta Fibres the gate closes.

A-delta fibres are always stronger.

The gate theory explains the pain relief by skin rubbing, shaking the painful part, transcutaneous electrical stimulation & acupuncture. All are supposed to stimulate mechanoreceptors that activate neurons of dorsal column, the collaterals relieve pain.

The gate is under control of higher centers.

Specialised nerve impulses arise in the brain itself and travel down the spinal cord to influence the gate.

This is called the central control trigger and it can send both inhibitory and excitatory The inhibitory neurons make a pain blocking agent called enkephalin. This is an opiate substance similar to heroin which can block Substance P, the neurotransmitter from the C fibres and this keeps the gate closed.

The opioid peptides

These are morphine-like substances naturally present in body.

They are natural analgesic substances that act by binding to opiate receptors in analgesic system and dorsal horn of SC on central ending of pain conducting pain fibers.

They are present in high concentration in:

1- The spinal dorsal horn.
2- Medulla.
3- Hypothalamus .
4- Peripherally.

Three classes of opioid peptides:

- ß-endorphins- basal hypothalamus -Proopiomelanocortin is the precursor for ß-END, ACTH, and MSH.
- Enkephalins - dorsal horn, raphe magnus, and the globus pallidus.
- Dynorphins - hypothalamus, PAG, reticular formation, and DH.

Opioid Antagonist: Naloxone

Used to reverse opioid overdose

Displaces receptor-bound opioids

Good for overcoming respiratory and CV depression.

The pain control analgesic system

This is a specific system that blocks pain transmission in CNS. Its major constituents are:

1- Perventricular N in hypothalamus near third ventricle.
2- Periaqueductal grey area in midbrain.
3- Raph magnum nucleus in upper medulla.
4- Pain inhibitory complex in dorsal horn of SC. It consists of multiple short encephalinergic neurons that terminate on central endings of pain conducting afferent fibers.

When these neurons are stimulated, the released encephalin cause pre & postsynaptic inhibition of pain transmission i.e it prevents the release of substance P from pain nerve endings.

Analgesia occurs as follows:

1- Periaqueductal grey area receives neuronal inputs from thalamus, hypothalamus, cerebral cortex.
2- PAG projects neurons containing aspartate & glutamate that stimulate raph magnus N
3- RMN projects serotoninergic neurons, this in addition to noradrenergic neurons project from adjacent medulla to dorsal horn. They block pain signals by activating PIC.