**LECTURE SYLLABUS**

**(General medicine, dental medicine)**

**Pain**

= subjective unpleasant sensation mediated by the nervous system and related to real or potential tissue injury

**Basic terms**

**Allodynia** = pain caused by a stimulus, which normally does not cause pain.

**Analgesia** = absence of pain during stimulation which normally causes pain.

**Anesthesia** = insensitivity to all types of stimuli (all modalities including pain) in a body area or whole body.

**Anesthesia dolorosa** = pain in insensitive area.

**Causalgia** = syndrome of permanent pain, allodynia and hyperpathy after traumatic nerve injury.

**Central pain** = pain caused by primary lesion or dysfunction of the CNS.

**Dysesthesia** = unpleasant abnormal spontaneous or induced sensation. Always unpleasant (X paresthesia).

**Hyperalgesia** = increased response to a stimulus, which normally causes pain (increased sensitivity to a suprathreshold stimulus).

**Hyperesthesia** = increased sensitivity to stimulation (usually tactile).

**Hyperpathy** = increased sensitive threshold for tactile, nociceptive and thermal stimuli, but if the threshold is exceeded, the stimulus is felt as painful. It leads to excessive response to non-painful or moderate painful stimuli.

**Hypoesthesia** = decreased sensitivity to stimulation.

**Hypoalgesia** = decreased response to a stimulus, which normally causes pain.

**Neuralgia** = pain in distribution zone of the nerve.

**Neurogenic pain** = pain caused by primary affection, dysfunction or transitory disorder in the peripheral neural system or CNS.

**Neuropathic pain** = pain caused by primary affection or dysfunction of the neural system – usually used for long lasting disorders and peripheral neural system affections.

**Neuropathy** = affection of the nerve function or pathological change of the nerve (mononeuropathy = affection of one nerve, polyneuropathy = affection of several nerves).

**Nociceptive pain** = physiological response to stimulation of nociceptors, long-term stimulation can induce sensitization, but the function of the nervous system is still correct.

**Paresthesia** = abnormal perception, spontaneous or evoked (not painful – tingling etc.)

**Components of pain**

Sensory and discriminative

Affection and motivation

Cognition and evaluation

Response

**Processes of nociception**

**Pain transduction**

Nociceptors

- high-threshold mechanoreceptors (Aδ)

- polymodal receptors (C)

- fibres (C) activated only after sensitization

Nociceptive stimuli

Mechanisms of transduction: TRPV1 H+-activated channels, purinergic receptors, mechanically activated channels

**Pain transmission**

Nociceptive pathway

**Neuron 1:** peripheral nerve, neuron of the ggl. spinale, cranial nerve ggl.

**Neuron 2:** - projection neuron of the dorsal spinal horn

 - Nc. tractus spinalis n. V. – subnucleus caudalis

 - local spinal interneurons - inhibitory and excitatory

**Neuron 3:** - thalamus and its ascending connections

Scheme of the nociceptive pathway in the dorsal spinal columns:



Simplified scheme of the nociceptive pathway on the CNS level



**Pain modulation**

Peripheral sensitization

- autosensitization

- heterosensitization

- Substance P

- Prostaglandins

**Central sensitization**

- Modulation of signal transmission on the level of the posterior spinal horns

- Postreceptor mechanisms of modulation on the spinal cord level (prostaglandins, NO)

**Gate-control theo**ry (Melzack and Wall, 1965) – rejected by further experiments!



**Stress analgesia**

- opioid

 receptors: μ, κ, σ, δ, ε

- nonopioid (glutamate, serotonin, noradrenaline, substance P, histamine, canabinoids, estrogens)

**Pain types**

**Duration**

- Acute

- Chronic

1. malignant
2. non-malignant

**Cause**

- Somatogenic - nociceptive

 - neuropathic, neurogenic

- Psychogenic

 – without somatic affection!

**Localization**

- Superficial somatic

- Deep somatic

- Parietal (pseudovisceral)

- Visceral

Referred pain

- Theory of convergence

- Theory of facilitation

**Disorders of pain perception**

**Syringomyelic dissociation of sensation** (affection of pain and thermic sensation but not tactile and proprioceptive sensation)

- causes: syringomyelia, tumour, injury, haemorrhage

Syringomyelia = cavities filled with cerebrospinal fluid, various causes (including idiopathic cases) and various theories explaining cavity formation mechanisms. Often related to Chiari malformation = dislocation of the cerebellum and oblongata + other potentiall changes of the cerebellum and/or spinal cord (4 types)

Transversal spinal lesion

Brown-Séquard spinal hemisyndrome

- Loss of thermal and algic sensation on the contralateral side

- Loss of proprioception and tactile sensation and central palsy (at the level of the lesion peripheral palsy) on the side of the lesion

Congenital and hereditary insensitivity to pain syndromes

- Disturbances of development of the nociceptive system neurons

Neuropathy

**Neuropathic pain**

= initiated or caused by a primary lesion or dysfunction of the neural system

- does not require stimulation of the nociceptors (however it can enhance neuropathic pain)

**Peripheral neuropathic pain**

- abnormal peripheral sensitization

- generation of ectopic impulses in nociceptive fibers (irritated, injured, regenerated axon...)

- ephaptic contacts (cross-talk)

- multiplication and functional change of ion channels (Na+)

- local dysfunction of sympathetic system → stimulation of nociceptive pathway by cathecholamines

- enlargement of receptive fields of dorsal spinal horn neurons

- inhibition of descendent inhibitory mechanisms

Examples: trigenimal neuralgia, glossopharyngeal neuralgia, neuralgia ganglii geniculi, carpal channel syndrome, post-operative neuralgia, post-traumatic neuralgia, post-herpetic neuralgia, post-irradiation neuropathy

**Central neuropathic pain**

* irritation of the nociceptive tract on the CNS level (inflammation, tumour, compression...)
* lesion on the lower level increases sensitivity of the higher level structures → hyperreactivity in unaffected CNS structures after loss of the normal patterns of afferentation

Examples: Traumatic spinal lesions, multiple sclerosis, central neurogenic post-ictal pain (e.g. thalamic pain), post-irradiation myelopathy, syringomyelia

**Painful syndromes and states**

Phantom pain

= pain localized in amputated part of the body

* persistence of original somatotopic organisation of the pathways and cortical projection
* irritation of the stump of the amputated nerve + ↓ threshold of sensitivity of regenerating nerve fibres

Thalamic pain

- Irritation of thalamic nuclei involved in nociceptive pathway

- No response to analgetics

Radicular pain

- Irritation of the dorsal spinal root (e.g. due to affection of the vertebral column)

- Pain in appropriate area radicularis

**Pain treatment**

**Pharmacological**

Analgetics

- NSAID (Non-Steroid Anti-inflammatory Drugs) – COX inhibitors

- paracetamol (children)

- opioids – tolerance, dependence

-ketamine - non-competitive NMDA receptor blocker

Anesthetics

Anticonvulsives

Corticoids

Capsaicin

Antidepressants

**Surgical**

**Neuromodulation**

stimulation - transcutaneous electric nerve stimulation (TENS)

 - of the dorsal spinal fascicles

 - of the dorsal spinal roots

 - of the thalamus

 - of the periaqueductal grey

 - of the motor cortex

**Psychological**