



The Brain and Neuromodulation in Management of Osteoarthritis Pain

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Title & Affiliation

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Disclosure

- Nothing to Disclose

Learning Objectives

- Describe the role of the brain in generating pain experiences
- Outline a neurologically-focused framework for a patient with osteoarthritis pain
- Summarize neuromodulation as a tool for pain medicine
- List effective neurologically-based techniques for managing osteoarthritis pain
- Approach
 - Assessment Design Framework Model
 - Content, Concept, and Context – based presentation of information

Agenda: The BRAIN and NEUROMODULATION in the management of OSTEOARTHRITIS PAIN

- BRAIN & NERVOUS SYSTEM
 - A framework for general purpose, development
 - Pedagogy, Protection, and Pain
- NEUROMODULATION
 - Traditional Approaches
 - Application of atypical Concepts
- OSTEOARTHRITIS PAIN (CASE-BASED EXAMPLE)

The Brain

Relevant Neurological Mechanisms and Sub-Systems

Peripheral

Tissue Injury and Nociception

Neurogenic and Abnormal Impulses

Central

Central Sensitization

Immune

Autonomic/Neuroendocrine
Motor

Nervous System Function and Strategy

- Survival
- Models, Prediction, and Protection

Pain

DEFINITION

KEY CONCEPTS

Pain

Four Decades Later: Revision of the IASP Definition of Pain and Notes

The currently accepted definition of pain was originally adopted in 1979 by the International Association for the Study of Pain (IASP)

1979 Definition of Pain

An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage

2020 Revised Definition of Pain

An unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage

In 2018, IASP constituted a 14-member multi-national task force with expertise in clinical and basic science related to pain, which sought input from multiple stakeholders to determine:

"Does the progress in our knowledge of pain over the years warrant a re-evaluation of the definition?"



Expert consultants



IASP council



The public

2020 Revised Definition of Pain Notes



Pain is always a personal experience that is influenced to varying degrees by biological, psychological, and social factors



Pain and nociception are different phenomena. Pain cannot be inferred solely from activity in sensory neurons



Through their life experiences, individuals learn the concept of pain



A person's report of an experience as pain should be respected



Although pain usually serves an adaptive role, it may have adverse effects on function and social and psychological well-being



Verbal description is only one of several behaviors to express pain; inability to communicate does not negate the possibility that a human or a nonhuman animal experiences pain

The revised IASP definition of pain: concepts, challenges, and compromises

Raja et al. (2020) | Pain

DOI: 10.1097/j.pain.0000000000001939

PAIN[®]

Neuromodulation

Neuromodulation: Typical Framework/Definition

The alteration of nerve activity through targeted delivery of a stimulus, such as electrical stimulation or chemical agents, to specific neurological sites in the body. It is carried out to normalize – or modulate – nervous tissue function

Neuromodulation: “Broad Net” View

- Deep Brain Stimulation
- Focused Ultrasound
- Spinal Cord Stimulation
- Dorsal Root Ganglion Stimulation
- Cryoanalgesia
- Radiofrequency Stimulation
- Sleep
- Exercise
- Cognitive Restructuring
- Autonomic Quieting

Osteoarthritis Case

CONTEXT

- A 75-year-old man is evaluated by his orthopedic surgeon and found to have end-stage degenerative arthritis involving his left knee.
- He had undergone right knee replacement 3 years earlier and had significant difficulties with pos-operative pain control.
- He also has a history of alcohol abuse, although he's been sober for 1 ½ years.
- Left knee replacement is an option, but both he and his surgeon are concerned about pain control.

Deeper Dive

Who is he?

Who's is he?

Adverse Childhood Experiences (ACEs)

- Background/Concept
- Effects on Neurological Systems
- Applications in Pain

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Research Article

Relationship of Childhood Abuse and Household Dysfunction to Many of the Leading Causes of Death in Adults

The Adverse Childhood Experiences (ACE) Study

Vincent J. Felitti, MD, FACP, Robert F. Anda, MD, MS, Dale Nordenberg, MD, David F. Williamson, MS, PhD, Alison M. Spitz, MS, MPH, Valerie Edwards, BA, Mary P. Koss, PhD, James S. Marks, MD, MPH

Background: The relationship of health risk behavior and disease in adulthood to the breadth of exposure to childhood emotional, physical, or sexual abuse, and household dysfunction during childhood has not previously been described.

Methods: A questionnaire about adverse childhood experiences was mailed to 13,494 adults who had completed a standardized medical evaluation at a large HMO; 9,508 (70.5%) responded. Seven categories of adverse childhood experiences were studied: psychological, physical, or sexual abuse; violence against mother; or living with household members who were substance abusers, mentally ill or suicidal, or ever imprisoned. The number of categories of these adverse childhood experiences was then compared to measures of adult risk behavior, health status, and disease. Logistic regression was used to adjust for effects of demographic factors on the association between the cumulative number of categories of childhood exposures (range: 0–7) and risk factors for the leading causes of death in adult life.

Results: More than half of respondents reported at least one, and one-fourth reported ≥ 2 categories of childhood exposures. We found a graded relationship between the number of categories of childhood exposure and each of the adult health risk behaviors and diseases that were studied ($P < .001$). Persons who had experienced four or more categories of childhood exposure, compared to those who had experienced none, had 4- to 12-fold increased health risks for alcoholism, drug abuse, depression, and suicide attempt; a 2- to 4-fold increase in smoking, poor self-rated health, ≥ 50 sexual intercourse partners, and sexually transmitted disease; and a 1.4- to 1.6-fold increase in physical inactivity and severe obesity. The number of categories of adverse childhood exposures showed a graded relationship to the presence of adult diseases including ischemic heart disease, cancer, chronic lung disease, skeletal fractures, and liver disease. The seven categories of adverse childhood experiences were strongly interrelated and persons with multiple categories of childhood exposure were likely to have multiple health risk factors later in life.

Conclusions: We found a strong graded relationship between the breadth of exposure to abuse or household dysfunction during childhood and multiple risk factors for several of the leading causes of death in adults.

Medical Subject Headings (MeSH): child abuse, sexual, domestic violence, spouse abuse, children of impaired parents, substance abuse, alcoholism, smoking, obesity, physical activity, depression, suicide, sexual behavior, sexually transmitted diseases, chronic obstructive pulmonary disease, ischemic heart disease. (Am J Prev Med 1998;14:245–258) © 1998 American Journal of Preventive Medicine

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Adverse Childhood Experiences (ACEs)

- Background/Concept
- Effects on Neurological Systems
- Applications in Pain

TABLE 2. BIOLOGICAL SYSTEMS DISRUPTED BY ACEs^{27–29,31–34,27–29,31–34,63,64}

Neurologic

- Dysregulation of the sympatho-adrenal-medullary (SAM) and hypothalamic–pituitary–adrenal (HPA) axes: difficulty modulating and turning off the stress response
- Activation of the amygdala: increased fear responsiveness, increased impulsivity, and aggression
- Inhibition of the prefrontal cortex: impaired executive function, with poorer planning, decision-making, impulse control, and emotion regulation
- Hippocampal neurotoxicity: difficulty with learning and memory
- Ventral tegmental area (VTA) and reward center dysregulation: increased risky behaviors and risk of addiction

Immunologic

- Increased inflammatory mediators and markers, along with inhibition of anti-inflammatory pathways: increased risk of infection, auto-immune disorders, and chronic inflammation

Endocrine

- Long-term changes in ACTH, cortisol, adrenaline, and other hormones: increased stress activation and impaired modulation of the stress response
- Changes in growth hormone, thyroid hormone, and pubertal hormones: changes in growth, development, metabolism, and puberty
- Changes to leptin and ghrelin: increased risk of overweight and obesity

Epigenetic

- Changes in the way DNA is read and expressed: alterations in the way the brain and organ systems respond to stress
- Telomere erosion: altered cell replication and premature cell death, which increases risk for disease, cancer, and mortality

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OPPORTUNITIES FOR NEUROMODULATION

- Office setup and logistics
- History and examination
- Education and cognitive restructuring
- Patient self-directed interventions
- Referrals
- Interventional procedures

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