ANALGESIA IN INTENSIVE CARE UNIT FOR ADULT

Essay

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By

Paula Medhat Ibrahim Azer

M.B.,B.CH. (2007)
Faculty of Medicine – Ain Shams University

Supervised by

Prof. Dr. Ahmed Abd El Kader Sheesh
Professor of Anaesthesia, Intensive Care and Pain management
Faculty of Medicine – Ain Shams University

Dr. Waleed Abd El Megeed Mohamed
Assistant Professor of Anaesthesia, Intensive Care and Pain Management
Faculty of Medicine – Ain Shams University

Dr. Abd El Aziz Abd Ala Abd El Aziz
Lecturer of Anaesthesia, Intensive Care and Pain management
Faculty of Medicine – Ain Shams University

Faculty of Medicine
Ain Shams University
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تسكين الألم في وحدة الرعاية المركزة للكبار

مقال
مقدمة توطئة للحصول على درجة الماجستير
فى الرعاية المركزة

مقدمة من الطبيب

بولا مدحت ابراهيم عازر
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تحت إشراف

أ.د/ أحمد عبد القادر شيش
أستاذ التخدير والرعاية المركزة وعلاج الألم
كلية الطب- جامعة عين شمس

د/ وليد عبد المجيد محمد
أستاذ م. التخدير والرعاية المركزة وعلاج الألم
كلية الطب- جامعة عين شمس

د/ عبد العزيز عبد الله عبد العزيز
مدرس التخدير والرعاية المركزة وعلاج الألم
كلية الطب- جامعة عين شمس

كلية الطب
جامعة عين شمس
2013

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LIST OF ABBREVIATIONS

AAA	abdominal aortic aneurysm
ACS	Abdominal Compartment Syndrome
CAD	coronary artery disease
CCK	CholeCystoKinin
CMV	cytomegalovirus
COPD	chronic obstructive airways disease
CPNB	Continuous peripheral nerve blockade
DKA	Diabetic ketoacidosis
DVT	Deep Venous Thrombosis
EEG	Electro-Encephalographic abnormalities
EMG	Electro-Myographic studies
GABA	gamma-aminobutyric acid
IAH	Intra-abdominal hypertension
IAP	Intra-Abdominal Pressure
ICNB	intercostal nerve blockade
LC	locus ceruleus
LTP	long-term potentiation
MAAS	Motor Activity Assessment Scale
MPQ	Mc Gill Pain Questionnaire
NMDA	N-methyl-D-aspartate
NRM	Nucleus Raphe Magnus
NRS	Numeric rating scale
NSAIDS	Nonsteroidal anti-inflammatory agents
OAA/S	The Observer's Assessment of Alertness/Sedation
PACU	Post Anaesthesia Care Unit
PAG	Peri-Aqueductal Gray matter
PCA	Patient-controlled analgesia
PCEA	Patient-controlled epidural analgesia
PDPH	Postdural puncture headache

PNB	peripheral nerve block
PONV	postoperative nausea and vomiting
RVM	Rostral Ventromedial Medulla
SAS	Ricker Sedation-Agitation Scale
SCCM	Society of Critical Care Medicine
TEA	Thoracic Epidural Analgesia
TRP	Transient Receptor Potential
TRPV1	Transiet Receptor Potential Valenoid1
VAS	Visual analogue scale
VICS	Vancouver Interaction and Calmness Scale
VMM	Ventro Median Mdulla

PHYSIOLOGY OF PAIN

In the past, pain was often regarded as a simple response by the brain to a noxious stimulus in the periphery; this nociceptive information was then transmitted along well-defined 'pain'pathways. The biologic processes involved in pain perception are, however, no longer viewed as a simple 'hard-wired' system with a pure 'stimulus–response' relationship. The International Association for the Study of Pain has defined pain as '…an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage **(Lo eser and Treede, 2008).** In consequence, the perception of pain and its threshold are the result of complex interactions between sensory, emotional, and behavioral factors**.** Inflammation and nerve injury can reduce pain thresholds and increase sensitivity to sensory stimuli **(Rowbotham and Fields, 1996)**. Conversely, 'battlefield analgesia', in which soldiers receive severe injuries with little immediate awareness of pain is a situation in which thresholds can increase **(Brodner, Pogatzki and Van Aken , 1998)**.

The purpose or function of pain is a withdrawal reflex response to an acute noxious stimulus is an understandable and necessary reaction that has an obvious protective function even in the absence of conscious perception. More importantly, the experience of pain may lead to the avoidance of potentially

harmful situations and possible injury. Immobility and withdrawal due to pain may serve to provide an environment in which healing and restoration of function can occur. The severe deformities developed by individuals with a rare congenital insensitivity to pain illustrate the useful protective function provided by the sensation of pain **(Hemmings et al., 2006).**

PAIN PATHWAY

I. Peripheral pathway

(1) Receptors :

The skin, subcutaneous tissues and internal organs are richly supplied by sensory receptors termed "nociceptors". Structurally, these nociceptors are free nerve endings which are sensitive to many pain producing substances known as inflammatory mediators or hyperalgesic mediators of pain.These substances include bradykinin, histamine, prostaglandins, substance P and others produced as a result of injury,inflammation or disease **(Mizumura and Kumazawa,1996).**

Two criteria are necessary to define a nociceptor:

1. A response threshold higher than that of mechano-receptors or thermo-receptors.
2. The ability of coding the intensities of such nociceptive stimuli.

(A) CUTANOUS NOCICEPTORS:

Nociceptors have been classified into three major groups according to their stimulant

1. Mechano-nociceptors: which respond to pinch stimuli.
2. Silent nociceptors: which respond only in the presence of inflammation.
3. Poly modal mechano-heat nociceptors: these are the most prevalent type stimulated by noxious mechanical, thermal or chemical stimuli and they are mostly unmyelinated. They were described in humans (**Arendt and Chen , 2003).**

Noxious sensation is devided into two components

1. A fast sharp and well localized sensation which is conducted by A delta fibers.
2. A dull, slower onset and often poorly localized sensation which is conducted by C fibers.

(B) MUSCLE AND ARTICULAR NOCICEPTORS:

Both A delta and C nociceptors are present in muscle. A delta nociceptors respond to chemical stimuli leading to muscle pain. C nociceptors are stimulated by chemical and other noxious stimuli causing muscle pain (**Treede et al., 1998**).

(C) VISCERAL NOCICEPTORS:

They are C nociceptors stimulated by stimuli causing visceral pain. It is generally believed that the activation of visceral receptors does not give rise to any sensation under normal condition .However,a painful sensation can be perceived upon various disorders as ischaemia ,mucosal and/or irritation,torsion and/or traction of the mesentry, visceral contraction or excessive distension .pain may be also referred to cutaneous zones **(Dmitrieva and McMahon ,1996).**

(2) Afferent fibers

The nerve endings of peripheral nociceptors are connected to two types of primary afferent fibers

a. A delta fibers: nociceptors are thinly myelinated fibers, which have a diameter of 2–5 μm and a conduction velocity of 6–30 m/s
b. C fibers: fibers (<2 μm diameter) are unmyelinated,with a conduction velocity of less than 2 m/s **(Millan, 1999).**

The ratio of myelinated to unmyelinated fibers in cutaneous nerves is about 1:4. Most small-diameter primary afferents are mechanically sensitive,although some are sensitive to thermal stimuli. Approximately 10% of cutaneous myelinated fibers and 90% of unmyelinated fibers are nociceptive.

The cell bodies of these fibers are present in the dorsal root ganglia and enter the spinal cord via the dorsal root then end within the posterior horn of gray matter of spinal cord. However, few C fibers (15-30) reach the spinal cord via the ventral root although their cell bodies present in the dorsal root ganglia **(Julius & Basbaum , 2001).**

II. Central pathway

(1) Spinal cord

There is separation of large and small caliber afferent fibers upon arrival to the dorsal root enterance, with fine fibers in the ventrolateral position compared to a mediodorsal position for large fibers .these result led to the use of a selective posterior radiculectomy in the treatment of pain.

As the afferent fibers enter the spinal cord, they run in Lissauer's tract in the dorsolateral area of the white matter. They run in this tract for one or two segments or even more before terminating in the spinal grey matter.There is a controversy concerning the origin of Lissauer's with two main theories:

(1) Lissauer suggesting that majority of fibers are small diameter primary afferent

(2) Others considered this tract as a propriospinal pathway having the axons of cells in the superficial laminae of the dorsal horn **(The Journal of Comparative Neurology, 1991)**.Anyway,further studies aided by autoradiography and electron microscopy have showed that at least half of the fibers of the tract arise from the dorsal root particulary the fine fibers of the ventrolateral component.

Small afferents enter the dorsal horn directly and many synapse with cells in the outermost laminae and laminae 2 with few arborization sent to substancia gelatinosa (lamina 2 &3).Others synapse in the dorsal gray commissure or in deeper laminae.

Ascending Spinal Tracts

- **SPINOTHALAMIC TRACT**

The spinothalamic tract is regarded as having a central role in pain perception and transmits information regarding pain, cold, warmth, and touch. The cells of origin of the spinothalamic tractare located predominantly within laminae I and IV–VI of the dorsal horn, with some in lamina X and the ventral horn. These cells project mainly to the contralateral thalamus, with some projecting ipsilaterally. The nuclei in the thalamus that receive these projections are located either laterally (ventral posterior-

lateral and ventral posterior inferior nuclei and medial posterior complex) or medially in the central lateral nucleus and other intralaminar nuclei **(Cross, 1994).**

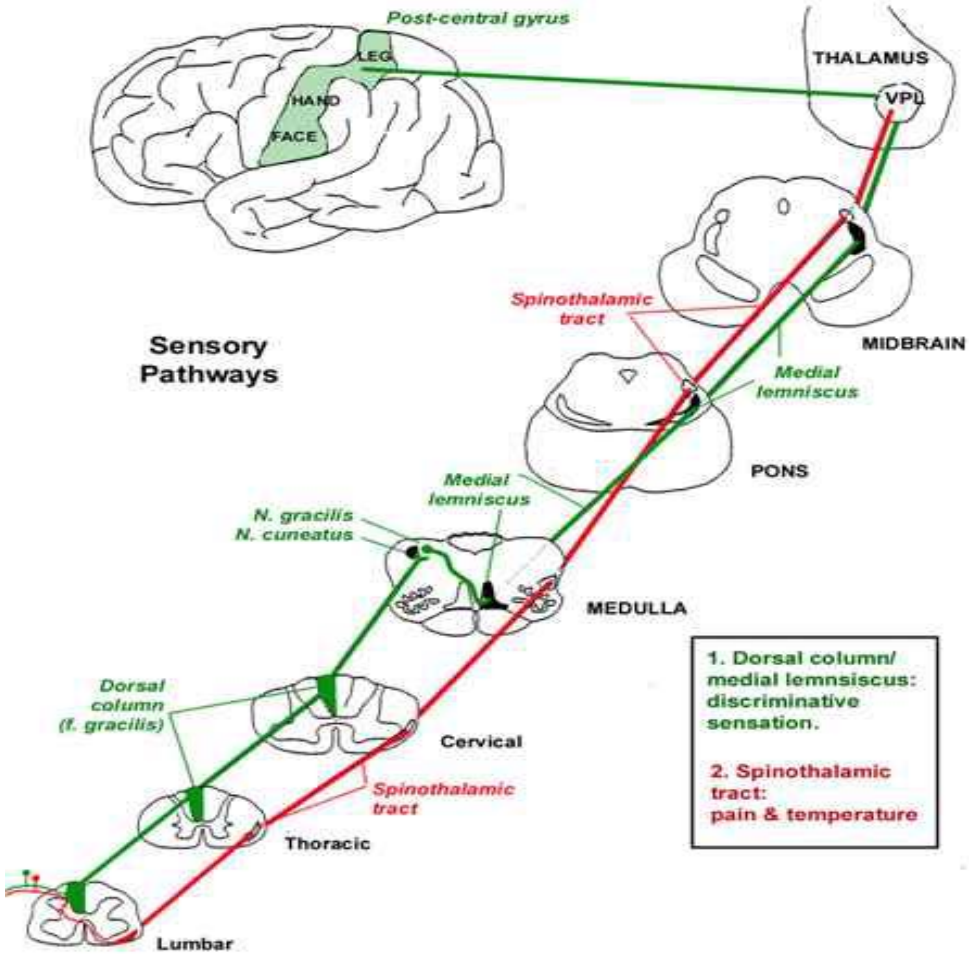

Figure (1-1): Spinothalamic Tract.

- **SPINORETICULAR TRACT**

The cells of origin of the spinoreticular tract are located in the deep layers of the dorsal horn and in laminae VII and VIII of the ventral horn. These cells send projections to several nucleiwithin the reticular formation of the brainstem, including the lateral reticular nucleus, nucleus gigantocellularis, nucleus para giganto-cellularis lateralis in the medulla, the pontine nucleioralis and caudalis, and the parabrachial region. Many spinoreticular neurons are activated preferentially by noxious input,but there is no clear somatotopic organization of the spinoreticular tracts. These projections terminate in close apposition to regions that are involved in blood pressure and motor control and the descending inhibition of pain. Therefore, it appears that this pathway is involved in the basic autonomic, motor and endogenous analgesic responses to nociceptive input. Central processing of this information may contribute to the negative emotional arousal and behavior associated with anxiety or threat **(Nathan, Smith and Deacon, 1990).**

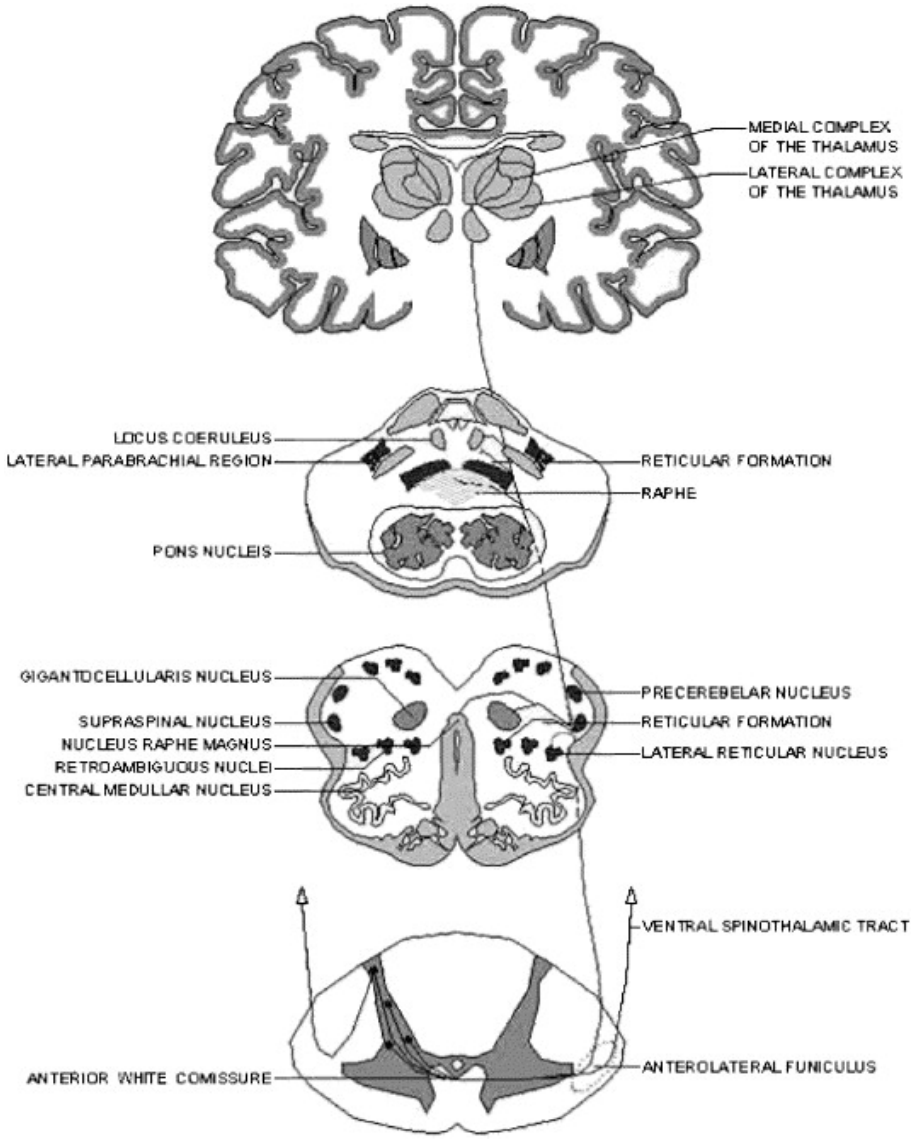

Figure (1-2): Spinoreticular tract