Updates for Post-Thoracotomy Pain Management

An essay

Submitted for partial fulfillment of master degree in Anesthesiology and Pain relief

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2012

Abstract

Thoracic paravertebral block have been successfully used to provide analgesia for multiple thoracic and abdominal procedures in both children and adults.

Several different techniques exist for TPVB; the classical technique, the use of nerve stimulator and ultrasound guidance Complications of thoracic paravertebral block include inadvertent needle penetration of adjacent structures, local anesthetic toxicity, complications due to distribution of local anesthetic and failure technique. Peripheral application of local anesthetics can be a useful adjunct in the treatment of acute postoperative pain. Surgical wound infiltration for relief of post thoracotomy pain has been shown to improve forced vital capacity and to have morphine-sparing effect. Local anesthetics interfere with impulse generation and propagation by blocking membrane permeability to sodium. Local anesthetic toxicity: allergy, neurotoxicity, cardio toxicity and CNS toxicity.

Key word:

CNS-TPVB- **Post-**Thoracotomy- Anesthesiology- Paravertebral
Pain physiology-blockade

Acknowledgment

*First and foremost, thanks to **Allah** who helped me to achieve this work.*

*I am greatly honored to express my deep respect and gratitude to **prof. Dr. Mohamed Farouk Youseef ,** Professor of Anesthesiology and Pain Management; Faculty of Medicine, Cairo University, whose overall supervision to all steps of the work, sincere guidance and support had a significant impact on the structure of the research.*

*I am very much obliged to **Prof. Dr. Mona Hossam El-Din Abdel-Hameed** Assistant Professor of Anesthesiology and Pain Management Faculty of Medicine, Cairo University, for her faithful supervision, understanding, help, and encouragement in initiating and completing this work.*

*Also I am very much grateful and oblige to **Dr. Ahmed Abdallah Mohamed,** lecturer of Anesthesiology, faculty of medicine, Cairo University, for his sincere effort from the start to the end of our work.*

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2012

Content

List of abbreviations

ADH : *Antidiuretic hormone*

ADRs : *Adverse drug reactions*

ACE : *Angiotensin converting enzyme*

ACTH : *Adrenocorticotrophic hormone*

ASA : *Acetylsalicylic acid*

CNS : *Central nervous system*

COX : *Cyclooxygenase*

CPP : *Chronic post-thoracotomy pain*

CSF : *Cerebro spinal fluid*

CV : *Closing volume*

ECG : *Electrocardiograph*

FDA : *Food and drug administration*

FRC : *Functional residual capacity*

GSH : Glutathione sulfhydryl group.

GIT : *Gastro intestinal tract*

IM : *Intramuscular*

INR : *International normalized ratio*

IV : *Intravenous*

LA : *Local anesthetic*

LMWH : *Low-Molecular-Weight Heparin*

M3G : *Morphine-3-glucuronide*

M6G : *Morphine-6-glucuronide*

MPQ : *McGill pain questionnaire*

NAPQI : *N-acetyl-p-benzo-quinone imine*

NMDA : *N-methyl-D-aspartate*

NSAIDs : *Non-Steroidal Anti-Inflammatory drugs*

PABA : *Para-aminobenzoic acid*

PCA : *Patient-controlled analgesia*

PGs : *Prostaglandins*

PI : *Paralytic ilieus*

PT : *Prothrombin time*

PTT : *Partial thromboplastin time*

PVB : *Paravertebral block*

SC : *Subcutaneous*

TPVB : *Thoracic ParaVertebral Block*

VAS : *Visual analogue scale*

VATS : *Video-assisted thoracic surgery*

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Introduction

Open thoracotomy is one of the most painful surgical procedures, and post-thoracotomy pain markedly affects postoperative respiratory function and patient recovery. Accordingly, optimizing postoperative analgesia is crucial to optimize recovery and patient discharge after surgery, implementing respiratory physiotherapy and reducing the incidence of postoperative respiratory complications. ***(Soto RG et al 2003)***

Thoracic epidural anesthesia provides better pain control and less depressant effects on respiratory function after lung resection surgery than intravenous (i.v.) opioids, with an associated reduction in the incidence of pulmonary morbidity. Moreover, it has the potential for modulating the endocrine metabolic response activated during lung resection without affecting intraoperative pulmonary function. For this reason it has become the standard treatment for this surgery**. *(Casati A et al 2005)***

However, thoracic epidural analgesia also carries the risk for severe complications such as dural puncture, epidural abscess, and spinal haematoma, which is also increased by the extensive use of low-molecular-weight heparin for thromboprophylaxis. ***(Horlocker TT 2003)***

Since post-thoracotomy pain is strictly unilateral and mostly related to somatic pain induced by the thoracotomy, a more peripheral and selective nerve block, such as paravertebral blockade, can be effectively used for postoperative analgesia with the advantage of avoiding the risks of spinal hematoma in patients receiving aggressive thromboembolic prophylaxis, due to the different anatomical approach as compared to epidural catheter placement. ***(Richardson J et al 1999)***

Aim of the work

The aim of this study is to give an idea about

- Types of thoracic incision
- Anatomy and pathophysiology of pain in thoracic surgery
- Impact of analgesia on outcome
- The choice of analgesic technique including:

Parenteral opioid infusions

Epidural analgesia

Paravertebral blocks

Intercostal nerve blocks

Inter-pleural analgesia

Cryoprobe neurolysis

Chapter 1 :Pain physiology

The word pain is derived from the Latin “poena”, meaning punishment. ***(Nagda J & Bajwa ZH 2004)*** The International Association for the Study of Pain defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage." This definition recognizes the interplay between the objective, physiological sensory aspects of pain and its subjective, emotional, and psychological components. The response to pain can be highly variable among persons as well as in the same person at different times. ***(Morgan GA et al 2006)***

The term "nociception," which is derived from *noci* (Latin for harm or injury), is used to describe the neural response only to traumatic or noxious stimuli? All nociception produces pain, but not all pain results from nociception. Many patients experience pain in the absence of noxious stimuli. It is therefore clinically useful to divide pain into one of two categories: (1) acute pain, which is primarily due to nociception, and (2) chronic pain, which may be due to nociception but in which psychological and behavioral factors often play a major role. ***(Morgan GA et al 2006)***

Pain can also be classified according to pathophysiology (i.e., nociceptive or neuropathic pain). Nociceptive pain is caused by activation or sensitization of peripheral nociceptors. Neuropathic pain is the result of injury or acquired abnormalities of peripheral or central neural structures. ***(Morgan GA et al 2006)***

Although acute pain may have survival value (causing e.g. removal of the injured limb from a harmful stimulus), chronic pain is of no value and is indeed a major scourge of humanity. **(*Ballantyne JC et al 2006)***

Stress Response To Injury

Tissue injury results in well characterized human response to stress, which is central, peripheral and immunological.

Centrally, the pituitary/hypothalamic axis is activated following tissue injury. Large amount of prohormones are synthesized and released, resulting in elevated level of Adrenocorticotrophic hormone (ACTH) and B-endorphin. There are also increased level of growth hormone, antidiuretic hormone (ADH), and other mediators of energy consumption.

Peripherally, the increased release of adrenaline and noradrenaline from the adrenal glands, as well as the decreased pancreatic release of insulin, causes a transient hyperglycemic response and metabolic tendency to catabolism. The increased tissue oxygen consumption results in increased respiratory demand. The central stress responses are mediated by primary afferent input to the central nervous system, while peripheral responses are modulated by the hormonal release and by the sympathetic nervous system. ***(Kehlt H 2000)***

***Pain pathways*. Fig (1):**

Surgery produces tissue injury with consequent release of histamine and inflammatory mediators, such as peptides (e.g., bradykinin), lipids (e.g., prostaglandins), neurotransmitters (e.g., serotonin), and neurotrophins (e.g., nerve growth factor). The release of inflammatory mediators activates peripheral nociceptors, which initiate transduction and transmission of the nociceptive information to the central nervous system (CNS) and the process of neurogenic inflammation in which release of neurotransmitters (i.e., substance P and calcitonin gene-related peptide) in the periphery induces vasodilatation and plasma extravasation. Noxious stimuli are transduced by the peripheral nociceptors and

transmitted by Aδ and C nerve fibers from peripheral visceral and somatic sites to the dorsal horn of the spinal cord, where integration of peripheral nociceptive and descending modulatory input (i.e., serotonin, noradrenaline, and encephalin) occurs. Further transmission of nociceptive information is determined by complex modulating influences in the spinal cord. Some impulses pass to the anterior and anterolateral horns to initiate segmental (spinal) reflex responses, which may be associated with increased skeletal muscle tone, or decreased gastrointestinal motility. Others are transmitted to higher centers through the spinothalamic and spinoreticular tracts, where they produce suprasegmental and cortical responses to ultimately produce the perception of pain. ***(Julius D and Basbaum AI 2001)***

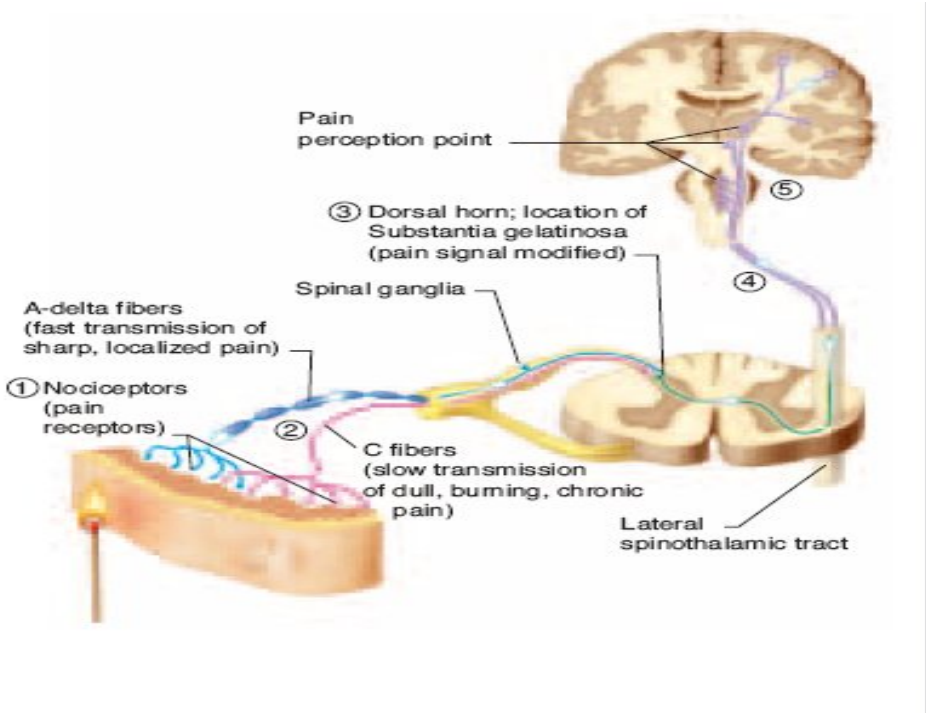

Fig (1): pain pathway ***(Franck LS et al 2000)***

Factors affecting post-operative pain

Clinical factors

The site of the surgery has a profound effect upon the degree of postoperative pain a patient may suffer. Operations on the thorax and upper abdomen are more painful than operations on lower abdomen which, in turn, are more painful than operations on the limbs. Operations on the thorax or upper abdomen may produce widespread changes in pulmonary function. ***(Rosenquist RW 2003)***

Patient-related factors

The patient's anxiety may lead to high levels of postoperative pain being reported. Patients who are afraid of anesthesia or surgery may report more pain and this can be difficult to treat. ***(Rosenquist RW 2003)***

Adequate time must be allowed to explain the intended operation and the steps that will be taken to ensure pain relief afterwards. Some may fear the unknown and others may have previous experience of surgery or have heard stories from friends and relatives that present the postoperative period in an unfavorable way. ***(Rosenquist RW 2003)***

Studies suggest that personality traits are strong modulatory factors in the overall post-thoracotomy pain experience. ***(Bachiocco V et al 1990)***

Local Factors

A major problem is that certain drugs may not be available. In addition, economic factors may make certain techniques of pain relief such as patient-controlled analgesia (PCA) unavailable. ***(Rosenquist RW 2003)***

Pre-emptive analgesia

Definitions of pre-emptive analgesia include what is administered before surgical incision, what prevents establishment of central sensitization resulting from incision injury only (i.e., intra-operative period), or what prevents central sensitization resulting from incision and inflammatory injuries (i.e., intra-operative and postoperative period). ***(Kissin I 2000)***

The importance of peripheral and central modulation in nociception has fostered the concept of "preemptive analgesia" in patients undergoing surgery. Development of central sensitization and hyper-excitability occurs after surgical incision and results in the amplification of postoperative pain. Preventing the establishment of altered central processing by analgesic treatment may result in short-term (e.g., reduction in postoperative pain and accelerated recovery) and long-term (e.g., reduction in chronic pain and improvement in health-related quality of life) benefits during a patient's convalescence. ***(Carli F et al 2002)***

This may involve infiltration of the wound with local anesthetic, central neural blockade, or the administration of effective doses of opioids, NSAIDs or ketamine. ***(Morgan GA et al 2006)***

Although experimental studies confirm the concept of preemptive analgesia in decreasing post-injury pain, some studies have failed to demonstrate its significance. ***(Moiniche S et al 2002)***

Post-operative analgesia

The concept of "pre-emptive" analgesia suggests that the best postoperative pain management begins pre-operatively. Some studies