Regional Anesthesia in Trauma

Essay

Submitted for partial fulfillment of Master Degree in Anesthesia ICU and Pain Management

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Abstract:

Regional anesthesia is considered one of those modalities for pain management either alone or in combination with general anesthesia or even be used for postoperative pain management. In this essay we discuss the history of regional anesthesia application and its importance in wars, also we discuss in another chapter the advantages and disadvantages of application of regional anesthesia in trauma patients. Finally we discuss different techniques of regional anesthesia application and different methods of identification of nerves to be blocked including the usage of ultrasound which is so promising in this field.

Key word:

Regional Anesthesia- Physiology of trauma and pain- Nerve Blocks-5-HT.
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LIST OF ABBREVIATIONS

5-HT  
Serotonin

ACL  
Anterior Cruciate Ligament

ACTH  
Adrenocorticotropic hormone

BC  
Before Christ

CCK  
Cholecystokinin

CGRP  
Calcitonin gene–related peptide

CNS  
Central Nervous System

COX-2  
Cyclooxygenase-2

CPNB  
Continuous peripheral nerve block

CRP  
C-reactive protein

DRG  
Dorsal Root Ganglia

DVT  
Deep Venous Thrombosis

ECG  
Electrocardiogram

ED  
Emergency department

ELH  
Lutinizing Hormone

ENK  
Enkephalin
FSH  Follicle stimulating hormone
GABA  Gamma-aminobutyric acid
h  Hours
ICU  Intensive Care Unit
IL-1/6/8  Interleukin 1/6/8
IV  Intravenous
LFC  Lateral Femoral Cutaneous
m/s  Meters per second
mA  Milliampere
mL  Milliliter
NMDA  N-methyl-D-aspartate
NSAIDS  Non Steroidal Anti-inflammatory Drugs
PCA  Patient Controlled Analgesia
PGE  Prostaglandin
PLP  Phnatom Limb Pain
PNBs  Peripheral Nerve Blocks
PNS  Periphera Nerve Stimulation
PSNB  Parasacral Nerve Block
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<tr>
<td>Sp</td>
<td>Substance P</td>
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<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt;</td>
<td>Tri-iodothyronine</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;</td>
<td>Thyroxin</td>
</tr>
<tr>
<td>TAP</td>
<td>Transverses Abdominus Plane</td>
</tr>
<tr>
<td>TBI</td>
<td>Traumatic Brain Injury</td>
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<tr>
<td>THA</td>
<td>Total Hip Arthroplasty</td>
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<tr>
<td>TKA</td>
<td>Total Knee Arthroplasty</td>
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<tr>
<td>TNF-α</td>
<td>Tumor necrosis factor-α</td>
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<tr>
<td>TSH</td>
<td>Thyroid stimulating hormone</td>
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<td>US</td>
<td>Ultrasound</td>
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<td>WDR</td>
<td>Wide Dynamic Range</td>
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<td>WHO</td>
<td>World Health Organization</td>
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<td>WRAMC</td>
<td>The Walter Reed Army Medical Center</td>
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Aim of the work

The aim of this work is to review the importance of application of different modalities of regional anesthesia in trauma patients, also to mention its complications and contraindications. And the techniques used for its application.
Traffic accidents kill more than a million people every year worldwide and injure or permanently disable millions more. The Middle East region ranks second highest in terms of road fatalities, according to the WHO, with Egypt alone suffering more than 7,000 deaths annually. (Jon Mark Hirshon, 2010)

Anesthesia for trauma patients is one of the greatest challenges in anesthesia. Critically ill patients whose history, status, and injuries are not well known must be treated. The pain management of a trauma patient, with their specific physical and emotional experience, imposes additional demands to anesthesiologists and critical care specialists.

Many factors in the management of the trauma victim (hemodynamic fluctuations, respiratory depression, and level of consciousness) contribute to the difficulties faced in the pain control of these patients. In addition, the consequences of inadequate pain management after an injury are more than just psychological. (Laura C. & Marina V., 2009)

Anesthesiologists have particular skills in the provision of pain relief and this is of vital importance in the early and consequent management of the injured patient. Analgesia should be regarded as part of the resuscitation process because it not only brings pain relief, but also improves hemodynamic stability resulting in improved organ and tissue perfusion. (Laura C. & Marina V., 2009)

Acute pain is known to potentiate the physiologic stress response to trauma. The tissue damage and the dynamic of the central nervous system can engage mechanisms and create chronic pain problems that outlast the period of healing. (Wu C.L. et al, 2006)
The role of regional anesthesia in the trauma patient is both complex and controversial. The decision-making is complex, because trauma patients may present with a spectrum of injuries and in various degrees of shock. Accordingly, simple rules cannot be applied to all patients. Use of regional anesthesia in the trauma patient is controversial, because initial historical reports of spinal anesthesia use in acute trauma predictably resulted in catastrophe, and several common trauma-related conditions constitute either absolute or relative contraindications to regional anesthesia (e.g., full stomach, hemodynamic compromise, unstable/unclear cervical, thoracic or lumbar spine, compartment syndrome of lower extremities, etc.). *(Bernstein RL et al, 2000)*

In cases of multiple trauma involving head or torso injuries where airway management and controlled ventilation are critical, general anesthesia is clearly a superior choice. However, there are many other trauma scenarios, for which regional anesthesia provides substantial benefit as the primary anesthetic, an adjunct to general anesthesia, or analgesia postoperatively.

Trained anesthesiologists can expeditiously administer regional anesthesia. The quick onset and lack of sophisticated equipment for delivery allow use in distant and austere environments (so long as appropriate monitoring and resuscitation equipment are available). Additionally, regional anesthetics allow the patient to remain awake and alert, facilitating ongoing evaluation of mental status. *(Wildsmith J., 2003)*
Mechanisms and demographics in trauma:

Injury is the leading cause of death in people aged between 1 and 44 years in the United States and a leading cause of death worldwide. It can be defined as “physical damage to the structure or function of the body, caused by an acute exchange of energy (mechanical, chemical, thermal, radioactive, or biological) that exceeds the body’s tolerance”. (Fingerhut LA & Warner M, 1996)

- Types of trauma:

1. UNINTENTIONAL MOTOR VEHICLE TRAFFIC-RELATED INJURY MECHANISMS:

Half of deaths are related to head-on impact, and the rest involve side impact (25%), rear impact (less than 10%), and rollover. (Pedro B. et al, 2008)

2. PEDESTRIAN VEHICLE COLLISION:

Adult pedestrian injury typically involves three impacts:
- Impact with the lower limbs as the impacting vehicle brakes and decelerates, lowering the front of the vehicle.
- Impact with the hood of the vehicle as the casualty is thrown forward, causing head and chest injuries.
- Impact with the ground, commonly causes head injury.
3. **FALLS:**

Falls involve a sudden deceleration in the vertical plane. The magnitude of injury depends on height, transference and absorption of energy, and orientation of the victim. Falls of 8 to 10 meters (25–30 feet, three stories in a building) are fatal in 50 percent of victims. *(Pedro B. et al, 2008)*

4. **FIRE AND BURN DEATHS:**

Deaths from fires and burns are the fifth most common cause of unintentional injury deaths in the United States. Most victims of fires die from smoke or toxic gases and not from burns. Smoking is the leading cause of fire-related deaths, and cooking is the primary cause of residential fires. *(Ahrens M., 2003)*

5. **PENETRATING TRAUMA MECHANISMS:**

- **Low-Energy Transfer Sharp Implements**

  Knives/ Swords: The main issue to appreciate when managing knife wounds is that tissue is elastic. The dimensions of the observed wound in a patient may not relate to the weapon used. A knife assailant may turn the blade in the target’s body, causing increased damage as structures are deliberately cut.

- **Projectiles**

  *Arrows:* In general, injuries from arrows can be considered as “low-energy transfer” wounds and the area of injury is closely related to the arrow trajectory.
**Bullets**: The injury produced by a bullet is the result of a complex interaction between the bullet and tissue.

- **Explosive Munitions’ Injury**

Blast injury has been classified as follows:

- **Primary**: due to the actions of the blast or overpressure wave. This can completely disintegrate a casualty.
- **Secondary**: due to fragments projected by the energy of the explosion. Fragments can be “natural” from the random fragmentation of the bomb’s components, or “preformed” from notched wire, metal balls, or squares packed into the bomb. These cause multiple penetrating injuries.
- **Tertiary**: due to the casualty being thrown/displaced by the explosion or injured due to structural collapse. This is generally “blunt” injury.
- **Quaternary**: all other effects, including fires from the explosive components or from ignited fuel, toxic effects of fumes, and exacerbation of medical conditions. *(Pedro B. et al, 2008)*
Trauma has been a major cause of death and injury throughout human history. Early civilizations evidently tried to manage pain with opium or its derivatives. The first effective local anesthetic was cocaine, which was isolated in 1859. It was first used in 1884 as a topical solution for ophthalmic surgery by Karl Koller. Before that, another method tried was pressure on select nerves to numb an area. Around 2500 BC, the Egyptians were already compressing peripheral nerves to achieve localized anesthesia. By the eighteenth century, clamps had been developed that were screwed onto a limb to compress the main nerves. (M.E. Ring, 2007)

The term “regional anesthesia” was first introduced by Harvey Cushing in 1901. Ansbro performed the first continuous nerve block in 1946 with repeated supraclavicular injections of the brachial plexus to prolong the duration of anesthesia in patients undergoing upper extremity surgery. (F.P.Anstro, 1946) More than 30 years later Selander published a study on 137 patients, in whom an axillary catheter was placed for hand surgery. Tuominen and colleague described the first reported use of continuous interscalene infusion for postoperative pain management in 1987 for shoulder surgery. The same group also evaluated the effects of a continuous interscalene block on the ventilatory function demonstrating paresis of the ipsilateral hemidiaphragm. (Dunn N. & Sutcliffe J., 1992)

The clinical history of neuraxial anesthesia dates back to August Bier and August Hildebrandt and their first attempt at spinal anesthesia on August 15, 1898. Epidural anesthesia by a caudal approach was known in the early twentieth century. In 1945 Tuohy introduced the needle, bearing his name, which is still the most commonly used needle for epidural anesthesia. (Visser V., 2001)
• **Regional anesthesia in the battlefield:**

   Treatment of traumatic pain in civilians has benefited tremendously from advances made in medicine on the battlefield.

   A decrease in mortality from 46% to 12.5% was reported in World War II when spinal anesthesia replaced inhalational anesthesia for abdominal wound surgery. The military is currently making strides to establish regional anesthesia as a more available option in combat.

   There has been a resurgence of interest in the use of regional anesthesia over recent years. This resurgence is due to many factors, including the development of new equipment for locating nerves, an increasing collection of evidence attesting to the efficacy, value and advantage of regional anesthesia. Also new agents with lower toxicity and techniques to provide continuous blockade have opened the way for blocks to be used for extended periods without increasing the risk of complications. *(Ayling MR et al, 2007)*

   The use of regional anesthesia in combat hospitals is not a new phenomenon, with its use being described throughout the 20th century. The predominant techniques were confined to spinal anesthesia. As such, these techniques had limited applicability because of hemodynamic instability in shocked casualties, and risk associated with contamination and sepsis. *(Noble MJ et al, 1968)*

   This approach offers some advantages for a hard-pressed field hospital, allowing more care to be comfortably provided to more patients with less skilled staff and less use of resources that are difficult to resupply, usually with a faster
and more stable recovery phase. This would potentially allow more rapid return to the battlefield and act as a force multiplier. This approach is not new and has been described from earlier conflicts. During mass casualty situations in Vietnam, American anesthesiologists used spinal, epidural and axillary blocks to allow simultaneous surgeries to be performed. This allowed the anesthesiologist to be available to provide anesthesia and resuscitation to the critically injured soldiers, while permitting the already blocked wounded to be operated on at the same time. (Scott DM and Chaun A., 2007)

The use of CPNB in patients with limb injuries would also reduce the workload in the operating room by allowing painful dressing changes to be performed on the ward either by topping up the block or by using minimal sedation. Elastomeric pumps can be attached to the catheters and used to provide excellent analgesia for injured soldiers during repatriation. This will also free nursing staff to care for other injured patients in-flight, reducing workloads and improving care for all. There have been several case studies presenting excellent outcomes when regional anesthesia was used, and one presenting the use of ultrasound in the combat setting for placement of a brachial plexus block following traumatic amputation from an improvised explosive device. (Scott DM & Chuan A., 2007)

Traditionally, regional anesthesia was regarded as the technique of choice for the very unwell patient, as it avoided the risks associated with general anesthesia, which had been described as “holding the patient over an open grave”. However, general anesthesia is now regarded as a very safe procedure, with an unpredicted death rate as low as 1:250 000 in otherwise healthy individuals. Regional anesthesia became regarded as difficult, time consuming and unreliable,
only worth the trouble for the very sick, so training in regional techniques fell to
the point that many trainees did little or no training in anything other than spinal
and epidural blocks. (David M Scot, 2008)

As evidence demonstrating the advantages of incorporating regional
anesthesia into standard practice accumulates, many anesthetists have to learn or
relearn the techniques, and many trainees are actively seeking opportunities to
learn them. The US military has established a Regional Anesthesia and Pain
Management Initiative within the Department of Anesthesiology at WRAMC to
specifically address this issue. (Stojadinovic A et al, 2006)

Introduction of portable ultrasound devices and the increasing understanding
of ultrasound neuroanatomy have led to many blocks being performed under direct
vision using ultrasound guidance. The use of ultrasound has also allowed the
introduction of new blocks such as the transverses abdominus plane (TAP) block,
which cannot be safely and reliably performed without ultrasound placement of the
needle and agent. (David M Scott, 2008)

As with many innovations on the battlefield leading to better technologies
in civilian life, the potential for improved patient care in trauma for civilian
patients by the timely application of regional anesthesia is likely. (David M Scott,
2008)
Stress response for trauma

The stress response is the name given to the hormonal and metabolic changes which follow injury or trauma. This is part of the systemic reaction to injury which encompasses a wide range of endocrinological, immunological and haematological effects.

The responses to trauma have been of interest to scientists for many years. In 1932, Cuthbertson described in detail the metabolic responses of four patients with lower limb injuries. He documented and quantified the time course of the changes. The terms ‘ebb’ and ‘flow’ were introduced to describe an initial decrease and subsequent increase in metabolic activity. (Little RA & Girolami A, 1999)

After the early work on the stress response to accidental injury, attention turned to surgical trauma, and responses to most types of surgery were reported. Following on from this, the ability of anesthetic agents and neural blockade to modify the endocrine and metabolic responses has been studied enthusiastically.

- **The hypothalamic–pituitary–adrenal axis:**

  The endocrine response is activated by afferent neuronal impulses from the site of injury. These travel along sensory nerve roots through the dorsal root of the spinal cord, up the spinal cord to the medulla to activate the hypothalamus.