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Ultrasound guided erector spinae plane block with dexmedetomidine as an adjuvant to local anesthetic in laparoscopic abdominal surgery: Review Article

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Abstract

Laparoscopic pain is related to the stretching of the peritoneum and peritoneal irritation caused by insufation of the parietal peritoneum with carbon dioxide. In 2017, erector spinae plane block (ESPB) was described for management of postoperative pain following open and laparoscopic abdominal surgery. Regional anesthesia and pain management have experienced advances in recent years, especially with the advent of fascial plane blocks. The erector spinae plane block is one of the newest techniques to be described. The goal of this narrative review article is to assess the efficacy of Erector spinae plane block to produce Opioid-free analgesia. Erector spinae plane block can decrease Opioid consumption in laparoscopic abdominal surgery. Ultrasound-guided erector spinae plane block (ESPB) is a recently defined regional anesthesia technique where local anesthetic is injected into the erector spinae muscle and fascial plane and the agent is allowed to diffuse in caudal and cranial directions. Adjuvants are widely used in clinical practice to prolong the duration of anesthesia/analgesia, stabilize hemodynamics, reduce postoperative pain, and reduce postoperative complications. However, their clinical use in most cases has not been ethically reviewed and demonstrated, with the unclear definition of possible neurotoxicity and systemic adverse effects. Therefore, any anesthesiologist should obtain the patient's informed consent before adding adjuvants and assess the risks and benefits adequately.

Keywords: Laparoscopy, Erector spinae, dexmedetomidine, opioid, opioid-free anesthesia, erector spinae plane block (espb).

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1. Introduction

Laparoscopic pain is related to the stretching of the peritoneum and peritoneal irritation caused by insufation of the parietal peritoneum with carbon dioxide. In 2017, erector spinae plane block (ESPB) was described for management of postoperative pain following open and laparoscopic abdominal surgery. The addition of dexmedetomidine to the anesthetic mixture significantly prolongs analgesia, without clinically significant side effects [1]. Erector Spinae Plane Block (ESPB) is one of the fascial plane blocks, in which local anesthetic is injected in plane between two fascial layers, afterwards extends to nerves situated inside that plane or neighboring tissue compartments [2].

2. Anatomic features of erector spinae plane block

The spinae erector is an anatomical word that describes a three-fold muscle group: iliocostalis lumborum, longissimus thoracis and spinalis thoracis Fig 1 [3]. These muscles are derived from the transverse processes of ribs, thoracic and lumbar and inserted on the sacrum and ilium [4]. The erector spinae constitute a paraspinal muscular column that overlooks the osteoporosis laminae and transverse events, along with the more medial transversal-spinalis group of muscles next to spinal processes. The muscles lie in a complex integrated sheet of aponeuroses and fasciae (a retinaculum) that runs from the sacrum to the base of the crane, which is synonymous to the thoracolumbar fascia in the lower parts of the retinaculum [5]. This fascial column envelope makes it possible to distribute fluid into the deep ESP from a single injection site in cranial-caudal direction, which is one of the distinctive qualities of ESPB [2].

3. Mechanism of action of erector spinae plane block

There are three probable mechanisms

- The first is that local anesthetics enter in advance via fenestrations of the connective tissues that cover neighboring transverse processes and ribs into the paravertebral and epidural areas that contain vertebral nerves and dorsal and ventral rams [6].
- The second, the dorsal rami are blocked as they ascend through the lake of local anesthetic deposited in the ESP [7].
- The third since the ESP is sideways to the earth and is superficial to both ribs and intercostal muscles and deep

to the serratus anterior muscular plane, it may perhaps reach and treat lateral skin nerve branches laterally inside this plane [8].

4. Technique

4.1. Positioning

The position of the patient for the realization of the block includes sitting, lying on the side, or lying prone. The technique can be performed with the patient awake or under the effects of general anesthesia. In pediatric patients, it is advisable to perform the procedure after the induction of anesthesia. However, there is no consensus about the best method for adult patients. The awake technique provides the advantage of being able to assess the efficacy and level of analgesia by means of a skin sensitivity test [9].

4.2. Transducer selection

The most regularly used technique with the thoracic region is the high-frequency linear probe, but obese individuals may need a curvilinear (2–5 MHz) probe [10].

4.3. Needle length and gauge

Although the needle length may vary according to application locations and patient characteristics, usually, for chest applications a needle of 22 G measure 50, 80 or 100 mm is utilized, while for lumbar or other applications a needle of 22 G measurement of 80–100 mm is used [11].

5. Local anesthetic volume and concentration

The most essential variables for ESPB, like other plane blocks, are local volume anesthetic and concentration. Flat blocks rely on volume; hence, dermatomal coverage rises as volume increases. ESPB applications with 10-40 mL quantities have been conducted [5].

6. Other uses of Erector Spinae plane block

6.1. Pain management

Since the erector spinae muscle extends to the cervical spine, the ESP block may be potentially useful in painful conditions of the shoulder girdle [12].

6.2. Rib Fractures

6.3. Renal surgery

6.4. Breast surgery

It was reported in a randomized controlled study in breast cancer surgery that a single-shot ESP block performed at the T4 thoracic level significantly reduced morphine consumption at the postoperative period [13].

6.5. Open abdominal surgeries and cesarean sections

7. Advantages of the ESP block

Part of the appeal of the ESP block could be that it is gaining indirect access to the paravertebral space and providing analgesia without the potential for needle-pleura interaction and consequent risk of pneumothorax. There are no structures at risk of needle injury in the immediate vicinity, such as, neuro-axis, pleura, and any major vascular structures. It permits the block to be performed by experienced practitioners in anticoagulated patients with a reasonable safety margin [14].

8. Dexmedetomidine

Dexmedetomidine is α2-adrenergic receptor (α2-AR) agonists have been successfully used in several clinical settings in view of diverse actions which include sedation, analgesia, anxiolysis, perioperative sympatholytic, cardiovascular stabilizing effects, reduced anesthetic requirements, and preservation of respiratory function [15]. Dexmedetomidine is a relatively new drug approved at the end of 1999 by the Food and Drug Administration (FDA) for humans use for short-term sedation and analgesia (<24 hours) in the intensive care unit (ICU). Dexmedetomidine is a useful sedative agent with analgesic properties, hemodynamic stability and ability to recover respiratory function in mechanically ventilated patients facilitating early weaning. Besides being a new modality of sedation and analgesia in ICU patient management [16].

8.1. Chemical structure

Dexmedetomidine is the dextrorotatory S-enantiomer of medetomidine, an agent used in veterinary medicine. It is chemically (S)-4-[1-(2, 3-dimethylphenyl) ethyl]-3H-imidazole [17].

8.2. Mechanism of action

By α2-AR, agonists produce clinical effects after binding to G-Protein-coupled α2-AR, of which there are three subtypes (α2A, α2B, and α2C) with each having different physiological functions and pharmacological activities. These receptor subtypes are found ubiquitously in the central, peripheral, and autonomic nervous systems, as well as in vital organs and blood vessels [18]. Locus ceruleus of the brain stem is the principal site for the sedative action and spinal cord is the principal site for the analgesic action, both acting through α2A-AR. In the heart, the dominant action of α2-AR agonists is a decrease in tachycardia (through blocking cardio accelerator nerve) and bradycardia via α2A-AR (through a vagomimetic action). In the peripheral vasculature, there is sympatholysis-mediated vasodilatation and smooth muscle cells receptor-mediated vasoconstriction [19].

8.3. Uses of dexmedetomidine

8.3.1. Loco regional analgesia

Dexmedetomidine is emerging as a useful adjunct to the analgesic regimen in the perioperative period owing to its opioid-sparing effects [20]. Dexmedetomidine is a lipophilic imidazole derivative that has sedative and analgesic properties without associated respiratory depressant effects. The sedative effects of dexmedetomidine result from the release of the neurotransmitter norepinephrine within the locus coeruleus of the brain, an area vital to producing an awake state. In addition, by directly stimulating α2− receptors in the spinal cord, dexmedetomidine inhibits the firing of nociceptive neurons responsible for the propagation of pain signals [21]. Adding Dexmedetomidine to Bupivacaine in ESP has a highly effective sedative and analgesic effect [22]. It has been found that, in many experimental and clinical regional block practices, the addition of dexmedetomidine (0.5μg/kg) to the local anesthetic reduces tissue and nerve damage, increases duration of sensory and motor block, and reduces postoperative pain. For example, Transversus abdominis plane (TAP) block done by ropivacaine combined with dexmedetomidine [23].

8.3.2. Analgesic effects following systemic administration

The α2-AR agonists and opioids act by different mechanisms and thus their combination produces a synergistic analgesic effect without increasing the respiratory depression that is often associated with opioid use [24].

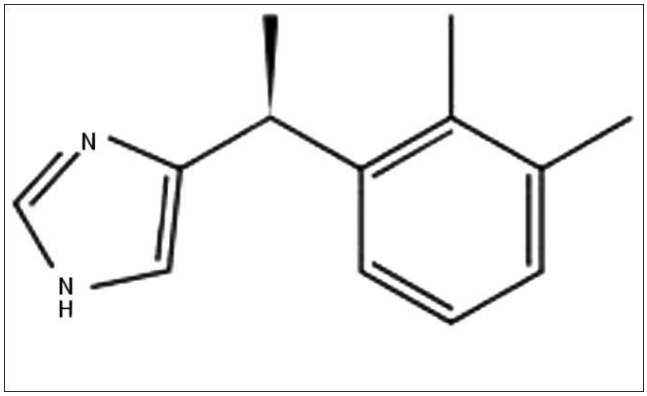

Figure 1: Chemical structure of Dexmedetomidine

8.3.3. Premedication

Dexmedetomidine is used as an adjuvant for premedication, especially in patients susceptible to preoperative and perioperative stress because of its sedative, anxiolytic, analgesic, sympatholytic, and stable hemodynamic profile [25].

8.4. Adverse effects of dexmedetomidine

The most common adverse effects of dexmedetomidine are hypotension, bradycardia, and hypertension. Hypertension can result from the stimulation of alpha subtypes of receptors in vascular smooth muscles. Hypertension usually does not require treatment and can be avoided by the slow administration or omission of the loading dose. Hypotension and bradycardia are the results of the stimulation of presynaptic alpha-receptors, which leads to a decreased release of norepinephrine; this is in addition to the decrease in the central sympathetic outflow. These are concerns regardless of the route of administration [26].

9. Stress Response

Stress generally affects all systems of the body including cardiovascular, respiratory, endocrine, gastrointestinal, nervous, muscular, and reproductive systems. Concerning the cardiovascular system, acute stress causes an increase in heart rate, stronger heart muscle contractions, dilation of the heart, and redirection of blood to large muscles. The respiratory system works with the cardiovascular system to supply cells of the body with oxygen while removing carbon dioxide waste [27]. The controlled trauma of a surgical insult activates adaptive changes in the neurohormonal system and the inflammation response [28]. The primary mechanism responsible for cortisol hypersecretion in response to stress is executed by the afferent nerve signals derived from the surgical site, which in turn stimulate the hypothalamus to release corticotropin releasing hormone and arginine vasopressin, these two peptides then stimulate secretion of adrenocorticotropic hormone from the anterior pituitary, which stimulates cortisol secretion by the adrenal cortex. Surgery can be considered a standardized model for assessing the cortisol response to stress and relevant modifying factors [29]. Cortisol is a steroid hormone, in the glucocorticoid class of hormones. When used as a medication, it is known as hydrocortisone. It is produced in many animals, mainly by the zona fasciculata of the adrenal cortex in the adrenal gland. It is produced in other tissues in lower quantities. It is released with a diurnal cycle and its release is increased in response to stress and low blood-glucose concentration. It functions to increase blood sugar through gluconeogenesis, to suppress the immune system, and to aid in the metabolism of fat, protein, and carbohydrates. It also decreases bone formation. Many of these functions are carried out by cortisol binding to glucocorticoid or mineralocorticoid receptors inside the cell, which then bind to DNA to impact gene expression [30].

10. Conclusion

Ultrasound-guided erector spinae plane block (ESPB) is a recently defined regional anesthesia technique where local anesthetic is injected into the erector spinae muscle and fascial plane and the agent is allowed to diffuse in caudal and cranial directions. Adjuvants are widely used in clinical practice to prolong the duration of anesthesia/analgesia, stabilize hemodynamics, reduce postoperative pain, and reduce postoperative complications. However, their clinical use in most cases has not been ethically reviewed and demonstrated, with the unclear definition of possible neurotoxicity and systemic adverse effects. Therefore, any anesthesiologist should obtain the patient's informed consent before adding adjuvants and assess the risks and benefits adequately.

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