Bilateral Transversus Abdominis Plane Block versus Epidural analgesia for Postoperative Pain Relief in Lower Abdominal Surgery

Thesis

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List of Abbreviations

AAG ..... Alpha 1 acid glycoprotein
ACLS ..... Advanced cardiovascular life support
ASRA ..... American society of regional anesthesia
CNB…… Central neuraxial block
CNS ..... Central nervous system
CSF ..... Cerebrospinal fluid
CVS ..... Cardiovascular system
ECG……..Electrocardiography
Fe+2 ..... Ferrous iron
Fe+3 ..... Ferric iron
G ..... Gauge
GA ..... General anesthesia
H ..... Hour
Hb..... Hemoglobin
IM ..... Intramuscular
IV ..... Intravenous
K+ ..... Potassium
kg..... Kilogram
LA ..... Local Anesthetics
ml ..... Milliliter
mm ..... Millimeter
n..... Number
Na+ ..... Sodium
NaHCO3 ..... Sodium bicarbonate
NRS…….. Numerical Rating Scale
NSAID ..... Non steroidal anti-inflammatory drugs
PACU ..... Post anesthesia care unit
PDPH ..... Postduralpuncture headache
PMA……Paramedian Approach
SD ..... Standard deviation
TAP ..... TransversusAbdominis Plane
US ..... Ultrasound
VAS…….. Visual Analogue Score

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Abstract

For many years, epidural and caudal analgesia have been considered the gold-standard techniques after abdominal surgery for adults and children, respectively. The techniques consist of injecting the local anesthetic within the epidural space, between the ligamentumflavum and the dura mater. Depending on the surgical site and the level of injection, cervical, thoracic, or lumbar nerve roots are blocked after their emergence from the neural foramen. Epidural and caudal analgesia have some drawbacks including hypotension secondary to the sympathetic blockade by the local anesthetic.

In the last decade, a new abdominal truncal block, called the tranversusabdominis plane (TAP) block, was described consisting of local anesthetic injection between the internal oblique and transversusabdominis muscle. This block provides analgesia by blocking the 7th to 11th intercostal nerves (T7–T11), the subcostal nerve (T12), and the ilioinguinal nerve and iliohypogastric nerve (L1–L2).

This study was conducted to compare the effectiveness and safety of US guided TAP block to epidural block as a good analgesia for patients undergoing lower abdominal surgery. The study was conducted on 60 randomly chosen patients in Ain Shams University Hospitals after approval of the medical ethical committee. Patients were divided randomly into two groups, each group consisted of 30 patients.

All patients received general anesthesia. Epidural anesthesia group received epidural anesthesia while TAP block group received bilateral TAP block. The two groups were adequately monitored and assessed intraoperatively and postoperatively for 12 hours and were compared regarding demographic data ,intraoperative and postoperative hemodynamics , postoperative pain control using Visual Analogue Score and complications of both anesthetic techniques .

The results of the study revealed that epidural block provided significantly prolonged postoperative analgesia and reduced postoperative analgesic requirements as compared to ultrasound guided TAP block in patients undergoing lower abdominal surgery. Both analgesic techniques are safe.

Keywords: Epidural analgesia, TAP Block, Lower Abdominal surgery

Introduction

For many years, epidural and caudal analgesia have been considered the gold-standard techniques after abdominal surgery for adults and children,butepidural and caudal analgesia have some drawbacks including hypotension secondary to the sympathetic blockade by the local anesthetic **(Wijeysunderaet al., 2008).**

In the last decade, a new abdominal truncal block, called the tranversusabdominis plane (TAP) block, was described consisting of local anesthetic injection between the internal oblique and transversusabdominis muscle. This block provides analgesia by blocking the 7th to 11th intercostal nerves (T7–T11), the subcostal nerve (T12), and the ilioinguinal nerve and iliohypogastric nerve (L1–L2)(**Albrechtet al., 2013)**.

Two distinct approaches have been described for TAP block : an intercostoiliac approach where the probe is positioned between the rib cage and the iliac crest, and an oblique subcostal approach where the probe is placed anterior to the midaxillary line in an oblique subcostal angle. Both approaches have been shown to effectively cover pain after abdominal wall surgery. The TAP block has achieved widespread clinical uptake due to the technique's simplicity when performed with ultrasound guidance and the absence of significant side effects**(Baeriswylet al., 2015).**

Aim of The Work

The aim of the current study was to compare the analgesic efficacy of epidural analgesia and transverse abdominis plane (TAP) block to provide postoperative analgesia after lower abdominal surgery.

Review of Literature

Chapter (1): Local Anesthetics

Introduction:

Local anesthetics (LA) are drugs that block conduction of electrical impulses in excitable tissues. These tissues include the nerve cells and myocytes (both cardiac and skeletal muscles). Analgesia and anesthesia occur as a result of the blockage of electrical impulses progression***(Mumba et al., 2017).***

Nerve Conduction:

The intracellular milieu of the nerve cell is negatively charged relative to the extracellular. Upon excitation of the nerve fibres, the electrical impulse propagates along the axon as a result of changes occurring in the adjacent membrane alternating from negative to positive values of about +50 mV due to rapid influx of Na+ ions this step called(Depolarization). At an electrical potential of +50 mV, there is rapid efflux of K+ ions in an attempt to maintain electrical neutrality of the cell this step called (Repolarization) To restore the resting membrane potential, the Na+/K+ ATPase pumps Na+ extracellularly, while the opposite happens to the K+. The conduction of impulses along nerve fibers occurs as small brief, localized spikes of depolarization on the surface of the cell membrane. Impulses travel in one direction as the axonal

membrane that has just undergone depolarization remains in the refractory state until the resting potential is restored by the Na+/K+ ATPase pumps ***(Mumba et al., 2017).***

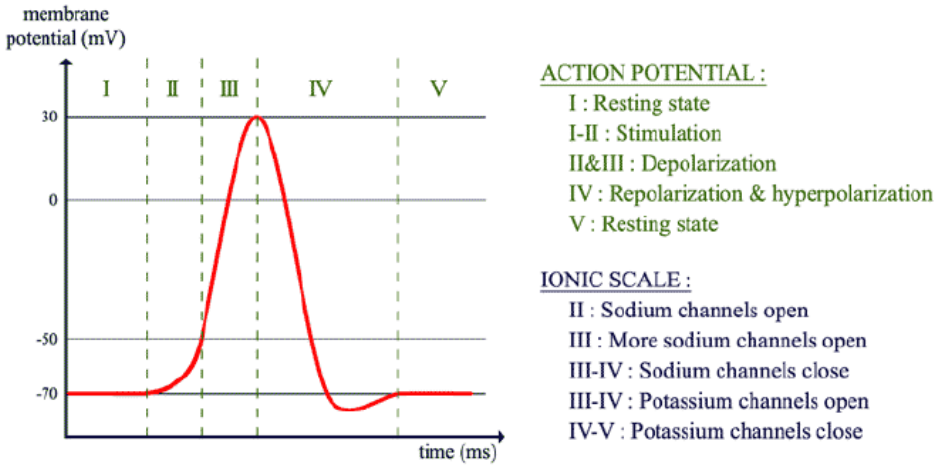

Figure (1): Action Potential***(Corson and Aziz, 2009)***

Because the rapid influx of Na+ ions occurs in response to a change in the transmembrane potential, Na+ channels in the nerve are characterized as "voltage gated." These channels are protein structures consist of the large sodium-conducting pore(Alpha-subunit)and varying number of adjacent smaller (Beta-subunits) those channels penetrate the full depth of the membrane bilayer and are in communication with both the extracellular surface of the nerve membrane and the axoplasm (interior) of the nerve. LA prevent the generation and conduction of nerve impulses by binding to the α subunit of the Na+ channel and preventing Na+ influx into the cell, halting the transmission of the advancing wave of depolarization down the length of the nerve ***(Gadsden., 2013)***.

A resting nerve is less sensitive to a local anesthetic than a nerve that is repeatedly stimulated. A higher frequency of stimulation and a more positive membrane potential cause a greater degree of transmission block. These frequency- and voltage- dependent effects of local anesthetics occur because repeated depolarization increases the chance that a local anesthetic molecule will encounter a Na+ channel that is in the activated, or open, form-as opposed to the resting form-which has a much greater affinity for LA. In general, the rate of dissociation from the receptor site in the pore of the Na+ channel is critical for the frequency dependence of LA action ***(Gadsden., 2013)***.

Pharmacology of local anesthetics:

Structure-activity relationship of local anesthetics:

Local anesthetics consist of a hydrophilic amine and a lipophilic aromatic ring connected by an intermediate chain. The structural bond in the intermediate chain determines whether the local anesthetic will be classified as an ester or an amide, (Fig 1). Furthermore, the bond in the intermediate chain determines the pathway of metabolism of the compound. Ester local anesthetics are metabolised by plasma pseudocholinesterases, whereas the amides are metabolised in the liver by the cytochrome family of enzymes ***(Mumba et al., 2017).***

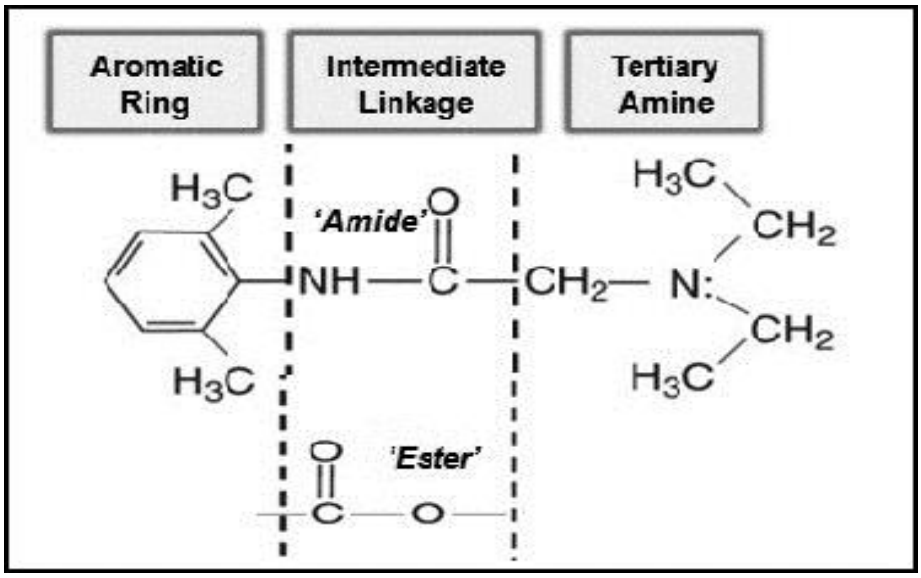

Figure (2): Structure of local anesthetics ***(Becker and Reed, 2012)***.

Mechanism of action of local anesthetics:

LA block the transmission of nerve impulses by reversibly blocking the fast voltage-gated Na channels, thereby inducing analgesia and anesthesia. Physico-chemically, LA are weak bases that are formulated in an acidic milieu, hence containing a larger proportion of the drug in the ionised state. However, it is the unionised fraction that is able to cross the lipid bilayer neuronal membrane and block the voltage-gated Na+ channels from the inside of the axoplasm. This blockade renders the Na+ channel inactive, and hence, no further conduction of impulses occurs ***(Mumbaet al., 2017)***.

Determinants of physiological activities of local anesthetics:

The activity of LA is influenced by a number of factors. These include the pH of the surrounding tissue, the lipid solubility of the LA, pKa, the bond in the intermediate chain and its length and the protein binding of the particular LA in question. Details of how each of these factors influence the activity of LA is discussed below:

1. pKa:

The pKa is the pH at which the number of ionized and non-ionized fractions of the drug is in equilibrium (the pH at which 50% of the drug is ionized and 50% is non-ionized). The pKa of the LA is related to pH and the concentrations of the cationic and base forms by the Henderson-Hasselbalch equation: pH = pKa + log ([base]/ [cation]). The pKa generally correlates with the speed of onset of action of most amide LA drugs; The lower the pKa, the more the unionised fraction is present for any given pH and hence the faster the onset of action**(Katzung and White .,2009).**

2. PH:

The lower the pH, the less the potency because in acidic conditions the ionised fraction predominates, there is less of the unionised fraction, and there is less of the LA available to cross the lipid bilayer and block the voltage gated Na+ channels. This explains why LA does not have much efficacy in reducing pain in

infected tissues like abscesses in which the pH of such tissues is much lower than the physiological pH of 7.4 **(Katzung and White., 2009)**.

For this reason, sodium bicarbonate (NaHCO3) is often added to LA. This increases the amount of drug in the non-ionized form, which slightly shortens the onset time. Obviously, the limiting factor for pH adjustment is the solubility of the base form of the drug. Unfortunately, only small changes in pH can be achieved by the addition of bicarbonate because of the limited solubility of the base. As such, only small decreases in onset time are realized. For instance, with the alkalinisation of bupivacaine, an increase in the amount of base in solution is limited by the minimal solubility of free base in solution. For each LA, there is a pH at which the amount of base in solution is maximal (a saturated solution). Further increases in pH result in precipitation of the drug and do not produce an additional shortening of onset time ***(Gadsden ., 2013)***.

3. Lipid solubility:

The more lipid soluble the local anesthetic is, the higher the potency and the longer the duration of action. This is because there are more drug molecules able to cross the lipid bilayer of the neuronal membrane and create a ‘depot’ of the drug from within the axoplasm***(Mumba et al., 2017).***