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Professional Paper

NEW CONCEPT OF FUSION TECHNICS IN REGIONAL ANESTHESIA

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ABSTRACT – The aim of this review article is to introduce a newer approach to multimodal anesthesia. In addition to the usual combination of epidural catheter and general anesthesia as standard techniques in surgical procedures accompanied by intense postoperative pain, we want to encourage reflection on the application of various regional techniques in equally complex surgical conditions. By simply modifying the standard neuraxial technique with a higher thoracic approach, excellent abdominal surgery can be performed to awake the patient. However, placement of an epidural catheter is not always possible due to technical difficulties or patient-related conditions that contraindicate its insertion. Trunk-level fascia blocks (PVB, ESPB, RLB) are simple, safe alternative to an epidural catheter because the transverse process, which is the target of ultrasound, is easily visualized and the injection site is away from neuroaxis, pleura, and large vascular structures. In addition, extensive craniocaudal diffusion of anesthetics allows wide coverage with a single injection. It has been confirmed that PVB, ESPB, RLB blocks act on visceral and somatic pain. Therefore, their ultrasound-guided use in laparoscopic and other abdominal surgeries may be useful. With a well-designed fusion of regional techniques in operations of the upper and lower abdomen, it is possible to achieve hemodynamically and respiratory stable anesthesia in an awake patient with reduced postoperative pain.

Key words: *spinal, epidural, US guided block, PVB, ESP, RLB, abdominal surgery*

Introduction

Today we are already witnessing that the proportion of the population over 65 is increasing. The rate of surgery in the elderly becomes larger and more extensive, so current predictions suggest that the demand for surgical services and personalized anesthesia approach will certainly be increased.

Weakness is a term used by some medical staff to describe an older person who appears weak, unsteady, and underweight. The natural decrease in physical condition replaced by weakness is more pronounced with increasing age and its expected incidence in the population is about 4% in 59-65 year olds, 9% in 75-79 year olds, and 26% in 85 year olds. (1) Weakness expresses a set of different deficits in multiple organ system that together cause physiological depletion and consequent change in pharmacokinetics and pharmacodynamics. The body composition of an elderly patient is characterized by a decrease in muscle mass, an increase in adipose tissue, and a reduction in total body water. Subsequently, lipophilic drugs have a larger volume of distribution with a potentially longer duration of action, whereas hydrophilic drugs will have a higher peak plasma concentration due to the reduction in the central compartment.(2) The decrease

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in muscle mass often means that declining renal function is not reflected precisely by the serum creatinine. With aging, hypertension and heart failure are often accompanied by changes in the vascular system and represent a major risk factor for major adverse events in the perioperative period. Heart failure is associated with instability of blood pressure and tissue perfusion, the impact of which can result in particularly deep and prolonged hypotension in response to applied anesthesia techniques, especially in conditions of hypovolemia, which is commonly present in the perioperative time. Weakness leads to progressive loss of respiratory muscle strength, loss of elasticity of the lung and reduction of the functional surface of the alveoli. All this results in a negative ratio between ventilation-perfusion mismatch and increased risk of hypoxemia and atelectasis. (3) General anesthesia involves depression of cerebral function and often paralysis of voluntary muscles, making tracheal intubation and artificial ventilation mandatory. Furthermore, decreased airway reflexes, especially in post-anesthetic states of residual weakness due to prolonged effects of drugs such as neuromuscular relaxants, opioids, or sedatives, may increase the need for prolonged intensive treatment and deeper complications.

Scientific studies indicate that in specific clinical situations, regional anesthesia has significant advantages over general anesthesia. This is especially evident in patients with severe conditions and when the relief of acute postoperative pain is very complex and demanding. The ability to confine anesthesia to a specific part of the body has many advantages for the patients and for the surgical staff too.

Neuraxial anesthesia – some rethinking

Regional anesthesia (RA), particularly neuraxial blockade, has gained popularity as an effective and safe technique. It might provide improved outcomes in terms of perioperative morbidity and mortality compared to general anesthesia (GA). (4) Spinal anesthesia and epidural anesthesia are the two main types of neuraxial blockade, which decrease respiratory and cardiac complications, the neuroendocrine stress response, to improve effective pain control, to promote return of gastrointestinal function, to protect against thromboembolic events, and to facilitate early patient mobilization.(5)

Since the outbreak of the Covid-19 pandemic, more and more clinical trials have confirmed that, in addition to the conventional lumbar spinal anesthesia, the thoracic spinal/epidural anesthesia is also safe and possible in high-risk elderly patients who have undergone upper abdominal surgery.(6) Even today, most anesthesiologists are afraid to perform spinal anesthesia above the end of the spinal cord for fear that the tip of the needle will damage the spinal cord. Results from MRI studies indicate that the spinal cord lies anteriorly within its thecal boundaries in the apex of the thoracic curve. Intrathecal injections, therefore, at thoracic levels may have a safety minimal distance before spinal needle contact with neural tissue.(7)

The safe use of thoracic combined spinal epidural anesthesia allows high-risk patients to be safely anesthetized and allows certain surgeries, which usually require an extended stay in intensive care unit, to be performed without it.(8)

Ellakany MH and Abdelhamid SA in 2013 have shown that segmental thoracic spinal anesthesia can be used as a sole anesthetic technique in breast cancer surgery with axillary lymph node clearance. (8)

One year later, a study published by the same author, reported a successful and effective use of the same technique: segmental thoracic spinal anesthesia, for open surgeries for abdominal malignancies, when delivered by expert anesthesiologists.(9) For instance, Imbelloni LE concluded that the use of thoracic puncture helps to reduce the doses of hyperbaric bupivacaine in combination with fentanyl for laparoscopic cholecystectomy that led to better outcomes with less hemodynamic instability, and shorter duration of sensory and motor blockade than lumbar spinal anesthesia with conventional doses. (10)

The general restraint toward thoracic spinal anesthesia is also a consequence of unjustified concern that, due to blockage of the thoracic spinal nerves, proper spontaneous breathing and oxygenation will be lost. (11) Also, we unjustifiably forget that the diaphragm is a muscle that plays an important role in inspiration, that it is innervated by the phrenic nerve (C3-C5) and that high spinal block does not affect its contractility. Expiration is a passive process, so we should not worry about hypercarbia. However, high thoracic block will affect the muscles of the anterior abdominal wall that are responsible for sudden exhalation and cough, due to the thoracic origin (T6-T11) of its nerve supply.

Thoracic neuraxial anesthesia also becomes acceptable because by placing a catheter in the subarachnoid or in the epidural space, a controlled prolongation of the anesthesia time and maintenance of continuous postoperative spinal or epidural analgesia becomes achievable. (12)

Therefore, it is reasonable to consider newer approaches and goals in the selection of neuraxial anesthesia for abdominal surgery in patients with demanding physical status, such as:

1. Thoracic spinal anesthesia for abdominal laparotomy and laparoscopy (TSA)
2. Continuous thoracic spinal anesthesia (CTSA)
3. Combined thoracic spino-epidural anesthesia (CTSEA)
4. Use of adjuvants to LA in regional anesthesia (e.g. ketamin, midazolam, dexmetomidine, dexamethasone).(13)
5. Fusion technics in regional anesthesia …PVB, ESP, RLB……

1. Thoracic spinal anesthesia (TSA)

For abdominal surgery of a defined duration, it is rational to choose the technique of a single shot spinal, with the puncture site being adjusted to the width of the surgical procedure. (10, 14)

For good hemodynamic stability, in addition to defining the puncture level, it is important to adjust the dose and the type of LA solution. At the thoracic level, the total dose of LA used may be lower than that administered at the lumbar level. Clinical experience suggests that the total dose of LA (in milligrams) is divided in half, i.e. within two different types of baricity; half of the total dose of LA is in one syringe with hyperbaric solution (which goes as the first application) and the other half of the dose of LA is in the other syringe of isobaric solution (which goes as the second one). Such a combination of baricity provides us with wider anesthetic coverage of the dermatome with good intraoperative ventilation and hemodynamics.

Examples and suggestions of thoracic puncture level for single shot spinal anesthesia and proposal of optimal dose of LA depend on the type of surgery:

- T7-T8 hyperbaric bupivacaine 8-10mg, or ropivacaine 10-12 mg (e.g. laparoscopic or laparotomy surgery of the esophagus, stomach, duodenum, ileum, bile)
- T9-T10 hyperbaric bupivacaine 8-10mg, or ropivacaine 10-12 mg (e.g. surgery of the right colon / appendix, cecum)
- T10-T11 hyperbaric bupivacaine 8-10mg, or ropivacaine 10-12 mg (e.g. surgery of transverse colon / colostomy)
- T11-T12 hyperbaric bupivacaine 10-12mg, or ropivacaine 12-15 mg (e.g. surgery left colon /colostomy, rectal prolapse)

2. Continuous thoracic spinal anesthesia (CTSA)

In fragile patients with a high-risk ASA status, a personalized approach through the technique of spinal catheter and continuous thoracic spinal anesthesia (TCSA) is rational because it provides: (15.)

- an overall reduction in intrathecal L.A. doses, both for induction and maintenance.
- regardless of the type of anesthetic, L.A. boluses of 2-2.5mg are appropriate.
- solution concentration of 0.2-0.25% is effective as well as 0.5% with better hemodynamic response and less motor block.
- if hypobaric boluses are required (for wider cephalic dispersion), it is sufficient to dilute them with H2O redestillate.
- to maintain anesthesia, it is necessary to plan top-up boluses of 2-2.5 mg every 45-60 min. or when pain occurs; the effect is achieved immediately.

3. Combined thoracic spino-epidural anesthesia (CTSEA)

Routine use of combined spino-epidural techniques (TCSEA) due to a certain fear of possible thoracic spinal cord injury has not yet been established in clinical practice. In the hands of an experienced anesthesiologist and adhering to published clinical protocols, TCSEA is just as safe as that at the lumbar level. (13) For a safe course of TCSA in abdominal surgery it is recommended that:

- it can be used as a unique "needle through needle" technique or two separate approaches to the spine.
- the epidural catheter goes first, always at least one level above the spinal level.
- the access height is on average similar to that for a single shot.
- it allows reduction of the spinal dose by 1/3 versus a single shot.
- the epidural dose can be reduced by 2/3 compared to a standard epidural.
- it is advantageous to apply lower epidural concentrations (0.2%; 0.25%; 0.3%) in a volume of 10 ml either for the initial bolus or for the top-up.

- careful control of programed top-ups, since the performance of the block is slower, requires a proper time interval of 45-60 min. to avoid loss of anesthetic effect.

4. Use of adjuvants to LA in neuraxial anesthesia and sedation

The primary goals of their application is to allow total reduction of the cumulative dose of LA, to achieve positive drug synergism that prolongs the duration of sensory-motor block, to potentiate the analgesic effect of L.A.(16)

adjuvants	extension	intensity	duration
Opioid's	X	-	X
Ketamine	-	X	-
Alfa-2agonist	-	X	X
Midazolam	-	-	X
Dexamethasone	-	-	X
NaHCO3	-	-	X
MgSO4	-	-	X
Adrenalin	-	X	X

- **Opioid's:** potentiate the anti-nociception of LA; the effect is dependent on lipophilicity, pH, site of application (exp. morphine 100-200 mcg, fentanyl 10-25 mcg, sufentany 15 mcg
- **Adrenalin:** vasoconstriction, antinociception through the alpha2-adrenoceptor (0.5-1.0 mcg/kg
- **Dexamethasone :** (1, 2, 4 -8 mg) prolongs the sensory blockade in all types of blocks
- **Midazolam:** potentiates sensory block through spinal suppression of sensory activity, prolongs antinociception via GABA and opioid receptors (1-2.5 mg, epidural 50 mcg/kg)
- **Dexmedetomidine:** alpha2-receptor, potentiates motor block, prolongs analgesia, is hemodynamically stable with bradycardia (5-10 mcg, epidur/fascia 1 mcg/kg)
- **Ketamine:** shortens block onset time and shortens motor block duration through activation of NMDA, cholinergic, and 5-HT receptors (0.5mg/kg)

Awake laparotomy may allow performing abdominal undelayable surgeries in high-risk ASA patients, despite the unavailability of ICU beds, resulting in feasibility, safety, and painlessness.

Nevertheless, although this approach did not entail a relevant elongation of the operative time and intraoperative pain was always well controlled, it may cause discomfort to the patient who becomes intolerant to long procedures. The awake patient constantly hears and sees what happens inside the operating room around him. During long procedures, this can make the patient upset, especially if intraoperative complication occurs. In order to optimize sedation, opiates are often used for this purpose (either i.v. or intrathecal) which in turn can cause side effects such as nausea, vomiting, pruritus, respiratory depression and delirium.

Italian authors, Vincenzi et al. (17), present a new sedation strategy based on limited but encouraging evidence that adjuvants such as midazolam and ketamine not only significantly improve the duration and quality of spinal anesthesia, but can also provide excellent sedation through continuous epidural infusion. LA adjuvants such as ketamine and midazolam, reduce the onset time of sensory and motor block, provide a mild intraoperative sedative effect, provide prolonged perioperative analgesia due to delayed recovery time of sensory block, and reduce the incidence of nausea and vomiting (PONV) without adverse effects and neurotoxicity. (18)

Suggestions on how to perform intraoperative neuroaxial sedation:

A. A new approach to intrathecal-spinal sedation (17) can be realized by injecting a bolus of ketamine 15-30 mg from a second syringe in a single shot after LA, and injecting a third syringe containing a bolus of midazolam 1.5-3 mg (or dexmedetomidine 8-12 mcg) + dexamethasone 4 mg; depending on patients age and ASA status. The complete sedative effect occurs relatively quickly, in 2-3 min. and does not last longer than 45-60min. If prolongation of sedation is required, it is possible by continuous spinal infusion and activation of the perfusor after 10-15 min. from the injected initial bolus. (E.g. In a volume of 10ml/Ketamine 20mg+Midazolam 2mg/ rate of 2-3ml/h). It is recommended to stop sedation about 30 min. before the end of the operation.
B. The epidural approach for the neuraxial sedation can be realized with the initial bolus solution of Ketamine 50-60 mg + Midazolam 5-6 mg (or Dexmedetomidine 8-12 mcg) + Dexamethasone 4 mg ; depending on patients age and ASA status. In the epidural approach the sedative effect is delayed,

it occurs after 5-10 min., and does not last longer than 45-60 min. If prolongation of sedation is required, it is possible by continuous epidural infusion and activation of the perfusor after 10-15 min. from the injected initial bolus. (E.g. In a volume of 20ml/Ketamine 50mg+Midazolam 5mg/ rate of 4-5ml/h). It is recommended to stop sedation about 30 min. before the end of the operation, time when postoperative epidural analgesia must be initiated.

At the same time, such spinal/epidural catheter techniques provide better surgical conditions and better treatment of postoperative pain by sparing intravenous nonsteroidal anti-inflammatory drugs and opioids. (19)

5. **Fusion technics in regional anesthesia …… PVB, ESP, RLB……**

Adequate pain control is crucial for postoperative recovery. The traditional analgesia is mainly based on opioids and is associated with adverse effects such as respiratory depression, nausea and vomiting, itching, and dizziness. The promoted multimodal approach to postoperative analgesia has been mainly based on combining epidurals with i.v. analgesia. However, neuraxial catheter techniques have been identified as a source of specific complication, such as catheter migration, infection, postdural puncture headache, spinal hematoma, and cauda equina syndrome. (20)

Fascial block are techniques primarily used to relieve acute postoperative and chronic pain. In last decade, with the development of ultrasound (US), newer different types of fascial blocks have been described and their clinical application has increased. Recently, they have been targeted in neuraxial anesthesia as an adjuvant technique to enhance and prolong epidural or spinal anesthesia. The main advantages offered by these techniques include the simplicity of performing them, the analgesic efficacy, and the low risk of complications.

Therefore, a fusion of regional techniques is advocated, a combination of neuraxial anesthesia along with various fascia block at trunk level that can analgesically cover the abdominal incision area, both laterally and anteriorly, thus improving early postoperative recovery.

a) **PVB – paravertebral block**

The paravertebral block (PVB) was first described by Sellheim in 1905 and has been used widely since 1978 to treat surgical anesthesia, perioperative analgesia, acute and chronic pain in breast, thoracic, urological, and abdominal surgery.(21) Thoracic paravertebral block (TPVB) is a classic trunk block, mostly a unilateral blockade of the spinal nerve, its dorsal and ventral branches, as well as the ganglion of the sympathetic chain.

The thoracic paravertebral space is a wedge shaped space alongside the thoracic spine. The boundaries of the space are:

- Medial - the vertebral body and intervertebral foramen.
- Antero - lateral – Pleura.
- Posterior - Costo-transverse ligament and the internal intercostal membrane laterally. These two structures are in continuous communication with each other.

Thoracic paravertebral space communicates with:

- Medially – Epidural space
- Laterally – Intercostal space
- Superiorly – Cervical paravertebral space
- Inferiorly –limited spread due to the origins of the Psoas Major muscle

Eleven Intercostal nerves (T1-T11) and one Subcostal Nerve (T12) originate from the spinal cord and exit the intervertebral foramen on both sides of the spine to immediately divide into anterior and posterior branch.(22)

These blocks can be performed at any level of the spine and have good analgesic effects for both somatic and visceral pain. Although most clinical trials of thoracic PVB (TPVB) evaluate its analgesic efficacy in breast and thoracic surgery (anterior divisions of T2-6 of the thoracic intercostal nerves), today we know that it is a safe and useful technique in both major open abdominal and laparoscopic surgery. The abdominal wall is innervated by the lower thoracoabdominal nerves (anterior division of T7-11 nerves run between the internal oblique and transverse abdominis and pierce the rectus sheath) and anesthesia or analgesia can be provided by PVB performed at these levels.

The PVB may be placed unilaterally or bilaterally, and either single-shot or continuous catheter techniques are possible. It can be achieved through landmark technique or ultrasound-guided technique. (23)

Proper identification of the space has traditionally been accomplished with landmarks using a predetermined distance lateral to the spinous process (SP) (2.5cm from spinous ridge) and/or loss of resistance. In some cases, this landmark technique has also been performed in combination with nerve stimulation, seeking an intercostal muscle twitch from intercostal nerve stimulation.

Today, there are several US guided techniques to the PVB that generally have a high success rate with few adverse effects. Generally, the ultrasound probe is positioned in a transverse or sagittal orientation, though modifications to these approaches have been suggested. Ultrasound can be used to easily identify key landmarks (SP-spinal process, TP-transverse process, PVS-paravertebral space, SCTL-superior costotransverse ligament, P-pleura) and needle position. Care must be taken to properly visualize the entire needle, to recognize pleural movement and SCTL displacement, to avoid vascular structures, to confirm proper local anesthetic placement, and thus to reduce harmful neuraxial effects. (24)

It is best to perform the PVB on an awake patient in a sitting position (ideal for bilateral access) but can also be performed under general anesthesia or sedation with the patient turned to lateral position with the operated side uppermost. In thoracic single wall surgeries, one level of PVB at or below the average dermatome level is usually sufficient as it can block as many as four dermatomes (e.g. T3/T4 level for simple mastectomy; T6/T7 for open cholecystectomy). The use of ultrasound has increased interest in PVB, enabled its wider application in the surgery of upper lumbar region, and thus expanded its indications to laparoscopic cholecystectomy and appendectomy, laparoscopic hernia repair, renal surgery and even to major laparoscopic colon surgery. (25) Therefore, in open abdominal or laparoscopic colon surgery, one level of PVB is usually sufficient (e.g. T6/T8 level recommended), but it must be bilateral and performed with a higher total volume and low concentration of LA (e.g. 15-20ml 0.3% ropivacaine or 0, 3-0,5ml/kg 0, 25% bupivacaine; for each side).

In the lower lumbar region, PVB is recommended to be performed with multiple injections, so that small amounts of LA are administered at each level, as spread between adjacent level is less reliable than in the thoracic region (e.g. three level injection on T12, L1, L2 for inguinal hernia repair)

Local anesthetic extends mainly in a craniocaudal direction, but it can also spread in the prevertebral plane, and into the epidural, intercostal spaces, or both to a variable extent. (26) A single injection of 15 ml of local anesthetic produces a somatic block over a median of three dermatomes and a sympathetic block over eight dermatomes. For continuous local anesthetic infusions, a rate of 0.1 ml kg^{-1} h^{-1} for adults is recommended. The addition of opioids, dexamethasone or bicarbonates to the local anesthetic infusions does not confer any benefit, but clonidine 1 mg kg^{-1} can improve the quality and duration of analgesia (can be associated with hypotension and bradycardia).

b) ESPB – erector spinae plane block

The erector spinae plane block (ESPB) is a novel inter-fascial plane block first introduced by Forero et al. in 2016, providing wide-ranging analgesia in lung surgery, laparoscopy, mastectomy, and pediatric surgery. (27)

The proposed mechanism of ESPB is that distribution of local anesthetic solution spreads into the paravertebral space and epidural space, which then blocks the dorsal, ventral, and traffic branches of spinal nerve. (28) However, a few studies disagreed.

The erector spinae muscle (ESM) is a complex formed by the spinalis, longissimus thoracis, and iliocostalis muscles that run vertically in the back. The ESP block is performed by depositing the local anesthetic (LA) in the fascial plane, deeper than the ESM at the tip of the transverse process of the vertebra. (29) Its effect seems to be due in part to diffusion of the local anesthetic into the paravertebral space through the non-osseous spaces between adjacent vertebrae, which then acts on both the dorsal and ventral branches of the thoracic spinal nerves, as well as the communicating branches that feed the sympathetic chain. (30, 31). The ventral ramus (intercostal nerve) is divided into the anterior and lateral branches and they provide sensory innervation of the entire anterolateral wall. The dorsal ramus, which is divided in two branches, gives a sensory innervation to the posterior wall. Furthermore, the diffusion of LA to the paravertebral space through the costotransverse foramina and the intertransverse complex provides both visceral and somatic analgesia. (32)

Initially, the technique was carried out at the level of the transverse process of T5, achieving an anesthetic distribution ranging from C7-T1 to T8 and resulting in effective analgesia of the ipsilateral thoracic wall. (27) As the erector spinae muscle extends throughout the lumbar region, ESP block can also produce abdominal analgesia if it is performed at a lower level. (31) In publications on ESP block for abdominal surgery, the block was performed at the level of T7 and its effect showed extensive extension from the T6 to T12 dermatomes, whereas injection of 20 ml of contrast material at T7 in cadavers showed extensive craniocaudal spread between the levels of the C5-T2 and L2–L3 transverse processes. (33)

Although cases of blind puncture or under fluoroscopy have been described, the technique is usually guided by ultrasound. (34) Usually, a high-frequency linear ultrasound transducer is used to block the thoracic level, and a convex transducer is used to block the lumbar level. The procedure can be performed in the cranio-caudal or opposite direction depending on the conditions and the region to be treated. Moreover, the block can be administered by a single shot or with a catheter insertion for continuous infusion; with the target as the transverse process. (35). In his work Navarro reports 11 cases of unilateral or bilateral erector spine block (ESP) used for laparoscopic nephrectomy and shows a high success rate without complications related to catheter placement or continuous LA administration. They encourage clinicians to continue to use it as first-line analgesia as part of multimodal analgesia, which replaces the use of an epidural catheter.

Tulgar et al. reported their results of comparing the single application of ESP block with i.v. analgesia in 36 patients undergoing laparoscopic cholecystectomy. They observed that the NRS scores in the first 3 hours were lower in the ESP group. Additionally, tramadol use was lesser in patients undergoing ESP block. (36)

The majority of publications (review of 242 reported cases between 2016 and 2018) reported single shot techniques (80.2%), followed by intermittent boluses (12.0%) and continuous infusions (7.9%). Altogether 90.9% reported the use of multimodal analgesia in addition to the ESPB and 34.7% reported sensory changes from ESPB. A reduction in opioid use was reported in 34.7% of cases. One adverse event involving a pneumothorax was reported. A wide group of authors concludes that ESP is safe and effective option for multiple types of thoracic, abdominal and extreme surgeries. (37)

Compared with TPVB, ESPB has the following advantages. First, the dermatomal distribution of sensory loss is extensive, which covers the area ranging from the ipsilateral parasternal to the midline of the lower back in a single shot block. It has been confirmed that ESP performed at the T5 level gives sensory loss of dermatomes from T2 to T9, while if performed at T7-T8 level the LA dispersion can go caudally up to the L2-L3 level without loss of cranial dispersion.

Second, regarding to safety, ESPB is conducted in a shallow layer and far away from important organs and blood vessels. Therefore, the risk of pneumothorax, hematoma, nerve injury, and other complications is theretically lower than TPVB. (38)

Finally, when it comes to the simplicity and convenience, the ultrasound imaging features of muscle layers and transverse processes are easy to identify and locate. (39)

Although studies have shown that ESPB has a better analgesic effect comparing with traditional opioid intravenous analgesia, there is still a lack of evidence in direct comparing the analgesic efficacy between ESPB and TPVB in abdominal surgery. Besides, most of previous studies just chose a single endpoint for postoperative pain evaluation and the follow-up period is often limited within 24 h after surgery.

c) **RLB – retrolaminar block**

Since PVB and ESP are also associated with the risk of complications such as pneumothorax, hypotension, or nerve injury, another block of fascia has been considered in recent years; the retrolaminar block (RLB).

RLB was first reported in 2006 as an alternative approach to PVB.(40) RLB is performed with US imaging or the landmark technique.

The traditional „blind“ approach is to prick the needle 1-1.5cm lateral to the target spinous process, to target with the needle tip the transverse process and then „walking the needle off“ in either the cephalad or caudal direction about 1 cm deeper or until a „pop“ is felt penetrating through the costotransverse ligament. With the paravertebral lamina approach, contact with the vertebral lamina is sought as the end point of needle localization. LA are injected on the lamina at dose of 20-30ml and can easily gain access to the paravertebral space through the porous costotransverse ligament.(41)

The US guided RLB is a modification of the lamina approach. The suggested ultrasound probe (low-frequency curvilinear transducer is recommended) orientation is sagittal-paramedian (cephalad-caudad direction) for in-plane visualization of the advancing needle tip. US scanning begin in a paramedian sagittal by findings the ribs 5-6 cm lateral to the spinous processes. The ribs have a round contour appearance, with appreciable pleural line located in between and typically less than 1 cm deeper. Sliding the scanning probe from lateral to medial, the transverse processes are identified next. The contour of the transverse processes usually appears more rectangular than that of the ribs; it is common to see a „step down" change with lateral to medial scanning when the transverse processes come into view from the ribs. Moreover, in the transverse process view, the costotransverse ligament can be visualized above the paravertebral space. Needle entry begins in plane, caudad, or cephalad until contact with the lamina is achieved under real-time US guidance. The LA is then injected with intermittent aspiration, while if resistance is encountered, the needle is retracted by 1 mm and injection is attempted again. (42, 43)

Dewing et al. investigate the analgesic efficacy of ESPB (performed at T8-T10 lamina with 30ml LA) compared to RLB (performed at T9 level with 30ml LA) in 106 retroperitoneal laparoscopic surgeries. In terms of the postoperative patient-reported pain control, their study demonstrated that both ESPB and RLB presented a stable and sustained analgesic effect within the 48 hours after surgery either at rest or cough state. The percentage of patients who used ephedrine was higher in the RLB group compared to the ESPB group (40.9% vs 19.0%, P=0.027). (17 patients vs.7 patients). They conclude that ESPB is more hemodynamically stable during surgery and that US-guided three-point RLB and single-point ESPB can provide safe and effective postoperative analgesia for retroperitoneal laparoscopic surgery. (44)

In order to approximate the idea of multimodal regional anesthesia, here are some suggestions based on examples from our clinical practice on how we apply high neuraxial anesthesia and fusion techniques using fascial blocks. In most cases, we achieve stable hemodynamics during anesthesia, but if necessary, we use vasoactive drugs for these purposes according to the clinical status of the patient.

e.g. 1 Fusion for total laparoscopic hysterectomy in 67-year-old woman, 90kg/167cm,
ASA IV (EF 29%, ST.p.IM STEMI, HA, CMP) – surgery time 160min:

a) CSE at T8 - T9 (needle through needle)
- spinal anesthesia (hyperbaric bupivacaine 10mg+ sufentanyl 2.5 micrgr)
- epidural catheter 4 mg dexamethasone and neuraxial sedation; start with it immediately after catheter placement (midazolam 5 mg+ketamine 50mg in volume of 20ml; perfusion rate 4ml/h – „Ramsay score 4")

b) on epidural catheter T8-9, every 45 minute 10ml LA bolus (e.g. 0.35% ropivacaine 3,75mg in 10ml NaCl, or lidocaine 1% 200mg in volume of 10-15ml)

d) 30 min before the end of the surgery stop with neuraxial sedation and start with postoperative epidural analgesia

e.g. 2 Fusion for abdominal laparotomy for Op.sec. Miles – Neoplasma recti in 64-year-old
patient 73kg/175 cm, ASA II – surgery time 180 min.:

a) spinal anesthesia at T9-T10 (single shot): -hyperbaric bupivacaine 12 mg + ketamine 25mg + dexmedetomidine 10 micrgr + sufentanyl 2.5 microgr

b) epidural catheter L1-L2 – 4 mg dexamethasone (used only for postoperative analgesia)

e.g. 3 Fusion for laparoscopic left hemicolectomy in 73-year-old ASA III patient
(COPD, HA, DM) – Surgery time 150 min.:

a) single shot spinal anesthesia at L2-L3
(hyperbaric bupivacaine 4mg + sufentanyl 2.5 micrgr)

b) ESP bilateral at T6 with ropivacaine 100mg /50ml (0.2%)

c) PVB bilateral at T5 with ropivacaine 80mg/20ml (0.4%)

d) dexmedetomidine i.v. – after an initial bolus of 0,5mcg/kg, continuous i.v. sedation at rate of 0.4-0.8 microgr/kg/h

e.g. 4 Fusion for laparoscopic tm-ovarii in 57-y-old ASA III woman (had recurrent
heart failure, COPD) - surgery time 130 min.:

a) ESP bilateral at T7 with ropivacaine 0.5% /40ml

b) single shot spinal anesthesia at T8-T9 (hyperbaric bupivacaine 10mg + dexmedetomidine 10mg+ ketamine 20mg + isobaric bupivacaine 2,5mg)

Conclusion

Peripheral trunk nerve block guided by ultrasound has changed the management ideas and strategies of clinical anesthesia. This technological revolution is no longer an occasional occurrence but has shown an irreversible trend in the application of modern anesthesia.

The advantages of these techniques are that they are easy to perform and have a low risk of severe complications. The anatomical investigations demonstrated that the distribution of the injectate in RLB and

ESPB follows the PVB pathway and the lateral pathway. Although the mechanisms of RLB and ESPB have not been fully explained, their clinical efficacy suggests that these blocks may be potentially useful for anesthesiologists. To establish RLB and ESPB as routine procedures in the clinical setting, high-quality RCTs will be essential in the future.

Based on our peer-reviewed series of cases and experiences, awake laparotomy under LA resulted safe and feasible. In selected patients, presenting fragile cardiovascular and respiratory reserves and in whom GA would presumably increase morbidity and mortality, we encourage neuraxial anesthesia supported by fusion technics as an alternative to GA.

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Sažetak

NOVI KONCEPT FUZIJSKIH TEHNIKA U REGIONALNOJ ANESTEZIJI

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Cilj ovog preglednog članka je uvesti noviji pristup multimodalnoj anesteziji. Osim uobičajene kombinacije epiduralnog katetera i opće anestezije kao standardnih tehnika u kirurškim zahvatima koji su popraćeni intenzivnom postoperativnom boli, želimo potaknuti promišljanje o primjeni različitih regionalnih tehnika u jednako složenim kirurškim stanjima. Jednostavnom modifikacijom standardne neuraksijalne tehnike s višim torakalnim pristupom, može se realizirati izvrsna abdominalna kirurgija kod budnog pacijenta. Međutim, postavljanje epiduralnog katetera nije uvijek moguće zbog tehničkih poteškoća ili stanja povezanih s pacijentom koja kontraindiciraju njegovo postavljanje. Blokovi fascije (PVB, ESPB, RLB) na razini trupa su jednostavnija i sigurnija alternativa epiduralnom kateteru jer se poprečni nastavak, koji je ciljno mjesto ultrazvuka, lako vizualizira, a mjesto ubrizgavanja udaljeno je od neuralnih struktura, pleure i velikih vaskularnih struktura. Osim toga, opsežna kraniokaudalna disperzija anestetika omogućuje široku pokrivenost jednom injekcijom. Potvrđeno je da PVB, ESPB i RLB blokovi djeluju na visceralnu i na somatsku bol; stoga njihova uporaba u laparoskopskim i drugim abdominalnim operacijama može biti korisna. Razvoj ultrazvučne tehnike omogućio je sigurniju i raznovrsniju primjenu blokova trupa u širem rasponu perioperativne analgezije. Dobro osmišljenom fuzijom regionalnih tehnika u operacijama gornjeg i donjeg abdomena moguće je ostvariti hemodinamski i respiratorno stabilnu anesteziju kod budnog bolesnika sa smanjenom razinom postoperativne boli.

Ključne riječi: *spinalna, epiduralna, UZV vođen blok, PVB, ESPB, RLB, abdominalna kirurgija*