

SPECIAL ARTICLE

Transversus abdominis plane block: a review of the technique and its efficacy

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ABSTRACT

Transversus abdominis plane (TAP) block is now a commonly used regional anesthesia technique. It can provide unilateral analgesia to the skin and muscles of lower abdominal wall. Original TAP block was introduced as regional abdominal field infiltration technique using landmarks. Use of ultrasound for TAP blocks enabled to perform safe and reliable block procedure. The indication for this block has been extended especially for lower abdominal surgeries. There are two concepts for TAP blocks. By subcostal to lateral TAP blocks, spread of local anesthetic is on the transvers abdominis plane. By, posterior TAP blocks including quadratus lumborum block, the target of local anesthetic is paravertebral space. The efficiency of these two techniques should be evaluated by prospective studies.

Key words: TAP block; Paravertebral space; Quadratus lumborum block; Ultrasound Guided Blocks; Abdominal Surgeries

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INTRODUCTION

The transversus abdominis plane (TAP) block is a commonly used regional anesthesia technique. It can provide unilateral analgesia to the skin and muscles of the lower abdominal wall. Currently, there are several TAP block approaches, including the lateral TAP block, posterior TAP block, subcostal TAP block, and ilio-inguinal TAP block.¹ A review of these techniques and their efficiency will be presented in the following sections.

ORIGINAL TAP BLOCK

The original TAP block was introduced as a regional abdominal field infiltration technique by McDonnell and colleagues. First, it was described in a case report,² which was later followed by a prospective randomised controlled trial.³ In their original technique, the needle insertion point was located in the triangle of Petit, which is surrounded by the external oblique abdominal muscle, the latissimus dorsi muscle, and the iliac crest (Figure 1). The needle was advanced without ultrasound guidance, while only relying on two pop sensations as the needle passed through the fascial layers underneath the external oblique and internal

oblique muscle.

The results were remarkable. The visual analogue scale (VAS) scores were lower in the TAP block group during the first 24 h after surgery, with a lower requirement of morphine in the first postoperative hours.³ This approach has proved useful in large bowel resections, caesarean section, and appendectomies.

However, the main complication of the TAP block is liver injury.⁴ Therefore, after the introduction of ultrasound-guided techniques, the indication of this block is now limited.

ULTRASOUND-GUIDED TAP BLOCK

The use of ultrasound for TAP blocks was introduced after the landmark technique. Shibata et al⁵ attempted the ultrasound-guided TAP block for gynaecologic surgery by injecting local anesthetic (LA) between the internal oblique muscle and the transversus abdominis muscle at the mid-axillary line, while Hebbard et al⁶ extended the TAP block for the supra-umbilical abdomen, as a subcostal TAP block.

The use of ultrasound for TAP blocks enabled the

performance of a safe and reliable block procedure, whose indication has been especially extended for lower abdominal surgery.

The 10th to 12th thoracic spinal nerves run between the iliac crest and the costal arch on the transversus abdominis muscle. By applying a lateral TAP block, LAs spread to the area, whereas a subcostal TAP block is used to achieve a more cephalad spread. To obtain a wider range of analgesia, in an oblique subcostal TAP block, also reported by Hebbard et al.⁷ A needle is inserted at the xyphoid and directed toward the anterior part of the iliac crest, along the oblique subcostal line using a 15–20 cm in length needle.

Three muscle layers are located on the lateral abdominal wall, including the external oblique muscle, internal oblique muscle, and transversus abdominis muscle, whereas on the upper abdomen, the rectus abdominis muscle lies above the transversus abdominis muscle (Figure 2).

Just lateral to the rectus abdominis muscle, there is only one muscle layer zone called the semilunar line. The 8th thoracic spinal nerve runs on the transversus abdominis muscle at the level on the subcostal line, at the semilunar line. An additional rectus sheath block is necessary if we want to cover the 6th thoracic spinal nerve, because it does not run on the transversus abdominis muscle. The 9th and subsequent thoracic spinal nerves run between the internal oblique muscle and the transversus abdominis muscle. The appropriate LA spread can be planned according to the procedure and LAs are then injected to the area. If the surgical incision is planned from the 8th to the 11th thoracic spinal nerve area, LAs should be injected from the semilunar line to the lateral abdominal wall. The effect of this block is unilateral analgesia to the skin and muscles. Therefore, in many cases, a block on both sides is necessary to achieve adequate analgesia for abdominal surgery. This block is not effective to avoid visceral pain. Therefore, additional opioid analgesia should be considered.

Recent studies in volunteers showed that the cutaneous sensory area of the TAP block after injection of 20 mL of 0.75% ropivacaine is predominantly located on a vertical line through the anterior superior iliac spine.⁷ The distribution of analgesia does not cross the midline and the block duration is approximately 10 h, albeit with large variations.

COMPLICATIONS OF ULTRASOUND-GUIDED TAP BLOCKS

Ultrasound-guided techniques have enabled safe and reliable block procedures, decreasing the incidence of liver and other visceral organ injuries. However, because TAP blocks use large amounts of LAs, the risk of LA toxicity is still possible. This issue is still under discussion as there have been numerous reports of patients in whom LA concentrations reached or were above systemic toxic levels. Therefore, careful attention should be paid to the total LA dose for each patient by calculating the appropriate concentrations within the maximum doses. In general, the maximum dose for ropivacaine and levo-bupivacaine is 3 mg/kg.

DISCREPANCY BETWEEN THE TWO TAP BLOCKS

After the development of the ultrasound-guided TAP block, anesthetists recognised that there was a discrepancy regarding the effect of the two TAP blocks.⁹ The classical landmark TAP block provides a wider range of analgesia and the duration of the effect is over 12 h (Table).

An ultrasound view revealed that by using the classical landmark TAP block, the LA was injected to the lateral end of the transversus abdominal muscle, and not between the internal oblique muscle and transversus abdominis muscle (Figure 3). This difference causes different analgesic effects. Furthermore, Carney et al⁹ evaluated the spread of LAs in four TAP block techniques, including the classical landmark TAP block, mid-axillary or so-called lateral TAP block, subcostal TAP block, and posterior TAP block. In the posterior TAP block, the LA was injected into the lateral end of the transversus abdominis muscle. The results were remarkable. In the mid-axillary TAP block, the LA spread between the internal oblique muscle and the transversus abdominis muscle at the lateral abdominal wall, whereas in the classical landmark TAP block and posterior TAP block, the LA spread into the posterior part of the transverse abdominal muscle and extended into the paravertebral space (Figure 4). Posterior TAP block enabled a wider range of analgesia, including a sympathetic nerve block, which provided longer duration of analgesia and visceral pain control.

The efficiency of the posterior TAP block over the lateral TAP block was evaluated by meta-analysis. The authors compared the efficiency of posterior TAP blocks and lateral (ultrasound-guided) TAP

blocks. The results showed that the posterior TAP block appeared to produce more prolonged analgesia than the lateral TAP block.¹⁰ However, no randomised controlled studies have been conducted yet to clarify the differences in the extent of analgesia between the two types of TAP block.

QUADRATUS LUMBORUM BLOCK

A novel concept in TAP blocks is the quadratus lumborum block (Figure 4). It targets an area around the quadratus lumborum muscle to achieve a more central spread of LA. The efficiency of this technique is described in some case reports especially in the field of paediatric anaesthesia,^{11,12} but its efficiency over previous techniques has not been evaluated by prospective studies so far.

TAP BLOCK FOR LAPAROSCOPIC CHOLECYSTECTOMY

The most common application of the TAP block is for laparoscopic cholecystectomy. However, since the position and number of laparoscopic ports differ between surgeons, the injection site of the LA must be planned according to the procedure. In general, as the largest port for endoscopy is around the umbilicus, the TAP block is aimed to target the area around T9 and T10 thoracic spinal nerves. For this purpose, a subcostal TAP block is the most recommended approach. For the other upper abdominal wall ports, an oblique subcostal TAP block is used to achieve a more cephalad spread of LA. Another option is the use of LA infiltration.

Basaran et al¹³ evaluated the bilateral oblique subcostal TAP block for laparoscopic cholecystectomy, after applying 20 mL of 0.25% bupivacaine on each side. VAS at rest and on movement were significantly lower after surgery, the postoperative requirement of tramadol was significantly reduced, and the respiratory function was well preserved in the group that received the bilateral oblique subcostal TAP block. These results support the postoperative usefulness of the TAP block after laparoscopic cholecystectomy.

TAP BLOCK AND LOWER ABDOMINAL SURGERY

Previous studies have demonstrated the efficiency of the TAP block after lower abdominal surgeries, including large bowel resection, caesarean delivery, and open appendectomy. Gynaecologic laparoscopic surgery is a good indication for the lateral TAP block, which is used as part of a

multimodal analgesic regimen. Kawahara et al¹⁴ evaluated the analgesic efficiency of the ultrasound-guided TAP block with a mid-axillary approach after gynaecologic laparoscopic surgery, and found that the TAP block successfully reduced postoperative pain at rest and on movement, as part of a perioperative multimodal analgesia approach.

TAP BLOCK AND GASTROSTOMY

Traditionally, postoperative pain control for gastrectomy is provided by thoracic epidural analgesia or intravenous opioids. Although epidural analgesia is still the gold standard for postoperative pain control, this technique is associated with complications. As the contraindications of epidural analgesia have increased in recent years, the TAP block appears to be a suitable alternative.

To provide analgesia to the supraumbilical abdomen, a subcostal TAP block is the appropriate approach. A previous study showed that the subcostal TAP block could block the range of the T7-T9 dermatome. Wu et al¹⁵ compared the analgesic efficiency of the subcostal TAP block, thoracic epidural analgesia, and intravenous opioid analgesia, by administering a single injection of 0.375% ropivacaine 20 mL on each side as a TAP block. A single-injection subcostal TAP block was more effective than intravenous opioid analgesia, while continuous thoracic epidural analgesia was more effective than the single-injection subcostal TAP block.

LIPOSOMAL BUPIVACAINE

The most exciting progress in LAs for TAP block might be the new liposomal formulation of bupivacaine (Exparel).¹⁶ This liposomal formulation was approved in 2011 for administration into the surgical site to produce postsurgical analgesia in the USA. After injection of Exparel into soft tissue, bupivacaine is released from the multivesicular liposomes over a period of time, enabling longer analgesic efficiency than conventional bupivacaine. Moreover, results from studies using Eparexel for TAP block, showed longer analgesic efficiency.

CONCLUSION

Today, two concepts for TAP blocks exist, ranging from the subcostal to the lateral TAP blocks, in which the spread of LA can be confirmed by ultrasound. Although this means that the analgesic effect is predictable, the analgesia range and duration are limited.

However, the posterior TAP blocks that include the quadratus lumborum block, achieve a wider analgesia range and longer duration, while also controlling visceral pain, but the effect is dependent on the type of procedure. Prospective studies should

be carried out in the near future to evaluate the efficiency of these two techniques, but at present, anesthetists should plan the procedure and choice of local anesthetics based on each individual case.

Conflict of interest: None declared by the authors

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