

# Transversus Abdominis Plane Block for Pediatric Postoperative Analgesia

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## Abstract:

Transversus abdominis plane (TAP) block is a promising effective method for postoperative pain control after surgery. Using a landmark technique, it is easily performed, but its popularity has decreased because of less efficacy due to inaccurate injection and the potential for intraperitoneal organ damage. Ultrasound-guided TAP block provides better results and less complications, but it requires experienced operators. Surgically administered TAP (sTAP) block is a simple technique and may cause less complications.

**Keywords:** TAP, Analgesia, Pain.

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## Introduction:

Regional anesthesia for abdominal wall procedures can be performed using a variety of peripheral nerve blocks. These blocks are typically ultrasound (US) guided and involves injecting a local anesthetic (LA) solution into interfascial planes. US-guided transversus abdominis plane (TAP) block implicates the injection of LA in between the transversus abdominis (TA) and internal oblique (IO) muscles. The TAP block can also be targeted using anatomical landmarks at the level of the Petit triangle. This interfascial plane contains the intercostal, subcostal, iliohypogastric, and ilioinguinal nerves. These nerves give sensation to the anterior and lateral abdominal wall as well as the parietal peritoneum, providing only somatic and not visceral analgesia (1).

The TAP block can be for postoperative analgesia management in open and laparoscopic abdominal surgeries as well as inpatient and outpatient surgical procedures. Unilateral left or right-sided blocks are used for unilateral surgical procedures, such as cholecystectomy, appendectomy, nephrectomy, or renal transplants, while bilateral TAP blocks are used for midline and transverse abdominal incisions, such as umbilical or ventral hernia repair,

cesarean deliveries, hysterectomy, and prostatectomy. TAP blocks are part of multimodal pain management for abdominal surgeries, which adds analgesic benefit to the patients, reducing postoperative opioid requirements. TAP blocks are usually placed intraoperatively, either before surgical incision or at the end of the procedure before emergence from anesthesia. The efficacy of the TAP block is dependent on the spread of LA across the interfascial plane. Newer tissue plane blocks like quadratus lumborum block provide visceral analgesia in addition to somatic analgesia (2).

The TAP block has become one of the most common truncal blocks performed for postoperative analgesia after abdominal surgeries (3).

### **Anatomy and Physiology**

Reviewing the anatomy of the anterior abdominal wall will result in a greater understanding of the neurovascular anatomy within the TAP block. The anterolateral abdominal wall has four muscles: the rectus abdominis, external oblique, internal oblique, and transversus abdominis muscles. The TAP anatomical compartment is a plane that is located between the internal oblique and transversus abdominis muscles and contains the T6–L1 thoracolumbar nerves (4).

The first description of the transversus abdominis plane block is accredited to Rafi in 2001, who advocated the performance of this block by anatomical landmarks at the level of the lumbar triangle of Petit. The Petit triangle edges are conformed by the iliac crest as the inferior edge, the latissimus dorsi as the posterior edge, and the external oblique as the anterior edge. The tip of the triangle is the rib cage (4).

### **Indications**

Provide analgesia after an abdominal wall procedure in a variety of abdominal surgeries are the indications of the TAP block. The TAP block can be performed for open abdominal surgeries as well as laparoscopic procedures. The TAP block is an easier and less risky substitute for epidural anesthesia in postoperative pain control for abdominal surgeries (5).

A unilateral block is used for a one-sided procedure, such as appendectomy, cholecystectomy, nephrectomy, and renal transplant (5).

Bilateral blocks are used for midline and transverse abdominal incisions, such as ventral hernia repair, umbilical hernia repair, exploratory laparotomies, colostomy closures, cesarean delivery, hysterectomy, radical retropubic prostatectomy, bariatric surgeries, inguinal hernia repair, and laparoscopic surgeries (5).

### **Contraindications**

This procedure is contraindicated in the following scenarios:

- Patient refusal

- Infection over the site of injection
- Allergy to local anesthetics
- Caution should be maintained in patients that are on therapeutic anticoagulation, pregnant and, where anatomical landmarks are difficult to distinguish (like very thin patients, elderly, or deconditioned) (6).

### Equipment

The following are the necessary materials to perform a TAP block (Image 1): (7).

Ultrasound machine with a linear transducer. (Sometimes a curvilinear transducer might be needed, if the patient is obese or if performing a posterior approach)

Sterile ultrasound probe cover sleeve

Sterile ultrasound gel

Sterile towels

Sterile gloves

Antiseptic for skin disinfection, such as chlorhexidine 2%

Nerve block needle (50-mm to 100-mm, 20-gauge to 21-gauge needle) with tubing

Two 20-mL syringes containing the local anesthetic solution

Local Anesthetic Agent: Ropivacaine, Bupivacaine or Liposomal Bupivacaine

One 5ml syringe containing lidocaine for skin local anesthesia (if the patient is awake)

Basic physiological monitors: EKG, pulse oximeter and blood pressure monitor

If performing the block in an awake patient: A 5-ml syringe with needle for skin infiltration with Lidocaine 1% local anesthetic

### Personnel

The TAP block should be performed by a skilled medical provider with regional anesthesia training, such as anesthesiologists. A second healthcare provider or nurse is required to perform a pre-procedure time-out and to assist during the procedure with the ultrasound and for the injection of local anesthetic while the anesthesiologist positions the needle and directs when and how much to inject (8).

### Preparation

Before performing a TAP block, the health care provider must:

Obtain informed consent for the procedure, discussing the possible risks, benefits, and alternatives for pain management.

The patient should have IV access before the procedure.

The patient should be monitored using continuous EKG, continuous pulse oximetry, and blood pressure cuff cycling every 5 minutes.

Position the patient supine and uncover the abdomen.

Prepare the area with an antiseptic solution to clean the skin of the anterolateral area of the abdomen (from the costal margin to iliac crest)

After prepping the area and let the antiseptic dry, place sterile towels surrounding the border of the procedural field

A pre-procedural time-out should take place prior to starting the procedure, including name, medical record number, date of birth, allergies, the procedure that will be performed and, laterality (9).

### **Technique or Treatment**

There are several TAP block techniques on how the TAP block compartment is identified:

Original landmark-guided TAP block at the level of the Petit triangle:

The blunt landmark-guided technique applies loss of resistance as the needle is advanced through the fascia layers of external oblique and internal oblique . After locating the triangle of Petit, the TAP is identified using the subjective double-pop loss of resistance technique. McDonnell et al. suggested that the first pop indicates penetration of the fascia of the external oblique muscle, and the second indicates piercing of the fascia of internal oblique and entry of the needle into the TAP .However, Rafi et al. suggested that the first pop indicates the needle has reached the plane between internal oblique and transversus abdominis, and the second pop indicates the needle has passed through transversus abdominis and thus the needle went too far. Currently, landmark-guided technique is no longer recommended because of ambiguity of the standard procedure sequence, small size and large variation of the lumbar triangle of Petit, and the risk of peritoneal perforation during the blind technique(10).



Fig (1):TAP block Landmark technique.

The ultrasound-guided TAP block that can be found anatomically in the subcostal, lateral, and posterior approach. The surgeon may perform a laparoscopic-guided TAP block visualizing from inside of the abdominal cavity and feeling 2 "pops" or loss-of resistance with the needle from outside of the abdomen during surgery (11).

The ultrasound-guidance technique is considered the gold standard in TAP blocks because it is easy for the operator to acquire ultrasound images and safe for the patient to perform the procedure under direct visualization of the needle before the injection of LA. For these techniques, the patient should be positioned supine for most of these approaches, except for slight lateralization for the posterior approach in some cases. A high-frequency linear or curvilinear ultrasound transducer should be used and placed in the abdomen with gel for adequate contact and transmission of the ultrasound waves (11).

In the ultrasound image visualized the most superficial layer is skin and subcutaneous fat, then there are three muscular layers, from superficial to deep: external oblique, followed by the internal oblique, and lastly, the transversus abdominis muscle. The internal oblique muscle is usually the thickest muscle layer in the majority of patients, while the transversus abdominis muscle is the thinnest. If uncertain of the layer borders, increase the depth of the ultrasound to confirm bowel beneath the transversus abdominis muscle. Scanning posteriorly, the internal oblique and transversus abdominis muscles show the two layers come together to form the thoracolumbar fascia. Scanning medially, the aponeurosis of the three muscle layers come together to form the rectus sheath. Upon identifying the TAP compartment with the ultrasound probe, infiltrate the patient's skin using lidocaine (if the patient is awake), penetrate the skin with the block needle using an in-plane technique, making sure to visualize the needle tip on ultrasound throughout its entire trajectory. Upon entering the plane between the internal oblique and the transversus abdominis muscles, and after negative aspiration of blood, the LA is slowly injected. The TAP compartment will begin to separate, hydrodissect, or "unzip" as the LA is injected, pushing the transversus abdominis muscle down. Usually, an injection of 15 to 20

ml of LA is recommended for each side for an adult patient. The dose and volume depend on the patient's weight as well as the concentration of the LA. The spread of LA along the TAP compartment is responsible for the success of the block. Studies had shown that the efficacy of the block is improved when injecting 15 ml or more (12).

There are three approaches for ultrasound-guided TAP block to target the compartment anatomically:

**Subcostal approach:** Targets the TAP compartment in the anterior abdominal wall, beneath the costal margin. The high-frequency probe should be located in the lower margin of the rib cage between the xiphoid process and the anterosuperior iliac spine at the level of the anterior axillary line. The objective is to deposit the LA in the plane among the transversus abdominis muscle and the posterior rectus sheath. The needle should be inserted above the rectus abdominis muscle and advanced it until it is positioned between the anterior edge of the transversus abdominis muscle and posterior rectus sheath. This area is covered by T6-T9 dermatomes, blocking the anterior cutaneous nerves. The anterior approach is used to provide analgesia for open or laparoscopic cholecystectomy surgeries (13).

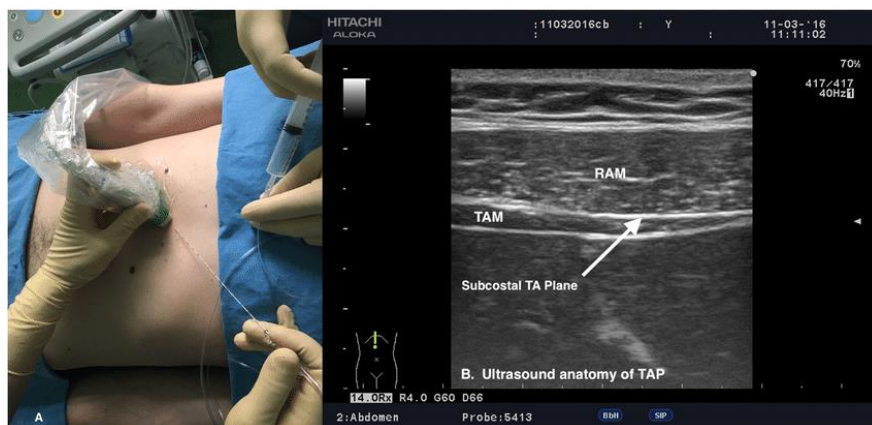


Fig (2):US guided TAP block Subcostal Approach.

**Lateral approach:** Targets the TAP compartment in the lateral abdominal wall. The high-frequency probe should be located in the midaxillary line between the bony prominences of the subcostal margin and the iliac crest. The three muscular layers in the abdominal wall muscles should be visualized. The objective is to deposit the LA in the plane among the transversus abdominis muscle and the internal oblique muscle. The needle should be inserted and advanced until it reaches the TAP plane. This area is covered by T10-T12 dermatomes, blocking the anterior cutaneous nerves. The lateral approach is used to provide analgesia for most abdominal surgeries, including laparoscopic surgeries, open appendectomy, ventral hernia repair, umbilical hernia repair, exploratory laparotomies, colostomy closures, cesarean delivery, hysterectomy, bariatric surgery, and radical retropubic prostatectomy among others(14).

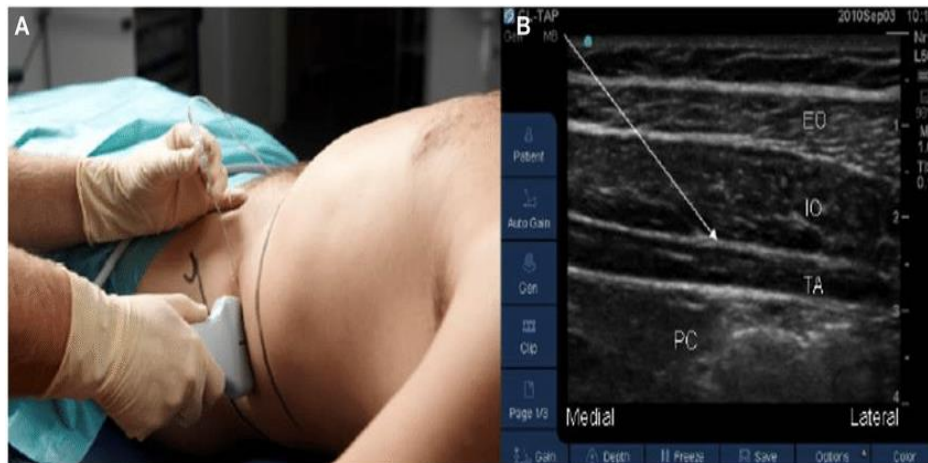


Fig (3):US guided TAP block Lateral Approach.

**Posterior approach:** Targets the TAP compartment at the level of the lumbar triangle of Petit or the anterolateral aspect of the quadratus lumborum muscle. The high-frequency probe should be located in the midaxillary line and then displaced lateral and posteriorly to the end limit of the three muscular layers. The objective is to deposit the LA in the plane among the transversus abdominis muscle and the internal oblique muscle but in the posterior end limit of the TAP plane. The needle should be inserted in the midaxillary line and advanced posteriorly until it reaches the TAP plane. This area is covered by T9-T12 dermatomes, blocking the anterior and lateral cutaneous nerves. The posterior approach is used to provide analgesia for nephrectomies, renal transplants, and others (15).

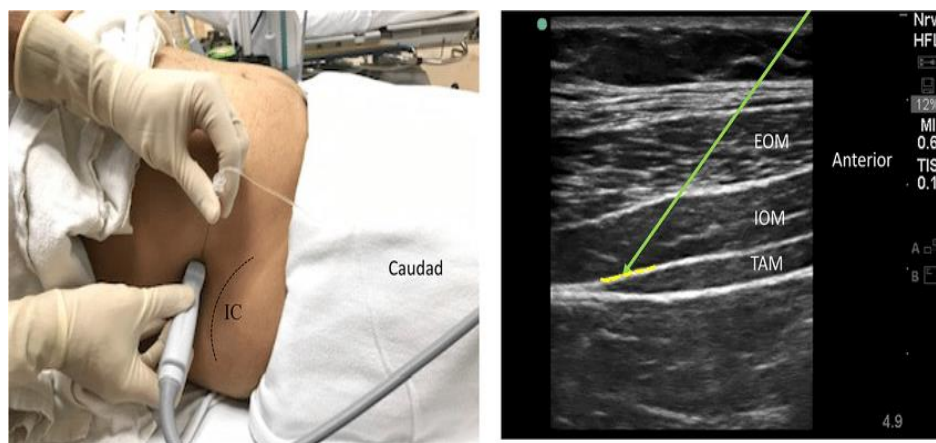


Fig (4):US guided TAP block Posterior Approach.

### Complications (16).

Complications related to TAP blocks are rare. Some complications have been reported in the literature, including:

- Bowel perforation
- Hematoma

- Liver/Spleen laceration
- Intrahepatic injection
- Intraperitoneal injection of local anesthetic
- Retroperitoneal hematoma due to vascular injury
- Transient femoral nerve blockage
- Local infection
- Intravascular injection
- Local Anesthetic systemic toxicity

It is recommended to utilize ultrasound guidance rather than anatomical landmarks to increase the success rate and minimize these complications. There have been minimal reported complications after the universal implementation of the ultrasound-guided technique for the TAP block.

Neurological injury is rare in TAP blocks, because these are field blocks, relying on the high volume of the local anesthetic injected to facilitate adequate blockade of the nerves that are located in the compartment, rather than targeting a specific nerve. If a neurologic injury occurs might be from direct nerve trauma from the needle, hematoma, or local infection. Excessive needle insertion, especially in thin, elderly, or deconditioned patients may also lead to complications such as visceral trauma, vascular injury, intraperitoneal injection, or intrahepatic injection.

### **Clinical Significance**

With the advent of US-guidance, there has been a surge in popularity for the TAP block, now being highly used for postoperative analgesia management following abdominal surgery. The TAP block is used as part of the multimodal analgesia management for abdominal surgeries that include the use of at least two non-opioid analgesic agents (e.g., acetaminophen, non-steroidal anti-inflammatory drug, gabapentinoids, IV lidocaine, ketamine or local anesthetic wound infiltration) in addition to oral or parental opioids (17).

The benefits of the TAP block includes a reduction in opioid requirements in the postoperative period and a decrease in postoperative nausea and vomiting, but no difference in visual analog pain scale scores. The TAP block has become an important addition to the clinicians because of its safety profile, ease to perform, effectiveness for pain control in a multimodal pain management approach with an increase in patient satisfaction, and in reducing the contribution to the world opioid crisis (18).



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