



INTRAPERITONEAL VERSUS ULTRASOUND GUIDED TRANSVERSUS ABDOMINIS PLANE BLOCK BY MAGNESIUM SULPHATE FOR PAIN RELIEF AFTER LAPAROSCOPIC CHOLECYSTECTOMY

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Abstract

The removal of a gallbladder due to disease can be accomplished with laparoscopic cholecystectomy, a minimally invasive surgical procedure. Since the early 1990s, this method has largely superseded the open method for performing regular cholecystectomies. Cholecystitis (acute/chronic), gallstone pancreatitis, biliary dyskinesia, symptomatic cholelithiasis, acalculous cholecystitis, & gallbladder masses/polyps are all conditions for which laparoscopic cholecystectomy is currently recommended. The mainstay of care for individuals with gallbladder cancer is an open cholecystectomy. The gallbladder is located underneath liver segments 4b & five on the underside of the liver. The physiological capacity of the gallbladder is 50 cc of fluid (bile), as well as its maximum length is ten centimeters. The body through the digestive process absorbs magnesium, a positively charged divalent cation. Magnesium sulfate (MgSO₄) has an antinociceptive effect, making it effective in chronic pain; it does this by decreasing the influx of calcium into the cell and by blocking the activity of N-methyl-D-aspartate (NMDA) receptors, which play a crucial role in pain processing and neuronal communication in the brain. Magnesium sulfate blocks both somatic and visceral pain pathways, leading to less discomfort after surgery. After abdominal surgery, it is normal for patients to experience pain in the abdominal wall. Transversus abdominis plane (TAP) blocks, which utilize ultrasound, can effectively alleviate somatic incision pain. When combined with other pain relief methods, Transversus abdominis plane blocks are highly effective.

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Introduction

The removal of a gallbladder due to disease can be accomplished with laparoscopic cholecystectomy, a minimally invasive surgical procedure. Since the early 1990s, this method has largely superseded the open method for performing regular cholecystectomies. Symptomatic cholelithiasis, Cholecystitis (acute/chronic), biliary dyskinesia, gallstone pancreatitis, acalculous cholecystitis, as well as gallbladder masses/polyps are all conditions for which laparoscopic cholecystectomy is currently recommended. Open cholecystectomy is the gold standard for treating gallbladder cancer. Gallstones affect over 20 million people in the US. About 300,000 cholecystectomies are done annually among this population. Asymptomatic gallstones affect ten to fifteen percent of the population. The symptomatic percentage (biliary colic) is 20 percent. Complications (gallstone pancreatitis, acute cholecystitis, choledocholithiasis, gallstone ileus) affect among one & four percent of the symptomatic twenty percent (1).

Magnesium was first used for therapeutic purposes in the early 17th century. Epsom salt, of which

magnesium sulfate is the main component, has been utilized to alleviate gastrointestinal distress, incontinence, & strained muscles. Magnesium is frequently utilized for the prevention and treatment of pain in modern medicine (2).

Research into the mechanisms behind the development and upkeep of central sensitization in response to nociceptive stimulation has long focused on N-methyl-d-aspartate receptors. Two of the most common drugs used to block NMDA receptors are magnesium & ketamine. Numerous research have looked into magnesium's potential as an adjunct analgesic due to its ability to regulate calcium entry into cells through antagonizing N-methyl-d-aspartate receptors receptors. In the treatment of postoperative pain & other types of chronic as well as acute pain, NMDA receptor antagonists have recently been presented as a viable option (3).

Alternative pain treatment has increased in popularity as a response to the rising incidence of opioid-related side effects & deaths. Regional anesthetic that is guided by ultrasonography is becoming increasingly common for the treatment of acute pain. After abdominal surgery, it is normal for

patients to experience pain in the abdominal wall. Transversus abdominis plane blocks, which utilize ultrasound, can effectively alleviate somatic incision pain. When combined with other pain relief methods, TAP blocks are highly effective. TAP blocks are effective for neuropathic pain; however, they may not be enough for visceral pain. Among the transversus abdominis and internal oblique muscles is a potential anatomical region called the thoracic aortic space (TAS), into which local anesthetic might be administered to provide a non-dermatomal "field block." (4).

Laparoscopic Cholecystectomy

Gallstones are more common in older people, and women have a higher risk of developing them than

men do. From the ages of 50 & 65, gallstones affect approximately twenty percent of women & five percent of males. Cholesterol makes up approximately seventy-five percent of gallstones, whereas pigments account for the other twenty-five percent. There is no distinction in the clinical manifestations of gallstones based on their composition (5).

By using this method, harm to the bile duct was reduced (Figure 1). **Lo et al.** (6) first documented early LC in individuals with acute cholecystitis three years later. When compared with interval cholecystectomy, these findings demonstrated fewer problems & a shorter length of stay in the hospital (7).

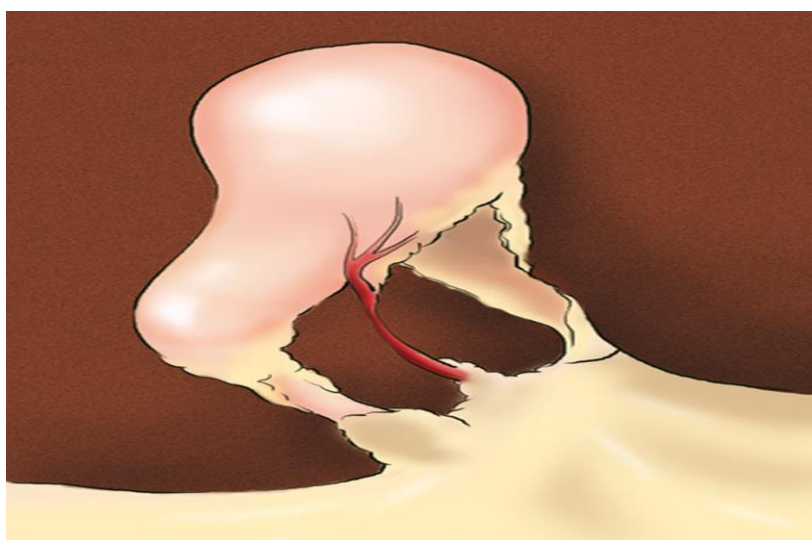


Figure 1. Critical view of safety for laparoscopic cholecystectomy (7).

Anatomy and Physiology

The gallbladder is located underneath liver segments 4b & five on the underside of the liver. The physiological capacity of the gallbladder is 50 cc of fluid (bile), as well as its maximum length is 10 cm. The liver is allocated into right and left lobes by a line running from the gallbladder to the inferior vena cava. The gallbladder is divided into the fundus, the body, the infundibulum, and the neck. The anatomy

of the biliary ducts varies greatly amongst individuals. The cystic duct normally branches off from the common bile duct & enters the gallbladder through its neck. The common hepatic duct begins at the place where the cystic duct branches off from the common bile duct, which is located in the upper part of the liver. The cystic artery, which ninety percent of the time branches off the right hepatic artery, supplies the gallbladder with blood (8).

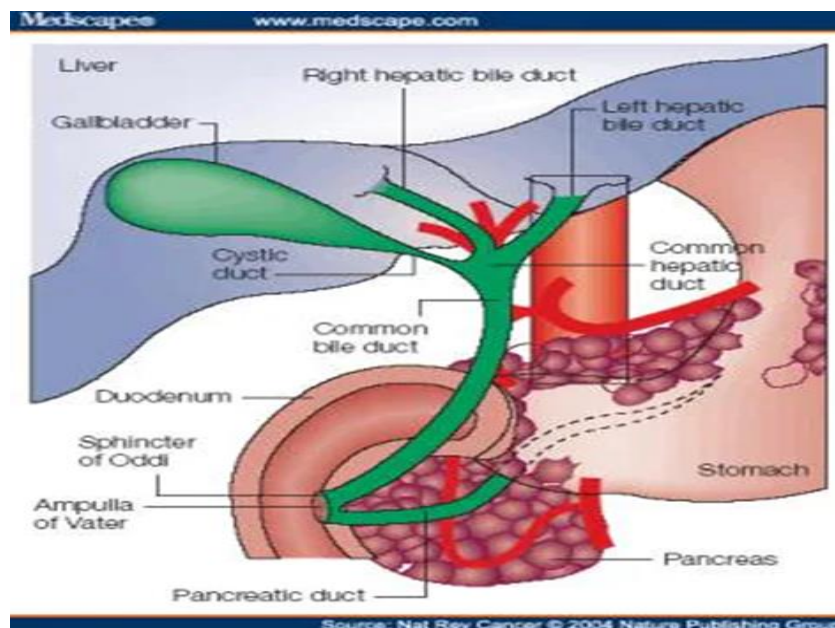


Fig 2 Anatomy of biliary tree.

Clinical Significance

Gallbladder dysfunction along with highly concentrated bile are thought to play a role in the development of gallstones. Stomach-related physiological changes (vagal input from antral distension, cholecystikinin, and migrating myoelectric complex) trigger gallbladder emptying. An excess of cholesterol in the gallbladder commonly causes cholesterol gallstones. Hemolytic disorders (causing black stones) and infections (causing brown stones) are the most common causes of pigmented stone formation due to the breakdown of bilirubin by bacterial enzymes. Gallstones are more likely to occur when the bile ducts or gallbladder become blocked (1).

Indications: Symptomatic cholelithiasis, Cholecystitis (Acute/Chronic), Acalculous cholecystitis, biliary dyskinesia (hypofunction or hyperfunction), Gallstone pancreatitis, Gallbladder masses/polyps

Contraindications: **A: related to difficulty of the surgical technique** (Diaphragmatic hernia, Large intra-abdominal masses, History of extensive surgery or adhesions, Morbid obesity, Peritonitis, Tumor of the abdominal wall, Coagulopathies & Surgeon inexperience (is the strongest contraindication), **B: related to difficulty of the anesthetic techniques** (Severe cardiovascular or pulmonary diseases (including bullae), Impending renal shutdown, Enlarged intracranial pressure or space occupying lesions, Hypovolemic shock, Sickle cell disease (since acidosis may precipitate sickle crisis), & Patients receiving B blockers and **C: Patient refusal**

Symptomatic gallstone disease

The most prevalent reason for an elective laparoscopic cholecystectomy is biliary colic with

stones that can be seen on a Sonogram. If acute cholecystitis is identified within seventy-two hours of the onset of symptoms, laparoscopic treatment is an option and often the preferred method of care. Dissection planes are thought to be more challenging after the 72-hour mark due to inflammatory changes in the surrounding tissues. As a result, the possibility of switching to an open operation may rise to 25%. This 72-hour threshold is not supported by randomized controlled trials, which also found no variance in mortality. Percutaneous cholecystostomy & interval laparoscopic cholecystectomy (performed four to six weeks after the initial procedure) are two further alternatives (9).

Equipment (10): There are two laparoscopic displays, Trocars ranging in size from 5 mm to 12 mm (usually three 5 mm functioning trocars along with a ten to Twelve mm trocar), a laparoscope with a camera cord & light source (0/30 degrees), a carbon dioxide source, also insufflation tubing. Retrieval bag, clip applier, electrocautery (hook, spatula), Maryland graspers, atraumatic graspers, clip applier, Possible conversion tools include a scalpel (11/15 blade), needle driver, forceps, absorbable sutures, as well as a Major open tray.

Preoperative assessment (10): Preoperative medical optimization is essential. Antibiotics prescribed before surgery should be given no later than thirty minutes after incision. Just above the bilateral costal borders, down to the pubic tubercle, & laterally to the right and left sides is an aseptic surgical field .

Perform a complete history & physical examination, paying close attention to the abdomen & looking for the "Murphy's Sign."

Imaging (10): Right upper quadrant abdominal ultrasound, ERCP, MRCP, & HIDA Scan can all detect gallstones, polyps, sludge, in addition to masses in the gallbladder, as well as measure the

gallbladder wall thickness, common bile duct width, & the presence or absence of pericholecystic fluid.

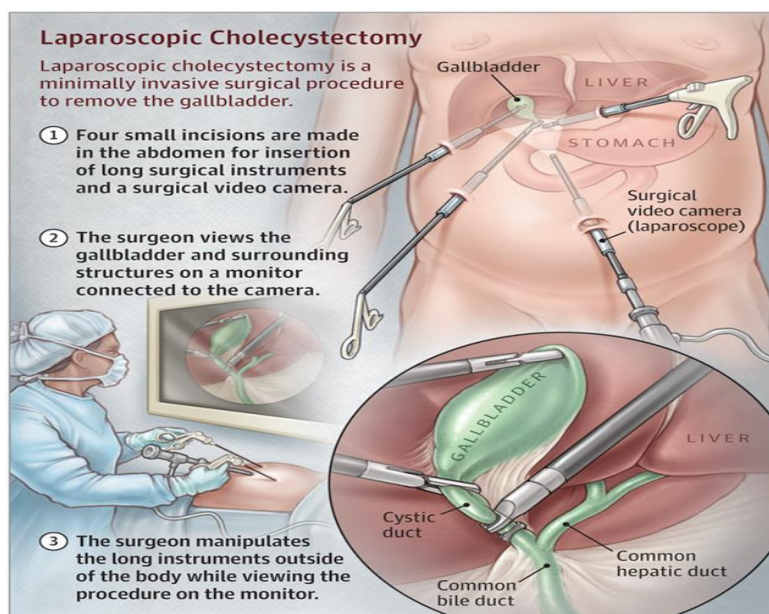


Fig 3 Laparoscopic Cholecystectomy (11).

Monitoring

Keeping a close eye on those attending the clinic, especially those with subcutaneous emphysema, congestion of the neck, upper chest, head as well as eyes, Controlling the temperature, Capnography, central venous pressure, Maximum airway pressure, along with an esophageal or precordial stethoscope.

Technique

Once general anesthesia has been administered & the individual has been intubated, laparoscopic cholecystectomy can commence. To begin, a 15-mmHg carbon dioxide insufflation of the abdomen is achieved. The next step is to make four tiny incisions in the abdomen (subxiphoid x1, supraumbilical x1, & right subcostal x2) to insert the trocar (10).

Complications

Bleeding, infection, & adjacent structure damage are just some of the most frequently encountered consequences. Due to the liver's high blood vessel density, bleeding is a common consequence. In order to avoid serious blood loss, even experienced surgeons need to be familiar with common artery abnormalities. Iatrogenic common bile/hepatic duct damage is the most alarming consequence. If either of these organs is damaged, the bile must be redirected through additional surgery before it may enter the intestines. A specialized hepatobiliary surgeon is typically needed for this operation (12).

Outcomes

The mortality rate for laparoscopic cholecystectomy is still quite low, among 0.22 to 0.4 percent. Only around five percent of individuals

do not make a full recovery. The following are examples of complications (13).

Magnesium Sulphate

Magnesium Metabolism

Magnesium, a positively charged divalent cation, is absorbed by the body through the digestive process. Renal reabsorption & excretion play a major role in regulating serum magnesium levels. Magnesium is excreted during hypercalcemia & hypermagnesemia, but is reabsorbed by the cortical thick ascending limb in response to parathyroid hormone. The optimal concentration of magnesium in the blood is amongst 0.7 besides 1 mmol/L (1.4 and 2.0 meq/L), however nearly half of the magnesium in the body is stored in the skeleton. (14).

Physiological Role of Magnesium

Magnesium contributes to ion transport & membrane homeostasis, for example. Glycolysis, the Krebs cycle, and additional metabolic pathways all require magnesium as cofactors for the activation of enzymes. By acting indirectly at the neuromuscular junction, intracellular magnesium is essential for neurochemical transmission and muscle contractions. In particular, the distribution of calcium absorption and release is impacted by the competition between Mg^{2+} ions on voltage-gated calcium channels. Parathyroid Hormone (PTH) can be stimulated or suppressed by magnesium, hence influencing calcium metabolism (15).

Magnesium and Perioperative Pain

Magnesium serves an important role in many of the body's physiologic processes. As a result, reviews, many studies, & meta-analyses have been conducted in the field of anesthesiology. Magnesium's analgesic effects were studied in detail to see if they could enhance surgery participants' recoveries (16).

Magnesium sulphate attenuates arterial pressure increase during laparoscopic cholecystectomy

Hypermagnesemia

When serum magnesium values are above two mmol/L, a condition known as hypermagnesemia exists. Extremely high amounts of exogenous magnesium or renal insufficiency are usually required for its manifestation. High amounts of circulating magnesium caused suppression of calcium influx through the voltage-gated channels, leading to clinical symptoms of neuromuscular blockade or vasodilation (17).

Hypomagnesemia

Serum magnesium values under 0.7 mmol/L are considered indicative of magnesium deficiency. Usually brought on by poor reabsorption because of intestinal malabsorption or renal dysfunction. Neuromuscular irritability can occur when competitive inhibition at the neuromuscular junction is lost due to low magnesium levels, allowing for greater acetylcholine release. (18).

Administration

Oral, intraosseous, intramuscular, & intravenous routes are all viable options for delivering magnesium sulfate to the body. Magnesium sulfate has 98.6mg (or 8.12Eq) of magnesium per 1g (or 1 gram). Magnesium sulfate intravenous solutions are prepared by mixing the salt with either five percent dextrose or water (15).

Adverse Effects

Individuals frequently report mild facial flushing & warmth upon administration, although these symptoms usually subside on their own. Cases with neuromuscular diseases like myasthenia gravis may experience a worsening of neuromuscular function at therapeutically feasible drug concentrations. Smooth muscle inhibition causes a transitory vasodilatory action, which might lead to acute hypotension if taken rapidly or in large dosages. Symptoms of hypermagnesemia may manifest clinically if the patient is receiving a continuous infusion of magnesium sulfate. Absent reflexes, aberrant cardiac conduction, as well as muscle weakness may result at suprathreshold serum concentrations (19).

Muscle Relaxation

Magnesium increases the effectiveness of a nondepolarizing neuromuscular blocker by inhibiting calcium channel activity at presynaptic nerve terminals and decreasing acetylcholine release at the motor endplate, both of which decrease muscle fiber excitability. Some researchers have highlighted how magnesium directly improves

neuromuscular blockade. However, other researchers found that patients needed less nondepolarizing neuromuscular blockers when magnesium sulfate was given as an adjuvant after surgery. (20).

Kim et al. (21) it was discovered that using magnesium sulfate in conjunction with rocuronium priming resulted in significantly enhanced rapid-sequence intubating circumstances. This was in comparison to using either magnesium sulfate or priming on their own.

Monitoring of mg level in blood includes: Normal plasma level is 1.5-2 mEq/L & Therapeutic level is 4-7mEq/L.

Judgement of the therapeutic level: The deep tendon reflex, sometimes known as the knee jerk, must be present but inactive. Its absence indicates impending toxicity, which happens at a concentration of 10 mEq/L; the respiratory rate should be over 10–12 breaths per minute; and the urine production should be above thirty milliliters per hour.

Effect of Magnesium Sulphate on Postoperative Pain

After major lumbar surgery, patients in the magnesium group reported less pain as well as opiate use, better sleep the first night, as well as higher levels of satisfaction overall. (22)

Rapid vasodilation & attenuation of agonist-induced vasoconstriction are both effects of acute magnesium delivery, while removal of magnesium increases peripheral vascular resistance. (23).

Transversus Abdominis Plane Block

Anatomy and Physiology

The iliac crest, pubic crest, inguinal ligament, as well as symphysis form the superior boundary of the anterolateral abdominal wall, whereas the costal margin of the seventh to tenth ribs in addition to the xiphoid process define the inferior boundary. The external oblique, the internal oblique, & the transversus abdominis are the muscles that make up the anterolateral abdominal wall, from the surface to the deep layers. It is the fascial plane that runs between the transversus abdominis and internal oblique muscles that is known as the transversus abdominis plane. The thoracoabdominal nerves, along with the ilioinguinal also iliohypogastric nerves, all connect to form both the lower & upper TAP plexuses, which innervate the anterolateral abdominal wall. Therefore, numerous injections must be done to cover the nerves of T6-L1 in order to obtain complete anesthesia of the abdominal wall (24).

Indications

Common indications for Transversus abdominis plane blocks include: Major abdominal operation, procedures affecting the abdominal wall, hernia repairs, colorectal surgeries, & cesarean sections are all examples of abdominal procedures that are considered major abdominal surgeries (25).

Contraindications

Contraindications to TAP blocks include the following (25): Refusal from the individual being treated, infection that is active over the site of the injection, Caution should be exercised when treating patients who are taking anticoagulants, when treating pregnant patients, and when treating patients whose anatomical landmarks are difficult to detect. Persons who are known to be allergic to local anesthetics should also be avoided.

Equipment

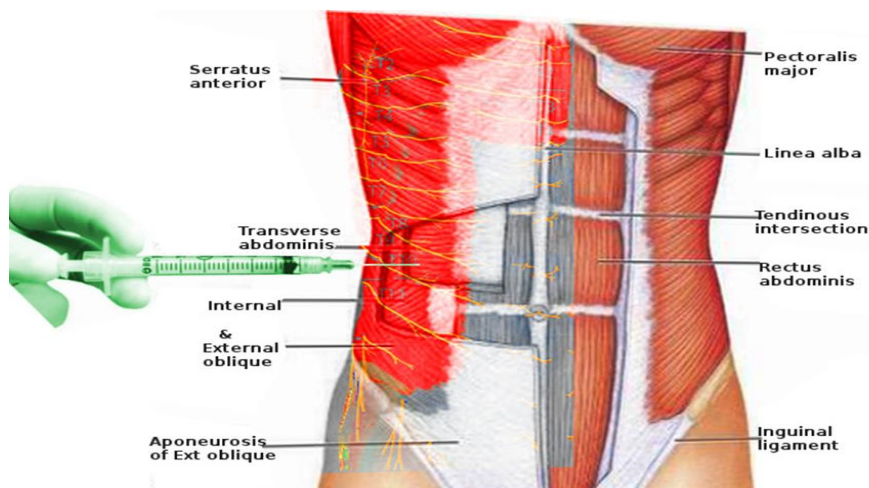
Materials for ultrasound-guided Transversus abdominis plane blocks include the following (25): 27- to 30-gauge 1.5-inch needle, A 5-ml syringe, A 20-mL syringe, Sterile gloves & towels, Anesthetic agent, Local anesthetic for skin infiltration for example one percent lidocaine with no epinephrine, Skin cleaning agents for example A pulse oximeter, chlorhexidine two percent, EKG monitor, in addition blood pressure monitor, sterile ultrasound transducer cover, Ultrasound, also ultrasound gel, Block needle: preferentially twenty to twenty two-gauge, five to fifteen cm

Preparation

The doctor is obligated to have a conversation with the patient about the potential hazards, advantages, and alternate treatments before obtaining the patient's informed consent. The individual needs to have a continuous electrocardiogram, continuous pulse oximetry, & blood pressure cuff cycling at regular intervals of no more than five minutes. Before beginning the operation, a person needs to have access to an IV (25).

Technique

Because of the widespread availability of ultrasonography machines & their contribution to the increased safety as well as dependability of regional anesthetic blocks, landmark-based TAP blocks are not a typical choice. Rafi was the first person to describe the landmark-based method. The practitioner needs to be able to recognize the lumbar triangle of Petit by using surface landmarks. This triangle is defined as being confined medially by inferiorly by the iliac crest, the external oblique, as well as posteriorly by the latissimus dorsi (26).



**Figure 4: Transversus abdominis plane. Image courtesy O.Chaigasame (25).
Lateral TAP Block**

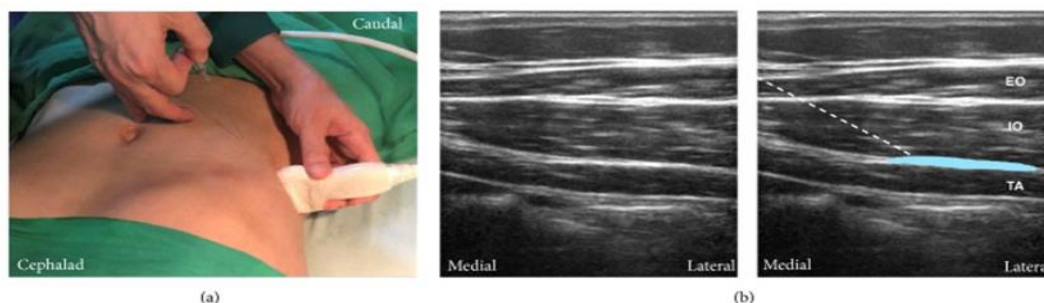


Figure 5: Lateral approach of transversus abdominis plane block. (27).

Posterior TAP Block

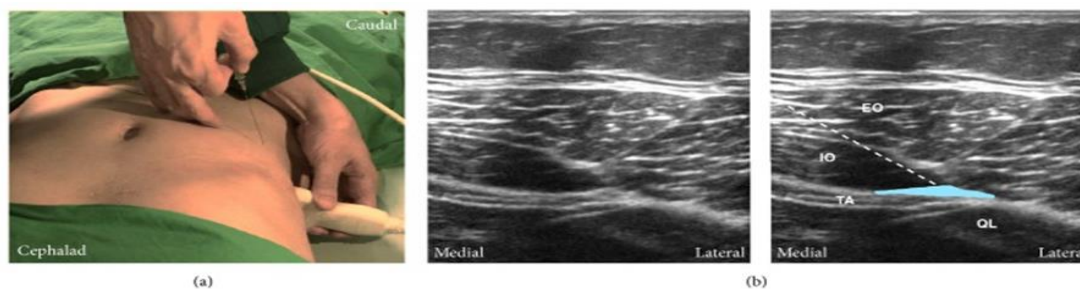


Figure 6: Posterior approach of transversus abdominis plane block. (28).

Oblique Subcostal TAP Block

The original subcostal Transversus abdominis plane block, which was presented for the first time by **Hebbard et al. (24)**, served as the basis for the development of the oblique subcostal TAP block.

Complications

Transversus abdominis plane blocks almost seldom lead to complications of any kind. Because abdominal wall blocks are field blocks that rely mostly on the amount of the local anesthetic to achieve appropriate blocking rather than targeting a specific nerve, neurological damage is uncommon because abdominal wall blocks are field blocks. Direct nerve trauma from the needle, hematoma, or local infection are all potential causes of neurologic impairment that can occur. An excessive amount of needle insertion can result in a variety of problems, including visceral trauma, intraperitoneal injection, vascular injury, & liver trauma. There has also been talk of a temporary femoral nerve palsy in the reports (29).

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