Utilization of Subcostal Transversus Abdominis Plane Block for Control of Pain After Laparoscopic Cholecystectomy

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Abstract

Laparoscopic cholecystectomy (LC), unlike laparotomy, is less invasive surgical procedure, and some patients report mild to moderate pain after surgery. Transversus abdominis plane (TAP) block has been shown to be an appropriate method for postoperative analgesia in patients undergoing abdominal surgery. However, there have been few studies on the efficacy of TAP block after LC surgery, with unclear information on the optimal dose, long-term effects, and clinical significance, and the analgesic efficacy of various procedures. TAP block has been shown to provide good postoperative analgesia as it provides analgesia to the skin, muscles and parietal peritoneum of the anterior abdominal wall from T7 to L1. It has multiple benefits as it decreases prolonged stay in the PACU, improve patient comfort and may improve compliance with postoperative care such as ambulation and respiratory exercise

Keywords: transversus abdominis plane block

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Introduction

The parietal, visceral, incisional, and referred areas may experience modest postoperative discomfort after laparoscopic cholecystectomy (LC), a minimally invasive method [1]. Patients with this condition typically undergo a combination of patient-controlled intravenous analgesia, epidural analgesia, and intraperitoneal injection of local anesthetics (LA) [2]. This method includes the well-known transversus abdominal plane (TAP) block for postoperative analgesia in laparoscopic abdominal surgery [3]. Reducing or eliminating the need for analgesics and having fewer side effects, such as postoperative nausea and vomiting (PONV), are all benefits of TAP block, which is a safe

procedure [4]. Furthermore, there are a number of doctors that are working to make ultrasonography LA absorption more accurate [5,6,7,8]. Therefore, this novel method has proven that laparotomy and laparoscopic operations are effective in reducing pain [9].

Rafi [10] pioneered the TAP block in 2001 as a historically guided practice for achieving a field block through the petit triangle. In this procedure, a solution (LA) is injected further into the plane between the obliquus internus and transversus abdominis muscles. The thoracolumbar nerves travel through this plane after exiting the T6 to L1 spinal roots, directing sensory nerves to the anterolateral abdominal wall [11]. The propagation of LA in this plane blocks neurological afferents and provides analgesia to the anterolateral abdominal cavity. TAP blockades are becoming technically easier and more feasible as ultrasound technology advances. As a result, curiosity about TAP blocks as a clinical tool for analgesia after abdominal surgical treatment has increased. The most commonly reported pain during laparoscopic cholecystectomy was of moderate to severe intensity [12].

TAP blocks are effective for a number of abdominal practices, including hysterectomy, cesarean section, cholecystectomy, colectomy, hernia repair, and prostatectomy [10,13,14,15]. Since the analgesic effect is limited to somatic pain and has a short life span [16], a single TAP blockade is efficient in multimodal analgesia. TAP blockades could solve the problem of limited duration by continuous infusion [17,18] or prolonged release of liposome's LA [19]. In contrast, clinical studies on TAP block yielded negative results [20,21]. Consequently, analgesic consistency, duration of analgesia, patient comfort, and different corporate strategies need further analysis. Numerous regional anesthetic adjutants such as Dexmedetomidine, Clonidine, Epinephrine, and Dexamethasone are usually combined with enhancement of analgesic efficacy and length chains [22,23].

Most patients undergoing laparoscopic cholecystectomy experience pain in the first 24 h after surgery, with port sites being the most painful. After laparoscopic surgery, pain is mainly felt as visceral pain due to the trauma of gallbladder resection and parietal pain due to skin incision [24]. However, the frequency and intensity of incisional pain were higher than visceral pain after laparoscopic cholecystectomy. Therefore, to optimize postoperative pain control in these patients, analgesic studies should focus on reducing incisional pain.

In human anatomy, the layers of the abdominal wall are (from superficial to deep):

Skin. 2- Subcutaneous tissue. 3- Fascia. Camper's fascia: Thick fatty superficial layer. Scarpa's fascia: deep fibrous, membranous layer (stratum membranosum), of the superficial fascia of the abdomen. It is found deep to the Fascia of Camper and superficial to the external oblique muscle (23).

4- Muscles.

External oblique abdominal muscle.

Internal oblique abdominal muscle.

Transversus abdominis muscle.

Rectus abdominals.

Pyramidalis muscle.

5- Transversalis fascia: a thin aponeurotic membrane which lies between the inner surface of the transverse abdominal muscle and the parietal peritoneum.

6- Extra peritoneal fat: Between the inner surface of the general layer of the fascia which lines the interior of the abdominal and pelvic cavities, and the peritoneum, there is a considerable amount of connective tissue.

7- Peritoneum: It is the serous membrane forming the lining of the abdominal cavity. It covers most of the intra-abdominal (or coelomic) organs, and is composed of a layer of mesothelium supported by a thin layer of connective tissue. This peritoneal lining of the cavity supports many of the abdominal organs and serves as a conduit for their blood vessels, lymphatic vessels, and nerves .

Anterior abdominal wall muscles: (fig 1)

The abdominal wall is composed of 5 paired muscles: 2 vertical muscles (the rectus abdominis and the pyramidalis) and 3 layered flat muscles (the external abdominal oblique, the internal abdominal oblique, and the transversus abdominis muscles) (24).

The external oblique muscle:

This is the largest and most superficial of the three flat abdominal muscles. It is located in the anterolateral aspect of the abdominal wall. Its fleshy part forms the anterolateral portion and its aponeurosis forms the anterior part

Its fibers run inferoanteriorly and medially in the same direction as do the extended digits when they are in one's side pockets. It originates from external surfaces of 5th to 12th ribs and insertion; the fibers pass medially, they become aponeurotic. This aponeurosis ends medially in the linea-alba, pubic tubercle and anterior half of the iliac crest. Innervation is via the inferior six thoracic nerves and subcostal nerves (25).

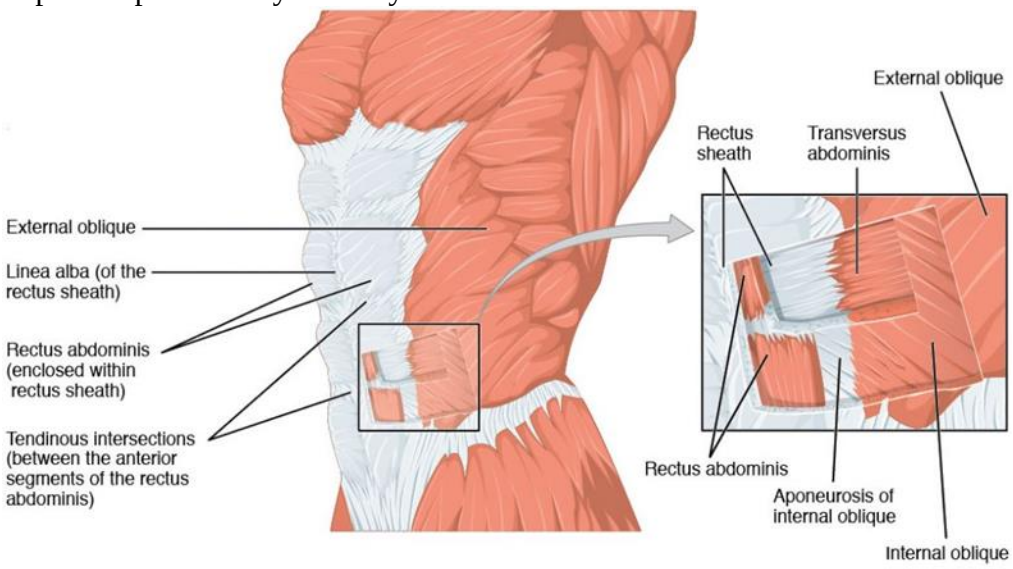

Figure (1): A cross-section of the abdominal wall layers. The TAP block is performed by deposition of local anesthetic between the transversus abdominis muscle and the fascial layer superficial to it (36).

Inferiorly, it folds back on itself to form the inguinal ligament between the anterior superior iliac spine and the pubic tubercle. Just superior to the medial part of the inguinal ligament, there is an opening in the aponeurosis called the superficial inguinal ring (26).

The internal abdominal oblique muscle:

Is the intermediate layer of the 3 paired flat abdominal muscles. It originates broadly from the anterior portion of the iliac crest, lateral half of the inguinal ligament and thoracolumbar fascia. The internal abdominal oblique inserts on the inferior border of the 10th-12th ribs, the linea Alba and the pubic crest via the conjoint tendon. The muscle fibers of the internal abdominal oblique course upward in a superomedial orientation, perpendicular to the muscle fibers of the external abdominal oblique (27).

The transversus abdominis muscle:

Is the deepest of the 3 paired flat abdominal muscles. It originates on the internal surfaces of the 7th–12th costal cartilages, thoracolumbar fascia, anterior three fourths of the iliac crest and lateral third of the inguinal ligament. As with the other flat muscles, the transversus abdominis forms a broad aponeurosis that helps make up the rectus sheath before it fuses in the midline to the linea alba. Above the arcuate line the transversus abdominus aponeurosis contributes to the posterior rectus sheath. Below the arcuate line it is fuses with the other flat muscles as the anterior rectus sheath (28).

The rectus abdominus muscle:

It is a paired muscle running vertically on each side of the anterior wall of the human abdomen. There are two parallel muscles, separated by a midline band of connective tissue called the linea alba. It extends from the pubic symphysis, pubic crest and pubic tubercle inferiorly, to the xiphoid process and costal cartilages of ribs 5to 7 superiorly. The proximal attachments are the pubic crest and the pubic symphysis. It attaches distally at the costal cartilages of ribs 5-7 and the xiphoid process of the sternum (29).

Nerve Supply of Anterior Abdominal Wall:

The abdominal wall is innervated by intercostal nerves (arising from T6 to T12) and ilioinguinal/iliohypogastric nerves (arising from L1). These nerves are easily blocked throughout their course between the abdominal muscles (30). After emerging from the paravertebral space, intercostal nerves lie between the transversus abdominis and the internal oblique muscles in the so-called transversus abdominis plane (TAP) Approximately at the level of the midaxillary line, intercostal nerves give out perforating branches innervating the lateral abdominal wall. Segmental nerves T6–T9 emerge from the anterior costal margin between the midline and the anterior axillary line (31).

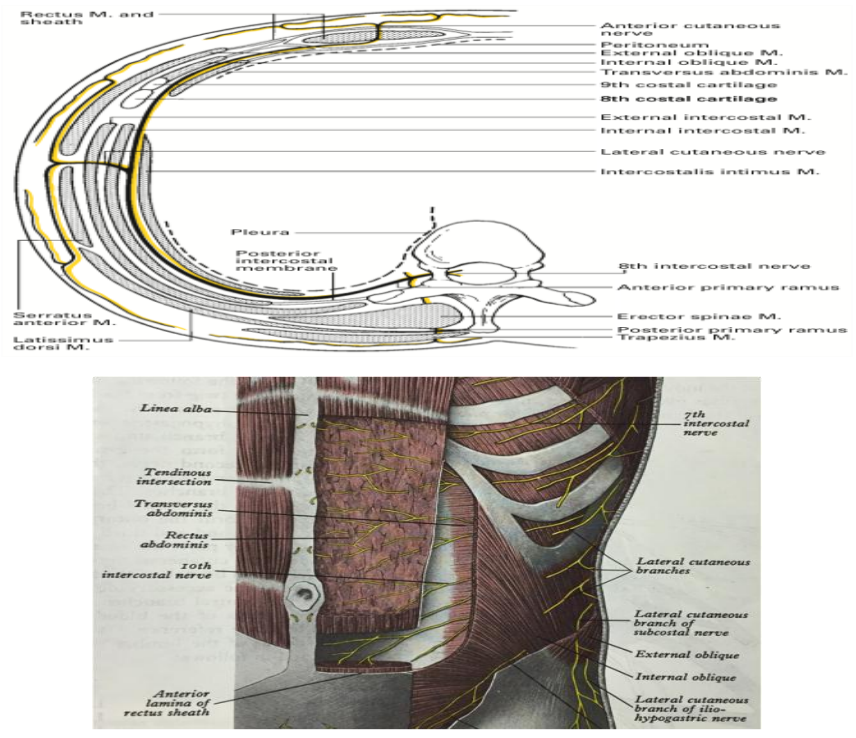

Figure (2): The path of the intercostal nerve from the spine, through the transversus plane, and posterior rectus sheath to form the anterior cutaneous nerves (31)

SUBCOSTAL TRANSVERSUS ABDOMINAL PLANE BLOCK (STAP BLOCK) :

TAP block is a simple procedure that can be used as an adjunct for postoperative pain control in abdominal, gynecologic or urologic surgery involving the T6 to L1 distribution. It was found to be effective in large bowel resection, caesarean delivery, abdominal hysterectomy, open appendectomy, and laparoscopic cholecystectomy. TAP block has also found clinical utility in procedures such as abdominal and inguinal hernia repair, radical prostatectomy, nephrectomy, and many different laparoscopic procedures in general (32).

Transversus abdominis plane block (TAP block) was firstly described by Rafi in 2001. It enables pain control through blocking sensory nerves by injecting local anesthetics into the neurofascial plane in the abdominal muscle (33).

TAP block has been shown to provide good postoperative analgesia as it provides analgesia to the skin, muscles and parietal peritoneum of the anterior abdominal wall from T7 to L1. It has multiple benefits as it decreases prolonged stay in the PACU, improve patient comfort and may improve compliance with postoperative care such as ambulation and respiratory exercise (34).

Bilateral TAP blocks can be used for midline incisions, this technique is also useful for procedures in which epidural analgesia is contraindicated (i.e, anti-coagulated patients). In addition, if prolonged analgesia is desired, a continuous TAP block technique with placement of a catheter has been described (35).

The introduction of ultrasound has allowed providers to identify the appropriate tissue plane and perform this block with greater accuracy under direct visualization. The ultrasound guided TAP block increases its safety and its complication rate is considered minimal as compared to the blind technique (37). A broadband linear array high frequency probe is used, with an imaging depth of 4-6cm. The ultrasound probe is placed transverse to the abdomen (horizontal plane) in the subcostal region at the mid clavicular line between the costal margin and the iliac crest (38)

Care should be taken not to exceed recommended safe doses of local anaesthetic agent with bilateral injections, Local anaesthetic toxicity could occur due to the large volumes required to perform this block especially if it was done bilaterally. There has been controversy in the literature regarding the spread and level of block achieved with a single TAP injection (39).

The oblique subcostal approach to the TAP nerve block ideally anesthetizes the intercostal nerves T6–T9 between the rectus abdominis sheath and the transversus abdominis muscle. The lateral TAP nerve block in the midaxillary line between the thoracic cage and iliac crest as well as between the internal oblique and transversus abdominis muscles ideally should reach intercostal nerves T10– T11 and the subcostal nerve T12. Of note, the umbilicus is innervated by intercostal nerve T10. The L1 segmental nerves in the TAP are not covered by the lateral TAP nerve block and require an anterior TAP nerve block medial to the anterior superior iliac spine. A posterior approach to nerve block the

TAP plexuses via the triangle of Petit has also been described. TAP nerve blocks provide somatic analgesia of the abdominal wall including the parietal peritoneum

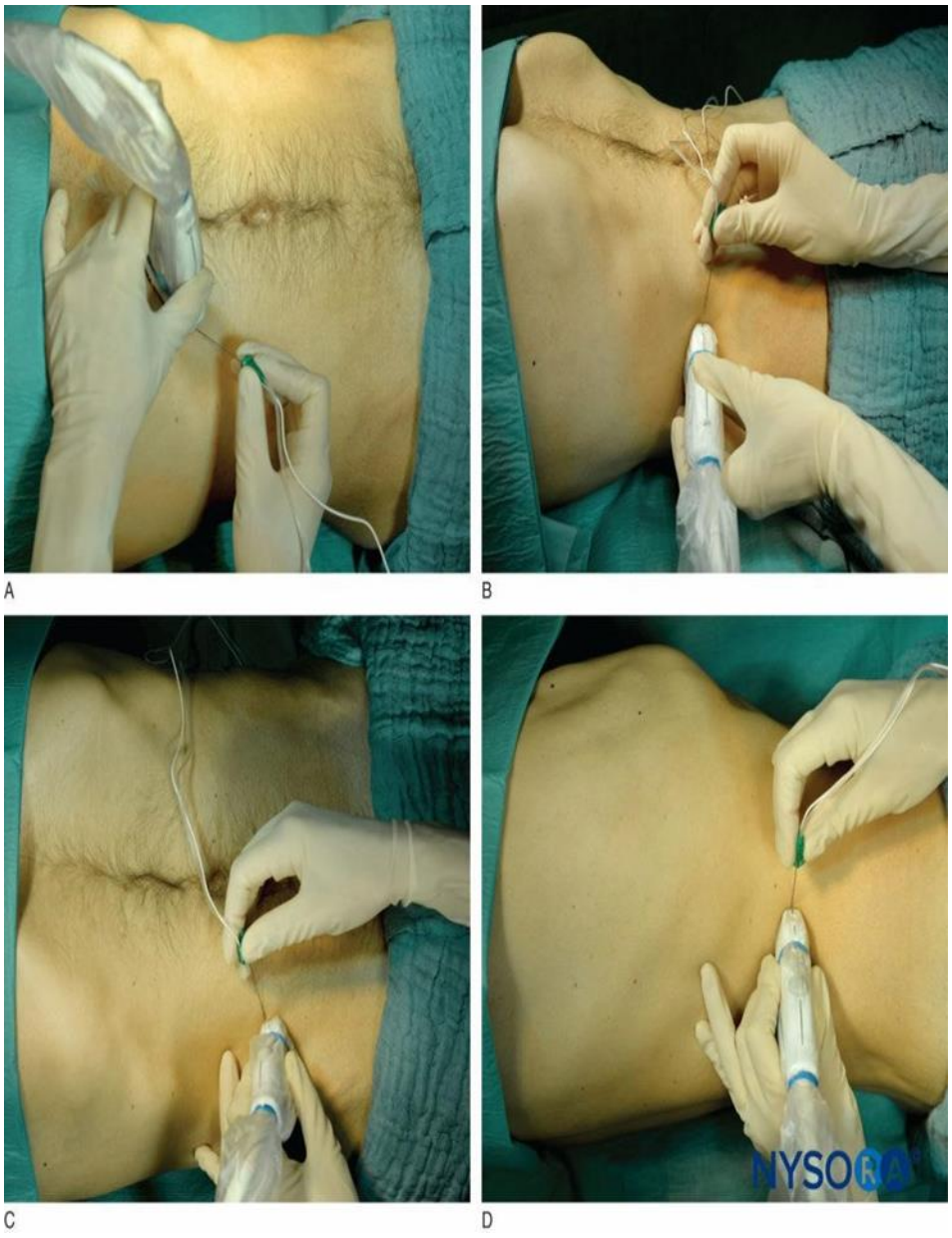

Figure (3): Patient and transducer position for different TAP nerve block approaches: subcostal (A), lateral (B), anterior (C), and posterior (D) (39).

The transducer is placed 2 cm subxiphoidian, then moved along the subcostal edge to identify the rectus abdominis muscle and the transversus abdominus. Once these structures are identified, the needle is introduced in-plane 2–3 cm lateral to the transducer, under direct ultrasound visualization, and 1–2 ml of solution are injected between the rectus abdominis muscle and the transversus abdominis muscle. After confirming the correct placement of the needle and the negative aspiration

probe, the rest of the anaesthetic substance is injected along the subcostal line in the transversus abdominis plane and the dissection of the plane is observed. The injected local anaesthetic appears hypo-echoic on ultrasound imaging. When the needle tip is positioned correctly the injected volume of local anaesthetic will be seen on ultrasound to spread out in the plane between the two muscles (40). (Figures 4-7).

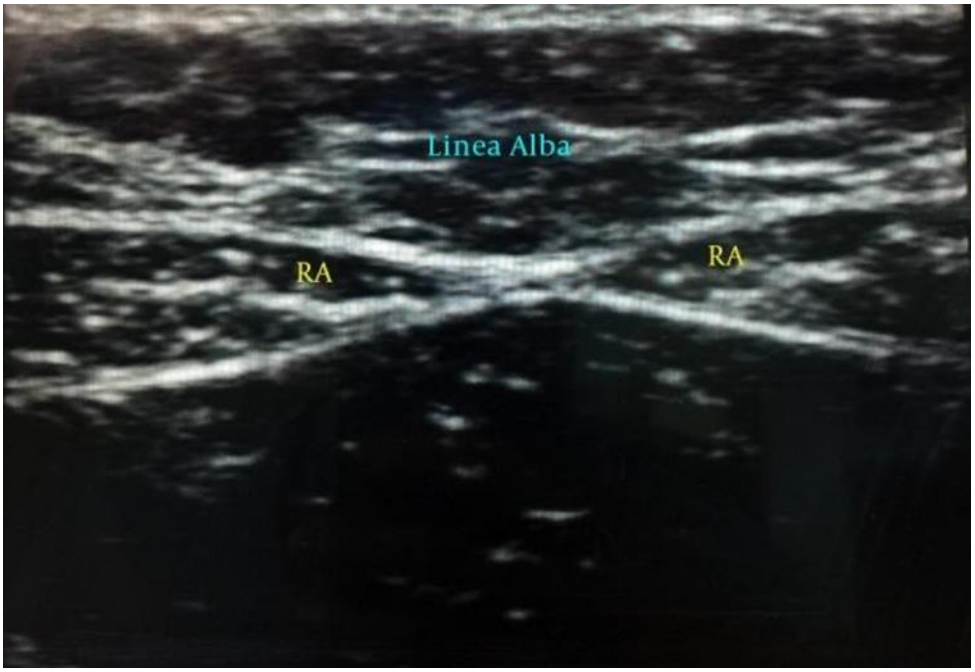

Figure (4): The linea alba is first viewed while placing the ultrasound below the xyphoid process. Bilateral rectus abdominis (RA) muscles are viewed (40).

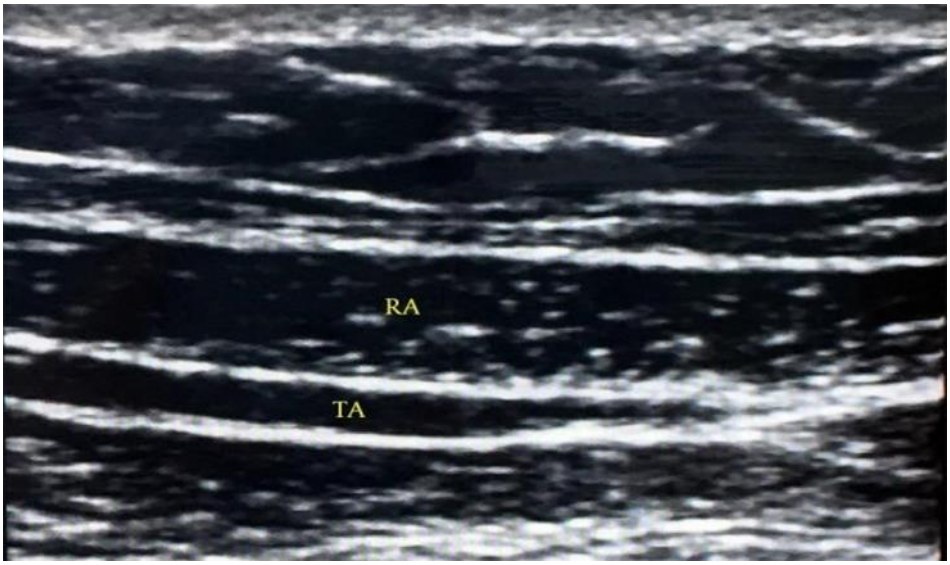

Figure (5): Transverse Abdominis Muscle As the ultrasound is directed down the costal margin, the transverse abdominis (TA) muscle comes into view. RA, rectus abdominis (40).

Figure (6): Ultrasound Image At the Semilunaris EO, external oblique muscle; IO, internal oblique muscle; TA, transverse abdominis muscle; RA, rectus abdominis muscle (40).

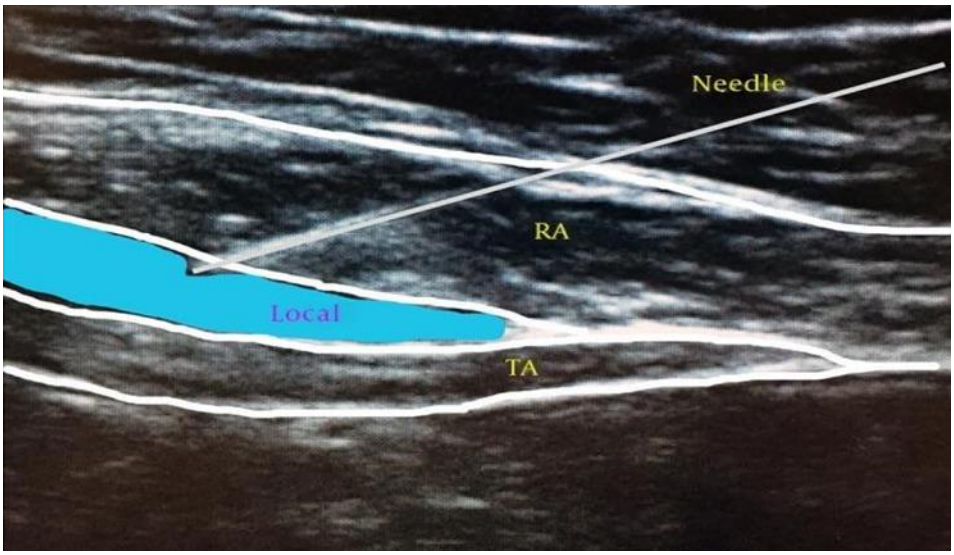

Figure (7): Ultrasound Image of Needle Insertion and Local InjectionTA, transverse abdominis muscle; RA, rectus abdominis muscle. The needle is inserted in the fascial plane between the TA muscle and RA muscle. As shown in this image, local anesthetic injection should cause separation of TA and RA muscles. The injection is medial to the semilunaris in this image (40).

Complications of TAP block:

There have been no reported complications to date with the ultrasound guided technique. A few complications have been reported with blind TAP block, the most significant of which was a case report of intrahepatic injection. Other complications include: pain, infection, bleeding at the site of

injection, vascular damage, and an inappropriate block since the location of the needle may not be precise.

Another complications, such as large bowel puncture, peritoneal puncture, peritonitis, injury to enlarged liver and spleen, allergy, local anesthetic toxicity and intravascular injection. As with any regional technique, careful aspiration will help avoid intravascular injections (41).

Conclusion

The use of a TAP block to alleviate postoperative pain has shown encouraging results, including a marked decrease in morphine intake and an improvement in pain scores. Subcostal US-TAP blockade may be correlated with lower postoperative opioid consumption and reduced need for rescue analgesics, However, additional research is needed to back up the results of the main published trials and provide broad guidelines for using a TAP block, particularly as part of a multimodal post-operative pain regimen, before it is used in everyday clinical practice.

No Conflict of interest.

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