Overview of Oblique Subcostal Transversus Abdominis Plane Block for Percutaneous Nephrolithotomy Analgesia

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Abstract

Background: Percutaneous nephrolithotomy (PCNL) is today the gold standard for the management of patients with renal calculi as it is less invasive than the open surgery, less time consuming, and is associated with less chances of infection. It is also associated with lower morbidity and faster recovery. However, placement of nephrostomy tube results in distressing peritubal pain requiring administration of analgesia. Inadequate analgesia can result in delayed mobilization, impaired ventilation, and prolonged hospitalization, which increases cost and causes delay of patient recovery and return to daily activities.. In addition, poor postoperative pain control contributes to patient dissatisfaction with the surgical experience and may have adverse psychological consequences. Tubeless PCNL can avert this problem but can be performed only in the selected patients. Analgesics such as non-steroidal anti-inflammatory drugs and opioids have side effects that limiting their use in patients with potential renal problems. There are multiple methods to diminish the intensity of postoperative pain. It may be lowered after tubeless and totally tubeless procedures or applying a small bore nephrostomy tube. The transversus abdominis plane (TAP) block is a peripheral nerve block which anaesthetises the abdominal wall. The increasing use of TAP block, as a form of pain relief after abdominal surgery warrants evaluation of its effectiveness as an adjunctive technique compared with other analgesic techniques. The aim of this study was to review the effective role of oblique subcostal TAP block for percutaneous nephrolithotomy.

Keywords: Percutaneous Nephrolithotomy; TAP Block; Pain Management

Introduction

Percutaneous nephrolithotomy (PCNL) was established as a minimally invasive treatment option for removal of kidney stones in the 1970s and was further developed in the ensuing years **(1)**. However, PNL frequency diminished with the introduction of extracorporeal shock wave lithotripsy (ESWL) in the early 1980s In recent years, as clinical experience with ESWL revealed its limitations, the role of PCNL for treating urolithiasis was redefined **(2)**.

Today, PCNL should be the first-line treatment for large or multiple kidney stones and stones in the inferior calyx **(3)**. Furthermore, improvements in instruments (i.e., flexible pyeloscopes and ureteroscopes) as well as lithotripsy technology increased the efficacy of percutaneous stone disintegration yielding stone-free rates of >90% **(4)**.

Rafi first described the TAP block in 2001. He portrayed it as a refined abdominal field block, with a targeted single shot anesthetic delivery into the TAP, a site traversed by relevant nerve branches. This was a significant advance from earlier strategies that required multiple injections. In this approach, utilizing surface anatomical landmarks, the TAP was reached by first identifying the lumbar triangle of Petit (an area enclosed medially by the external oblique, posteriorly by the latissimus dorsi, and inferiorly by the iliac

crest). A 24-gauge, blunt-tipped, 2-inch needle was then advanced perpendicular to the skin through a preceding skin incision until a single confirmatory "pop" was appreciated. This sensation was thought to indicate proper needle depth for anesthetic delivery site **(5)**.

The preliminary evidence to support the anatomical basis for TAP blocks and demonstrated sensory loss spanning the xiphoid to the pubic symphysis following delivery of local anesthetic to the TAP via the triangle of Petit. By the time the study was completed and published in 2007, McDonnell and his colleagues had already adopted the term TAP block and had demonstrated its analgesic utility in patients undergoing open retropubic prostatectomy **(6).**

Ultrasound Identification of TAP

The TAP is a potential anatomical space between transversus abdominis and internal oblique (or rectus abdominis)**,** and the field block by TAP infiltration is referred to as a TAP block. There are several different approaches for ultrasound-guided TAP block, such as lateral, posterior, and subcostal approaches. Unlike specific peripheral nerve blocks, TAP block is a nondermatomal "field block." This has led to a debate on whether there is a need for standardization of techniques or technique nomenclature**.** Even with the same ultrasound-guided technique, the extent of spread of local anesthetics can be variable due to individual anatomical variations **(7,8)**.

Initial studies were able to demonstrate blocks extending from T7-L1 using bilateral injections **(9,10)**. It therefore sensible to recommend that the TAP block can only reliably be used for analgesia in surgery on the lower abdomen, for example: hernia repair, open appendicectomy, caesarian section, total abdominal hysterectomy and radical prostatectomy. A subcostal TAP block has been described in addition to the posterior TAP injection. This can be performed to provide analgesia for abdominal surgery extending above the umbilicus **(8)**.

It should be kept in mind that TAP block has always been used as a component of multimodal pain treatment, in combination with paracetamol, NSAIDs and morphine patient controlled analgesia (PCA) **(11)**.

Several randomized controlled studies have confirmed that single-shot TAP block with local anesthetics provides analgesia for up to 48 hours and decreases postoperative morphine consumption by 70–85% **(12)**.

Technique of TAP block using U/S:

Transversus Abdominis Plane (TAP) block is a relatively new way of anaesthetising nerves which numb the abdomen after surgery in order to help improve patient comfort after their surgery **(7)**. According to the following steps: put the transducer transversely just below the xiphoid process and locate the paired rectus abdominis and the linea alba. Rotate the transducer obliquely and move laterally, parallel to the costal margin. At this level, the TAP is between rectus abdominis and transversus abdominis, or the TAP is absent here because transversus abdominis ends at the lateral end of rectus abdominis in some patients. Move the transducer along the costal margin more laterally until the aponeurosis of the linea semilunaris, which is lateral to the rectus abdominis, appears. Internal oblique and external oblique are located lateral to the linea semilunaris. Identification of the three muscle layers: transversus abdominis, internal oblique, and external oblique (from deep to superficial). The TAP is located just above transversus abdominis. Move the transducer more laterally to the midaxillary line, and scan up and down between the costal margin and iliac crest **(Figure 1)**. Typically, three muscle layers can be seen. The TAP is between internal oblique and transversus abdominis. If the transducer is placed posteriorly, internal oblique and transversus abdominis taper off into a common aponeurosis, also called the thoracolumbar fascia, which is connected to the lateral border of the quadratus lumborum. The TAP is between internal oblique and transversus abdominis and continuous with the aponeurosis **(13,14).**

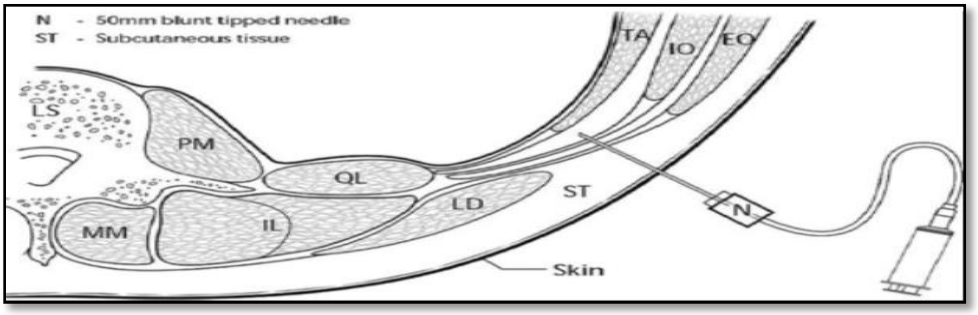

Figure (1): Diagram of transverse section of abdominal wall during landmark TAP block performance (N, needle; ST, subcutaneous tissue; EO, external oblique muscle; IO, internal oblique; TA, transversus abdominis; LD latissumis dorsi; QL, quadratus lumborum) **[92].**

The nomenclature regarding TAP block is four groups comprising subcostal, oblique subcostal, lateral, and posterior TAP blocks. The classification is based on the involved spinal nerves rather than the probe positions only. Although all anterior branches communicate on TAP, each segmental nerve supplies different areas. The T6-8 supply the area below the xiphoid and parallel to the costal margin; T9-12 supply the periumbilical area and the lateral abdominal wall between the costal margin and iliac crest **(Figure 2)**; L1 supplies the anterior abdomen near the inguinal area and thigh **(15).**

Classification of TAP blocks based on a unified nomenclature system is shown in **Table (1).** Many approaches have been suggested to provide analgesia over the upper abdomen, such as oblique subcostal, subcostal, or upper subcostal approaches. However, they are quite similar in the area where local anesthetics deposit except for the oblique subcostal approach, which covers both the upper and lower abdomen using the hydrodissection technique **(16)**.

Table (1): Classification of US-guided TAP blocks and the corresponding supplied areas (17).

Approach	The main segmental thoracolumbar nerves	Supplied area
Subcostal	T6-9 Anterior cutaneous branches.	Upper abdomen just below the xiphoid and parallel to the costal margin
Lateral	T10-12 Anterior cutaneous branches.	Anterior abdominal wall at the infraumbilical area, from midline to midclavicular line
Posterior	T9-12 Anterior cutaneous branches (possibly lateral cutaneous branches).	Anterior abdominal wall at the infraumbilical area and possibly lateral abdominal wall between costal margin and iliac crest
Oblique subcostal	T6-L1 Anterior cutaneous branches	Upper and lower abdomen

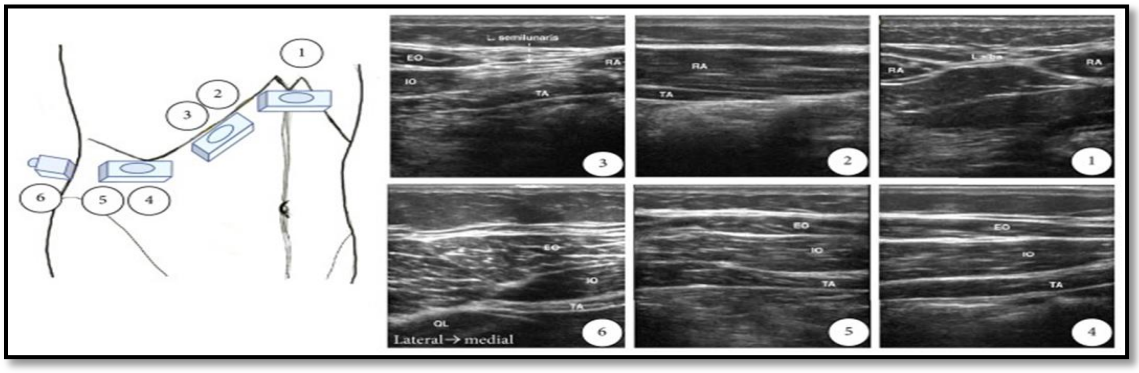

Figure (2): Ultrasound identification of the transversus abdominis plane. RA: rectus abdominis; TA: transversus abdominis; IO: internal oblique muscle; EO: external oblique muscle; QL: quadratus lumborum; L. alba: linea alba; L. semilunaris: linea semilunaris **(18)**.

Ultrasound guidance is now considered the gold standard for peripheral nerve block **(19)**. Usually, a linear probe is adequate for most TAP blocks. However, a convex probe is preferable for TAP blocks in markedly obese patients **(18)**.

The oblique subcostal TAP block is a modified subcostal TAP block, which was first introduced by Hebbard et al. **(20)**. By hydrodissecting the TAP along the oblique subcostal line (from the xiphoid toward the anterior part of the iliac crest), the anesthetic solution spreads across the location of T6-L1 nerves and thus potentially covers both the upper and lower abdominal walls **(Figure 3)**. Since it requires only a single penetration through the subcostal approach but covers both the upper and lower TAP plexuses . Only single penetration is required for the oblique subcostal approach. and might be better compared to the lateral approach **(21)**.

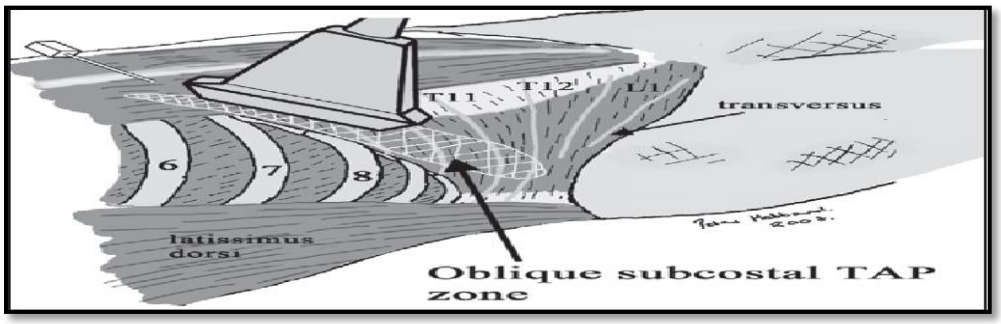

Figure (3): Needle and probe position for US guided oblique subcostal TAP block (20).

Other Considerations

1- **Dual TAP Block:** If analgesia is needed for both the supraumbilical and infraumbilical abdomen, the dual TAP block could also be considered. Dual TAP block is the combination of the subcostal and the lateral/posterior TAP block **(22)**.

2- **Continuous TAP Block:** A point-source catheter, such as an epidural catheter, was used for providing a continuous TAP block. A continuous TAP block using a catheter with more extensive holes may produce a wider spread of sensory block and superior analgesia **(23)**.

Regional anesthesia and analgesia techniques are commonly used to facilitate pain control during pediatric surgical practice. The advantages and disadvantages of TAP block is illustrated in **Table (2) (24)**.

Table (2): advantages and disadvantages of TAP block [102]

Advantages	**Disadvantages**
1. Can be performed when epidural is not technically feasible or contraindicated (sepsis, coagulopathy).	1-Dermatomal limitation with Posterior TAP block only produces reliable analgesia from T10 to L1and sub-costal TAP block only produces reliable analgesia from T7 toT12
2.Reduced opioid requirements	2.Provides only somatic analgesia
3. No hemodynamic effects like systemic hypotension as seen with epidural blockade.	3.Acquisition and maintenance costs for ultrasound equipment
4.No motor block which facilitates early mobilization	4.Steep learning curve for ultrasound-guided "in-plane‟ needle technique
5.Unilateral block is possible in, nephrectomy, open cholecystectomy, appendicectomy, splenectomy etc.	5.Analgesia limited to 24 h for single-shot Technique but can be increased by special additives or catheter technique.

- **Complications of TAP Block**

(1)Trauma: Visceral damage due to inadvertent peritoneal puncture while performing blind TAP block has been reported **(25)**. Although the risk can be minimized with ultrasound guidance, the potential of iatrogenic injury still exists due to a failure to image the entire needle

during its advancement **(26)**. Although there is only one reported complication for TAP block (liver injury secondary to needle insertion), other complications are possible with the administration of this block. There is a potential for injury to the intra-peritoneal structures if the needle is not inserted carefully **[104]**. Bowel haematoma, bowel injury, liver injury, splenic injury and renal injury, are possible complications of this block **(27).**

(2)Local anesthetic systemic toxicity:

Other reported complications of TAP block include seizure, ventricular arrhythmia, and transient femoral nerve palsy **(28)**. To limit local systemic toxicity, a low concentration of local anesthetic should be chosen when a high-volume regimen (e.g., 20 ml bilaterally) is necessary for a successful block. Good communication between anesthesiologists and surgeons also helps to prevent overdose by incidental repeated local anesthetics injection after a TAP block. The immediate availability of lipid emulsion along with other emergency therapeutics is recommended for TAP block **(29)**.

(3)Femoral nerve palsy:

Transient femoral palsy after TAP block is induced by incorrect local anesthetic deposition between transversus abdominis and the transversalis fascia **(30)**. Since the femoral nerve lies in the same tissue plane, as little as 1 ml of injectate flowing posteromedially can surround the femoral nerve **(31)**. This complication is usually self-limited but will delay patient discharge especially in day-case surgeries. Using a test solution to locate the needle tip under ultrasound guidance will help identify the TAP and avoid spread of the anesthetic toward the femoral nerve **(32)**.

Since the role of a nerve stimulator during TAP block is elusive and the nervous structures might be too small to be identified by ultrasound, "half-the-air" setting should be considered to avoid intrafascicular spread by keeping the injection pressure below 15 psi **(33)**.

(4) Hematoma:

Since the TAP belongs to a vessel-rich plane **,**the test solution instead of local anesthetic should be injected first. By using the test solution to hydrolocate the needle tip and visualize the hypoechoic spread, the surrounding tissues, not only vessels but also nerves, are usually pushed away from the needle tip by the test spread **(34)**.

CONCLUSION:

Due to the importance of pain control after abdominal surgery, several methods such as transversus abdominis plane (TAP) block are used to reduce the pain after surgery.

TAP block provides analgesia for the skin, subcutaneous tissue and peritoneum, while additional analgesia is required for visceral pain. The TAP block can be used as part of an analgesic regimen for abdominal surgery.

TAP blocks can be performed using various ultrasound-guided approaches. TAP block under ultrasound guidance proved to be safe with no recorded complications either intra or postoperatively.

Conflicts of Interest: The authors declare no conflict of interest.

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