Ultrasound-guided Subcostal Transversus Abdominis Plane Block

Niraj G, A Kelkar, R Powell
Specialist Registrar, Department of Anaesthesia, Leicester General Hospital, Gwendolen Road, Leicester, LE5 4PW, UK
Consultant, Department of Anaesthesia, Leicester General Hospital, Gwendolen Road, Leicester, LE5 4PW, UK
Correspondence: Niraj G, Specialist Registrar, Department of Anaesthesia, Leicester General Hospital, Gwendolen Road, Leicester, LE5 4PW, Phone: 01162584661, Fax: 01162584661, e-mail: nirajgopinath@yahoo.co.uk

Abstract
Ultrasound-guided subcostal transversus abdominis plane block is a recently described regional anaesthetic technique for providing postoperative analgesia after upper abdominal surgery. Use of subcostal TAP catheters holds considerable promise on account of its relative simplicity, efficacy and safety profile. This article reviews the current literature on this technique and reflects on personal experience.

Keywords: Subcostal TAP block, TAP catheter, ultrasound-guided.

INTRODUCTION
A substantial component of the pain experienced by patients after abdominal surgery is derived from the abdominal wall incision.1 The benefits of utilising abdominal field blocks as a component of multimodal analgesia are well known and include an opioid sparing effect, reduction in pain scores and increased patient comfort. Transversus abdominis plane (TAP) block is a recently described abdominal field block technique that acts on the myocutaneous sensory supply of the anterior abdominal wall.2

There are two types of ultrasound-guided TAP blocks: Posterior and subcostal. The ultrasound-guided version of the classical TAP block that was initially described as a landmark technique has now been termed the posterior TAP block.3 It has shown to be effective in providing analgesia after lower abdominal surgery.

Hebbard et al have described the ultrasound-guided subcostal TAP block for providing analgesia after upper abdominal surgery.4

The aim of this article is to contribute to better understanding of the ultrasound guided subcostal TAP block by reviewing the current literature and reflecting on personal experience.

ANATOMY
The sensory innervation of the anterior abdominal wall which includes skin, muscles and parietal peritoneum arises from the anterior rami of spinal nerves T6 to L1.5 These include the intercostal nerves (T6 to T11), the subcostal nerve (T12) and the iliohypogastric and ilioinguinal nerves (L1).

The classical posterior TA plane is the fascial plane between the internal oblique and the transversus abdominis muscles. Deposition of local anaesthetic agent in this plane has shown to reliably produce a block that extends from T10 dermatome to L1 dermatome and therefore is suitable for lower abdominal surgery.3,6

The subcostal TAP is a neurofascial plane between the rectus abdominis and the transversus abdominis muscles (Fig. 1). Deposition of local anaesthetic agent in this plane has shown to block dermatomes T6 to T10 with an occasional spread to T12 and definite sparing of L1 dermatome.

SUBCOSTAL TAP BLOCK TECHNIQUE
After preparing the skin with 2% chlorhexidine solution, a high frequency (5 to 10 MHz) ultrasound probe is placed obliquely on the upper abdominal wall along the subcostal margin near the midline. The rectus abdominis muscle is identified first. Then the ultrasound probe is gradually moved laterally and obliquely along the subcostal margin and the transversus abdominis muscle can be identified lying posterior to the rectus muscle (Fig. 1). After identification of the neurofascial plane (TAP) between the rectus abdominis and the transversus abdominis muscle, the skin and subcutaneous tissue overlying the probe is anaesthetised with 1% lignocaine. Thereafter the block needle is introduced.
The needle is directed to approach the transversus abdominis plane and on entering the fascial plane, 20 ml of 0.375% bupivacaine is injected after negative aspiration. The injectate can be seen spreading in the transversus abdominis plane as a dark oval pocket.

**SUBCOSTAL TAP CATHETER TECHNIQUE**

After preparing the skin and identifying the subcostal TA plane, a 16 gauge epidural needle is introduced anteriorly in the plane of the ultrasound beam. The needle is directed to approach the transversus abdominis plane and on entering the fascial plane 10 ml of saline 0.9% is injected to open up the plane (hydrodissection). Thereafter the epidural catheter is threaded into the TA plane. Gentle pressure may be required to coax 8 to 10 cm of the catheter into TA plane. Confirmation of catheter placement in the plane can be done by injecting 5 ml of saline 0.9% with a few air bubbles in the syringe. The sudden appearance of the hyperechoic air bubble in the fluid distended (hypoechoic) TA plane confirms the correct positioning of the catheter. After leaving 8 to 10 cm of the catheter in the plane, the catheter is cut at the 20 cm mark and attached to the filter which is taped on the chest wall in the midline (Fig. 2).

**INDICATION**

There have been numerous randomised studies confirming the clinical efficacy of the classical posterior TAP block (single shot) in patients undergoing various lower abdominal surgeries. However, to date there have been no randomised trials reported on the efficacy of subcostal TAP blocks.

Case studies of single shot subcostal TAP blocks have reported an opioid sparing effect after upper abdominal surgery. Hebbard et al used subcostal TAP blocks to provide postoperative analgesia in a series of 20 patients undergoing upper abdominal surgery. It was reported that there is occasional sparing of L1 dermatome in this series. However, pain scores and morphine consumption were not mentioned.

In another case report, subcostal TAP blocks were used to provide rescue analgesia in a patient with an ineffective epidural following major upper abdominal surgery. There was significant improvement in pain scores and reduction in morphine consumption.

The duration of action after TAP blocks has not been clearly defined. Studies on posterior TAP blocks (single shot) have all reported a prolonged duration of action ranging from 16 to 24 hours after a single injection. In the studies mentioned, posterior TAP block was used in conjunction with patient controlled analgesia (PCA) with morphine.

The authors have used serial single shot subcostal TAP blocks to provide postoperative analgesia after major hepatobiliary and gastrointestinal surgery. The duration of action after subcostal TAP blocks has been observed to be 6 to 8 hours and most patients complain of pain on movement after 8 hours. This observation led us to use subcostal TAP catheters. The catheters are inserted by the anaesthetist under ultrasound guidance at the end of the...
surgery or in the intensive care unit. A recent report from our institution has illustrated the benefits of subcostal TAP catheters in providing postoperative analgesia in patients where epidural analgesia was either contraindicated or ineffective.\textsuperscript{16} This technique has the potential to be a viable alternative to epidural analgesia in patients undergoing upper abdominal surgery. Our experience shows that patients need 8 hourly top ups when the subcostal TAP catheters are used without patient controlled analgesia (PCA) with morphine.

Ozelsel et al have reported on a significant opioid sparing effect of subcostal TAP catheter in patients undergoing elective right hepatectomy through a unilateral transverse incision. The catheter was inserted at the end of surgery by the surgeon under direct vision. The patients received intermittent boluses of 40 ml of ropivacaine 0.2\% every 6 hours for 72 hours in conjunction with PCA with morphine. The average morphine consumption over 96 hours after surgery was reported as 79.63 ± 35.2 mg.\textsuperscript{17}

Harish et al have reported the use of low dose infusion via a unilateral subcostal TAP catheter inserted by the surgeon in a patient undergoing open nephrectomy. The catheter was used for 3 days and the patient did not require any supplemental opioid.\textsuperscript{18}

The potential advantages with subcostal TAP catheter are primarily, improved patient comfort and reduction in concomitant opioid use with a resultant decrease in side effects like nausea, vomiting, sedation and respiratory depression. When compared to epidural analgesia, the advantages are an absence of sympathetic and motor block and avoidance of damage to spinal cord structures.

The principal drawback of the technique appears to be the dermatomal limitation of the block. In our experience subcostal TAP block produces consistent and reliable analgesia covering T6 to T10 dermatomes in the midline and laterally up to the anterior axillary line. Incisions extending below the umbilicus or the presence of surgical drains below the level of umbilicus can produce significant pain unresponsive to either further increase in volume or concentration of the local anaesthetic agent. The sensory block can occasionally extend to T12 dermatome; however, the L1 dermatome is usually spared. Hebbard et al in their original description of this technique have advocated initial hydrodissection to open up the subcostal TA plane and subsequent progressive insertion of the block needle (100 to 150 mm) as far as the iliac crest.\textsuperscript{4} This has the potential to block T11 and T12 dermatomes in addition to T6-T10 dermatomes. It would require the practitioner to be extremely adept at real-time ultrasound scanning as it is vital to visualise the needle tip at all times. It may be possible to coax a block needle deep down the subcostal TA plane towards the iliac crest. However, manoeuvering a rigid needle (Tuohy) used for catheter placement could prove to be a challenge.

The other disadvantage is the inability to block visceral pain. Although a substantial amount of pain after abdominal surgery is known to arise from the anterior abdominal wall, visceral pain can cause major discomfort. This may be observed in patients undergoing pancreatic surgery where postoperative backache can cause considerable discomfort in the absence of epidural analgesia.

The authors are in the process of conducting a randomised controlled trial (ISRCTN08486065) comparing the analgesic efficacy of subcostal TAP catheters with epidural analgesia in patients undergoing upper abdominal surgery. The preliminary results appear to be encouraging.

**CONCLUSION**

Subcostal TAP block is a new regional anaesthesia technique that provides analgesia following upper abdominal surgery. The ultrasound-guided technique involves either a single shot injection or catheter introduction into the neurofascial plane between the rectus abdominis muscle and the transversus abdominis muscle. Single shot injection can provide dynamic analgesia for 6 to 8 hours. Catheter system can provide highly effective analgesia for over 72 hours in patients undergoing upper abdominal surgery. It is also suitable for unilateral analgesia. Current role is limited in patients in whom epidural is contraindicated or when there is a lack of facilities for epidural analgesia. Before the subcostal TAP catheters gain widespread acceptance, they have to be compared against epidural analgesia which is the gold standard in providing postoperative pain relief after upper abdominal surgery. Further questions that need to be answered are:

1. Concentration and volume of local anaesthetic agent
2. Insertion of the catheters: ultrasound guided technique by anaesthetist or under direct vision by surgeon.
3. The efficacy of continuous infusion vs 8 hourly bolus top ups.
4. Role of adjuvants in improving efficacy and prolonging duration of action (adrenaline, clonidine).
5. Whether surgeons could limit the extension of the incision to the level of umbilicus and site drains at or above T10 dermatome.

We conclude that the use of subcostal TAP catheter hold considerable promise for patients undergoing upper abdominal surgery on account of its relative simplicity, efficacy and safety profile.

REFERENCES