Should we stop doing blind transversus abdominis plane blocks?

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** Editor’s key points

- Ultrasound is being used increasingly to ensure correct needle placement for regional techniques.
- Blind needle placement for Transversus abdominis plane blocks was evaluated by ultrasound.
- An unexpectedly high number of inaccurate needle placements led to early study termination.
- Use of ultrasound is recommended as routine for correct performance of TAP blocks.

** Background.** Any landmark-based regional anaesthetic technique raises two important issues. The first is the accuracy of placement of the needle and thus the local anaesthetic in a ‘blind’ technique and the second is the potential for damage to adjacent structures. We designed a prospective, blinded study in an adult general surgical population to evaluate with ultrasound the placement of the needle tip and local anaesthetic during transversus abdominis plane (TAP) blocks using the landmark-based ‘double-pop’ technique.

** Methods.** After induction of general anaesthesia, 36 adult patients had a TAP block performed bilaterally using the standard landmark-based technique. Ultrasonography was then used to record the actual needle position and local anaesthetic spread. The anaesthetist performing the block was blinded to the ultrasound images.

** Results.** Thirty-six adult patients were included in the study, which was terminated early due to what was considered an unacceptably high level of peritoneal needle placements. The needle tip and local anaesthetic spread were in the correct plane in only 17 (23.6%) of the injections. In the remaining 55 (76.4%), the needle was in the subcutaneous tissue 1 (1.38%), external oblique muscle 1 (1.38%), plane between the external and internal oblique muscles 5 (6.94%), internal oblique muscle 26 (36.1%), transversus abdominis muscle 9 (12.5%), and peritoneum 13 (18%).

** Conclusions.** We conclude that the needle and local anaesthetic placement using the standard landmark-based approach to the TAP block is inaccurate, and the incidence of peritoneal placement is unacceptably high.

** Keywords:** abdominal wall; anaesthesia, regional; complications

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The transversus abdominis plane (TAP) block was reported in 2001 as a novel approach to the blockade of the neural afferents to the anterior abdominal wall.1 A landmark-based ‘double-pop’ technique via the lumbar triangle of Petit, which accesses the nerves as they course through the fascial plane between the internal oblique and transversus abdominis muscles, was described, and has been shown to be an effective analgesic adjunct for lower abdominal surgery.2–4 Ultrasound is increasingly used for regional anaesthesia and several modified approaches to the TAP block using ultrasound guidance have been described. These include a subcostal approach and an anterior approach at the mid-point of the 12th rib and iliac crest in the mid-axillary line.

Any landmark-based regional anaesthetic technique raises two important issues. The first is the accuracy of placement of the needle and thus the local anaesthetic in a ‘blind’ technique. While no study to date has looked at the accuracy of injection of local anaesthetic in TAP blocks, a landmark-based approach to the ilioinguinal/iliohypogastric nerve block was shown to result in inaccurate injection of local anaesthetic in 86% of cases in a paediatric population.5 The second issue is the potential for damage to adjacent structures from blind placement of the needle. An inadvertent liver puncture in a patient post-Caesarean section has been reported after a landmark-based approach to the TAP block,6 and there have been several case reports of colonic puncture in the paediatric population after ilioinguinal nerve block.7 8

We designed a prospective, blinded study in an adult general surgical population to evaluate with ultrasound the placement of the needle tip and local anaesthetic during TAP blocks using the landmark-based ‘double-pop’ technique.

These two authors should be considered joint first authors.
Methods

After approval from the hospital ethics committee and written informed consent, we planned to enrol 60 adult patients undergoing elective abdominal surgery in the study. Patients with infection at the proposed site of injection, coagulation disorders, allergy to bupivacaine, pregnancy, BMI > 35, and planned postoperative intensive care unit admission were excluded.

All patients had standard monitoring and i.v. induction of general anaesthesia. Before placement of the block, the area was prepared with chlorhexidine and an initial ultrasound scan of the area was performed by an experienced anaesthetic ultrasonographer using a SonoSite M-Turbo® unit and a 6–13 MHz linear probe (SonoSite, Bothell, WA, USA) covered with a sterile sheath. All TAP blocks were performed bilaterally by one of the six investigators (three consultant anaesthetists and three anaesthetists in training, each of whom had previously performed a minimum of 50 landmark-based TAP blocks) using a blunt regional anaesthesia needle (22 G, 2′′, Plexufix, B. Braun, Melsungen AG, Germany) using a ‘double-pop’ landmark technique (mid-point of the iliac crest and the costal margin in the mid-axillary line).

After careful aspiration, 20 ml of 0.25% bupivacaine was injected bilaterally under real-time ultrasound imaging (using an out-of-plane technique) to detect both the position of the needle tip and the spread of local anaesthetic. The ultrasonographer recorded images pre- and post-injection of local anaesthetic and recorded the anatomical site of injection (subcutaneous tissue, external oblique muscle, plane between the external and internal oblique muscle, internal oblique muscle, TAP, transversus abdominis muscle, peritoneum). The anaesthetist performing the block was blinded to the ultrasound image. However, if the needle was in the peritoneum, the anaesthetist performing the block was alerted by the ultrasonographer and the procedure was repeated. Postoperative pain scores were not assessed, as the aim of the study was simply to evaluate the position of the needle tip and local anaesthetic spread.

Logistic regression analysis was used to explore the influence of patient age, sex, BMI, presence of stoma, and the level of experience of the anaesthetist performing the block (consultant vs trainee) on the likelihood of correct placement of the needle tip and local anaesthetic and the likelihood of peritoneal placement.

We analysed data using the Mann–Whitney and Fisher’s exact tests. Logistic regression analysis was used to determine both patient and operator factors contributing to inaccurate needle placement.

Results

Thirty-six adult patients were included in the study, which was terminated early due to what was considered an unacceptably high level of peritoneal needle placements. Patient characteristics are presented in Table 1.

The needle tip and local anaesthetic spread were in the correct plane (TAP) in only 17 (23.6%) of the injections. In

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<th>Table 1 Baseline patient characteristics</th>
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<td>Age (yr) [mean (range)]</td>
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<td>Large bowel resection</td>
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Fig 1 Needle position.
the remaining 55 (76.4%), the needle was in the subcutaneous tissue 1 (1.38%), external oblique muscle 1 (1.38%), plane between the external and internal oblique muscles 5 (6.94%), internal oblique muscle 26 (36.1%), transversus abdominis muscle 9 (12.5%), and peritoneum 13 (18%) (Fig. 1).

Of the 72 injections performed, 32 were by consultants and 40 by trainees. Fifteen (46%) of injections by consultants, but only two (5%) of injections by trainees were in the correct plane. There were no peritoneal needle placements by consultants; however, 13 (33%) of needle placements by trainees were in the peritoneum (Fig. 2). Although the study protocol alerted the operator to peritoneal needle placement, three patients went on to have repeat peritoneal placement on the contralateral side.

The only patient factor that predicted peritoneal injection was age after adjusting for training (consultant or not). In the logistic regression model, age was significant ($P=0.04$) (OR = 1.13), 95% confidence interval (1.01, 1.26) for every single-year increase in patient age.

Patient BMI had no effect on successful or peritoneal placement of the needle tip. There was no relationship found between BMI and thickness of muscle layers or peritoneal depth.

No block-related complications were noted.

**Discussion**

In our study of the landmark-based approach to the TAP block, the correct needle tip position and local anaesthetic spread was achieved in only 23.6% of attempts. As we also observed a high rate of peritoneal needle placement (18% of first attempts), we terminated our study early.

A literature search for complications of TAP block only identified four trials (172 patients) and one case series (more than 200 patients) using a landmark-based technique and reported no complications attributable to TAP block. We found only two case reports of complications attributed to TAP blocks, both of which were liver punctures. In all of the four trials, the endpoints for successful blocks were assessed based on pain scores. A systematic review has shown that intraperitoneal injection of local anaesthetic can also reduce pain scores in patients having abdominal surgery. This might explain the lack of identification of peritoneal injection in these trials. Equally, as a relatively large volume of local anaesthetic is used for TAP blocks (typically 20 ml or more), it is possible that the local anaesthetic could diffuse from an adjacent plane to block the neural afferents in the TAP.

Inadvertent intraperitoneal injection, with the potential for visceral injury, is probably more common than thought and our study raises serious concerns about the safety of any blind approach to the TAP block. Despite the fact that all trainees involved in the trial had performed more than 50 blocks each (and two had performed more than 100), they still had a 33% peritoneal injection rate. The clinical interpretation of the logistic regression could be that training status on its own might or might not predispose to inaccurate block placement, but that the problem is seen particularly in elderly patients who perhaps have thinner less-defined abdominal muscles. This may also apply to patients who have previous abdominal wall incisions. Learning manual skills in anaesthesia differs greatly among individual procedures. The fact that trainees were much more likely to place needles intraperitoneally came as a surprise, as all participants had carried out a similar number of blocks (>50) before the study began (we did not test for proficiency). However, beyond early screening for poor competency, there is no evidence that examining learning curves predicts harm. Skill levels are measured by a surrogate variable of early success rate for a procedure. In comparison with epidural,
where loss of resistance is primarily felt but also can be appreciated visually, there is no definite objective visual endpoint for the trainer with a blind TAP technique in the absence of ultrasound. A learning curve for TAP block has not been described in the literature to date. Indeed, with quality assurance and performance evaluation becoming increasingly important in the practice of medicine, one could question how manual skills for a blind procedure can possibly be effectively acquired or taught.

Our study had several limitations, the first being the early termination for safety reasons, with only 36 of the planned 60 patients enrolled. While the original approach to the TAP block is a posterior approach through the lumbar triangle of Petit, we studied the described anterior approach using the mid-point of the iliac crest and ribcage in the mid-axillary line. We had two reasons for this. First, the precise location of the triangle of Petit remains controversial. A study of 26 cadaveric specimens suggested that the triangle of Petit is quite posterior, quite small, and not all target nerves had entered the TAP in the specimens at the point of the lumbar triangle of Petit. In contrast, all the nerves were in the TAP at the mid-axillary line. Secondly, the anterior approach was chosen for optimal visualization on ultrasound of all the anatomical layers and local anaesthetic spread, as described by Shibata and colleagues. We deemed the fascial layers and thus the ‘pop’ sensations to be similar as we used the same needle as described in the original studies.

We conclude that placement of the needle tip and local anaesthetic using the standard landmark-based approach to the TAP block is inaccurate, and the incidence of peritoneal damage is unacceptably high. We believe that our study makes a strong argument against any blind approach to the TAP block and in favour of ultrasound guidance in all cases.

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Declaration of interest

None declared.

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