PERIODICUM BIOLOGORUM
VOL. 111, No 2, 203–208, 2009

UDC 57:61
CODEN PDBIAD
ISSN 0031-5362

Original scientific paper

Transversus abdominis plane block: The Holy Grail of anaesthesia for (lower) abdominal surgery

ZORICA JANKOVIC

Consultant Anaesthetist
Honorary Senior Lecturer
St James's University Hospital
Leeds, LS9 7TF, UK

Key words: Transversus abdominis plane block

Abstract

The transversus abdominis plane (TAP) block is a new, rapidly expanding regional anaesthesia technique that provides analgesia following abdominal surgery. It involves a single large bolus injection of local anaesthetic into the TAP, an anatomical space between the internal oblique and transversus abdominis muscles. This article presents the development of the TAP block over the last 10 years, with an analysis of all anatomical and case studies and randomized controlled trials, and an account of the author's own experience. Diagrams and a detailed description of the techniques contribute to a better understanding of this block. The change in technique from landmark to ultrasound guided, the expansion of indications, and changes in local anaesthetic type and quantity are described and discussed. Furthermore, comparison with similar regional anaesthesia techniques, such as rectus abdominis sheath, paravertebral and ilioinguinal/iliohypogastric blocks, clarifies similarities and differences. Some comparison with epidural analgesia is made. The advantages and disadvantages of this block are summarized. Armed with a sound knowledge of its advantages and limitation, this promising new regional anaesthesia technique can be used successfully for intra/postoperative analgesia in abdominal surgery.

Received March 10, 2009

INTRODUCTION

The transversus abdominis plane (TAP) block is a new, rapidly expanding regional anaesthesia technique that provides analgesia following abdominal surgery. Introduced 10 years ago in Ireland, where there was a lack of facilities and staff for acute postoperative pain treatment, it became increasingly popular worldwide because of its relative simplicity and efficacy. TAP block significantly reduces pain associated with lower abdominal surgery, regardless of whether it is used as the primary anaesthetic or for pain control after general or spinal anaesthesia. The aim of this article is to contribute to better understanding of the TAP block by reviewing the current literature and adding personal experience and research results.

Anatomy of the TAP block

The TAP block involves a single large bolus injection of local anaesthetic into the TAP, an anatomical space between the internal oblique (IO) and transversus abdominis (TA) muscles *(1)*. The TAP spans the abdomen wherever these two muscles exist (Figure 1) and is a fascial plane of triangular shape. The anterior border of the TAP is the linea

semilunaris, which consists of the aponeuroses of both the IO and external oblique (EO) muscles and the TA muscle, and extends from the cartilage of rib 9 to the pubic tubercle *(2)*.The superior border of the TAP plane is the subcostal margin, from the cartilages of the 9th to 12th ribs continued into the border of the latissimus dorsi (LD) muscle and the lumbar triangle of Petit (LTOP). The inferior border is the inguinal ligament, iliac crest and posterior border of LTOP *(3)*. The TAP thus provides a space into which local anaesthetic can be deposited to achieve myocutaneous sensory blockade.

The TAP is used to approach and block the abdominal wall neural afferents. The sensory supply of the skin, muscles and parietal peritoneum of the anterior abdominal wall is derived from the anterior rami of the lower six thoracic nerves and the first lumbar nerve. The intercostal, subcostal, iliohypogastric and ilioinguinal nerves course through the lateral abdominal wall within the TAP before they pierce the musculature to innervate the abdomen *(4)*. There is extensive branching of and communication between nerves within the TAP (Figure 2) *(5)*.

Extent and time course of the spread of agents introduced into the TAP

The first study to examine the spread of agents introduced into the TAP was McDonnell's computerized topographic and magnetic resonance imaging study conducted in 3 volunteers *(4)*. This study ascertained the spread and time course of the deposition of radio-opaque due (iopamidol contrast) within the TAP *in vivo*. Twenty minutes after the TAP block was administered, computed tomography imaging clearly identified the presence of dye in both TAPs *(4)*. The injectate spread within the TAP from the superior margin of the iliac crest to the level of the costal margin, and as far posteriorly as the quadratum lumborum muscles *(4)*. Magnetic resonance imaging of iopamidol contrast showed that the contrast receded within 4 to 6 hours, and then started to appear in the psoas major *(4)*.

A recently published cadaveric study in which 20 ml of aniline blue dye was injected into the TAP in the midaxillary line confirmed deposition within a narrow transverse band on the trunk, limited by the lateral border of the rectus sheet, the iliac crest and the costal margin *(2)*.

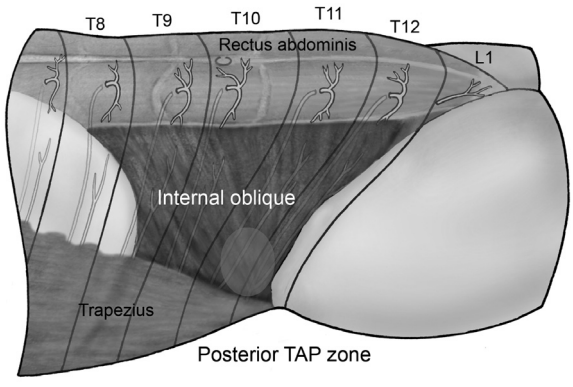

Figure 1. *Anatomy of Transversus Abdominis Plane (TAP).*

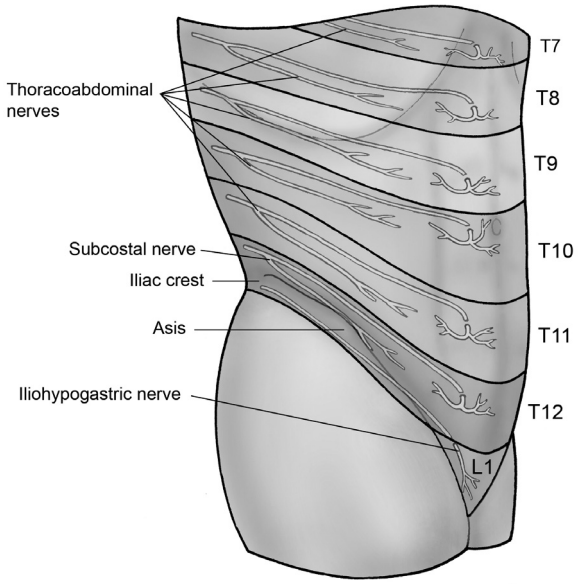

Figure 2. *The sensory supply of the skin, muscles and parietal peritoneum of the anterior abdominal wall.*

At present, the pharmacokinetic profile of local anaesthetic agents within the TAP is not known.

Indications

The clinical efficacy of the TAP has recently been demonstrated in 3 randomized controlled clinical trials of adults undergoing colonic resection surgery, Caesarean delivery and total abdominal hysterectomy, respectively *(1, 6, 7)*. In several case studies the TAP block has been demonstrated to provide excellent analgesia to the skin and musculature of the anterior abdominal wall following appendectomy, inguinal hernia repair and radical prostatectomy (*8, 9, 10)*. In our institution it has been used for postoperative analgesia following renal transplantation, abdominal wall reconstructive flaps and inguinal lymphadenectomy. This promising new regional anaesthetic technique can be used successfully for plastic surgery of abdominal wall (abdominoplasty and liposuction).

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) *(1)*. TAP block provides analgesia for the skin, subcutaneous tissue and peritoneum, while additional analgesia is required for visceral pain.

Several randomized controlled studies have confirmed that single-shot TAP block provides analgesia for up to 48 hours and decreases postoperative morphine consumption by 70–85% *(1, 6, 9)*. TAP block has been used as rescue analgesia when other analgesic modalities were unsuccessful *(11, 12)*. There is a single report of TAP block as a method for management hyperalgesia follow-

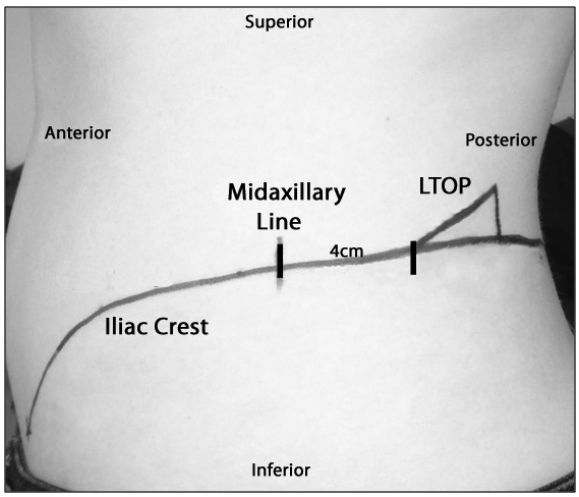

Figure 3. *Position of the lumbar triangle of Petit (LTOP) shown in a lateral view marked on the surface of the skin.*

ing major abdominal surgery *(13)*. All reports concerned adult patients.

Multiple techniques have been described for accessing the TAP. Detailed descriptions of the most commonly used techniques follow.

Landmark technique

This involves the single injection of local anaesthetic into the TAP *(1)*. The most commonly used site of injection is via the LTOP (the only area of the abdominal wall where the IO muscle can be accessed directly), through two muscle fascias but avoiding any muscles on top of it *(1, 6, 7)*. The triangle is formed posteriorly by the lateral border of the LD muscle and anteriorly by the posterior free border of the EO muscle, with the iliac crest as the base. The floor of the triangle from superficial to deep is formed by subcutaneous tissue, the IO muscle and TA muscle, respectively *(3)*. The iliac crest serves as a fixed and easily palpable landmark (Figure 3) *(3)*.

The landmark technique was first described in 2001 by Rafi *(14)* as the 'one-pop technique' and was modified by McDonnell *(1)* who described a 'two pop' technique using blind insertion of a regional anaesthesia needle perpendicular to the skin, just superior to the iliac crest and behind the midaxillary line. Initial resistance indicates arrival of the needle tip at the EO fascia, followed by the two 'pop' sensations, one as the needle penetrates the EO fascial layer and another as it penetrates the IO fascia layer and enters the TAP *(1)*.

Our unpublished cadaveric study (completed in 2008) shows that the LTOP is more posterior than the literature suggests. The position of the LTOP varies largely and its size is relatively small. The relevant nerves to be blocked do not enter the TAP at the point of the LTOP. Consequently, the appropriate landmark for entry into the TAP plane is the space above the iliac crest, at or slightly behind the midaxillary line, rather than always being in the area of the LTOP as previously considered.

In recent studies the reported success rate with the landmark technique is 85% amongst experienced practitioners *(1, 6, 7)*.

The block is technically easier to perform in elderly patients, on account of the loss of muscle mass and tone *(14)*. It may not be easy in obese patients, in whom the needle insertion point can be 2.5 cm behind the highest point of the iliac crest, the distance from the skin to the TAP can be long, and the two 'pop' sensations may not be obvious.

Ultrasound-guided technique

The use of ultrasound was introduced to improve the success rate and accuracy of TAP block and to prevent potential complications; its application is subject to ongoing evaluation.

The standard ultrasound-guided procedure begins with the ultrasound probe being placed on the lateral abdominal wall cephalad to the iliac crest and caudal to the costal margin. The probe is slid probe anteriorly–posteriorly and tilted as necessary in a cephalad-caudal direction until a clear, optimized image of the three lateral abdominal muscles (lateral to rectus abdominis) and the TAP is obtained *(2)*. Changing the depth, gain and frequency, and reducing the ambient light, achieves further optimization of the image *(2)*. A needle is then moved forward from an anteriomedial position in a posterior and lateral direction using an in-plane technique with the entry point in the skin being separated from the probe in order to improve needle visibility in the long axis *(2)*. The needle trajectory can proceed in an anterior-posterior direction using an in-plane technique, with the local anaesthetic injection observed in real-time. (Figures 4, 5) *(2)*.

Hebbard has described a slightly different technique, called the 'oblique subcostal' TAP block, which is a combination of rectus abdominis and TAP blocks, with the upper part of the TAP plane being accessed close to the costal margin *(15)*. An ultrasound-guided needle is ini-

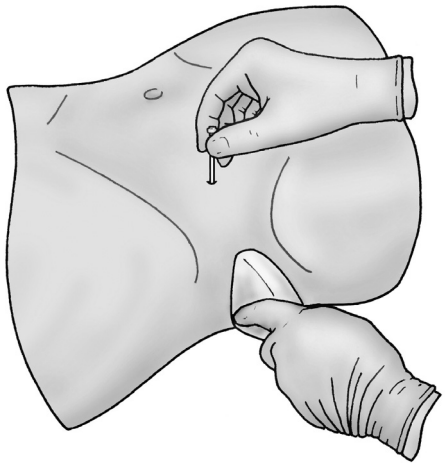

Figure 4. *Position of ultrasound probe and the needle for ultrasound-guided technique.*

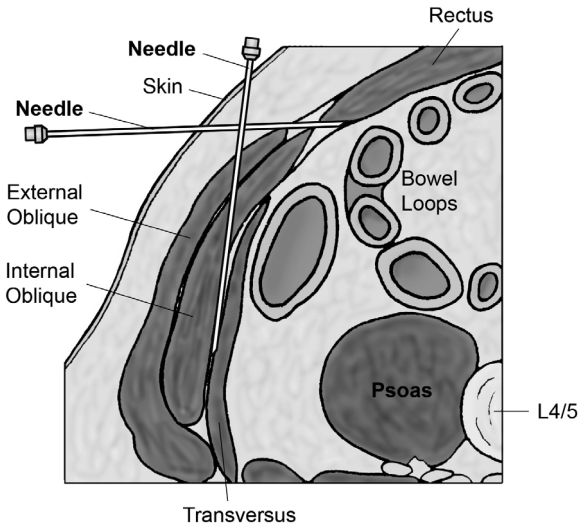

Figure 5. *Cross section of the abdominal wall, showing external oblique (EO), internal oblique (IO), transverses abdominis (TA) and rectus abdominis muscle. Needle one is pointing TAP plane and needle 2 is pointing where rectus sheath block should be performed.*

tially inserted close to the xyphoid process and local anaesthetic is deposited between the TA and rectus abdominis (RA) muscles *(15)*. The needle is then directed inferolaterally to progressively distend the TAP parallel to the costal margin, blocking the intercostal nerves as they emerge to run into the TAP *(15)*.

Less experienced practitioners may find this technique technically challenging.

Level of block

Initially, McDonnell and colleagues reported a sensory block assessed by pinprick test from T7 to L1 in 3 volunteers *(4)*. However, all clinical and cadaveric studies that followed reported a lower sensory level with TAP block. Hebbard described the upper extent of the sensory block to ice in 12 patients to be 52% of the distance from the pubic symphysis to the xiphoid process, which is approximately at T10 level, or to the umbilicus *(15)*.

A recent cadaveric study in 10 cadavers confirmed T10-L1 involvement *(2)*. Another anatomical study has demonstrated that the nerves located between the costal margin and inguinal ligament in the anterior axillary line have variable segmental origin from T9 to L1 *(5)*. Shibata and colleagues assessed sensory block by pinprick in 26 patients after ultrasound-guided TAP block for laparoscopic gynaecological surgery. They reported a block over the T10-L1 dermatomas. All the studies cited here, with the exception of that by McDonnell *et al. (1)* suggest only lower abdominal surgery as an indication for TAP block *(2, 5, 8, 9, 10, 11, 12)*

In order to achieve higher block, Hebbard's oblique subcostal TAP block technique should be used. The mean block height, assessed using ice, as a proportion of the distance from the xiphoid process to the pubis was 0.86 in Hebbard's study, equivalent to T6/7 *(15)*. This approach sometimes spares part of the L1 segment *(15)*.

The clinical implications from clinical and cadaveric studies are that TAP block should be used when analgesia between the umbilicus and groin, including the groin, is requested. For analgesia above the umbilicus, either the oblique subcostal or a combination of TAP with rectus abdominis sheet or paravertebral block is required.

Catheter technique

Bearing in mind that a continuous infusion technique can be used whenever a nerve block is applied, there are several case reports in the literature where an epidural catheter was used for continuous TAP block *(15, 16)*. It is strongly recommended that catheters should be placed only under ultrasound guidance. However, feeding a catheter through a needle can sometimes meet resistance. Significant resistance to catheter insertion can be reduced by injecting 5 to 10 ml of saline beforehand. An absence of resistance may suggest that the catheter is intraperitoneal *(16)*.

Our observation during lower abdominal surgery is that the IO and TA muscles are connected with the fascia and that there is no virtual space between them. We recently introduced surgically assisted catheter placement under direct vision. Surgical dissection was necessary to create space for catheter tip placement. A simple infusion device that delivers a constant amount of local anaesthetic through the catheter over a certain period of time has the potential to make this technique widely accepted on account of efficacy, simplicity and low cost for postoperative pain treatment in lower/mid-abdominal surgery.

Comparison with rectus abdominis sheath block

TAP block provides analgesia with a single bolus injection of local anaesthetic; in this respect it is similar to rectus abdominis sheath block *(17)*. However, the main difference between TAP block and rectus abdominis sheath block is the position of the local anaesthetic injection, which is the TAP for the former block and the medial border of the rectus abdominis muscle for the latter (Figure 5). Consequently, the sensory block is T10 to L1 for TAP, and T5 to T10 for rectus abdominis sheath *(7, 17)*. Spread of local anaesthetic injected into the TAP is limited by the lateral border of the rectus sheath *(15)*. These two blocks are complementary in terms of analgesic effect and can be used in combination for major surgical procedures when epidural analgesia is contraindicated, providing analgesia from T5 to L1 segments.

Comparison with epidural analgesia

There are no randomized controlled trials comparing TAP block and epidural analgesia. At present, TAP block is recommended in patients undergoing abdominal surgery when epidural blockade is contraindicated or not available *(16)*. Epidural analgesia has the advantage of providing analgesia for visceral and somatic pain. TAP block can provide

unilateral analgesia, a potential advantage in patients undergoing non-midline abdominal incision. Furthermore, TAP block can preserve bladder and lower limb motor function, thereby assisting early mobilisation after surgery. The haemodynamic instability following the cardiovascular effects of epidural block is avoided. Importantly, TAP injection can be performed in sedated and ventilated patients with less risk of neuroaxial injury.

Comparison with paravertebral block

There is only a small number of reports on the use of paravertebral block (PVB) for postoperative analgesia in abdominal surgery *(20, 21)*.

Low thoracic PVB is very different from TAP block with regard to the site of a single bolus injection of local anaesthetic: the thoracic paravertebral space lies on either side of the vertebral column and contains the intercostal (spinal) nerve, the dorsal ramus, the rami communicantes and the sympathetic chain *(22)*. It is very similar to TAP block as (i) it can be used for postoperative pain treatment in upper abdominal surgery, (ii) it is relatively safe to perform and has a low incidence of side effects, and (iii) it may be achieved with a single large-volume injection and can be maintained by infusion via a paravertebral catheter *(21, 22)*. Other similarities with TAP include the preservation of bladder and motor limb function, avoidance of haemodynamic instability, and the ability to administer the injection to sedated and ventilated patients with a low risk of neuroaxial injury *(21, 22)*.

A similar level and quality of analgesia can be reached with PVB and TAP block, and either technique can be used to create adequate analgesia for uni- or bilateral major abdominal surgery with the addition of paracetamol, NSAIDs and morphine PCA *(23)*.

Comparison with ilioinguinal/iliohypogastric block

Both the iliohypogastric and ilioinguinal nerves emanate from the first lumbar spinal root. The iliohypogastric nerve supplies the skin over the inguinal region. The ilioinguinal nerve runs anteroinferiorly to the superficial inguinal ring, where it emerges to supply the skin on the superomedial aspect of the thigh *(24)*.

Ilioinguinal/iliohypogastric block comprises one part of TAP block, because it blocks the same two lowest nerves blocked by TAP block. Consequently, the nerve is approached in a way that differs from TAP block (2 cm medial and 2 cm superior from superior iliac crest for ilioinguinal/iliohypogastric block, and the space between the EO/IO and IO/TA muscles is infiltrated with local anaesthetic). A smaller amount of local anaesthetic is required for this block, and block is provided at L1 sensory level. A catheter technique is described for ilioinguinal/iliohypogastric block *(25)*.

Complications of TAP block

Generally, TAP block has so far displayed a good safety profile. A large incentive for the widespread use of TAP block is the fact that other than the recently published liver damage and bowel haematoma there are few complications attributable to TAP block in the current literature *(26, 27)*. Anaesthetists using TAP block should be aware of the possibility of visceral damage if the needle is advanced too far inadvertently. The catheter technique has the potential to result in more complications compared with single shot *(16)*.

Transient femoral nerve palsy is a potential complication because of the proximity of the TAP and the femoral nerve. There is always the possibility of under-reported minor complications.

The reported incidence of transient femoral anaesthesia is 3.7–5% for ilioinguinal/iliohypogastric block *(28)*. The mechanism of femoral anaesthesia with these methods is tracking of the local anaesthetic along the fascia iliaca *(28)*.

Which local anaesthetic and which concentration?

Over time, the type and concentration of local anaesthetic used for TAP block has changed. For first reported TAP block used 0.5% lignocaine *(4)*. This was followed by 0.375% bupivacaine 20 ml, levobupivacaine to a maximum dose of 1 mg/kg each side, and finally 0.75% ropivacaine up to 1.5 mg/kg (to a maximum dose of 150 mg) on each side for bilateral block *(6, 7)*. Doses were increased in order to provide prolonged postoperative analgesia. Current high doses of ropivacaine are still within manufacturer safety guidelines for infiltration anaesthesia. Another way to prolong the analgesic effect is to add adrenaline, ketamine or clonidine to local anaesthetic solution, in concentrations recommended for other peripheral blocks.

For continuous infusions, ropivacaine at concentrations of 0.2–0.5% is used.

Equipment

Any atraumatic needle that is blunt enough to appreciate a loss of resistance is used for this block, e.g. 22-gauge Whitacre or Sprotte, 18-gauge Tuohy-type (which can also be used to place catheters), 21-gauge Stimuplex needles, etc.

Advantage

The clinical efficacy of the TAP block has been demonstrated in a case series *(8, 9, 10, 11, 12, 13, 14)* and more recently in randomised, controlled clinical trials of adults undergoing abdominal surgery *(1, 6, 7)*. These studies have shown that TAP block provides highly effective postoperative analgesia in the first 24–48 hours. Overall, during the first 24 postoperative hours, the TAP block reduced mean IV morphine requirements by more than 70%. This reduction in opioid requirement resulted in fewer opioid-mediated side effects, and the incidence of post-operative nausea and vomiting was reduced by more than half in the TAP block group. Sedation scores were also modestly reduced in the patients who underwent TAP block *(1, 6, 7)*.

Other advantages have already mentioned in different sections of this article: TAP block comprises a single large bolus injection that provides unilateral analgesia for up to 24 hours in combination with paracetamol, NSAIDs and rescue opioids. The landmark technique is simple and the ultrasound-guided technique can further improve accuracy, with minimal complications. Block can be performed under general anaesthesia with minimal chance of neuroaxial damage. It is convenient for unilateral analgesia and when epidural analgesia is contraindicated or when there is a lack of facilities for epidural analgesia.

Disadvantages

Most reports limit the use of this technique to lower abdominal surgery, with a success rate of approximately 85% in experienced hands *(1, 6, 7)* (this rate may be lower among the inexperienced). It provides analgesia for skin, muscles and parietal peritoneum of the anterior abdominal wall, but pain in pelvic and abdominal visceral sites is not covered. The analgesic effect lasts up to 48 hours, but some patients may need analgesia for longer than this *(6)*.

CONCLUSION

TAP block is a new regional anaesthesia technique that provides analgesia following abdominal surgery. It became increasingly popular worldwide because of its relative simplicity and efficacy. The technique involves a single large bolus injection of local anaesthetic into the TAP, an anatomical space between the internal oblique and transversus abdominis muscles and provides highly effective postoperative analgesia in the first 24–48 hours. As a component of a multimodal analgesic regimen. TAP block reduces IV morphine requirements by more than 70% and consequently reduces opioid-mediated side effects. It is convenient for unilateral analgesia and when epidural analgesia is contraindicated or when there is a lack of facilities for epidural analgesia. Further studies are necessary in order to fully characterize the clinical utility, dose response, and segments involved in this nerve block. Further studies are also needed to investigate the most suitable local anaesthetic agent (type, concentration and volume of injection), efficacy of continuous infusion through a catheter and comparison with epidural analgesia.

TAP block holds considerable promise on account of its efficicay, low complication rate and simplicity. It should be used more often in everyday practice.

REFERENCES

1. MCDONNELL J G, O'DONNELL B D, CURLEY G, HEFFERNAN A, POWER C, LAFFEY J G 2007 The analgesic efficacy of TAP block after abdominal surgery: A prospective randomised controlled trial. *Anesth Analg 104:* 193–197
2. TRAN T M, IVANUSIC J J, HEBBARD P, BARRINGTON M J 2009 Determination of spread of injectate after ultrasound-guided transversus abdominis plane block: A cadaveric study. *Br J Anaesth 102*: 123–174
3. MOORE K L, DALLEY A F 2005 Clinically oriented anatomy. 5th edition. Lippincott Williams & Wilkins.
4. MCDONNELL J G, O'DONNELL B D, FARRELL T, GOUGH N, TUITE D, POWER C, LAFFEY J G 2007 Transversus abdominis plane block: A cadaveric and radiological evaluation. *Reg Anesth Pain Med 32*: 399–404
5. ROZEN W M, TRAN T M, ASHTON M W, BARRINGTON M J, IVANUSIC J J, TAYLOR G I 2008 Refining the course of the thoracolumbar nerves: A new understanding of the innervation of the anterior abdominal wall. *Clin Anat 21*: 325–333
6. MCDONNELL J G, CURLEY G, CARNEY J, BENTON A, COSTELLO J, MAHARAJ C H, LAFFEY J G 2008 The analgesic efficacy of transversus abdominis plane block after Caesarean delivery: A randomised controlled trial. *Anesth Analg 106*: 186–191
7. CARNEY J J, MCDONNELL J G, OCHANA A, BHINDER R, LAFFEY J G 2008 The transversus abdominis plane block provides effective postoperative analgesia in patients undergoing total abdominal hysterectomy. *Anesth Analg 107*: 2056–2060
8. O'DONNELL B D 2006 The transversus abdominis plane (TAP) block in open retropubic prostatectomy. Letter to the Editor. *Reg Anesth Pain Med 31 (1)*: 91
9. MUKHTAR K, SINGH S 2009 Transversus abdominis plane block for laparoscopic surgery. *Br J Anaesth 102*: 143–144
10. FRENCH J L, MCCULLOUGH J, BACHRA P, BEDFORTH N M 2009 Transversus abdominis plane block for analgesia after Caesarean section in a patient with an intracranial lesion. *Int J Obstet Anesth 18*: 52–54
11. RANDALL I M, COSTELLO J, CARVALHO J C 2008 Transversus abdominis plane block in a patient with debilitating pain from an abdominal wall hematoma following Cesarean delivery. *Anesth Analg 106*: 1928
12. HEBBARD P 2007 Audit of »rescue« analgesia using TAP block. *Anaesth Intensive Care 35*: 617–618
13. PAK T, MICKELSON J, YERKES E, SURESH S 2009 Transverse abdominis plane block: A new approach to the management of secondary hyperalgesia following major abdominal surgery. *Paediatr Anaesth 19*: 54–56
14. RAFI A N 2001 Abdominal field block: A new approach via the lumbar triangle. Correspondence. *Anaesthesia 56*:1024–1026
15. HEBBARD P 2008 Subcostal transversus abdominis plane block under ultrasound guidance. *Anesth Analg 106*: 674–675
16. JANKOVIC Z, AHMAD N, RAVISHANKAR N, ARCHER F 2008 Transversus abdominis plane block: how safe is it? *Anesth Analg 107*: 1758–1759
17. WILLSCHE H, BOSENBERG A, MARHOFER P, JOHANSTON S, KETTNER SC, VANZEL O, KAPRAL S 2006 Rectus sheath block in paediatric anaesthesia – A new approach to an old technique. *Br J Anaesth 97*: 244–249
18. TORNERO-CAMPELLO G 2007 Transversus abdominis plane block should be compared with epidural for postoperative analgesia after abdominal surgery. *Anesth Analg 105*: 281–282
19. MCDONNELL G, LAFFEY J 2007 The transversus abdominis plane block. Response. *Anesth Analg 105*: 282–283
20. HO A M, KARMAKAR M K, CHEUNG M, LAM G C S 2004 Right thoracic paravertebral analgesia for hepatectomy. *Br J Anaesth 93*: 458–461
21. NAJA M Z, ZIADE M F, LONNQVIST P A 2004 General anaesthesia combined with bilateral paravertebral blockade (T5-6) vs. general anaesthesia for laparoscopic cholecystectomy: A prospective, randomized clinical trial. *Eur J Anaesthesiol 21*: 489–495
22. MYLES P 2006 Underutilization of paravertebral block in thoracic surgery. Editorial. *J Cardiothorac Vasc Anesth 20*: 635–637
23. HADZIC A, KERIMOGLU B, LOREIO D, KARACA P E, CLAUDIO R E, YUFA M, WEDDERBURN R, SANTOS A C, THYS D M 2006 Paravertebral blocks provide superior same-day recovery over general anesthesia for patients undergoing inguinal hernia repair. *Anesth Analg 102*: 1076–1081
24. www.nysora.com
25. MAALIKI H, NAJA Z, ZEIDAN A 2008 Repeated ilioinguinal block using a catheter technique for pain relief in inguinal neuralgia. *Pain Pract 8*: 144–146
26. FAROOQ M, CAREY M 2008 A case of liver trauma with a blunt regional anesthesia needle while performing transversus abdominis plane block. *Reg Anesth Pain Med 33*: 274–275
27. FRIGON C, MAI R, VALOIS-GOMEZ T, DESPARMET J 2006 Bowel hematoma following an iliohypogastric-ilioinguinal nerve block. *Paediatr Anaesth 16*: 993–996
28. ROSARIO D J, JACOB S, LUNTLEY J, SKINNER P P, RAFTRY A T 1997 Mechanism of femoral nerve palsy complicating percutaneous ilioinguinal field block. *Br J Anaesth 78*: 314–316