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ULTRASOUND-GUIDED BILATERAL DUAL TRANSVERSUS ABDOMINIS PLANE BLOCK

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Background and aims: The purpose of this abstract is to describe some characteristics of the bilateral dual transversus abdominis plane (BD-TAP) block. Some of these characteristics have already been published[1,2], some novel findings have been submitted for publication in another context[3], or have been presented in part at the American Society of Regional Anesthesia and Pain Medicine (ASRA) congress, Las Vegas, May 2011. Finally, some data presented herein are preliminary in nature or will be presented at other venues at the European Society of Regional Anaesthesia (ESRA) congress, Dresden, September 2011[4-6].

Methods: In one study, a cohort of twenty-five consecutive patients were assessed in the postoperative phase following major abdominal surgery, where the BD-TAP blocks were administered as escape treatment for pain in the post anaesthesia care unit (PACU)[1]. The BD-TAP block was considered only if the patients had abdominal pain VAS ≥5, when other methods had failed or were contraindicated. The effect of the BD-TAP blocks on such postoperative pain management was recorded in this cohort study. Following this initial cohort, three subsequent randomized controlled trial (RCT) studies were conducted. These RCT studies included twelve, ten and eight healthy volunteers, respectively. All subjects were enrolled in the studies after responding to an announcement on a Danish website, designed for the recruitment of subjects to scientific studies. The first of these studies examined whether the BD-TAP block negatively affected the pulmonary function of the patients. We examined whether the application of a BD-TAP block would affect forced expiratory volume in 1 sec (FEV_1), forced vital capacity (FVC) and maximum expiratory pressure (MEP). The last two RCT studies describe (i) the temporal distribution of injected local anaesthetic (LA) by quantifying and qualifying the spread of LA over time by magnetic resonance imaging (MRI) of the BD-TAP block and the classical TAP block, and (ii) the venous serum concentrations of ropivacaine in a six hour period following administration of a fixed volume of 60 ml of ropivacaine 0.375% (225 mg in total). The volunteers in these two last studies were all randomized and blinded to receive "half" a BD-TAP block on one side of the abdomen (i.e. a so-called unilateral dual TAP block consisting of a medial intercostal TAP block (15 ml) in the upper abdomen combined with a classical-TAP block (15 ml) in the lower abdomen), or a solitary classical TAP block (30 ml) in the lower abdomen on the contra-lateral side (Figure 1).

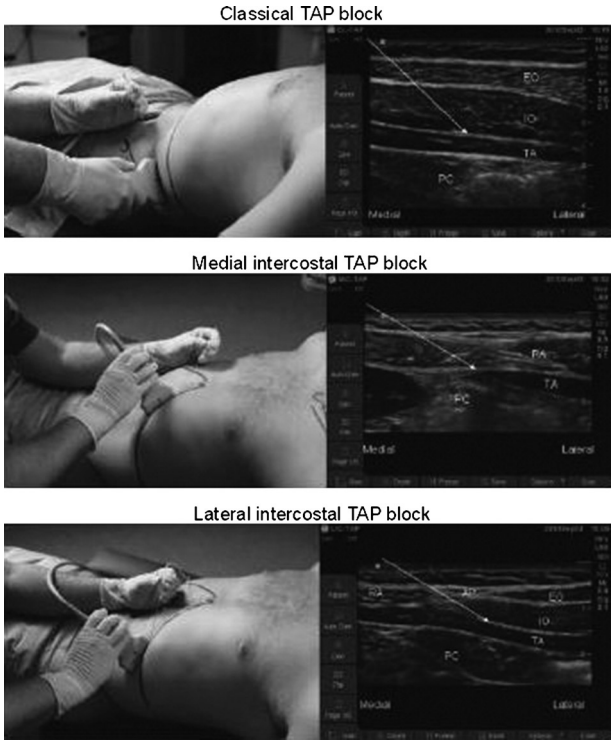
All patients and volunteers received the BD-TAP blocks in the PACU under standard monitoring. Blocks were performed under aseptic conditions using a SonoSite S-Nerve (SonoSite™, Bothell, WA, USA) apparatus and a linear high-frequency ultrasound transducer (6-13 MHz), HLX38) covered with a sterile sheath (Flexasoft®). All blocks were applied using an in-plane technique in a medial to lateral direction at all four sites of injection. A 21-gauge, 90 mm long needle was used (Polymedic® ultrasound needle 30° bevel, SAS, France).

Results: In the initial cohort study the 25 patients reported a reduction of their maximum pain at rest (VAS 0-10) from a mean of 8.2 (range, 6-10) to a mean of 2.2 (range, 0-6) ($P< 0.001$)[1]. Twenty-one patients (84%) did not require any i.v. opioids in the following 6 h. Sixteen patients (64%) were mobilized within 6 h following the blocks. In the RCT crossover study examining the effect of the BD-TAP block on the pulmonary function, we found that the block had no clinically or statistically significant influence on the pulmonary function as measured with FEV1, FVC and MEP[3].

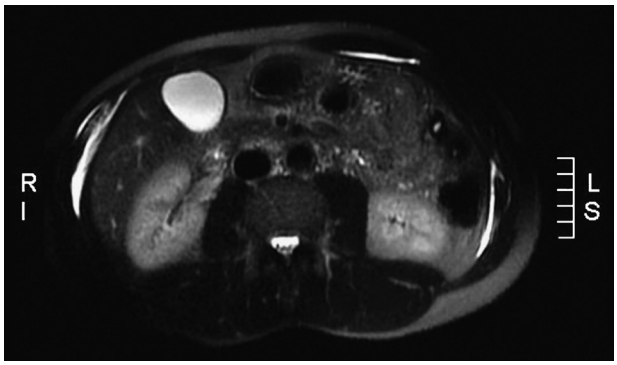
The majority of the primary results from the last two RCT studies employing MRI to visualize spread of LA over time and measuring s-ropivacaine levels are presented in more detail elsewhere at the ESRA congress, Dresden 2011[4-6]. However, the general trend when quantifying and qualifying the spread of LA over time can be visualized in Figure 2.

With the solitary large volume classical-TAP (30 ml) block it was evident that even after 6 hours duration the LA did not spread cephalad to the intercostal TAP plexus. Preliminary measurements on one of the typical MR images show that the distance between the most cephalad tip of the well-defined LA pool to the lateral border of the rectus abdominis muscle (where the aponeurosis are formed) change from 5 cm at 30 minutes to 3 cm at 360 minutes following the block procedure. Further, on the other side of the abdomen where the unilateral dual TAP block was placed, the distance on the same MR image measured between the two pools of LA (high and low) change from 7.2 cm at 30 minutes to 2.7 cm at 360 minutes following the block procedure. Degree of dermatomes anaesthetized in general confirmed this spread pattern. In addition, preliminary results analysing venous serum-ropivacaine levels following blocks with a fixed volume and amount of ropivacaine (60 ml of 0.375% = 225 mg) never exceeded the potential toxic level of 2.2 mg/l total ropivacaine[7]. Figure 3 depicts the exponential tendency curve calculated from the direct measured venous serum concentrations in one patient with a R^2 value of 0.99, indicating an almost perfect fit to the expected pharmacokinetic model.

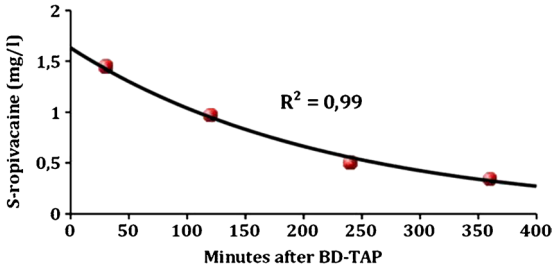
Conclusions: We conclude that the BD-TAP block may be a useful adjunct to the multimodal analgesia regime after abdominal surgery as rescue analgesia after failure of other methods. The particular timing of BD-TAP block placement and its use in elective surgery still remains an issue of debate. When placed preoperatively, the abdominal wall easily presents itself ultrasonically, making blocks easy to perform, but the instilled injectate may be washed away by surgical incisions. Both arguments may reduce the duration of effective postoperative analgesia. Placing the blocks postoperatively, however, may be more technically difficult because of oedema and abdominal wall disruptions, again affecting block efficiency adversely.



[BD-TAP block - general technique]



[BD-TAP axial MRI]



[serum ropivacaine after BD-TAP block]

The rectus abdominis, external and internal oblique and transversus abdominis muscles are the most important accessory expiratory muscles and mainly active in forced expiration. Our studies have also lead us to conclude that, in a selected population, the collated effects on the abdominal wall muscles of a BD-TAP block (in theory anaesthetizing all the thoracolumbar nerves from Th6 to L1) did not have a measurable adverse effect on pulmonary function, as assessed by FEV_1, FVC and MEP. Future studies should investigate if these encouraging results are reproducible in patients with limited pulmonary function.

There has been some controversy as to how effective the various forms of TAP blocks have been to provide complete analgesic coverage of the abdominal wall. Our novel studies quantifying and qualifying the spread of LA over time by MRI of the BD-TAP block and the classical TAP block seem to support the need to anaesthetize both the upper intercostal TAP plexus (Th6-Th9) and the lower classical TAP plexus (Th10-Th12). Even with a large volume classical lower TAP block (30 ml) the LA did not spread cephalad to the intercostal TAP plexus after 6 hours. On the other hand, with the administration of a unilateral dual TAP block (a combination of a medial intercostal TAP block (15 ml) and a classical lower TAP block (15 ml) we could image a marked distribution of LA both at the intercostal TAP plexus and at the lower classical TAP plexus. Degree of dermatomes anaesthetized confirm this spread pattern.

Finally, none of our patients or volunteers experienced any adverse toxic side effects from the administration of the LA in the abdominal wall. We conclude that serum concentrations of ropivacaine following the administration of a total of 225 mg in our preliminary analyses did not reach toxic levels during a 6-hour trial. However, other studies have recently found that TAP blocks using 3 mg/kg ropivacaine produce venous plasma concentrations that are potentially neurotoxic[7]. This difference may in part be explained by a more heterogeneous population of patients in terms of age, abdominal wall anatomy and sex than our study in healthy male volunteers. Nevertheless, more studies are needed in this crucial area concerning patient safety.

References:

1. Ultrasound-guided bilateral dual transversus abdominis plane block: a new four-point approach. J. Børglum, C. Maschmann, B. Belhage, K. Jensen. Acta Anaesthesiol Scand 2011; 55: 658-63.
2. Transversus abdominis plane blocks for rescue analgesia after major abdominal surgery. Z. J. Koscielniak-Nielsen. Acta Anaesthesiol Scand 2011; 55: 635-37.
3. Bilateral-dual TAP block: Is pulmonary function affected? M. Petersen, J. Elers, J. Børglum, B. Belhage, J. Mortensen, C. Maschmann. Reg Anesth Pain Med 2011 (Submitted May 2011).
4. Ultrasound-guided BD-TAP block: MRI imaging of the distribution of local anaesthetic. T. Jansen, A. F. Christensen, M. Petersen, K. Jensen, J. Børglum. 30th ESRA Congress, Dresden 2011.
5. Calculations of local anaesthetic volume spread in ultrasound-guided (USG) transversus abdominis plane (TAP) blocks: Validity of MRI measurements. J. Børglum, T. Jansen, A. F. Christensen, K. Jensen. 30th ESRA Congress, Dresden 2011.
6. The direction and geometric spread of a TAP block. An MRI study in healthy volunteers. K. Jensen, T. Jansen, A. F. Christensen, J. Børglum. 30th ESRA Congress, Dresden 2011.
7. Plasma ropivacaine concentrations after ultrasound-guided transversus abdominis plane block. J. D. Griffiths, F. A. Barron, S. Grant, A. R. Bjorksten, P. Hebbard, C. F. Royse. Br J Anaesth 2010; 105(6): 853-6.

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WHY DOES A US-GUIDED TAP BLOCK NOT WORK?

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Ultrasound (US) guidance for nerve localization during peripheral nerve blockade has gained considerable popularity worldwide. Much of this popularity is attributable to several important advantages of real-time sonographic visualization compared with traditional nerve localization techniques.

The transversus abdominis plane (TAP) block is a technique of locoregional anesthesia recently introduced to control the postoperative pain of procedures that involve incisions of the anterior abdominal wall.

A substantial component of the pain experienced by patients after abdominal surgery is derived from the abdominal wall incision. The abdominal wall consists of three muscle layers, the external oblique, the internal oblique, and the transversus abdominis, and their associated fascial sheaths. The central abdominal wall also includes the rectus abdominis muscles and its associated fascial sheath.

The TAP block blocks the sensorial afferent nerves localized between the transversus abdominis muscle and the internal oblique muscle. The local anesthetic is delivered blindly or under direct visualization in this plane. This plane contains the thoracolumbar nerves originating from T6 to L1 spinal roots which supply sensation to the anterolateral abdominal wall.

Data obtained after different types of surgical operations [1-5] show to be effective in reducing morphine consumption (reducing the side effects from it) and improving postoperative pain relief in several clinical settings. The TAP block is comparable to morphine for postoperative analgesia. The TAP block reduces the requirement of postoperative opioid use, increases time to first request for further analgesia, provides more effective pain relief, and reduces opioid-associated side effects.

The TAP block was first described in 1993 [6] for the management of surgical abdominal pain, but TAP blocks were formally documented by Rafi [7] in 2001. Since then several anatomical approaches to the TAP have been described.

The technique was initially described using a blind approach in the flank, via the iliolumbar triangle of Petit [8]; bounded inferiorly by the iliac crest, posteriorly by the latissimus dorsi, and anteriorly by the external oblique muscles. The blunt technique uses a double-loss of resistance as the needle is advanced through the external and internal obliques fascia layers. A single-pop technique through the Triangle of Petit highlighting entrance into the plane. A second pop is felt when the needle passes through the transversus abdominis muscle. Although it is not yet clear as to what the actual spread of the block is. As with all blind approaches to regional anesthesia, the TAP block relies on imprecise endpoints; namely two pops felt as the needle traverses both the external and internal oblique muscles.

This "double pop" technique has been validated in cadaveric, radiological, and clinical studies[9]. Failure to recognize these pops may result in needle advancement deep to the transversus abdominis muscle and into the peritoneal cavity.

Since then, ultrasound-guided approaches have been described[10-12].

The standard or "posterior" approach involves injecting local anesthetic into the TAP midway between the iliac crest and the costal margin, typically depositing local anesthetic between the anterior and middle axillary lines. Studies in cadavers and healthy volunteers suggest that a 20 ml solution spreads from the iliac crest to the costal margin and ensures a complete sensory blockade of the abdominal wall[9]. However, others cadaveric studies, involving the ultrasound-guided injection 20 mL of aniline have suggested that the T10-L1 nerve roots can be reliably blocked using the technique[13].

More recently, a "subcostal" injection has been described, in which local anesthetic is delivered into the same anatomical plane, but using an insertion point near the xiphoid process, and a needle path parallel to the costal margin[14]. This subcostal approach may have a better effect on higher incisions, but it does extend down to the pubis with occasional sparing of L1 in some patients. It has been proposed that this approach offers superior analgesia for incisions superior to the umbilicus.