Transversus abdominal plane (TAP) block for postoperative pain management: a review [version 1; peer review: 2 approved]

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Abstract
Transversus abdominal plane (TAP) block has a long history and there is currently extensive clinical experience around TAP blocks. The aim of this review is to provide a summary of the present evidence on the effects of TAP block and to provide suggestions for further studies.

There are several approaches to performing abdominal wall blocks, with the rapid implementation of ultrasound-guided technique facilitating a major difference in TAP block performance. During surgery, an abdominal wall block may also be applied by the surgeon from inside the abdominal cavity. Today, there are more than 11 meta-analyses providing a compiled evidence base around the effects of TAP block. These analyses include different procedures, different techniques of TAP block administration and, importantly, they compare the TAP block with a variety of alternative analgesic regimes.

The effects of TAP block during laparoscopic cholecystectomy seem to be equivalent to local infiltration analgesia and also seem to be beneficial during laparoscopic colon resection. The effects of TAP are more pronounced when it is provided prior to surgery and these effects are local anaesthesia dose-dependent. TAP block seems an interesting alternative in patients with, for example, severe obesity where epidural or spinal anaesthesia/analgesia is technically difficult and/or poses a risk. There is an obvious need for further high-quality studies comparing TAP block prior to surgery with local infiltration analgesia, single-shot spinal analgesia, and epidural analgesia. These studies should be procedure-specific and the effects should be evaluated, both regarding short-term pain and analgesic requirement and also including the effects on postoperative nausea and vomiting, recovery of bowel function, ambulation, discharge, and protracted recovery outcomes (assessed by e.g., postoperative quality of recovery scale).

Keywords
TAP-block, Transversus abdominal-plane block, ultra-sound, pain management
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Introduction
There is an increasing interest in abdominal wall block. The ultrasound-guided technique has improved the performance and success rate. The effects, advantages and potential disadvantages as compared to alternative pain management are, however, not obvious. There are several alternatives and the best technique is not clear. The ultrasound guidance has made this block more attractive. There are today several videos describing anatomy and how to perform the TAP block effectively (https://www.youtube.com/watch?v=9THDn7uBZI, https://www.youtube.com/watch?v=CzDDrPbLEM). Not introducing the needle too close to the probe is important in order to visualise the needle reaching the layer between the internal oblique and transverse abdominal muscle (https://www.youtube.com/watch?v=6E3yIn6Ud4).

Our aim in this paper is to present the benefits and merits of TAP block in adults. It will provide a review of techniques and outcomes from available studies. There are more than 11 meta-analyses available compiling studies assessing TAP blocks. This paper will provide summaries of these meta-analyses and suggest best practice. It will also suggest areas where there is a need for further high-quality studies.

What we know now: meta-analyses and systematic reviews
There are 11 published meta-analyses around the effects of TAP block. The most recent was published in September 2015 and the first was a Cochrane review by Charlton et al. published in 2010. They assess the effects of various abdominal blocks, most provided by ultrasound-guided technique. The studies are, however, hard to compare as different approaches, local anaesthetic concentrations, and volumes have been used. The abdominal block has been compared to “placebo” or to other anaesthetic techniques, for example, local infiltration analgesia or intrathecal anaesthesia. The most recent meta-analysis by Baarswyl et al. was published in the September 2015 issue of Anaesthesia and Analgesia. It included 31 controlled trials and 611 adult patients in all. Its primary focus was on the opioid-sparing effects, and the cumulative morphine consumption at 6 hours postoperatively, and its secondary objectives were 24-hour morphine consumption, pain ratings, and postoperative nausea and vomiting. It showed that the ultrasound-guided TAP block was associated with a reduced IV morphine consumption at 6 hours postoperatively by a mean difference of 6 mg, independent of the type of surgical anaesthesia (general anaesthesia, spinal anaesthesia with or without intrathecal long-acting opioid). The beneficial effect of cumulative morphine consumption was also seen at 24 hours (mean 11 mg). Pain ratings were reduced at 6 hours postoperatively but no effect was seen in the incidence of postoperative nausea and/or pruritus, either at rest or during movement. The authors conclude, “Ultrasound-guided TAP block provides marginal postoperative analgesic efficacy after abdominal laparotomy or laparoscopy and cesarean delivery. However, it does not provide additional analgesic effect in patients who also received spinal anaesthesia containing a long-acting opioid”. Thus the result of this most recent review is in line with the ones previously published.

Charlton et al. published a Cochrane systematic review in 2010 assessing the effect of TAP block for pain relief after abdominal surgery. They included 8 prospective randomised studies. A clear opioid-sparing effect was found as compared to placebo or “no block”. Compared with no TAP block or saline placebo, TAP block resulted in significantly less postoperative requirement for morphine at 24 hours (mean difference -21.95 mg) and 48 hours (cumulative difference -28.50 mg). No effect was found on nausea and vomiting. The authors requested further studies comparing TAP block with alternative local anaesthesia techniques, for example, local infiltration and single-shot intrathecal anaesthesia.

Siddiqui et al. published a second meta-analysis in 2011 around the efficacy of the TAP block. Four studies were included: laparoscopic cholecystectomy, caesarean section with Pfannenstiel incisions, total abdominal hysterectomy, and large bowel resection midline incision. It was found that patients that were randomised to active TAP block had a significantly lower cumulative morphine need during the first 24 hours post surgery (P<0.001), a significantly longer time until they needed rescue morphine (P<0.001), as well as less pain up to 24 hours post surgery. No significant effects from the TAP block were noticed in postoperative nausea and vomiting. The most profound TAP block effects were noticed for the caesarean section and colon surgery.

Mishriky et al. published a third meta-analysis in 2012, looking at analgesia after caesarean section. Nine studies were included. They found that TAP block significantly reduced opioid consumption (mg morphine equivalents) after caesarean section. The mean difference in opioid need was -10.18, -13.83, and -20.23 mg at 6, 12, and 24 hours respectively. TAP block also reduced pain during the first 12 hours and reduced nausea among the patients who did not have intrathecal morphine. The combination of TAP block and spinal morphine was associated with a small reduction in pain during movement in the first 6 hours after surgery. Intrathecal morphine was, however, more effective; it was associated with a lower pain score and opioid consumption at 24 hours after surgery. The intrathecal morphine group also had a longer time before the first rescue analgesia request. The intrathecal morphine caused more morphine-related side effects.

Johns et al. conducted a fourth meta-analysis published in 2012 looking at the analgesic effects of TAP block after abdominal surgery. In all, 9 studies representing both published and unpublished results were analysed including 413 patients; 205 that had a TAP block and 208 control patients. TAP block was found to be safe and effective and was associated with a significantly lower morphine need both 24 and 48 hours after surgery, -23.71 mg (P<0.0001) respectively, and also a lower incidence of postoperative nausea and vomiting. Pain scores did not differ significantly.

Abdallah et al. published a meta-analysis in 2012 assessing TAP block for postoperative analgesia after caesarean delivery performed under spinal anaesthesia. They analysed the results for 5 studies including 312 patients. TAP block was found to reduce the mean first 24-hour post surgery cumulative morphine need by 24 mg when intrathecal morphine had not been used. TAP block also lowered pain scores (0.8/10) and morphine related adverse effects. The effects of TAP block were not significantly different.
from intrathecal morphine. It was concluded that TAP block can reduce morphine need during the first 24 hours after surgery when intrathecal morphine is not used.

Abdallah et al. published another meta-analysis in 2013 focusing on the difference between two TAP block approaches (the posterior and the lateral) and their effect on the duration of pain relief after lower abdominal surgery incision. In all, 12 randomised studies were included in the analysis (641 patients); 4 studies with a posterior TAP technique and 8 with a lateral technique. They found the posterior approach was associated with a significantly lower morphine need both 12 to 24 hours and 24 to 48 hours after surgery; a mean difference of 9.1 mg (P<0.02) and 5 mg (P<0.03), respectively. The TAP posterior block also had significant effects on pain, reducing pain scores at rest and during movement at 24, 36, and 48 hours after surgery. The lateral TAP was not associated with any significant differences.

De Oliveira et al. published a 7th meta-analysis assessing TAP block analgesic effects after laparoscopic surgery. They included 10 randomised studies covering 633 patients. They found TAP block to lower pain at rest -2.41/10 during the first 4 hours postoperatively and -1.33/10 at 24 hours post surgery. TAP also reduced IV morphine need (weighted mean -5.74 mg morphine equivalents). It was also found that TAP block administered preoperatively was more effective on pain, and reduced postoperative morphine consumption when compared with blocks placed postoperatively. No local anaesthesia toxicity was reported.

Zhao et al. published an 8th meta-analysis assessing TAP block for postoperative analgesia after laparoscopic surgery. In all, 14 studies with a total of 905 patients were included in this analysis. TAP block resulted in significantly less postoperative analgesic consumption at 24 hours (mean difference = -25.46, P<0.00001), and less patients requiring analgesic postoperatively (P=0.03). TAP block reduced pain; pain scores were significantly different at 2 hours (mean difference = -1.55, P<0.00001). A borderline difference between the active TAP block and control was seen at 6 hours (mean difference = -1.13, P=0.05). TAP block had no effect on pain at 24 hours. TAP block was associated with significantly more postoperative nausea and vomiting (odds ratio 2.04, P=0.34). The authors concluded TAP reduced 24-hour analgesic requirements, had minor effects on early pain, and may increase the risk of postoperative nausea and vomiting.

Yu et al. published the 9th meta-analysis in December 2014 assessing TAP block as compared to local wound infiltration analgesia in patients undergoing lower abdominal surgery. In all, 4 randomised studies were included in this analysis; 96 patients having a TAP block and 100 patients having local infiltration analgesia. The TAP block reduced pain, pain scores were lower both at rest and during movement as compared to local infiltration analgesia at 24 hours postoperatively; weighted mean difference -0.67 (P<0.01) and -0.89 (P<0.01) respectively. Postoperative 24-hour morphine need, incidence of postoperative nausea and vomiting, and pain assessed by the visual analogue scale score at 2 and 4 hours did not differ between the TAP and local infiltration analgesia groups of patients.
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Table 2. Considerations around TAP-block.

| Patient | Lean vs. obese
|---------|----------------|
| Surgery | Unsuitable for spinal
| Upper vs. lower abdominal | Open vs. minimally invasive
| Midline or lateral or Pfannenstiel incision |
| Pain management/Comparator; alternative | Local infiltration analgesia
| Paravertebral block | Spinal
| Epidural | PCA[AU: Please define] morphine
| Technique and drugs | Ultrasound vs. blind
| Lateral vs. posterior |
| Local anaesthetic | • Concentration and volume
| • Adjuncts |

is a volume block and is performed by injecting local anaesthetic solutions in the transverse abdominis plane without specific reference to the nerves responsible for the innervations of the abdomen wall. It is not surprising that in these conditions the quality of a TAP block is dependent on the approach and the volume administered. There are more specific approaches: blocks specifically blocking the involved innervation of the abdomen include ilioinguinal, iliohypogastric, and/or intercostal blocks that can be used alone and/or in combination depending on the surgical incision. Early reduced opioid consumption is a consistent finding associated with the TAP block. These effects are seemingly most pronounced in transverse incisions, when the block is provided prior to surgery, and there is also a dose effect. Kokulu et al. showed that TAP block provided preoperatively was associated to a reduction of desflurane need and thus was cost effective during elective cholecystectomy. It is somewhat surprising that the effects on postoperative nausea and vomiting are not entirely conclusive: one meta-analysis even suggested there was no benefit and another a potential increase in postoperative nausea and vomiting in the TAP groups.

The long-term effects require further studies. Keller et al. found, studying 200 consecutive patients who underwent a laparoscopic colorectal resection, that adding TAP blocks to an enhanced recovery pathway facilitated shorter length of hospital stay with lower readmission and reoperation rates, when compared to previously published series. This suggested TAP blocks might be an efficient, cost-effective method for improving laparoscopic colorectal surgery results. Similar positive experiences were reported by Favuzza et al. Both these studies compared a TAP block performed at the end of surgery with the laparoscope still in place, actually visualising the muscle layers of the structures from the “inside”, thus not performed by ultrasound technique but by the surgeon. The surgeon performed the block from the outside, passing the needle through the skin, mid-axillary, approximately half the distance between the iliac crest and the costal margin. The traditional two pops technique, passing two fascia borders, was used and the injection of 30 ml of 2.5 mg/ml bupivacaine was injected under surveillance of the laparoscope, imaging the spread at the place for the transversus abdominis muscle. It should be acknowledged that these studies were not randomised or blinded.

The analgesic effect has a duration related to the local anaesthetic administered. The analgesic duration has been shown to be longer when dexamethasone is added to local anaesthesia. There are also positive results from the use of liposomal bupivacaine: the total opioid use in the first 72 hours after injection was significantly decreased in the group that received liposomal bupivacaine compared to non-liposomal bupivacaine. Patients in the liposomal bupivacaine group had significantly lower maximal pain scores at all time periods studied, as well as a decreased incidence of nausea/vomiting. There was a trend toward decreased length of stay in the liposomal bupivacaine group. The addition of sufentanil to bupivacaine did not provide longer or more effective effects as compared to bupivacaine alone for pain management following laparoscopic cholecystectomy.

Today, there are several meta-analyses around the effects of TAP block, but still, the exact place for TAP block requires further studies. The last meta-analysis by Ripollés et al. concludes that the data found in randomised clinical trials are not conclusive and, as a result, it is necessary to develop new and well-designed randomised clinical trials, with enough statistical power to compare different approaches, drugs, doses, and volumes for the same intervention, aiming to answer the current questions and monitoring their effects in routine clinical practice. The TAP block as part of a multimodal analgesic strategy, as compared to local wound infiltration analgesia,
and spinal/intrathecal analgesia (IT morphine), not only improved morphine consumption during the first 24 to 48 hours but also quality of recovery assessed in a broader and more protracted/long-term time perspective, for example, assessed by postoperative quality of recovery scale\textsuperscript{9}. It seems it would also be of value to conduct studies comparing the TAP block to paravertebral block. Chelly et al. have shown that the paravertebral block was effective for pain management following open radical retropubic prostatectomy\textsuperscript{9}. There is also a need to better explore the place for TAP block in paediatric peripерioperative care\textsuperscript{11}.

**Conclusion**

In conclusion, TAP block is a safe and interesting block that may be provided by ultrasound-guided technique or intraoperatively by the surgeon, providing postoperative analgesia, and a reduced need for morphine analgesia during the first 24 to 48 hours following abdominal procedures. TAP block administered prior to surgery reduces not only postoperative opioid requirements but also intraoperative anaesthetic needs. There is, however, a need for further high-quality studies assessing the effects of TAP block as part of multimodal analgesia, and as compared to local infiltration analgesia and intrathecal morphine, assessed in a more protracted time perspective of quality of recovery. Studies performed should also be procedure specific.

**Abbreviations**

TAP block, transversus abdominal plane block.

**Competing interests**

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**References**


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