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The Efficacy of a Novel Approach to Transversus Abdominis Plane Block for Postoperative Analgesia After Colorectal Surgery

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BACKGROUND: The analgesic efficacy of transversus abdominis plane (TAP) block has been established for patients undergoing abdominal surgery. We evaluated the efficacy of a novel approach to TAP block for postoperative analgesia after colorectal surgery.

METHODS: Forty adult ASA physical status I to III patients undergoing colorectal surgery were recruited to this double-blind randomized controlled trial. A standard general anesthetic technique was used. TAP block was performed at the end of surgery by piercing the transversus abdominis muscle from inside the abdominal wall at the midaxillary line at the level of the umbilicus with a 22-gauge blunt needle. The patients were randomly assigned to receive either 20 mL of 0.25% bupivacaine (TAP group) or normal saline (control group) on each side of the abdominal wall. Each patient was assessed at 0, 0.5, 1, 2, 4, 8, 12, and 24 hours postoperatively for pain at rest and on coughing using a visual analog scale. IV morphine was used for postoperative rescue analgesia. Time to first request for rescue analgesia, total morphine requirement in 24 hours, cumulative morphine consumption at 2, 4, 6, 12, and 24 hours, and adverse effects (respiratory depression, sedation, nausea/vomiting) were recorded.

RESULTS: A 65% decrease in 24-hour total morphine consumption was observed in the TAP group compared with the control group ($P < 0.0001$). The cumulative morphine requirement was also significantly lower in the TAP group at all time points. Although the time to first request for morphine was comparable, the subsequent doses of morphine were required at significantly longer time intervals in the TAP group than in the control group. TAP group patients had significantly lower pain scores at rest and on coughing as compared with the control group, at all time points assessed. The incidence of sedation was also less in the TAP group at 1, 2, 4, and 6 hours postoperatively ($P < 0.05$).

CONCLUSIONS: This new approach to the TAP block provides effective postoperative analgesia after colorectal surgery. (Anesth Analg 2011;112:1504–8)

Colorectal operations are among the most frequently performed major abdominal surgical procedures.[1] Postoperative pain requiring bed rest, and persistent gastrointestinal dysfunction, are key factors keeping patients in the hospital.[2] Opioids remain the mainstay of postoperative pain relief but can result in significant adverse effects including sedation, nausea, vomiting, urinary retention, respiratory depression, delayed recovery of colonic mobility, and prolonged postoperative ileus.[3,4] Although epidural analgesia traditionally had a key role in postoperative pain management after colorectal surgery,[5] the technique is labor intensive and has the risk of serious neuraxial morbidity, albeit rare.[6]

Direct blockade of the neural afferent supply of the abdominal wall by abdominal field block has been used previously in patients undergoing cesarean delivery.[7] Rafi[8] demonstrated a modified technique of abdominal field block known as the transversus abdominis plane (TAP) block. In this technique, the local anesthetic, injected in the neurovascular plane between the transversus abdominis muscle and internal oblique muscle of the anterior abdominal wall via the lumbar triangle of Petit, blocks the lower intercostal (T7-11), iliohypogastric, and ilioinguinal nerves. Various studies have shown that TAP block using this technique provides effective analgesia and reduces postoperative morphine consumption after retropubic prostatectomy,[9] colorectal surgery,[10] cesarean delivery,[11] abdominal hysterectomy,[12] laparoscopic appendicectomy, and incisional hernia repair.[13] Although the technique is effective, severe complications as a result of inadvertent needle positions have been described.[14,15]

The injection of local anesthetic into the TAP from inside the abdominal wall may reduce the risk of inadvertent visceral puncture. In this prospective randomized double-blind study, we investigated the feasibility and efficacy of this new approach to TAP block for postoperative analgesia after colorectal surgery.

METHODS

After approval from the institutional ethical committee and written informed consent was obtained from the patients,

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this study was conducted on 40 ASA physical status I to III patients, aged 18 to 60 years, scheduled for colorectal surgery via a midline abdominal incision. Patients with a history of relevant drug allergy, inflammatory bowel disease, opioid dependence, morbid obesity (body mass index >40 kg/m^2), or sepsis were excluded. Patients were fasted for 8 hours preoperatively and received diazepam 5 mg and ranitidine 150 mg as premedication. Anesthesia was induced with IV morphine sulfate 0.15 mg/kg and propofol 2 to 2.5 mg/kg and maintained with a propofol infusion 50 to 150 μg/kg/min and 35% oxygen in nitrous oxide. Neuromuscular blockade was achieved with vecuronium bromide (0.1 mg/kg). Intraoperative monitoring consisted of electrocardiography, noninvasive arterial blood pressure, pulse oximetry, end-tidal carbon dioxide, and nasopharyngeal temperature.

The TAP block was performed at the end of the surgery before fascial closure. The subjects were randomly allocated to receive TAP block with 20 mL of 0.25% bupivacaine (TAP group) or 20 mL normal saline (control group) on each side of the abdominal wall. The allocation sequence was generated by a random number table, and group allocation was concealed in sealed opaque envelopes that were not opened until patient consent had been obtained. The patients and the investigators performing the block and providing postoperative care were blinded to group assignment. Study solutions were prepared by an anesthesiologist not involved in performing the block or data collection. All patients received IM diclofenac 1.5 mg/kg and IV ondansetron 0.1 mg/kg 30 minutes before completion of surgery. After surgery, neuromuscular blockade was reversed with neostigmine and atropine. Tracheal extubation was performed upon meeting criteria for extubation. Postextubation patients were transferred to the postanesthesia care unit for further monitoring.

Technique of TAP Block

A 22-gauge 50-mm regional anesthesia needle (Plexufix; B. Braun, Melsungen, Germany) with flexible tubing was attached to a 20-mL syringe filled with the study solution. All blocks were performed by one of the investigators (VG). With the patient in the supine position and the investigator standing on the contralateral side, the abdominal wall was lifted with a retractor. The needle was advanced into the anterior abdominal wall from inside by piercing the parietal peritoneum in the midaxillary line at the level of the umbilicus (Fig. 1). There is a loss-of-resistance sensation when perceiving a "pop" or fascial click as the needle tip moves into the TAP. After careful aspiration to exclude vascular puncture, 1 mL study solution was injected to confirm needle tip placement within the fascial plane. The presence of substantial resistance to injection or a bleb formation (at the peritoneal site) suggests incorrect needle tip position, resulting in needle repositioning by advancement or retraction as required. After correction of the needle tip position, 20 mL of 0.25% bupivacaine or normal saline was injected in incremental doses. The block was then performed on the opposite side using an identical technique.

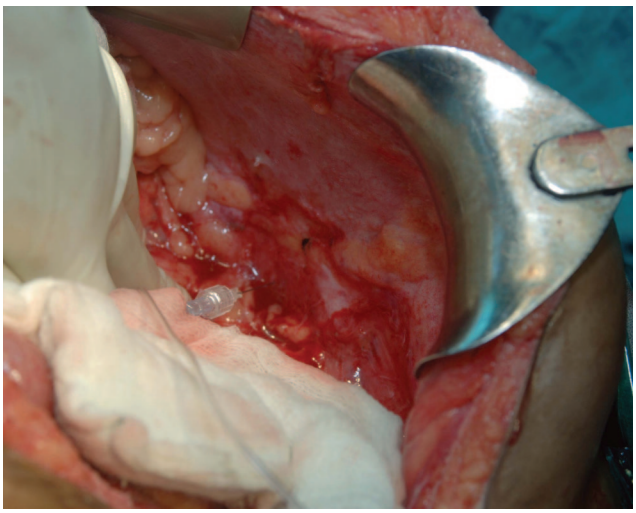

Figure 1. Site of needle placement in the plane between the transversus abdominis and internal oblique muscle.

Postoperative Care

The patients' heart rate, arterial blood pressure, respiratory rate, and oxygen saturation were monitored for the first 24 postoperative hours. All patients received IM diclofenac 1.5 mg/kg every 8 hours. The presence and severity of pain, sedation, nausea, vomiting, and respiratory depression were assessed postoperatively at 0, 0.5, 1, 2, 4, 6, 12, and 24 hours by an investigator blinded to group allocation (anesthesia resident). The severity of pain at rest and on coughing was assessed using a 10-cm visual analog scale (0 = no pain and 10 = worst imaginable pain). Morphine (0.05 mg/kg at 15-minute intervals until complete pain relief) was administered on demand by the patient or if the visual analog scale score was >3 on assessment. The time to request for rescue analgesia, total morphine consumption in 24 hours, and cumulative use of morphine at 2, 4, 6, 12, and 24 hours were recorded. Sedation was assessed using a 4-point sedation scale (awake and alert = 0; sleepy but responding to verbal command = 1; asleep but easily aroused = 2; and deep sleep = 3). Respiratory depression was defined as pulse oximeter saturation <92% and/or respiratory rate <8 per minute. The severity of nausea was assessed by a categorical scale (0 = none, 1 = mild, 2 = moderate, 3 = severe). Rescue antiemetic was given with metoclopramide 10 mg IV when patients complained of nausea (score 2) or vomiting. Patient satisfaction with the anesthetic technique was assessed 24 hours postoperatively using an 11-point scale (0 = not satisfied; 10 = fully satisfied). The patients were transferred from the postanesthesia care unit to a postsurgical ward after 24 hours.

Statistical Analysis

Sample size was calculated on the basis of 50% reduction in morphine consumption with $\alpha = 0.05$ and $\beta = 0.1$. Based on the pilot study, we projected a mean 24-hour morphine requirement of 18 mg with a standard deviation of 6 mg in the control group. Results are expressed as the mean ± SD or median ± interquartile range. Parametric data were compared using the Student t test, whereas nonparametric data were compared by the χ^2 test and Fisher exact test.

Table 1. Demographic Data

Variables	TAP group	Control group	*P* value
Age (y)	49.45 ± 13.29	42.20 ± 12.11	0.056
Weight (kg)	54.95 ± 9.99	54.75 ± 9.99	0.950
Sex (male/female)	14/6	14/6	1.00
ASA physical status (I/II)	13/7	16/4	0.288
Duration of surgery (min)	152.75 ± 40.73	169 ± 40.91	0.238

Continuous data are presented as mean ± SD. Categorical variables are presented as number of patients. No significant differences between the groups.
TAP = transversus abdominis plane.

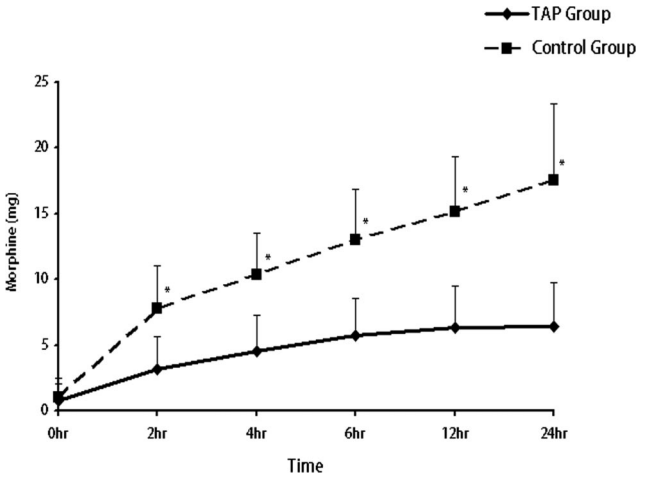

Figure 2. Mean cumulative dose of morphine (mg) from 0 to 24 hours postoperatively. Bars indicate standard deviation. *Significantly ($P < 0.05$) higher morphine consumption in the control group compared with the transversus abdominis plane (TAP) group.

Repeated-measures analysis of variance with post hoc analysis was used to assess the trends in change of serial values of heart rate, arterial blood pressure, and respiratory rate. Pain scores, sedation score, adverse effects, and patient satisfaction score were compared by χ^2 test, Mann-Whitney *U* test, and Fisher exact test as appropriate. A *P* value <0.05 was considered statistically significant.

RESULTS

The groups were comparable with respect to demographic data, ASA physical status, and duration of surgery (Table 1). The surgical subtypes were mainly resection anastomosis for intestinal obstruction or hemicolectomy for carcinoma of the colon. The midline incision was a maximum 3 cm above the umbilicus in both groups. A 65% decrease in 24-hour total morphine consumption was observed in the TAP group compared with the control group (total morphine requirement, 6.45 ± 3.26 mg and 17.55 ± 5.78 mg in the TAP group and control group, respectively; $P < 0.0001$). The cumulative morphine requirement was also significantly less in the TAP group at all time points (Fig. 2). Although the time to request for first rescue analgesia was not significantly prolonged in the TAP group, the subsequent doses of morphine were required at significantly longer time intervals in this group compared with the control group ($P < 0.01$).

Patients in the TAP group had significantly lower pain scores at rest and when coughing as compared with the control group at all time points assessed (Fig. 3). Postoperative heart rate, arterial blood pressure, and respiratory rate were comparable between groups. Sedation scores were significantly lower in the TAP group at 1, 2, 4, and 6 hours postoperatively (Fig. 4). After 6 hours, the sedation scores were low (0–1) in both groups. The incidence of postoperative nausea and vomiting was not statistically different between groups. The severity of nausea and vomiting was worse in the control group ($P < 0.05$); 6 patients in the control group required metoclopramide compared with 2 patients in the TAP group. Patients in the TAP group were significantly more satisfied than the control group (satisfaction score, 6.8 ± 1.1 vs 3.6 ± 1.5 in the TAP and control group, respectively; $P < 0.001$). No complication related to block was reported in either group of patients.

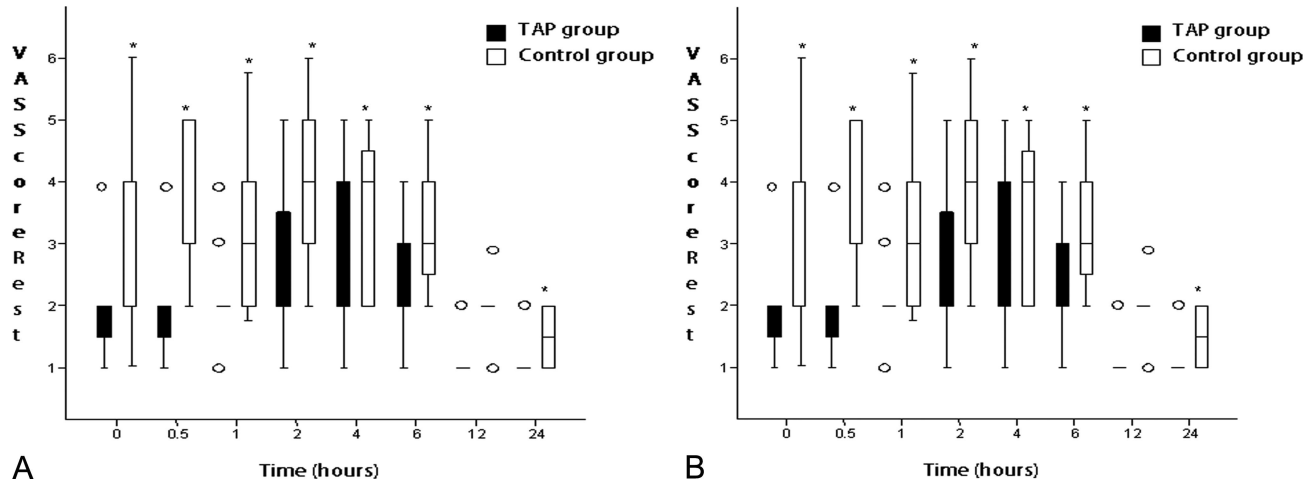

Figure 3. Median visual analog scale (VAS) scores in each group for the first 24 hours after surgery at rest (A) and during coughing (B). Bars indicate interquartile range. *Significantly ($P < 0.05$) higher VAS score in the control group compared with the transversus abdominis plane (TAP) group.

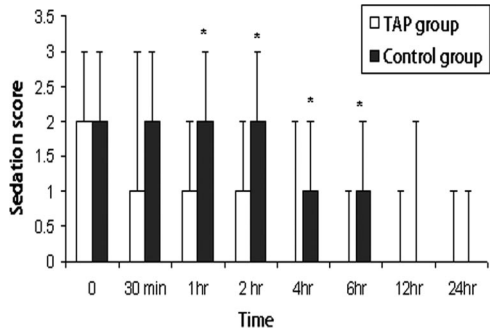

Figure 4. Median sedation scores in each group for the first 24 hours after surgery. Bars indicate interquartile range. *Significantly ($P < 0.05$) higher sedation score in the control group compared with the transversus abdominis plane (TAP) group.

DISCUSSION

TAP block is a relatively new technique that provides effective analgesia after abdominal surgery by blocking the sensory nerve supply of the anterior abdominal wall. In this study, the analgesic efficacy of TAP block was assessed using a novel approach. We observed that TAP block with this technique provided effective postoperative analgesia after colorectal surgery and reduced morphine consumption leading to decreased side effects.

In most of the previous studies, the TAP block was given before surgery through the lumbar triangle of Petit.[9,10,12,13] McDonnell et al.[10] reported a >70% reduction in morphine requirements after colorectal surgery in patients receiving TAP block with 20 mL of 0.375% levobupivacaine. In a similar study,[12] TAP block with 0.75% ropivacaine significantly reduced postoperative morphine consumption for 48 hours and prolonged the time to first supplemental analgesia after abdominal hysterectomy. The analgesic efficacy of TAP block has also been assessed after cesarean delivery via a Pfannenstiel incision under spinal anesthesia.[11]

However, in our study, the time to first rescue analgesia was not statistically prolonged; the cumulative morphine consumption at 2, 4, 6, 12, and 24 hours was significantly less in the TAP group as compared with the control group. Our results differ from previous studies[10–12] in which the time to first rescue analgesia was also prolonged in the block group. This may be because the block was administered at the end of surgery in the present study. McDonnell et al.[16] demonstrated sensory blockade (in volunteers) from T7 to L1 dermatomes at 90 minutes after administration of local anesthetic in the TAP, which started to recede at 4 hours, with complete regression of the block at 24 hours. However, previous studies demonstrated the analgesic effect of TAP block up to 48 postoperative hours. We did not assess pain scores and morphine consumption after 24 hours in the present study because the patients were shifted to the postsurgical ward after 24 hours.

Our overall incidence of nausea and vomiting was low in both groups; 20% of patients had nausea and 10% vomited in the control group, whereas only 10% of patients complained of nausea and vomiting in the TAP group. This is in contrast with previous findings[10] in which the incidence of postoperative nausea and vomiting was high in both groups (31% and 69% in the block group and control group, respectively). The difference may have been attributable to the prophylactic use of ondansetron in our study. The reduced incidence of sedation in the TAP group is a finding consistent with the morphine-sparing effect of the block. In later periods (at 12 and 24 hours), morphine consumption producing effective sedation was less in both groups. The reduction in postoperative pain intensity combined with less sedation in the TAP group facilitated a greater degree of postoperative care and thereby resulted in high patient satisfaction levels in this group.

The present technique is reliable and safe, because the block is given at the midaxillary line from inside the abdominal wall avoiding the risk of inadvertent peritoneal puncture and visceral damage as observed in previous techniques.[14,15] In a cadaveric study, Jankovic et al.[17] found that the position of the lumbar triangle of Petit varies considerably and the size is relatively small. Therefore, the relevant nerves to be blocked may pass laterally to the triangle. At the midaxillary line, however, all nerves were in the TAP.[17] Recent studies[18–20] demonstrated the use of ultrasound for TAP block. Although ultrasound-guided TAP blocks have the potential to improve efficacy and/or safety compared with landmark and tactile techniques, there are no studies demonstrating this.

Although our technique is simple, it can be difficult to identify definitive tissue planes. The observation of thickness of abdominal wall, feel of fascial click during needle insertion, ease of injection of local anesthetic, and absence of swelling or bleb formation after injection can help in the detection of correct plane. There are some limitations to our study. Measurement of sensory blockade in the postoperative period was not performed and would have contributed to our understanding of the potential duration of analgesia and recession of sensory block after single-shot TAP blockade. Our findings may not be generalized to the pediatric and obese population and different surgical subtypes.

We conclude that this new TAP block technique provides effective postoperative analgesia after colorectal operations. However, these results require confirmation. Future studies using various groups of patients (children, obese, elderly) for different surgical procedures, using multiple injection techniques at different levels, are required to prove its feasibility and efficacy. The use of ultrasound to delineate the tissue planes and position of the needle tip may further increase the efficacy of this technique.

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