Comparison of Transversus Abdominis Plane Block and IV Patient-Controlled Analgesia after Lower Abdominal Surgery

Emre Erbabacan, Pınar Kendigelen, Güniz M. Köksal, Çiğdem Tütüncü, Birsal B. Ekici, Tuğçe Barca Şeker, Güner Kaya, Fatih Altındaş
Department of Anaesthesiology and Reanimation, İstanbul University Cerrahpaşa Faculty of Medicine, İstanbul, Turkey

Abstract

Objective: We aimed to compare the first 24-hour postoperative analgesic efficiency of ultrasound (USG)-assisted transversus abdominis plane (TAP) block to IV morphine patient-controlled analgesia (PCA) in patients undergoing lower abdominal surgery.

Methods: Fifty ASA I-III patients were included into this randomised, prospective clinical study. At end of surgery, Group 1 received 1 mg kg⁻¹ 0.5% bupivacaine and 1 mg kg⁻¹ 1% lidocaine in a 30-mL volume during TAP-block. Group 2 received 1 mg kg⁻¹ tramadol IV 10 minutes before extubation, and PCA was started with 1 mL morphine IV at a concentration of 1 mg kg⁻¹ and a 10-min lock time. Visual analogue scale (VAS), heart rate (HR), respiratory rate, peripheral oxygen saturation (SpO₂), additional analgesic need and nausea-vomiting at the postoperative 30th minute and 1, 2, 3, 6, 12, and 24 hours were evaluated. In both groups, when VAS values were >4, patients were given 1 mg kg⁻¹ tramadol IV in first evaluation at the 30th minute or 15 mg kg⁻¹ paracetamol at other evaluations.

Results: No difference was observed between groups in terms of VAS values. No difference was observed in terms of HR in the within-group comparison, but Group 1 HR values were lower compared to Group 2 (p<0.01). No difference was observed in additional analgesic need at any times. Nausea-vomiting score was higher in Group 2 in the between-group comparison at the 30th minute (p<0.04), but no difference was observed after the 1st hour.

Conclusion: Transversus abdominis plane block is effective as IV morphine-PCA in postoperative pain therapy in lower abdominal surgery, when given in a 30-mL volume. It may be preferable to IV-PCA, as the analgesic effect starts earlier and decreases the systemic effect of the morphine used in PCA.

Key Words: TAP block, postoperative pain, patient-controlled analgesia

Introduction

Postoperative pain treatment is often provided with systemic opioid use or neuraxial techniques in patients who undergo lower abdominal surgery (1). Side effects such as sedation associated with opioids, respiratory depression, itching and nausea-vomiting and possible complications of neuraxial techniques such as paraplegia or bleeding appear as the disadvantages of this method. Transversus abdominis plane (TAP) block is an intraoperative and postoperative anaesthesia technique (1, 2). The effect of TAP block on multimodal postoperative pain management in lower abdominal surgeries has been reported (2, 3).

TAP block was first defined by Rafi in 2001 (4). In this technique, two facial nerve clicks are felt while passing through the external and internal oblique muscles benefiting from the 'triangle of Petit,' and local anaesthesia is given at this area. In 2007, this technique was defined again with ultrasound (USG) guidance. Ultrasound-guided TAP block is performed by monitoring the region between the internal oblique muscle and transversus abdominis muscle, called 'TAP', for blocking the frontal branches of T6-L1 nerves and administering local anaesthetic agents (5).

Today, TAP block is an auxiliary analgesic method used for decreasing the use of opioids during the intraoperative period or the use of systemic analgesics for postoperative pain management.

In our study, we aimed to compare the first 24-h postoperative analgesic efficiency of USG-guided TAP block to that of intravenous patient-controlled analgesia (PCA) with morphine in patients who were to undergo lower abdominal surgery.

Methods

Approval for this study was received from the Ethics Committee of the İstanbul University Cerrahpaşa Faculty of Medicine (10.07.2013/18228). Moreover, written informed consent was obtained from the patients who participated in the study. This randomised and prospective study included 50 ASA I-III patients in the age group of 18-80 years, who were to undergo lower abdominal surgery under general anaesthesia in the general surgery and urology operating room.

Patients with dementia, Alzheimer's disease, depression diagnosis, chronic pain and a known allergy to any anaesthetic agent were excluded from the study. The patients included in the study were randomised into two groups with computer assistance. A 20 Gauge cannula was inserted on the back of the left hand of the patients who were taken to the operating room, and 4 mL kg⁻¹ 0.9% infusion was initiated. The age, weight and gender of patients were recorded, and then electrocardiogram, peripheral oxygen saturation (SpO₂) and non-invasive blood pressure monitoring, which are standard procedures in an operating room, were performed (Datex Ohmeda S/5 Avance). In both groups, routine anaesthesia induction was provided with 2 mg kg⁻¹ propofol, 0.1 mg kg⁻¹ morphine and 0.6 mg kg⁻¹ rocuronium, and anaesthesia was maintained with 50%/50% O₂/air, 2% sevoflurane and 0.05-0.1 µg kg⁻¹ min⁻¹ remifentanyl infusion. Following the operation, during TAP block, 1 mg kg⁻¹ 1% lidocaine and 1 mg kg⁻¹ 0.5% bupivacaine were given in a total volume of 30 mL to Group 1 patients. TAP block was performed in accordance with the rules of asepsis and antisepsis. With ultrasound, the site of injection was confirmed by giving a test dose of 0.5-1 mL 0.9% NaCl into the internal oblique and transversus abdominis muscles, and (when swollen muscle fascia was observed) local anaesthetic agents were injected into TAP. In Group 2 patients, 1 mg kg⁻¹ intravenous tramadol was administered 10 min before extubation. After the operation ended, the patients were decuratised with 0.01 mg kg⁻¹ intravenous atropine and 0.02 mg kg⁻¹ intravenous neostigmine and were extubated. They were then taken to the recovery unit.

The patients in Group 2 were given 1 mL intravenous morphine as PCA at a concentration of 1 mg mL⁻¹ for a 10-min lock time.

Visual analogue scale (VAS), additional analgesic need, and the presence of nausea-vomiting were evaluated at the postoperative 30th minute and 1st, 2nd, 3rd, 6th, 12th and 24th hours. Moreover, heart rate (HR), mean arterial pressure, respiratory rate and SpO₂ were also evaluated in the preinduction period and at the postoperative 30th minute and 1st, 2nd, 3rd, 6th, 12th and 24th hours. The patients in both groups were given 1 mg kg⁻¹ intravenous tramadol when VAS was higher than 4 in the evaluation carried out at the 30th minute and 15 mg kg⁻¹ intravenous paracetamol when VAS was higher than 4 in the later evaluation. The nausea-vomiting scale ranging from 0 to

Table 1. Demographic data (mean±SD)

	Group 1 (n:25)	Group 2 (n:25)	p
Age (year)	49.7±17.0	52.9±15.3	0.487
Height (cm)	162.3±8.7	165.2±10.1	0.579
Weight (kg)	69.7±20.1	71.2±19.3	0.624
Gender (F/M)	4/21	3/22	0.631
Diagnosis (Inguinal hernia/ varicosele)	20/5	18/7	0.452
SD: standard deviation; F: female; M: male			

3 was used to assess nausea and vomiting (0: no nausea-vomiting, 1: mild nausea-vomiting; no requirement for treatment, 2: moderate nausea-vomiting; requirement for treatment, 3: severe nausea-vomiting; resistance to treatment).

Statistical analysis

Mean, median, standard deviation and minimum and maximum values were used for expressing quantitative parameters, and number and percentage were used for categorical variables. The statistical limit of significance (p) was identified as 0.05. In comparisons, parametric or non-parametric statistical methods were employed depending on the normal or non-normal distribution of the variable. In comparisons between the two groups, Student's-t test was used for normally distributed quantitative parameters. Crosstab statistics were preferred for comparing categorical variables (Fisher's test). Repeated measures analysis of variance was performed in order to compare quantitative variables measured during seven separate times in the two groups.

Results

No significant difference was found among the demographic features of the patients. The distribution of diagnoses according to the groups is presented in Table 1.

In the within-group comparison, VAS values significantly decreased in time for both groups (p<0.05). In the between-groups comparison, no significant difference was observed with regard to VAS values (p=0.76) (Table 2).

In terms of heart rate values, there was no statistically significant difference among all time periods in the within-group comparison for Group 1 patients. In Group 2 patients, no significant difference was found among the HR values at the postoperative 30th minute and 1st, 2nd, 3rd, 6th, 12th, and 24th hours. When the preinduction HR values of the Group 2 patients were compared with the values at the postoperative 30th minute and 1st, 2nd, 3rd, 6th, 12th, and 24th hours, they were found to be significantly lower. While there was no significant difference between the preinduction HR values of Group 1 and Group 2 patients, the HR values of Group 1 patients were significantly lower than those of Group 2 patients at the postoperative 30th minute and 1st, 2nd, 3rd, 6th, 12th, and 24th hours (p<0.01) (Table 3).

Table 2. VAS values (mean±SD)

	30 min	1 h	2 h	3 h	6 h	12 h	24 h
Group 1	3.2±3.1	3.1±1.9*	3.0±1.8*	2.2±1.7*	1.5±1.4*	1.0±1.4*	0.8±1.2*
Group 2	4.7±1.5	4.0±1.5*	2.6±1.8*	1.5±1.7*	0.6±1.3*	0.7±1.2*	0.0±0.2*

VAS: Visual analogue scale; SD: standard deviation; *p=0.001 in within-group comparison

Table 3. HR and MAP values (mean±SD)

	Preinduction	30 min	1 h	2 h	3 h	6 h	12 h	24 h
Group 1 HR	74.7±13.1	69.4±13.6	74.1±11.5	74.7±12.8	73.7±11.7	72.4±11.7	69.6±8.9	71.1±9.3
Group 2 HR	77.7±9.6	85.0±13.2*,†	82.6±9.3*,†	79.3±9.8*,†	77.0±8.2*,†	79.1±7.9*,†	76.0±8.9*,†	79.0±7.6*,†
Group 1 MAP	99.3±14.2	103.3±16.2	104.0±13.4	99.8±15.1	102.3±13.0	101.3±16.1	104.2±14.4	105.1±12.9
Group 2 MAP	101.1±13.7	105.2±15.4	101.5±16.1	100.3±13.1	101.3±14.7	99.4±14.1	102±13.1	103.8±13.3

HR: heart rate; MAP: mean arterial pressure; SD: standard deviation; *p<0.01 in the comparison of Group 1 to Group 2, †p<0.05 in within-group comparison, preinduction values according to other time periods

Table 4. Peripheral oxygen saturation (SpO₂) values

	Preinduction	30 min	1 h	2 h	3 h	6 h	12 h	24 h
Group 1	98.1±1.1	99.5±1.2	98.9±1.9	97.4±2.3	97±2.1	97.4±2.2	97.5±1.9	97.8±1.6
Group 2	98.4±1.4	97.4±2.4*	97.6±1.7*	97.2±1.4*	96.8±1.1*	97±1.0*	96.8±0.8*	97.1±0.9*

* p<0.003 in the comparison of Group 1 to Group 2

Table 5. Respiratory rate per minute (r min⁻¹)

	Preinduction	30 min	1 h	2 h	3 h	6 h	12 h	24 h
Group 1	16.1±2.4	18.8±2.3	18.8±1.6	18±2.5	17.0±2.5	16.8±2.8	16.7±2.8	16.3±3.0
Group 2	15.9±1.8	18.2±1.8	18.2±1.1	17.8±1.2	17.0±1.0	16.6±1.5	16.8±1.6	17.4±1.2

Table 6. Additional analgesic need (existing/not existing)

	30 min	1 h	2 h	3 h	6 h	12 h	24 h
Group 1	1/25	0/25	0/25	0/25	0/25	0/25	0/25
Group 2	3/23	1/24	0/25	0/25	0/25	0/25	0/25

With regard to the values of mean arterial pressure, no significant difference was observed in the within-group and between-groups comparisons (Table 3).

In both groups, the SpO₂ values were not significantly different in the within-group comparison; however, in the between-groups comparison, they were significantly higher in Group 1 patients at the postoperative 30th minute and 1st, 2nd, 3rd, 6th, 12th, and 24th hours (p<0.003) (Table 4).

No significant difference was observed in terms of respiratory rates both in the within-group and between-groups comparisons in all time periods (Table 5).

Moreover, no significant difference was found with regard to additional analgesic need in the within-group and between-groups comparisons in all time periods (Table 6).

In the between-groups comparison, the nausea-vomiting score was significantly higher in Group 2 patients at the 30th minute (p=0,04), whereas no significant difference was found in the within-group and between-groups comparisons at the 1st hour (Table 7).

Discussion

Effective postoperative pain treatment reduces surgical stress and plays a direct role in morbidity (6). Furthermore, prevention of respiratory depression due to early patient mobilization and pain affects postoperative respiratory functions positively. With an improvement in regional anaesthesia techniques in postoperative pain management, it is possible to decrease the adverse effects of drugs with systemic action, and pain treatment can be provided more efficiently.

Table 7. Nausea-vomiting

	30 min	1 h	2. h	3 h	6 h	12 h	24 h
Group 1	1.0±0.4	0.8±0.5	0.4±0.4	0.2±0.4	0.5±0.4	0.3±0.4	0.0±0.2
Group 2	1.9±0.7*	1.1±0.9	0.7±0.9	0.4±0.6	0.8±0.7	0.3±0.4	0.4±0.6

* p<0.003 in the comparison of Group 1 to Group 2

Although the effect of TAP block on postoperative pain after lower abdominal surgery was indicated in many studies (2, 3), Cahrlton et al. (7) stated in their systematic review that the effect of TAP block is controversial, and data about its effect on pain scores are limited. In addition, they pointed out that no study comparing TAP block to a different pain treatment method is available. Similarly, in our literature review, we did not find any study comparing the analgesic effects of intravenous morphine PCA and TAP block.

Sharma et al. (6) compared the analgesic effects of tramadol PCA and TAP block performed in addition to PCA, and they revealed that VAS values were lower in patients undergoing TAP block than in patients not undergoing TAP block.

On the other hand, in patients who underwent inguinal hernia repair, Peterson et al. (8) applied postoperative TAP block under USG in one group and assured the surgeon to perform both blind local anaesthetic infiltration and ilioinguinal nerve block in another group. They compared both groups to a placebo group. They suggested that VAS values are significantly higher in the TAP block group than in the infiltration group, but they were not different from the placebo group. The volume of 0.75% ropivacaine was reported to be 25 mL for the TAP group and 40 mL for the infiltration group. Moreover, 10 mL 0.375% ropivacaine was used for ilioinguinal block. The patients in all groups were given 1 g oral paracetamol and 400 mg ibuprofen every 6 h. Although the amount and volume of local anaesthetic agent used in the infiltration group were higher compared with the TAP block group, ilioinguinal block was given additionally, which can explain the differences in VAS values. Furthermore, the dose of paracetamol and ibuprofen given to the placebo group regardless of the presence of pain is considerably high for postoperative pain treatment after inguinal hernia surgery, and it removes the need for additional intervention. A pain treatment protocol of additional dose regardless of VAS values is an example of systemic drug usage that we wanted to avoid in our study.

Similarly, Sivapruapu et al. (9) performed local anaesthetic infiltration in one group and TAP block in another in addition to morphine PCA during gynaecological lower abdominal surgeries. They found that TAP block decreases postoperative pain and also additional narcotic need.

In our study, we observed that there was no significant difference between the patients who received only intravenous morphine PCA or those who received only TAP block in terms of VAS values and additional analgesic need in the first

24 hours. The reason for more apparent efficiency in TAP block can be the volume of 30 mL, not 20 mL or less, because the block is volume-dependent, which increases the efficiency.

Because TAP block application was before extubation, its effect began during the recovery of the patient. The patients who underwent TAP block woke up more easily and without pain because the use of opioid was not needed for postoperative pain management during this time period. We think that this effect prevented respiration to be restricted by pain and caused SpO₂ to be higher than in the PCA group.

It was suggested that the application of TAP block before surgery decreases the perioperative use of opioids remarkably (10). However, we applied TAP block after surgery because we observed, in our preliminary study, that preoperative TAP block, especially in high doses, caused the surgeon to have difficulties in determining the anatomy and prolonged the duration of surgery in upper abdominal operations such as inguinal hernia and varicocele.

In our study, HR values were found to be significantly lower in the TAP block group than in the PCA group, which may have resulted from less sympathetic system activation in association with less pain complaints of patients. The absence of significant difference between the values of mean arterial pressure does not support this effect, but this effect can be related to the vasodilation effect of morphine PCA. This statistical difference in HR values was not clinically significant.

While SpO₂ values were significantly higher in the TAP block group, there was no difference between their frequencies. This finding can be explained by the depressive effect of opioids on respiration and the positive effect of low pain scores on respiration.

In our study, a significant difference was not observed in the nausea-vomiting frequency except at the 30th minute. However, at the 30th minute, the nausea-vomiting frequency was higher in the PCA group. This result is consistent with the result of the study conducted by Sivapurapu et al. (9). We think that the higher level of nausea-vomiting resulted from the emetic effect of tramadol given to the PCA group before extubation.

The limitation of our study is that the persons who evaluated and patients were not blinded because TAP block and PCA were different techniques.

Conclusion

In lower abdominal surgery, when TAP block is given in the volume of 30 mL, it is as effective as intravenous PCA in pain treatment. Compared with intravenous PCA, TAP block can be considered as a more preferable method because it can avoid the systemic actions of morphine used for PCA, and its analgesic effect begins earlier.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of İstanbul University Cerrahpaşa faculty of Medicine (10.07.2013/18228).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - G.K., F.A., G.M.K., E.E.; Design - E.E., G.M.K., P.K., B.B.E., T.B.Ş.; Supervision - Ç.T., G.M.K., G.K., E.E.; Funding - F.A., G.M.K.; Data Collection and/or Processing - T.B.Ş., E.E., B.B.E., P.K.; Analysis and/or Interpretation - G.M.K., Ç.T.; Literature Review - P.K., B.B.E., T.B.Ş.; Writer - E.E., G.M.K., G.K.; Critical Review - F.A., Ç.T., P.K., B.B.E.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

References

1. Elkassabany N, Ahmed M, Malkowicz SB, Heitjan DE, Isserman JA, Ochroch EA. Comparison between the analgesic efficacy of transversus abdominis plane (TAP) block and placebo in open retropubic radical prostatectomy: a prospective, randomized, double-blinded study. *J Clin Anesth* 2013; 25: 459-65. [\[CrossRef\]](#)
2. McDonnell JG, O'Donnell B, Curley G, Heffernan A, Power C, Laffey JG. The analgesic efficacy of transversus abdominis plane block after abdominal surgery: a prospective randomized controlled trial. *Anesth Analg* 2007; 104: 193-7. [\[CrossRef\]](#)
3. Carney J, Finnerty O, Rauf J, Curley G, McDonnell JG, Laffey JG. Ipsilateral transversus abdominis plane block provides effective analgesia after appendectomy in children: a randomized controlled trial. *Anesth Analg* 2010; 111: 998-1003.
4. Rafi AN. Abdominal field block: a new approach via the lumbar triangle. *Anaesthesia* 2001; 56: 1024-6. [\[CrossRef\]](#)
5. Tran TM, Ivanusic JJ, Hebbard P, Barrington MJ. Determination of spread of injectate after ultrasound-guided transversus abdominis plane block: a cadaveric study. *Br J Anaesth* 2009; 102: 123-7. [\[CrossRef\]](#)
6. Sharma P, Chand T, Saxena A, Bansal R, Mittal A, Shrivastava U. Evaluation of postoperative analgesic efficacy of transversus abdominis plane block after abdominal surgery: A comparative study. *J Nat Sci Biol Med* 2013; 4: 177-80. [\[CrossRef\]](#)
7. Charlton S, Cyna AM, Middleton P, Griffiths JD. Perioperative transversus abdominis plane (TAP) blocks for analgesia after abdominal surgery. *Cochrane Database Syst Rev* 2010; 12: CD007705.
8. Petersen PL, Mathiesen O, Stjernholm P, Kristiansen VB, Torup H, Hansen EG, et al. The effect of transversus abdominis plane block or local anaesthetic infiltration in inguinal hernia repair: a randomised clinical trial. *Eur J Anaesthesiol* 2013; 30: 415-21. [\[CrossRef\]](#)
9. Sivapurapu V, Vasudevan A, Gupta S, Badhe AS. Comparison of analgesic efficacy of transversus abdominis plane block with direct infiltration of local anesthetic into surgical incision in lower abdominal gynecological surgeries. *J Anaesthesiol Clin Pharmacol* 2013; 29: 71-5. [\[CrossRef\]](#)
10. Chen CK, Tan PC, Phui VE, Teo SC. A comparison of analgesic efficacy between oblique subcostal transversus abdominis plane block and intravenous morphine for laparoscopic cholecystectomy. A prospective randomized controlled trial. *Korean J Anesthesiol* 2013; 64: 511-6. [\[CrossRef\]](#)