

Efficacy of ultrasound-guided transversus abdominis plane block and rectus sheath block compared with epidural analgesia and intravenous fentanyl infusion for postoperative analgesia after laparoscopic colorectal surgery: a retrospective observational study

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Abstract

Ultrasound-guided abdominal wall nerve block has become a widespread technique for analgesia after laparoscopic colectomy. However, its efficacy, particularly on the postoperative stress response, remains unclear.

Fifty-five patients undergoing laparoscopic colectomy were included in this study. They received one of three postoperative analgesic methods: continuous epidural infusion of levobupivacaine (group E, n = 20), continuous intravenous fentanyl (group V, n = 20) and a lower dose of continuous intravenous fentanyl following ultrasound-guided abdominal wall nerve block (group P, n = 15). Plasma epinephrine concentration, pain score, use of additional analgesics, occurrence of postoperative nausea and vomiting

(PONV) and the postoperative length of hospital stay were obtained from the medical records and compared among groups.

Demographic data showed no statistical differences among the three groups. Plasma epinephrine concentration tended to be lower in groups E and P (p = 0.041). The incidence of PONV was significantly lower for group P vs. the other two groups (p = 0.021). There were no statistically significant differences for the other findings.

Ultrasound-guided peripheral nerve block of the abdominal wall is comparable to continuous epidural analgesia in terms of stress control and pain relief, and may be useful for the prevention of PONV after laparoscopic colectomy.

**Key words :** *laparoscopic colectomy, ultrasound-guided peripheral nerve block, transversus abdominis plane block, rectus sheath block, postoperative nausea and vomiting*

**I. Introduction**

Epidural anesthesia and analgesia has long been the gold standard of intra- and postoperative pain relief for patients undergoing open laparotomy<sup>1, 2)</sup>. However,

less-invasive laparoscopic surgery has become popular due to its improved postoperative course and oncological quality comparable to conventional open laparotomy<sup>3)</sup>. Moreover, an emerging ultra-short-acting opioid, remifentanyl, may achieve better hemodynamic stability and suppression of surgical stress responses compared with epidural-based

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general anesthesia<sup>4, 5</sup>. Therefore, the use of epidural block has shifted to other analgesic methods, such as spinal block, intravenous opioids and peripheral nerve block<sup>6</sup>. It has been reported that ultrasound-guided peripheral nerve block may have similar analgesic efficacy to epidural analgesia to improve the quality of analgesia compared with pain management with intravenous opioids alone after abdominal surgery<sup>7-9</sup>. However, the effect of ultrasound-guided peripheral nerve block on postsurgical stress response remains unclear in patients undergoing laparoscopic colectomy. Therefore, we investigated the effect of ultrasound-guided peripheral nerve block of the abdominal wall on the postoperative stress response and recovery after laparoscopic colectomy.

## II. Materials and methods

This study was approved by Ethics Committee of Iwate Medical University School of Medicine (Iwate Pref., Japan; Approval number: H27-141), and written informed consent was obtained from each patient prior to surgery.

Patients undergoing elective laparoscopic colectomy from August 2011 to November 2015 were enrolled in the study. The anesthetic method and the postoperative analgesia were performed according to the protocol of our department during this period. All data were gathered retrospectively from the medical records. All patients received continuous infusion of propofol and remifentanyl, and bolus administration of fentanyl and rocuronium during general anesthesia. They were divided into 3 groups based on the different postoperative analgesic

methods: epidural analgesia (group E,  $n = 20$ ), intravenous fentanyl infusion (group V,  $n = 20$ ) and peripheral nerve block with a lower dose of intravenous fentanyl (group P,  $n = 15$ ). In group E, 5 ml of 0.75% levobupivacaine was administered by bolus, followed by 300 ml of 0.25% levobupivacaine containing 700  $\mu\text{g}$  of fentanyl at 4 ml/h via epidural catheter using a COOPDECH<sup>®</sup> Balloonjector (Daiken Medical Co., Ltd., Osaka, Osaka Pref., Japan). A rescue bolus of 3ml per hour was also prepared. In group V, intravenous administration of 60 ml of saline solution containing 36  $\mu\text{g}/\text{kg}$  of fentanyl and 5mg of droperidol was initiated at 1ml/h using a COOPDECH<sup>®</sup> Syrinjector I (Daiken Medical Co., Ltd., Osaka, Osaka Pref., Japan). The rescue bolus was set at 1ml per 30 minutes. In group P, ultrasound-guided transversus abdominis plane block and rectus sheath block was performed with 60 ml of 0.25% levobupivacaine immediately after the operation was completed, followed by intravenous administration of 60ml of saline solution containing 12  $\mu\text{g}/\text{kg}$  of fentanyl and 5 mg of droperidol at 1ml/h using a COOPDECH<sup>®</sup> Syrinjector I.

The plasma epinephrine concentration, pain score, frequency of additional analgesic requirement, occurrence of PONV on the morning of postoperative day 1, and length of hospital stay were compared between the 3 groups.

For the statistical analyses, one-way ANOVA, Kruskal-Wallis test with Dunn's post-hoc test, and Chi-square test with residual analysis were used. The differences with a  $p$ -value  $< 0.05$  were considered significant. IBM<sup>®</sup> SPSS<sup>®</sup> Statistics Version 22 (IBM Corp., Armonk, NY, USA) was used for the statistical analyses.

Table 1. Demographic data

	group E	group V	group P	p-value
Age (years)	66 ± 10	67 ± 12	57 ± 14	0.051
Gender (male/female; n)	10 / 10	9 / 11	6 / 9	0.840
Height (cm)	160 ± 9	158 ± 8	158 ± 11	0.783
Weight (kg)	59 ± 11	59 ± 11	60 ± 12	0.957
ASA PS (I/II/III; n)	5 / 15 / 0	6 / 14 / 0	7 / 6 / 2	0.075
Pathology (adenoma/cancer; n)	2 / 18	1 / 19	1 / 14	0.826
Types of resection (ICR/RH/S/AR; n)	7 / 2 / 9 / 2	3 / 2 / 7 / 8	2 / 1 / 2 / 10	0.043*

Values are expressed as the mean ± SD or the number of patients. P-values were obtained from the 3-group comparisons. Types of resection showed intergroup differences (\*p = 0.043). ASA PS = American Society of Anesthesiologists physical status, ICR = ileocecal resection, RH = right hemicolectomy, S = sigmoidectomy and AR = anterior resection.

Table 2. Intraoperative data

	group E	group V	group P	p-value
Duration of anesthesia (min)	249 ± 45	269 ± 44	294 ± 43	0.017* E vs. V: 0.485 E vs. P: 0.017* V vs. P: 0.312
Duration of surgery (min)	187 ± 40	207 ± 42	207 ± 43	0.246
Blood loss (ml)	9 (1 - 44)	9 (1 - 75)	16 (2 - 40)	0.355
Infused fluid volume (ml)	1970 ± 360	1930 ± 530	1540 ± 330	0.010 † E vs. V: 1.000 E vs. P: 0.003 † V vs. P: 0.055
Urine volume (ml)	440 (52 - 965)	350 (80 - 1050)	290 (35 - 660)	0.037 ‡ E vs. V: 0.490 E vs. P: 0.045 ‡ V vs. P: 0.485

Values are expressed as the mean ± SD or median (ranges). P-values were obtained from 3-group comparisons or post-hoc analyses. Duration of anesthesia (\*), infused fluid volume (†) and urine volume (‡) showed intergroup differences (p = 0.017, 0.010 and 0.037, respectively). Dunn's post-hoc analysis showed significant differences between groups E and P for all 3 parameters (p = 0.017, 0.003 and 0.045, respectively).

### III. Results

There were almost no significant differences in the demographic data among the three groups except for types of resection (Table 1). In the intraoperative data, the duration of anesthesia was longer, and infused fluid and urine volume were less in group P than in group E (Table 2). Plasma epinephrine concentrations among the three groups were significantly different (p = 0.041, Table 3), but

a post-hoc multiple comparison test did not indicate any differences between pairs of groups. The occurrence of PONV in group E was significantly higher and that in group P was significantly lower compared with group V (p = 0.022, 0.013, respectively, Table 3). There were no statistically significant differences among the three groups for the other measurements (Table 3).

Table 3. Postoperative data

	group E	group V	group P	p-value
IPOD VAS (0-100mm)	23 (0 - 54)	37 (9 - 60)	25 (10 - 70)	0.174
Rescue analgesics (number of times)	0 (0 - 3)	0 (0 - 3)	0 (0 - 4)	0.404
Plasma epinephrine (ng/mL)	0.035 (0.000 - 0.170)	0.070 (0.000 - 0.120)	0.040 (0.000 - 0.080)	0.041* E vs. V: 0.065 E vs. P: 1.000 V vs. P: 0.161
IPOD PONV (+/-, n)	12 / 8	8 / 12	2 / 13	0.021† E: 0.022† V: 1.000 P: 0.013†
Diet resumption (days)	3 (2 - 6)	4 (3 - 7)	3 (2 - 7)	0.080
Postoperative stay (days)	8 (6 - 10)	9 (6 - 14)	9 (5 - 50)	0.278

Values are expressed as the median (ranges) or numbers. P-values were obtained from 3-group comparisons or post-hoc analyses. IPOD = 1st postoperative day, VAS = visual analog scale, PONV = postoperative nausea & vomiting. The values of rescue analgesics are the frequency of PCA rescue bolus, flurbiprofen, pentazocine or buprenorphine usage. \*p = 0.041 with Kruskal-Wallis test; however, Dunn's post-hoc test showed no significant difference. †p = 0.021 with Chi-Square test; residual analysis subsequently showed significant differences for groups E and P (p = 0.022, 0.013 respectively).

#### IV. Discussion

For more than two decades, it has been said patients undergoing colorectal surgery should receive thoracic epidural anesthesia and analgesia<sup>1,2)</sup>. Previous reports have shown that epidural block was useful to reduce the total anesthetic agents, block stress hormone release, provide optimal pain relief, prevent postoperative ileus and other postoperative morbidity, and to shorten the length of hospital stay.

On the other hand, as operative and anesthetic methods have been changing, it has been reported that epidural analgesia could have some disadvantages for patients undergoing laparoscopic colorectal surgery<sup>3)</sup>.

In consideration of severe complications, such as neurological disorder due to epidural hematoma, the benefits of epidural analgesia could be reduced<sup>6)</sup>.

In recent years, the use of ultrasound-guided peripheral nerve block has become widespread

as an emerging analgesic method. In several reports, it has been indicated that the addition of ultrasound-guided abdominal wall peripheral nerve block may improve the quality of analgesia and shorten the postoperative length of hospital stay compared with intravenous opioids, and that the postoperative analgesic efficacy is not inferior to that of epidural infusion after abdominal surgery<sup>7-9)</sup>. However, there has been no report of the efficacy of ultrasound-guided peripheral nerve block in patients undergoing laparoscopic colectomy from the perspective of postsurgical stress response. Previously, it has been reported that epidural infusion was useful to reduce the release of surgical stress hormones. Thus, it can be expected that ultrasound-guided peripheral nerve block may have a similar effect on the postsurgical stress response<sup>10)</sup>.

In this study, we found that the occurrence of PONV in group E was significantly higher

and that in group P was significantly lower compared with group V ( $p = 0.022, 0.013$ , respectively, table 3). As mentioned above, epidural analgesia may cause postoperative hypotension followed by excessive fluid loading, which could lead to more PONV due to gastrointestinal edema<sup>6)</sup>. Postoperative opioid is also a risk factor for PONV<sup>11)</sup>. In group P, the intravenous dose of fentanyl was less than that in group V. Therefore it is possible that ultrasound-guided abdominal wall nerve block is useful to prevent postoperative hypotension following excessive fluid infusion, to reduce the dose of intravenous fentanyl and to reduce the occurrence of PONV with comparable analgesic efficacy.

Plasma epinephrine concentration on the morning of postoperative day 1 tended to be lower in groups E and P, but post-hoc multiple comparison test did not indicate any differences between groups. The pain score and requirement for rescue analgesics were also equivalent among the three groups. The reason for this may be that the numbers of patients, the power of detection, was not sufficient for this 3-group-comparison study. In our previous study, epidural-based postoperative analgesia was able to suppress the release of epinephrine and provide lower pain scores compared with fentanyl-based analgesia by 2-group comparisons<sup>12)</sup>. At the very least, ultrasound-guided abdominal wall nerve block combined with a lower dose of intravenous fentanyl may be comparable to epidural-based analgesia based on suppression of catecholamine release and provision of good pain relief. In the future, investigations with greater numbers of patients will be necessary to demonstrate that ultrasound-

guided abdominal wall nerve block provides better catecholamine suppression compared with intravenous opioid alone. Referring to table 2, the duration of anesthesia was a little longer in group P because of the nerve block procedures. However, it had little effect on postoperative course and outcome.

Our study has another limitation. In group P, the patients received fewer fluids and the urinary output was lower compared with group E (Table 2). Based upon previous reports, fluid overloading could lead to gastrointestinal edema and PONV. In this study, it cannot be denied that the lower fluid volume led to a reduction in the occurrence of PONV in group P. A prospective randomized controlled study for patients with more unified backgrounds will be necessary to further elucidate the efficacy of peripheral abdominal wall nerve block towards the prevention of PONV after laparoscopic colorectal surgery.

In the demographic data, types of resection showed intergroup difference (Table 1). However, there was no significant difference if dividing patients based upon the position of the ports and wounds ( $p = 0.221$ ). Therefore, it seemed to have little influence on the results.

In conclusion, the combination of ultrasound-guided transversus abdominis plane block and rectus sheath block has similar efficacy to continuous epidural analgesia, in terms of stress control and pain relief. Moreover, such blockade may have several advantages in the prevention of PONV for patients undergoing laparoscopic colectomy.

Conflict of interest: The authors have no conflict of interest to declare.

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腹腔鏡下大腸手術に対する術後鎮痛としての硬膜外鎮痛  
および静脈内フェンタニル注入と比較した  
超音波ガイド下腹横筋膜面ブロックおよび  
腹直筋鞘ブロックの有効性: 後ろ向き観察研究

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要旨

超音波ガイド下腹壁神経ブロックは, 腹腔鏡下大腸切除術後の鎮痛法として広く普及しているが, その有効性は, 特に術後ストレス反応に関して未だ明らかではない. 対象は腹腔鏡下大腸切除術を受けた患者 55 名. 硬膜外鎮痛群 (E 群 20 名), フェンタニル群 (V 群 20 名), 腹壁末梢神経ブロック併用群 (P 群 15 名) の 3 群に分け, 後ろ向きに調査した. 第一病日朝の血漿エピネフリン値, 疼痛尺度, 追加鎮痛薬使用回数, 術後悪心嘔吐発生頻度, 術後在院日数について群間比

較した. エピネフリン値は E 群と P 群で低い傾向にあった ( $p=0.041$ ). また P 群では術後悪心嘔吐発生頻度が有意に低かった ( $p=0.021$ ). その他の項目において統計学的有意差を認めなかった. 腹腔鏡下大腸切除術に対する超音波ガイド下腹壁末梢神経ブロックはストレスおよび疼痛コントロールの面で硬膜外鎮痛と同等であり, また術後悪心嘔吐抑制に有用である可能性が示唆された.

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