Intrathecal morphine plus patient-controlled intravenous fentanyl infusion is not as effective as patient-controlled thoracic epidural analgesia in patients undergoing gastrectomy

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The Master's Thesis
submitted to the Department of Medicine
the Graduate School of Yonsei University
in partial fulfillment of the requirements for the degree
of Master of Medicine

Jin Ha Park

December 2011

This certifies that the Master's Thesis of
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December 2011

ACKNOWLEDGEMENTS

This dissertation could not be fructified without the supports, advices, and encouragements of many people and colleagues. I would like to express my gratitude to those who have contributed to this work in various ways.

First of all, I would like to express sincere gratitude to my academic advisor, Prof. Bon-Nyeo Koo, who has provided advices, supports, and encouragements over years. Next, I would like to thank the other members of my dissertation committee, Prof. Hae Keum Kil and Prof. Seung Ho Choi.

Likewise, I would like to thank Prof. Jae Hoon Lee. Prof. Lee gave me a lot of help and advices throughout the study, especially in experimental techniques and analysis of the results.

I would like to extend my thanks to my residency colleagues, who supported me to concentrate all my effort on the study.

My family always gave me love, support and encouragement, and I would like to thank all of them.

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ABSTRACT

Intrathecal morphine plus patient-controlled intravenous fentanyl infusion is not as effective as patient-controlled thoracic epidural analgesia in patients undergoing gastrectomy

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Patient controlled thoracic epidural analgesia (PCTEA) is widely used due to its excellent pain relieving effect even with a small amount of opioid; however, its use is limited by procedural difficulty, patient discomfort, and side effects from the catheter itself. The combined use of intrathecal morphine and intravenous patient controlled analgesia (ITM-IVPCA) has been shown to be a viable approach for analgesia

after abdominal surgery. The aim of this study was to compare the analgesic effect and postoperative outcomes of PCTEA and ITM-IVPCA in patients undergoing gasatrectomy.

Sixty patients undergoing gastrectomy due to gastric cancer were randomly allocated into the intrathecal morphine group (IT group) or the epidural group (EP group). The IT group received preoperative intrathecal morphine, followed by postoperative IVPCA. The EP group preoperatively underwent thoracic epidural catheterization, followed by postoperative PCTEA. Visual analog scale (VAS) scores and postoperative adverse events were assessed until postoperative day (POD) 2. Times to ambulation, eating, gas passing and postoperative complications within 30 days after surgery were also evaluated.

This study failed to demonstrate non-inferiority of intrathecal morphine administration at POD 1. The IT group required more systemic additional analgesics ($P = 0.003$) and took a longer time to ambulate than the EP group ($P = 0.021$). In the IT group, postoperative ileus ($P = 0.012$) and pulmonary complications ($P = 0.05$) developed more frequently, compared with the EP group.

ITM-IVPCA is not as effective as PCTEA in patients undergoing gastrectomy, with respect to greater analgesic requirement, later

ambulation, more frequent postoperative ileus and pulmonary complications within 30 days after gastrectomy.

Key words: ambulation, gastrectomy, intrathecal morphine, patient controlled analgesia, postoperative ileus, postoperative pain, postoperative pulmonary complication, systemic opioid, thoracic epidural analgesia

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I. INTRODUCTION

Patient controlled epidural analgesia (PCEA) is widely used in patients undergoing various surgeries,[1] such as major abdominal,[2-4] thoracic,[5,6] cardiac,[7] obstetric,[8] and orthopedic surgery,[9] as it demonstrates excellent pain relieving effect even with a small amount of opioid.

However, for patients undergoing gastrectomy, analgesia is recommended to be administered via thoracic epidural space, which is known to be procedurally difficult, consume a lot of time, cause patient discomfort, and lead to many side effects from the catheter itself.[10]

The combined use of intrathecal morphine and intravenous patient controlled analgesia (ITM-IVPCA) has been shown to a viable approach for analgesia after abdominal surgery,[11,12] cesarean section,[13] prostatectomy,[14] coronary artery bypass graft surgery[15] and hepatobiliary surgery.[16] Above all, intrathecal injection is easy to perform and leads to fewer complications because it is usually done at the level of L3-4 or L4-5.[17]

However, no study yet has compared the analgesic effects of patient controlled thoracic epidural analgesia (PCTEA) and ITM-IVPCA in patients undergoing gastrectomy.

Accordingly, the aim of this study was to compare the analgesic effect of ITM-IVPCA and PCTEA in patients undergoing gastrectomy. Also, the incidence of postoperative complications within 30 postoperative days (POD) was compared between the two groups as the second end point.

II. MATERIALS AND METHODS

1. Patient Selection

This study was approved by the Institutional Review Board of Severance Hospital and conducted according to the Declaration of Helsinki and Good Clinical Practices. Written informed consent was obtained from all patients.

Sixty patients (aged ≥ 20 yrs, ASA I-II), scheduled to undergo gastrectomy for stomach cancer, were included. Exclusion criteria were as follows: presence of spinal deformity or spinal disease; pulmonary, hepatic or renal disease; any contraindication to epidural or intrathecal injection; allergy to fentanyl and local anesthetics; inability to understand the pain scale; and any type of chronic pain or current opioid use. The patients were instructed on using the device for patient-controlled analgesia (PCA) and reporting visual analogue scale (VAS) pain score, on the day before surgery.

By using a table of random sampling numbers, the patients were randomly allocated into either the intrathecal morphine group (IT group, n = 30) or the epidural analgesia group (EP group, n = 30) on the day of surgery

2. Study Design

A. Perioperative Pain Management

In the EP group, an epidural catheter was placed before the induction of general anesthesia. Under standard monitoring including noninvasive blood pressure, electrocardiography (ECG), pulse oximetry, the epidural catheter was inserted at the level of T8-9 or T9-10 via a 17-gauge Touhy needle and advanced 5 cm upward into the epidural space by the same anesthesiologist. Intravascular or subarachnoid placement of the epidural catheter was ruled out by confirming that no blood or cerebrospinal fluid was aspirated. Also, 3ml of 1% lidocaine was administered. If there was no rapid onset of neuroaxial block, suggesting intrathecal delivery of the local anesthetic, the placement of the epidural catheter was completed. After 30 min, sensory block around the level of T8-T10 was tested by pinprick to assess the relevance of the placement of epidural catheter. Before induction of anesthesia, 5ml of 0.2% ropivacaine was administered through the epidural catheter. Upon peritoneal closure, 5ml of 0.2% ropivacaine was administered once more, and PCTEA device (Accufuser plus, P2015M, Woo Young Medical Co. Ltd, Korea) containing a mixture of 0.2% ropivacaine and 4 μg/ml of fentanyl in 0.9% saline solution (total volume, 250ml), was connected to epidural catheter. The basal infusion of the device was set at 5 ml/hr with 0.5 ml bolus doses allowed every 15 min for 2 days.

In the IT group, 0.3 mg of morphine in 0.9% saline solution (4 ml) was administered into the intrathecal space via a 27-gauge pencil-point spinal needle at the level of L4-L5, before the induction of general anesthesia. Upon peritoneal closure, 1 μg/kg of fentanyl was administered intravenously, and the same device used in the EP group, containing 20 μg/kg of fentanyl in 0.9% saline solution (total volume, 250 ml), was connected, and intravenous patient-controlled analgesia (IVPCA) was initiated. The patients in the IT group thus received basal infusion of fentanyl at 0.4 μg/kg/hr with boluses of 0.04 μg/kg, and a lockout period of 15 min.

Additional fentanyl administration (0.4 μg/kg) upon patient demand was allowed for further analgesia in the both groups. Total additional fentanyl administration was also recorded. After administration of additional fentanyl, respiration rate and the level of consciousness were closely monitored for 30 min to check the presence of respiratory depression or oversedation arised from the effects of opioid.

To evaluate patient discomfort related to the procedure, we assessed the duration of the procedure (from infiltration of local anesthetic to removal of the Tuohy needle or spinal needle) and subjective grade of discomfort which the patient suffered during the procedure (1, minimal; 2, mild; 3, moderate; 4, severe) for both groups.

B. Anesthetic Procedure

Anesthesia was performed following the same standard protocol in both groups. All patients were premedicated with 0.1 mg of glycopyrrolate intravenously. Anesthesia was induced with 1.5 mg/kg of propofol and 1 μg/kg of remifentanil. For tracheal intubation, 0.6 mg/kg of rocuronium was given. Thereafter, the patient was mechanically ventilated to maintain end-tidal carbon dioxide at 35 ± 5 mmHg during the surgery. Anesthesia was maintained with 0.6-1.2 MAC end tidal desflurane in an air-oxygen mixture (fraction of inspired oxygen = 0.5) and 0.05-0.3 μg/kg/min remifentanil infusion. The concentration of end-tidal desflurane and the infusion rate of remifentanil were adjusted according to clinical parameters (blood pressure or heart rate within 20% of the baseline). Pulse oximetry, heart rate, and noninvasive blood pressure were monitored and recorded every 5 min throughout the surgery. For prevention of postoperative nausea and vomiting, 0.3 mg of ramosetron was administered intravenously upon peritoneal closure.

C. Data Collection

An anesthesiologist blinded to group allocation evaluated the postoperative

assessments throughout the study period. VAS at rest and upon coughing was assessed at 1, 3, 6, 24, and 48 hour after surgery. We recorded the maximum pain experienced at rest and upon coughing at each time point. Besides the PCA, the total additional fentanyl administration was also evaluated.

Postoperative respiratory depression was defined as less than or equal to 8 breaths/min. Postoperative sedation was evaluated using the 8-point modified Ramsey Sedation Scale, and oversedation was defined for patient status of 4 points or more. Patients were excluded from the study and treated with naloxone if they had respiratory depression or oversedation persisting more than 1 hour. Other adverse effects of analgesia such as nausea, vomiting, pruritus, and hypotensive episode were evaluated until POD 2. To compare the recovery profile from the surgery, time to ambulation, eating, and gas passing were also assessed. .

3. Study Materials

For patient-controlled analgesia, postoperative pain control device (Accufuser plus, P2015M, Woo Young Medical Co. Ltd, Korea) was used in this study.

4. Clinical Assessment

The incidence of postoperative complications within POD 30 were assessed, which were diagnosed and treated by the Yonsei Gastric Cancer Clinic team[18] who was blind to this study: intraperitoneal fluid collection, intraluminal bleeding, postoperative ileus, anastomosis site leakage, pancreatitis, pulmonary atelectasis or pleural effusion, pancreatitis and urinary complications were assessed following their protocols. Mortality referred to any death within 30 days after operation.

Intraperitoneal fluid collection was confirmed by ultrasonography or computed tomography (CT). Intraluminal bleeding was confirmed by CT or CT angiography after observing the clinical symptoms of hematemesis, hematochezia or melena and the clinical signs of hypovolemia. Ileus referred to intolerance of oral intake or vomiting during a meal after surgery as well as paralytic intestinal obstruction upon plain abdominal radiography, which was treated conservatively. Anastomosis site leakage was characterized by drainage of bowel contents from the wound or drain and by confirmation with a barium enterography. Pancreatitis was defined as serum amylase elevation (> 150 U/L) and was diagnosed in patients with the suggestive clinical symptoms thereof, including abdominal pain, nausea, vomiting, fever, upon physical examination. Pulmonary complications including atelectasis, pleural effusion, empyema, pneumonia and pneumothorax were confirmed by chest radiography or CT.

Urinary complications were defined as symptoms of urinary frequency, nocturia, dysuria or significantly increased white blood cells (WBCs) in urinalysis.

5. Statistical Analysis

The primary outcome variable was VAS score at rest and upon coughing at POD 1. Therefore, the number of patients required for each group was determined according to VAS score at POD 1 on the basis of the non-inferiority hypothesis. For non-inferiority of the IT group versus the EP group, a maximum difference of 10 (margin of non-inferiority) on the VAS score was considered as acceptable. On the basis of previously published data,[19] a standard deviation of 13.6 was assumed for VAS score distribution. Under these conditions, power analysis indicated that a sample size of 29 patients in each group would be required with $\alpha = 0.025$ (one-sided hypothesis) and a power of 80%. Taking into consideration the potential for drop-out, we decided to enroll 30 patients per group.

The primary outcome variable was analyzed according to a non-inferiority approach. The 95% confidence intervals of the mean differences in VAS scores, at rest and upon coughing, between the two treatments at postoperative 24 hours were calculated and shown in relation to the predefined margin of inferiority.

Where appropriate, results were shown as mean ± SD or median (25^{th} -75^{th}

percentile interquartile, IQR). Comparison of the continuous variables between the two groups was analyzed using unpaired Student's *t*-test. Differences between the two groups regarding the grade of discomfort during the procedure, additional fentanyl administration, and the incidence of adverse effects were analyzed by the Mann-Whitney rank-sum test for continuous variables and Fisher's exact test for categorical variables. For these variables, a *P*-value < 0.05 was considered to be statistically significant.

SPSS software version 18.0 (SPSS Inc, Chicago, IL) and SAS software version 9.2 (SAS, Cary, NC, USA) were used for the aforementioned statistical analyses.

III. RESULTS

A total of 60 patients were randomly allocated to one of the two groups. One patient in the IT group was excluded because of persistent oversedation. The two groups were comparable in terms of patient characteristics, calculated comorbidity index (CCI)[20] and duration of surgery (Table 1). There were no significant differences between two groups.

In our study, we used CCI[20], to compare comorbid conditions of patients, that could affect postoperative complication or mortality. The method for calculate CCI was described in Table 2.

TABLE 1. Patient demographic characteristics, duration of surgery, anesthesia and hospital stay

	Group EP (N = 30)	Group IT (N = 29)
Age	53.8 ± 9.8	55.6 ± 10.1
Gender (M/F)	20/10	18/11
Height (cm)	164.5 ± 6.6	162.6 ± 6.8
Weight (kg)	64.4 ± 9.6	61.4 ± 11.3
ASA class (I/II)	22/8	20/9
CCI (0/ 1 or 2)	24/6	20/9
Smoking history (non/past/active)	18/7/5	15/9/5
RSTG/ RTG	24/6	23/6
Duration of anesthesia (min)	198.6 ± 50.1	196.9 ± 48.3
Duration of surgery (min)	164.9 ± 39.6	166.9 ± 38.2
Hospital stay (d)	8 (8-8.3)	8.5 (8-10)
Re-admission	2	1
Re-operation	0	0

Data were shown as number of patients or mean ± SD or median (IQR).

There are no significant differences between the two groups.

CCI means calculated comorbidities index.[20] (Table 2)

RSTG and RTG mean radical subtotal gastrectomy and total gastrectomy, respectively.

TABLE 2. Variables for calculated comorbidities index (CCI)[20]

Assigned weights for diseases	Conditions
1	Myocardial infarct
	Congestive heart failure
	Peripheral vascular disease
	Cerebrovascular disease
	Dementia
	Chronic pulmonary disease
	Connective tissue disease
	Ulcer disease
	Mild liver disease
	Diabetes
2	Hemiplegia
	Moderate or severe renal disease
	Diabetes with end organ damage
	Any tumor
	Leukemia
	Lymphoma
3	Moderate or severe liver disease
6	Metastatic solid tumor
	AIDS

The total equals the score.

The procedure related profiles for the intrathecal injection or epidural catheter placement are shown in Table 3. Length for procedure was significantly shorter in the IT group than the EP group ($P = 0.013$). Grade of discomfort during the procedure was lower in the IT group than the EP group ($P = 0.004$).

TABLE 3. Procedure related profiles for epidural catheter placement and intrathecal morphine administration

	Group EP (N = 30)	Group IT (N = 29)	*P*-value
Time for procedure (sec)	401.3 ± 189.7	245.7 ± 144.6	0.013
Grade of discomfort*	3 (2~4)	2 (1~4)	0.004

Data were shown as mean (SD) or median (range).

Time for procedure; from infiltration of local anesthetic to removal of the Tuohy needle or spinal needle.

* The grade of discomfort: 1, minimal; 2, mild; 3, moderate; 4, severe.

The 95% confidence interval of the mean differences in VAS scores between the two groups, at rest and upon coughing, at POD 1, failed to demonstrate non-inferiority of intrathecal morphine administration to PCTEA (Fig. 1), even though VAS scores at rest (Fig. 2A) and upon coughing (Fig. 2B) were comparable for both the IT and the EP groups. The total additional fentanyl administration up to POD 2 was significantly greater in the IT group than the EP group [3 (0~10) vs. 1 (0~4), P = 0.003].

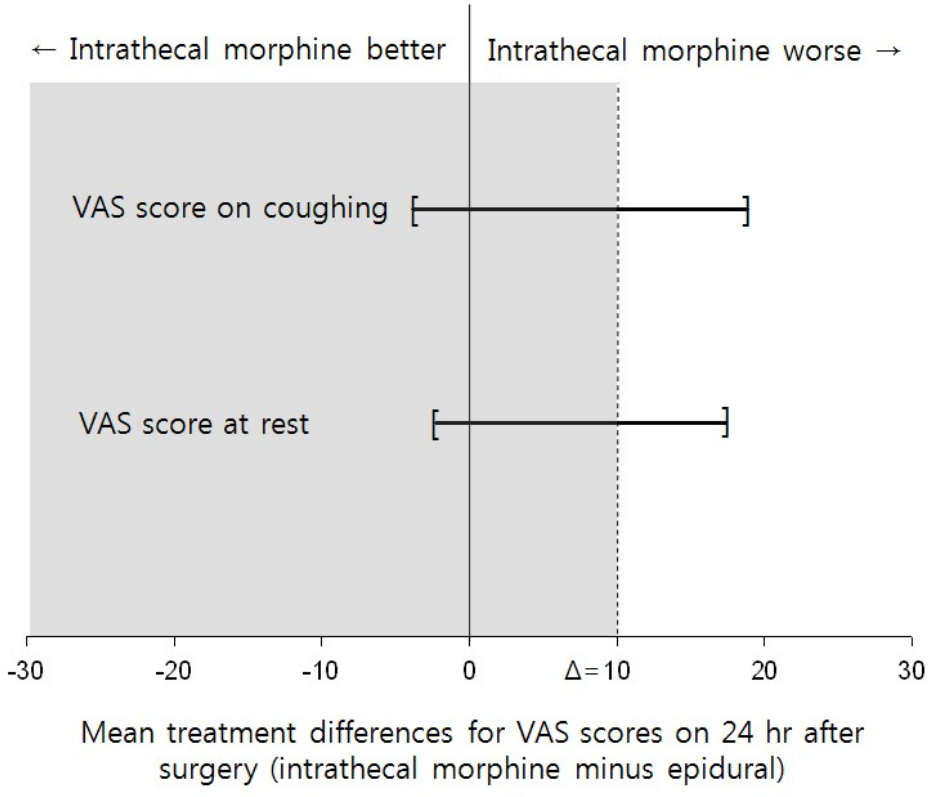

FIGURE 1. Mean differences in VAS scores for the two treatments at 24 hours after surgery. Error bars indicate two-sided 95% confidence intervals (CIs). As the CIs include Δ and zero, the difference is non-significant, but the result regarding non-inferiority is inconclusive. Δ, margin of non-inferiority. Non-tinged area indicates zone of inferiority. VAS, visual analogue scale.

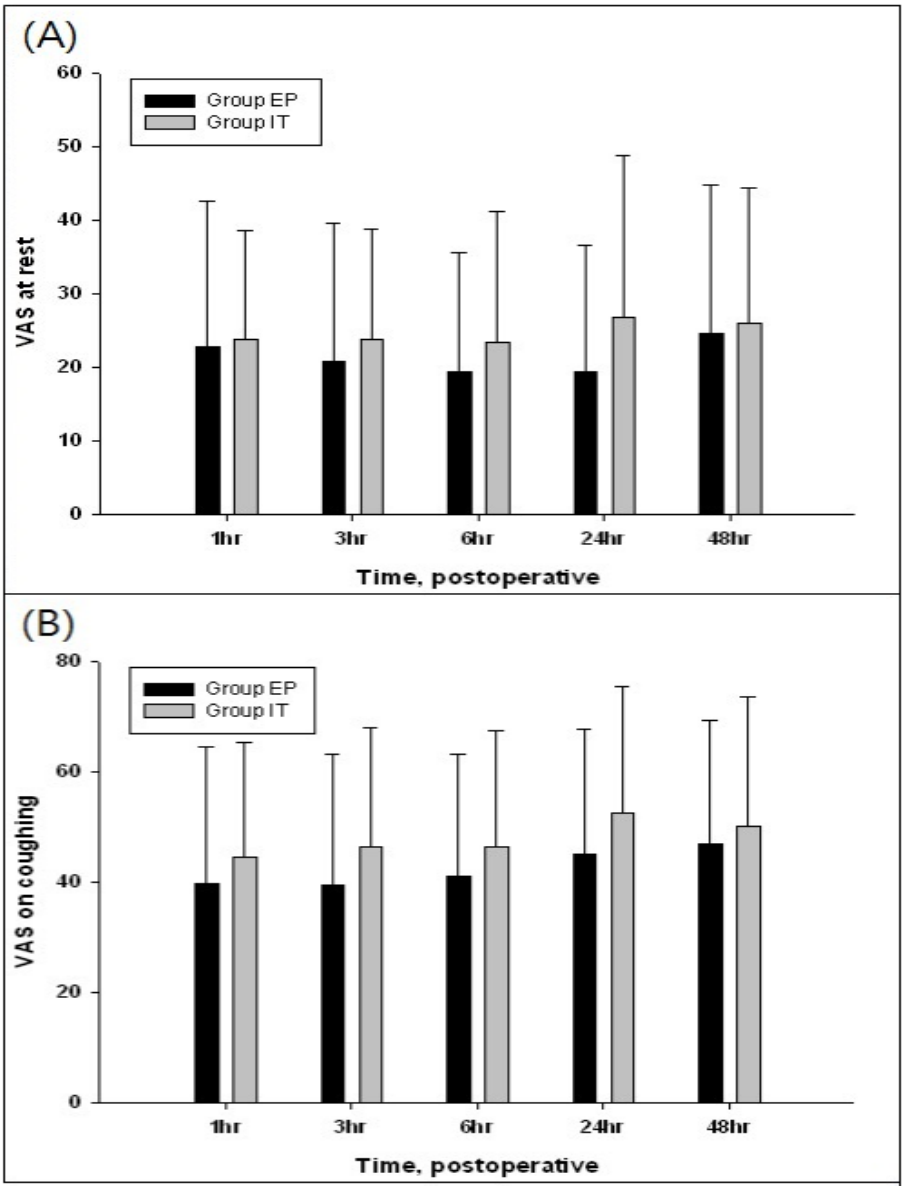

FIGURE 2. VAS scores at rest (A), VAS scores upon coughing (B). VAS scores between the IT group and the EP group were comparable at rest and upon coughing.

Adverse effects of the opioid are presented in Table 4. Postoperative nausea developed more frequently in the IT group.

TABLE 4. Profiles of opioid and local anesthetics related adverse effects between the two groups

	Group EP (N = 30)	Group IT (N = 29)	*P*-value
Nausea	4 (13.3%)	13 (44.8%)	0.01
Vomiting	0	4 (13.8%)	0.052
Pruritus	4 (13.3%)	5 (17.2%)	0.731
Hypotensive episode	7 (22.3%)	4 (13.8%)	0.506

Data were shown as number of patients (proportion).

Regarding the recovery profiles from the surgery, the IT group took 12 hours longer to ambulate than the EP group (P = 0.02). However, there were no differences in time to eating and gas passing (Table 5).

TABLE 5. Comparison of recovery profiles between the groups

	Group EP (N = 30)	Group IT (N = 29)	*P*-value
Time to ambulation (hours)	32.6 ± 16.0	45.4 ± 25.1	0.021
Time to eating (hours)	78.4 ± 23.3	83.1 ± 21.1	0.411
Time to gas passing (hours)	100.9 ± 21.1	99.3 ± 19.9	0.762

Data were shown as mean ± SD.

The number of days in the hospital for the EP group were fewer than that of the IT group (8 vs. 8.5); however, there were no statistic significant differences in hospital stay (P = 0.14) and re-admission. There were no re-operations in either group.

We assessed the postoperative outcomes documented within POD 30 (Table 6). In the IT group, postoperative ileus (P = 0.012) and pulmonary atelectasis or effusion (P = 0.05) developed more frequently, compared to the EP group. Two patients in the IT group died due to multi-organ failure during post-gastrectomy chemotherapy at POD 75 and 168, respectively.

TABLE 6. Postoperative complications within postoperative day 30

	Group EP (N = 30)		Group IT (N = 29)		*P*-value
The number of patients with					
Fluid collection	9	(30.0%)	9	(31.0%)	0.931
Intraluminal bleeding	9	(30.0%)	4	(13.8%)	0.209*
Ileus	1	(3.3%)	8	(27.6%)	0.012*
Anastomosis site leakage	1	(3.3%)	1	(3.4%)	1.000*
Pancreatitis	6	(20.0%)	9	(31.0%)	0.330
Pulmonary complications	9	(30.0%)	16	(55.2%)	0.050
Urinary complications	20	(66.7%)	23	(79.3%)	0.275
Mortality	0		0		

* Fisher's exact test; otherwise Chi-square test.

IV. DISCUSSION

The present study revealed that the analgesic effect of single intrathecal morphine injection combined with IVPCA is not as effective as the analgesic effect of PCTEA in patients undergoing gastrectomy, despite shorter time and less discomfort during procedure. Furthermore, intrathecal morphine plus fentanyl-IVPCA results in longer time to ambulation, more additional analgesics and, eventually, an increased incidence of postoperative ileus and pulmonary atelectasis or effusion.

The treatment differences in regards to VAS score failed to demonstrate non-inferiority of the intrathecal morphine injection at POD 1 (Fig. 1) compared to PCTEA. Also, the IT group required a larger amount of additional analgesic than the EP group. In contrast, PCTEA enables early ambulation, and consequently reduces postoperative ileus and pulmonary complications.

In this study, epidural catheterization took longer than the intrathecal injection. Also, patient discomfort grade was higher in the EP group. Thoracic epidural catheterization is technically more difficult and is associated with a high risk of neurological damage, in contrast to the rather simple procedure of lumbar puncture performed in the IT group. The rate of neurological complications

related with thoracic epidural catheter insertion is unknown. In agreement with previous studies,[21-24] no permanent neurological complications attributable to the thoracic epidural catheter were observed in this current study. Also, there were no cases of epidural hematoma or abscess.

In our study, ITM-IVPCA failed to demonstrate a non-inferior analgesic effect to that of PCTEA at POD 1. Until now, only a few comparative studies between ITM-IVPCA and PCTEA have been undertaken. In hepatectomies, ITM-IVPCA provided comparable pain relief to continuous epidural analgesia up to 48 hours after surgery and ITM-IVPCA was proven as a valid alternative to epidural analgesia, when the placement of an epidural catheter is considered unsafe due to postoperative coagulation disturbances.[25] However, these studies revealed that the EP group took a longer time to require first analgesics and consumed less morphine IVPCA, while postoperative nausea and vomiting less frequently occurred therein, compared with the IT group. These are in agreement with our study which demonstrated that an EP group required less additional fentanyl and less postoperative nausea occurred. Unfortunately, De pietri et al.[25] did not evaluate the postoperative outcomes.

As the secondary endpoint, we demonstrated that PCTEA reduced the incidence of postoperative ileus after gastrectomy. Postoperative ileus is a major gastrointestinal complication of abdominal surgery, leading to increased rates of

morbidity and mortality, longer lengths of hospital stay, and higher costs. Gastrointestinal hypomotility, caused by surgical reflex via inflammatory cascades, also leads to postoperative ileus; furthermore, exposure to systemic opioids can cause postoperative ileus by stimulation of opioid receptors as well as inhibition of intestinal secretomotor neurons.[2] Secondly, thoracic segmental neural blockade by PCTEA disturbs nociceptive afferent and sympathetic efferent activity, meanwhile passing over parasympathetic activity. This increase of parasympathetic tone could increase gastrointestinal activity and improve postoperative ileus without increasing the risk of anastomotic leakage.[26] Therefore, we inferred that this is one of the reasons PCTEA decreased development of postoperative ileus compared with ITM-IVPCA.

Recently, van Lier et al.[27] reported improved outcomes in surgical patients with chronic obstructive pulmonary disease who received epidural analgesia, which provided better analgesic effect than systemic opioids and decreased postoperative pneumonia as well as 30-day mortality. This may have resulted from better preservation of pulmonary function in TEA.[27-29] The decreased incidence of pulmonary complications in the PCTEA group in this study may have resulted from a similar preservation of pulmonary function.

The potential benefits resulting from postoperative pain control and improved postoperative outcomes should be weighed against the potential risks of PCTEA,

when patients were planned to receive PCTEA. The observed advantage of PCTEA such as less additional analgesics, fewer postoperative ileus and pulmonary complications may have implications on clinically important outcomes, such as shorter hospital stay and reduced perioperative mortality. On the other hand, it should be mentioned that thoracic epidural catheterization is not a procedure free of risk.[30,31] To solve these problems, further larger trials are required. Although no complications were noted in our study population, epidural abscess and hematoma as well as neurological damage are rare but serious complications that should be taken into consideration by all physicians. Accordingly, a risk-benefit analysis should be individualized for each patient.

Our results demonstrated that postoperative pain control by PCTEA required less additional analgesic, enabled earlier ambulation, and led to fewer postoperative ileus and pulmonary complications; however, this study had several limitations. First, we did not evaluate lung function or conduct biochemical tests related with endocrine metabolic responses. Therefore, the mechanism by which PCTEA decreases postoperative ileus and pulmonary complications remains unknown. Second, this study was unable to discriminate whether the systemic opioid in the IT group increased the incidence of postoperative ileus or whether PCTEA directly decreased the incidence thereof. Third, we could not show that PCTEA shortened hospital stay, even by using the same discharge criteria and a single

surgical team. Forth, there was no statistical significant difference between the two groups with respect to VAS score, even though ITM-IVPCA failed to show non-inferiority to PCTEA and required more additional analgesic. Therefore, improved outcomes might come not from better pain control, but rather from less systemic opioid or preservation of pulmonary function.

V. CONCLUSION

ITM-IVPCA is not as effective as PCTEA in patients undergoing gastrectomy, with respect to greater analgesic requirement, later ambulation, more frequent postoperative ileus and pulmonary complications within 30 days after gastrectomy, despite the technical difficulty and potential neurological complications related with thoracic epidural catheterization.

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ABSTRACT (IN KOREAN)

위 절제술 환자군에서 척수강내 모르핀 주사 후 펜타닐을 이용한 정주용 자가 통증 조절법의 병행은 흉부 경막외 자가 통증 조절법에 비해 효과적이지 않다.

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박 진 하

흉부 경막외 자가 통증 조절법은 소량의 아편양제제로 진통효과가 좋다는 점 때문에 널리 사용되고 있으나, 시술상의 어려움과 환자의 불편감, 카테터로 인한 부작용으로 사용이 제한되고 있다. 척수강내 모르핀 주사 후 정주용 자가 통증 조절법의 병행이 복부 수술 후의 가능한 진통 방법으로 이용되고 있다.

본 연구의 목적은 위 절제술 환자군에서 흉부 경막외 자가 통증 조절법과 척수강내 모르핀 주사 후 정주용 자가 통증

조절법 병행의 진통 효과와 수술 후 결과를 비교하고자 하였다.

위암 진단 후 위 절제술을 받는 60명의 환자들을 무작위로 척수강내 모르핀 주사군과 흉부 경막외 자가 통증 조절군으로 나누었다. 척수강내 모르핀 주사군은 수술 전 척수강내로 모르핀을 주사받은 후 수술 후 정주용 자가 통증 조절법을 사용하였다. 흉부 경막외 자가 통증 조절군은 수술 전 흉부 경막외 카테터를 삽입하였으며 수술 후 경막외 자가 통증 조절법을 사용하였다. 수술 후 2일까지 시각 통증 척도와 수술 후 부작용을 평가하였다. 수술 후 보행 시작 시간, 식사 시간, 가스 통과 시간과 수술 후 30일까지 수술 합병증을 평가하였다.

본 연구에서는 수술 후 1일째 척수강내 모르핀 주사의 비열등성을 증명하는데 실패하였다. 척수강내 모르핀 주사군은 흉부 경막외 자가 통증 조절군에 비해 전신적 진통제를 더 많이 필요로 하였고 ($P = 0.003$), 거동까지 걸리는 시간이 오래 걸렸다 ($P = 0.021$). 또한 척수강내 모르핀 주사군은 흉부 경막외 자가 통증 조절군에 비해 수술 후 장폐색 ($P = 0.012$)과 폐합병증 ($P = 0.05$) 이 더 많이 발생하였다.

본 연구를 통해 위 절제술 환자에서 척수강내 모르핀 주사 후 정주용 자가 통증 조절법의 병행은 추가적인 진통제 요구량 증가, 거동까지 필요한 시간 증가, 수술 후 30일까지의 장폐색

및 폐합병증 발생률 증가 측면에서 볼 때 흉부 경막외 자가 통증 조절법에 비해 효과적이라고 할 수 없음을 알 수 있다.

핵심되는 말: 보행, 위 절제술, 척수강내 모르핀, 자가 통증 조절법, 수술 후 장폐색, 수술 후 통증, 수술 후 폐 합병증, 전신 아편유사제, 흉부 경막외 통증 조절.