—Original—

Comparison of Postoperative Pain Following Laparoscopic Versus Open Gastrostomy/Jejunostomy in Patients with Complete Obstruction Caused by Advanced Esophageal Cancer

Takeshi Matsutani, Tsutomu Nomura, Nobutoshi Hagiwara, Itsuo Fujita, Yoshikazu Kanazawa, Daisuke Kakinuma, Hitoshi Kanno, Akihisa Matsuda, Keiichiro Ohta and Eiji Uchida

Department of Gastrointestinal and Hepato-Biliary-Pancreatic Surgery, Nippon Medical School, Graduate School of Medicine, Tokyo, Japan

Background: When percutaneous endoscopic gastrostomy is not feasible, a gastrostomy tube may be inserted for enteral access by a laparoscopic or open technique. The aim of this study was to compare the postoperative pain of laparoscopic versus open gastrostomy in patients with complete obstruction caused by advanced esophageal cancer.

Methods: Fifteen patients who had undergone either a reduced port access laparoscopic gastrostomy/jejunostomy (LGJ, n=7) or open gastrostomy/jejunostomy (OGJ, n=8) between July 2011 and December 2015 were retrospectively studied. Variables examined comprised age, sex, body mass index (BMI), operative time, blood loss volume, and American Society of Anesthesiologist physical status (ASA-PS) scores. The degree of postoperative pain was also assessed in both groups during the first seven postoperative days.

Results: The patients in the two groups were comparable in age, sex, BMI, ASA-PS scores, intraoperative blood loss or postoperative complication rates. Operative time was shorter in the LGJ group than the OGJ group. No patients in the LGJ group required conversion to open laparotomy. Tube feedings were started on postoperative Day 1 in both groups; there were no postoperative complications. The duration of rescue nonopioid analgesic use was significantly shorter in the LGJ than the OGJ group (1.3 versus 3.5 days; P=0.0005). There was a significant difference in frequency of postoperative nonopioid analgesic use: 7.9 times in the LGJ group versus 17.9 times in the OGJ group (P=0.0219).

Conclusions: LGJ is associated with less postoperative pain than OGJ in patients with complete obstruction caused by advanced esophageal cancer. (J Nippon Med Sch 2016; 83: 228–234)

Key words: postoperative pain, laparoscopic gastrostomy, reduced port surgery, advanced esophageal cancer

Introduction

During the last 3 decades, percutaneous endoscopic gastrostomy (PEG) has become the standard technique for establishing access of long-term enteral feeding for patients with malignancies of the upper gastrointestinal tract[1–4]. However, PEG placement can be problematic if an endoscope cannot be passed through the upper gastrointestinal tract because of severe stenosis which can occur in patients who have head and neck cancer or benign or malignant esophageal disease[5,6]. Because such patients cannot undergo endoscopic procedures, they require conventional open gastrostomy or laparoscopic gastrostomy. Open gastrostomy procedures, which require an incision approximately 10 cm long, have an increased risk of wound infection or dehiscence and can impair patient's quality of life because of postoperative pain or ileus[7]. Postoperative complications should be minimized in patients with advanced malignancies.

Laparoscopic surgery, which was first described in 1991[8,9], has several advantages over standard open gas-

Correspondence to Takeshi Matsutani, MD, Department of Gastrointestinal and Hepato-Biliary-Pancreatic Surgery, Nippon Medical School, 1–1–5 Sendagi, Bunkyo-ku, Tokyo 113–8603, Japan
E-mail: matsutani@nms.ac.jp
Journal Website (http://www.nms.ac.jp/jnms/)

trostomy, including smaller incisions, less postoperative pain, better cosmetic outcomes, and lower rates of incisional hernia, ileus, and wound infection. A conventional multiport laparoscopic gastrostomy (3-trocar approach) is reportedly less invasive than open gastrostomy[6,7,10]. Recently, laparoscopic procedures with a single port or reduced port access have been performed in general and gastrointestinal diseases and have been found to have even better cosmetic benefits, less postoperative pain, earlier recovery, and fewer port-site complications than conventional multiport laparoscopic surgery[11,12]. Laparoscopic gastrostomy/jejunostomy (LGJ) with reduced port access in patients unable to undergo PEG were first reported in 2009 and 2011[13,14]. However, laparoscopic gastrostomy with reduced port access has not been shown to have advantages over conventional open gastrostomy with regard to recovery and postoperative pain. We believe that laparoscopic gastrostomy with reduced port access results in minimal abdominal scarring and is associated with less postoperative pain than open gastrostomy in patients with complete obstruction of the upper gastrointestinal tract.

The aim of present retrospective study was to compare postoperative pain following reduced port access LGJ versus open gastrostomy/jejunostomy (OGJ) in patients with complete obstruction caused by advanced esophageal cancer.

Patients and Methods

Patients

Placement of a feeding tube with open laparotomy or a laparoscopic approach was considered for all patients seen between July 2011 and December 2015 in whom standard PEG placement was impossible. Fifteen eligible patients (12 men and 3 women; age range, 53–85 years) were identified, and were found to have complete obstruction caused by advanced esophageal cancer. The indication for a gastrostomy in these patients was an anticipated need for enteral feeding support for at least several months.

The operative procedure was chosen according to the patient's general medical condition or anatomical condition after abdominal surgery. The patients were divided into 2 groups: an LGJ group (n=7) and an OGJ group (n=8). This retrospective study was performed in accordance with the principles of the Declaration of Helsinki. Informed consent for the surgical procedures had been obtained from the patients or their families.

Surgical Technique for Open Gastrostomy

With the patient under general anesthesia, OGJ was performed via a minimal vertical midline incision, approximately 10 cm long, in the upper abdomen. The stomach or jejunum was exposed, and purse-string sutures were placed on its wall. A 12-Fr gastrostomy/jejunostomy feeding tube was placed with the Witzel tunnel technique and the feeding tube fixed to the anterior abdominal wall.

Surgical Technique for Laparoscopic Gastrostomy

Laparoscopy was performed with the patient under general anesthesia. Carbon dioxide was insufflated to a pressure of 8–10 mm Hg. The stomach and/or jejunum were visualized laparoscopically through a single abdominal access device, EZ Access™ (Medical Device Division, Hakko Co., Ltd., Nagano, Japan) or SILS port™ (Covidien, Mansfield, MA, USA), via an umbilical incision less 3 cm long. Three 5-mm trocars were then attached with the access device. The insertion site for button-type gastrostomy/jejunostomy catheters was determined with laparoscopic identification of the stomach/jejunum. The gastrostomy was placed on the anterior wall of the stomach between the smaller and greater curvature or on the contralateral wall. After the jejunum had been identified 20 to 30 cm from the ligament of Treitz, the jejunostomy was placed on the mesenteric contralateral portion of the loop of the jejunum. A stab skin incision was then made in the left upper quadrant, and a straight needle with non-absorbable 2-0 nylon thread was used to insert two stay sutures in the selected puncture site. The straight needle was passed through the abdominal and stomach/jejunum walls, and was then passed back in the same way to form a continuous double U-stitch (**Fig. 1a**). Next, an introducer needle was passed percutaneously into the stomach/jejunum under direct laparoscopic vision and a guide wire passed into the stomach/jejunum through the needle. The lumen of the stomach/jejunum was then dilated (**Fig. 1b**), after which a button type catheter (Kangaroo™ Seldinger P.E.G kit, Medtronic, Memphis, TN, USA) was inserted (**Fig. 1c**). A 24-Fr catheter for gastrostomy and a 20-Fr catheter for jejunostomy were then placed (**Fig. 1d**), and intraluminal placement was confirmed by flushing saline into the tube; finally, the tube was tested for leaks. The double stay sutures were tied, and the umbilical wound was closed in layers.

Postoperative Managements

Epidural analgesia or intravenous patient-controlled analgesia (IV-PCA) for postoperative pain control was se-

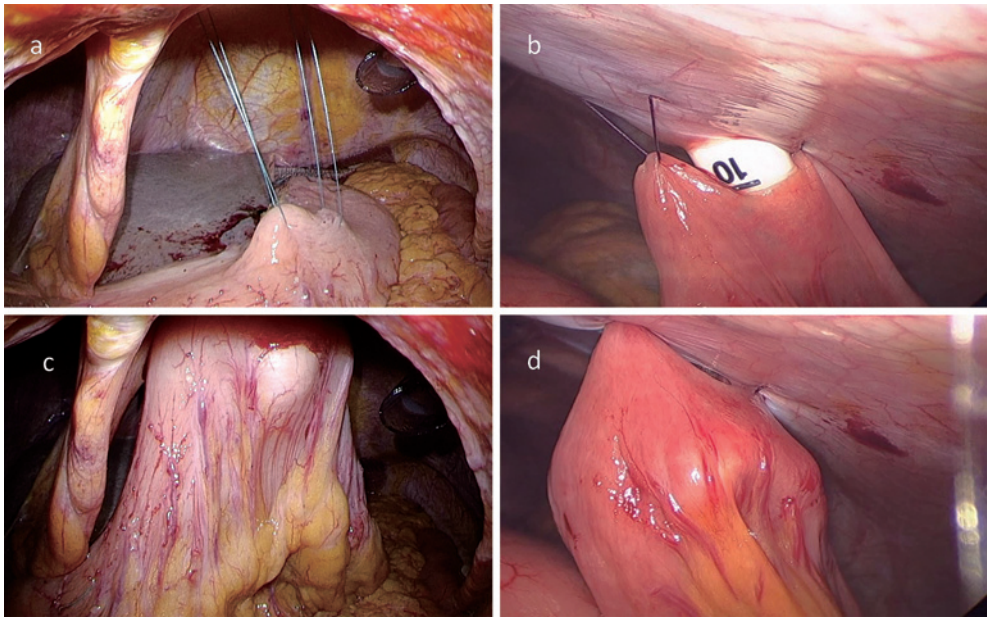

Fig. 1 **a**: Laparoscopic view showing two continuous double U-stitch sutures on the abdominal and stomach walls. **b**: Laparoscopic view of dilation of the lumen of the jejunum. **c, d**: A 24-Fr catheter for gastrostomy (c) and a 20-Fr catheter for jejunostomy (d) is inserted through the anterior abdominal wall.

lected according to either the anesthetist's preference or the patient's medical condition. All patients in both groups received similar postoperative care. Feeding via gastrostomy/jejunostomy was started 24 hours after the operation in both patient groups.

Outcome Measures

Data were collected from patient's medical charts and records. Variables compared between the LGJ and OGJ groups were age, sex, body mass index (BMI), surgical method, operative time, medical history and complications such as leakage, infections and re-operations within the short term (i.e. less than 30 days), and the postoperative duration and frequency of rescue nonopioid analgesic use. Operative risk was assessed with the American Society of Anesthesiologists physical status classification system (ASA-PS). All patients were followed up for at least 30 days after surgery.

Statistical Analysis

Data are expressed as mean ± standard error of the mean. Differences in the characteristics and operative outcomes of patients were analyzed with Student's *t*-test. The Mann-Whitney *U* test was used to compare the postoperative duration and frequency of rescue nonopioid analgesic use between the LGJ and OGJ groups. Other factors were analyzed with the χ^2 test or Fisher's extra probability test. All statistical computations were performed with the JMP statistical software program (SAS Institute, Cary, NC, USA). The level for statistical significance was set at $P<0.05$.

Results

During the study period, all operations were performed by resident surgeons under the supervision of specialist surgeons. The LGJ was performed in 7 patients and OGJ was performed in 8 patients. The procedures were well tolerated in all patients.

The values of age, sex, BMI, and ASA-PS were similar in both groups (**Table 1**). Tumor status (primary tumor or recurrence) and preoperative treatment (chemoradiotherapy, esophagectomy, or none) did not significantly between the groups. No patients in the LGJ group had previously undergone esophageal resection and reconstruction; however, previous operations did not differ significantly between the groups.

The mean operative time was significantly shorter in the LGJ group (40.0 minutes; range, 22–75 minutes) than in the OGJ group (74.8 minutes; range, 52–117 minutes; P =0.0045) (**Table 2**). The volume of blood loss did not differ significantly between the groups. No serious intraoperative or postoperative complications occurred in either group. No patients in either group had died within 30 days of the procedure. Conversion of the LGJ to open la-

Table 1 Relevant patient characteristics

Variable	LGJ group (n=7)	OGJ group (n=8)	*P*-value
Age (yo)	68.3±2.6	67.1±2.5	0.7536
Sex (M/F)	6/1	6/2	0.6048
BMI (kg/m2)	16.8±1.1	16.1±1.0	0.6317
Primary/Recurrence	7/0	5/3	0.0701
Pre-treatment (CRT/Esophagectomy/none)	5/0/2	2/3/3	0.179
ASA-PS (class 2/class 3)	6/1	7/1	0.9192

LGJ, laparoscopic gastrostomy/jejunostomy; OGJ, open gastrostomy/jejunostomy; BMI, body mass index; chemoradiotherapy, CRT; ASA-PS, American Society of Anesthesiologist physical status

Table 2 Operative factors and outcomes

	LGJ group (n=7)	OGJ group (n=8)	*P*-value
Operation time (min)	40.0±7.4	74.8±6.9	0.0045
Blood loss volume (mL)	1.14±1.63	4.38±1.52	0.1721
Intraoperative complication (n)	0	0	-
Postoperative complication (n)	0	0	-
Conversion (n)	0	0	-

LGJ, laparoscopic gastrostomy/jejunostomy; OGJ, open gastrostomy/jejunostomy

Table 3 Treatment of postoperative pain

Postoperative anesthesia	LGJ group (n=7)	OGJ group (n=8)	*P*-value
None	7	2	0.00699
IV-PCA	0	3	
Epidural anesthesia	0	3	

LGJ, laparoscopic gastrostomy/jejunostomy; OGJ, open gastrostomy/jejunostomy; IV-PCA, intravenous patient-controlled analgesia

parotomy was not required in any patient. Feeding was successfully started within 24 hours of the procedure in all patients and advanced to goal rates of feeding volume without difficulty. All patients were discharged to long-term care facilities within 30 days of the procedure. During 30 days of follow-up, no tube-related complications such as occlusion, leakage, or cracking, had occured.

No patients in either group received anesthetic medication preoperatively and all were anesthetized with a standard technique for the procedure. Epidural analgesia or IV-PCA was administered for postoperative pain control to 6 patients of the OGJ group and 0 patients of the LGJ group (*P*=0.00699) (**Table 3**). The duration of use of rescue nonopioid analgesic was significantly shorter in the LGJ than in the OGJ group (1.3 versus 3.5 days; *P*= 0.0005) (**Fig. 2a**). Rescue nonopioid analgesics were administered on fewer occasions to the LGJ than the OGJ group (7.9 versus 18.0 times; *P*=0.00219) (**Fig. 2b**).

Discussion

We have described a modified (reduced port) laparoscopic technique for creating a button-type gastrostomy/jejunostomy in patients with complete obstruction caused by advanced esophageal cancer. Reduced port access LGJ is minimally invasive with the expected decreases in postoperative pain and, consequently, in the duration and frequency of postoperative use of rescue nonopioid analgesic. We confirmed the efficiency of this technique is associated with less physical/surgical stress compared with the OGJ.

PEG has rapidly replaced surgical gastrostomy as the gold standard approach for enteral access in patients with head and neck cancer or esophageal cancer who are undergoing anticancer therapy[3,4]. The benefits of PEG over other methods include shorter procedure time, lower cost[15], and a lower rate of complications, with a mortality rate of 0.3% to 1% and a morbidity rate of 3% to 5.9%[16–18]. When patients with incomplete obstruction of

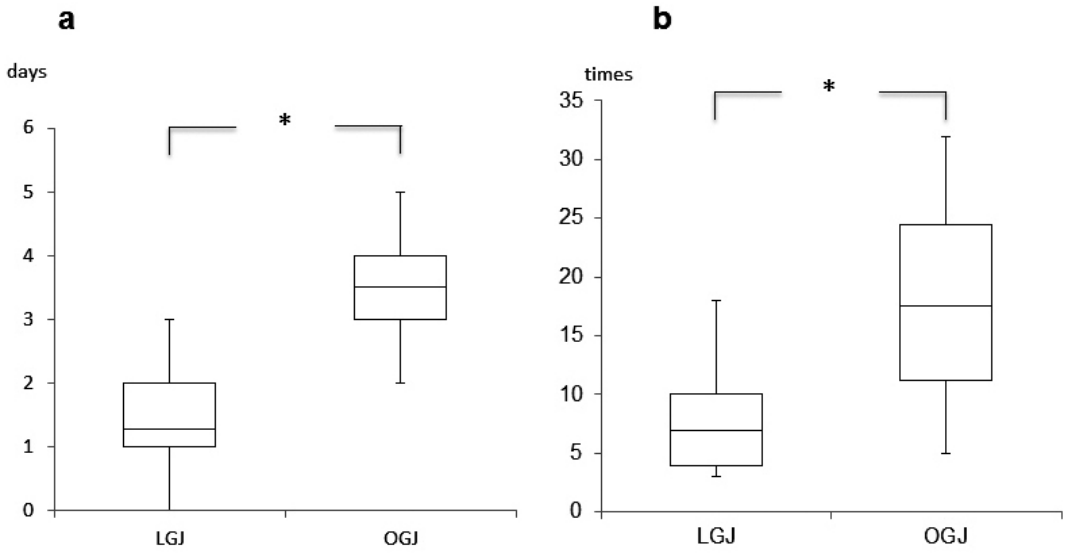

Fig. 2 Postoperative duration (a) and frequency of nonopioid analgesic use (b). Box plots showing comparisons between laparoscopic and open gastrostomy/jejunostomy group. The median values are indicated by horizontal lines, and the lower and upper edges of the boxes indicate the 25 and 75 percentiles, respectively. *indicates significant differences between the groups (P<0.05) according to Student's t-test.

the upper gastrointestinal tract require enteral access for feeding, a narrow endoscope can be passed through the stenosis to provide visual access to the stomach and thus enable PEG placement to be monitored. However, PEG placement can be problematic when malignancies cause complete obstruction of the upper gastrointestinal tract and prevent passage of an endoscope. An established alternative means of placing a PEG in such patients is direct percutaneous feeding tube placement under radiologic guidance. However, PEG is superior to both radiologically guided gastrostomy and surgical gastrostomy[4]. A systemic review of outcomes in patients with head and neck cancer has suggested that radiologically guided gastrostomy has a higher risk of mortality and complications than does PEG[19]. Radiologically guided gastrostomy might also have several severe complications, including leakage, extrusion, cracking, and rupture of tube components. Therefore, we rarely consider radiologically guided gastrostomy to be indicated in our hospital. However, accepted by both surgeons and gastroenterologists as optimal alternative to PEG are laparoscopic procedures.

Although laparoscopic gastrostomy achieves essentially the same goal as PEG, it is not the gold standard approach because of its disadvantages, such as having a higher cost and a longer procedure time than PEG[15]. However, laparoscopic gastrostomy is an excellent choice for patients who are not candidates for a PEG. The benefits of laparoscopic surgery over open surgery include less postoperative pain, reduced incidence of incisional hernia, improved cosmesis, and lower wound infection rates[6,7,10]. Furthermore, open gastrostomy has the greater disadvantages of intra-abdominal adhesions and incisional wound infection because of gastric fluid discharge. If additional intra-abdominal procedures were performed, these operative difficulties would be further reduced by decreasing the number and size of incisions. Likewise, the choice of laparoscopic jejunostomy is the most suitable method for patients who require enteral access but have contraindications for a gastrostomy tube[13]. Laparoscopic surgery with a single incision or a reduced port has rapidly gained popularity at both academic and private institutions, most often for performing cholecystectomy, appendectomy, gastrostomy, and jejunostomy[7,13].

Poorly controlled postoperative pain results in harmful and adverse physiologic responses, and delays long-term recovery[20]. However, no objective, universal and reliable means of assessing severity of postoperative pain has yet been recognized in the pain research field[21]. Six of the 8 patients who underwent OGJ received epidural anesthesia or IV-PCA as needed because of their moderately intense pain. However, none of the LGJ group was considered to require epidural anesthesia or IV-PCA in the early postoperative period. Even though most of the OGJ group received epidural anesthesia or IV-PCA, patients in the LGJ group required fewer doses of rescue nonopioid analgesics over a shorter period of time than those in the

OGJ group. Thus, the total analgesia use was lower after LGJ than after OGJ. Effective management of postoperative pain control can reduce complications, improve recovery and shorten hospital stay[22–24]. We considered that the decreased pain medication requirement contributes to the lower cost of laparoscopic surgery compared with open surgery.

The present study to compare the postoperative pain of LGJ and OGJ in patients with advanced esophageal cancer has several limitations. First, the main limitations are that it was carried out in a single institution and that was retrospective. Second, the sample size was very small because gastrostomies are rarely needed to place enteral feeding tubes in patients with advanced esophageal cancer. Third, there was likely selection bias in deciding which patients underwent LGJ because no selection criteria were set. Other confounding variables relate to differences between the procedures operative environment, postoperative care, and timing of the introduction of feeding. Furthermore, pain is a subjective experience, making it difficult to evaluate the postoperative pain associated with each procedure. Despite this study's limitations, we conclude that LGJ has an advantage over OGJ in reduction in postoperative pain. The observed differences in postoperative duration and frequency of use of rescue nonopioid analgesic is likely attributable to differences in length of incisions.

In conclusion, we demonstrated LGJ is associated with less postoperative pain than OGJ in patients with complete obstruction caused by advanced esophageal cancer. This is, to our knowledge, the first to compare the severity of postoperative pain between patients undergoing LGJ and OGJ.

Conflict of Interest: The authors have no conflicts of interest or financial ties to disclose.

References

1. Gauderer MW, Ponsky JL, Izant RJ Jr: Gastrostomy without laparotomy: a percutaneous endoscopic technique. J Pediatr Surg 1980; 15: 872–875.
2. Ponsky JL, Gauderer MW: Percutaneous endoscopic gastrostomy: a nonoperative technique for feeding gastrostomy. Gastrointest Endosc 1981; 27: 9–11.
3. Marks JM, Ponsky JL: Access routes for enteral nutrition. Gastroenterologist 1995; 3: 130–140.
4. Rustom IK, Jebreel A, Tayyab M, England RJ, Stafford ND: Percutaneous endoscopic, radiological and surgical gastrostomy tubes: a comparison study in head and neck cancer patients. J Laryngol Otol 2006; 120: 463–466.
5. Denzer U, Mergener K, Kanzler S, Kiesslich R, Helmreich-Becker I, Galle PR, Lohse AW: Mini-laparoscopically guided percutaneous gastrostomy and jejunostomy. Gastrointest Endosc 2003; 58: 434–438.
6. Murayama KM, Schneider PD, Thompson JS: Laparoscopic gastrostomy: a safe method for obtaining enteral access. J Surg Res 1995; 58: 1–5.
7. Mizrahi I, Garg M, Divino CM, Nguyen S: Comparison of laparoscopic versus open approach to gastrostomy tubes. JSLS 2014; 18: 28–33.
8. Edelman DS, Unger SW, Russin DR: Laparoscopic gastrostomy. Surg Laparosc Endosc 1991; 1: 251–253.
9. Reiner DS, Leitman IM, Ward RJ: Laparoscopic Stamm gastrostomy with gastropexy. Surg Laparosc Endosc 1991; 1: 189–192.
10. Lydiatt DD, Murayama KM, Hollins RR, Thompson JS: Laparoscopic gastrostomy versus open gastrostomy in head and neck cancer patients. Laryngoscope 1996; 106: 407–410.
11. Leggett PL, Churchman-Winn R, Miller G: Minimizing ports to improve laparoscopic cholecystectomy. Surg Endosc 2000; 14: 32–36.
12. Waters JA, Guzman MJ, Fajardo AD, Selzer DJ, Wiebke EA, Robb BW, George VV: Single-port laparoscopic right hemicolectomy: a safe alternative to conventional laparoscopy. Dis Colon Rectum 2010; 53: 1467–1472.
13. Nagle AP, Murayama KM: Laparoscopic gastrostomy and jejunostomy. J Long Term Eff Med Implants 2004; 14: 1–11.
14. Podolsky ER, Rottman SJ, Curcillo PG 2nd: Single Port Access (SPA) gastrostomy tube in patients unable to receive percutaneous endoscopic gastrostomy placement. Surg Endosc 2009; 23: 1142–1145.
15. Barkmeier JM, Trerotola SO, Wiebke EA, Sherman S, Harris VJ, Snidow JJ, Johnson MS, Rogers WJ, Zhou XH: Percutaneous radiologic, surgical endoscopic, and percutaneous endoscopic gastrostomy/gastrojejunostomy: comparative study and cost analysis. Cardiovasc Intervent Radiol 1998; 21: 324–328.
16. Foutch PG, Haynes WC, Bellapravalu S, Sanowski RA: Percutaneous endoscopic gastrostomy (PEG). A new procedure comes of age. J Clin Gastroenterol 1986; 8: 10–15.
17. Larson DE, Burton DD, Schroeder KW, DiMagno EP: Percutaneous endoscopic gastrostomy. Indications, success, complications, and mortality in 314 consecutive patients. Gastroenterology 1987; 93: 48–52.
18. Ponsky JL, Gauderer MW, Stellato TA, Aszodi A: Percutaneous approaches to enteral alimentation. Am J Surg 1985; 149: 102–105.
19. Burkitt P, Carter LM, Smith AB, Kanatas A: Outcomes of percutaneous endoscopic gastrostomy and radiologically inserted gastrostomy in patients with head and neck cancer: a systematic review. Br J Oral Maxillofac Surg 2011; 49: 516–520.
20. Moslemi F, Rasooli S, Baybordi A, Golzari SE: A Comparison of Patient Controlled Epidural Analgesia With Intravenous Patient Controlled Analgesia for Postoperative Pain Management After Major Gynecologic Oncologic Surgeries: A Randomized Controlled Clinical Trial. Anesth Pain Med 2015; 5: e29540.
21. Ling P, Siyuan Y, Wei W, Quan G, Bo G: Assessment of postoperative pain intensity by using photoplethysmography. J Anesth 2014; 28: 846–853.
22. Holte K, Kehlet H: Effect of postoperative epidural analgesia on surgical outcome. Minerva Anestesiol 2002; 68: 157–161.
23. Powell ES, Cook D, Pearce AC, Davies P, Bowler GM, Naidu B, Gao F: A prospective, multicentre, observational

cohort study of analgesia and outcome after pneumonectomy. Br J Anaesth 2011; 106: 364–370.
24. Rigg JR, Jamrozik K, Myles PS, Silbert BS, Peyton PJ, Parsons RW, Collins KS: Epidural anaesthesia and analgesia and outcome of major surgery: a randomised trial. Lancet 2002; 359: 1276–1282.

(Received, May 29, 2016)
(Accepted, June 13, 2016)