Clinical research

The effect of active gas aspiration to reduce pain after laparoscopic sleeve gastrectomy for morbid obesity: a randomized controlled study

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Abstract

Introduction: Residual, intra-abdominal CO_2 contributes to abdominal distension and pain after laparoscopic surgery. Our aim was to investigate the effects of active gas aspiration on postoperative outcomes and pain following laparoscopic sleeve gastrectomy.
Material and methods: Patients were randomly assigned to either the active gas reduction group (Group 1, n = 69) or the control group (Group 2, n = 74). After completion of the operative procedures, residual gas was aspirated with a flexible cannula in Group 1. In Group 2, gas release from the abdomen was performed using the port site by opening the gas tap only. The demographic data, body mass index, educational status, operation time, insufflated CO_2 volume during the operation, and intraabdominal pressure were recorded. Postoperative pain assessment was performed using a numerical pain intensity scale (NPIS) at the 1st h, the 24th h, and the 3rd day.
Results: NPIS scores at the 24th h were significantly lower in Group 1 (p < 0.001). However, there were no significant differences in the NPIS scores following the 1st h and the 3rd day. No differences were found in the operation time (p > 0.05). According to the correlation analysis between the operation time and NPIS scores between the groups, in Group 1 the duration of surgery was significantly proportional to NPIS24. All patients were discharged from the hospital on the 4th postoperative day.
Conclusions: Active aspiration of the remaining gas just before the removal of the trocars is a simple procedure that reduces pain, leading to a more comfortable hospital stay.

Key words: laparoscopic surgery, sleeve gastrectomy, postoperative pain.

Introduction

Laparoscopic sleeve gastrectomy (LSG) has been one of the most common procedures worldwide in bariatric surgery since 2014 [1–3]. During laparoscopic surgery, it is imperative to create a pneumoperitoneum in order to view the abdomen and work comfortably [4]. The most commonly used gas in laparoscopy is carbon dioxide (CO_2) [5]. The reason for this is that CO_2 is not flammable, it is colourless, and it has low cost [6].

However, visceral pain and shoulder pain after laparoscopic surgery are mostly caused by CO_2 delivered to the abdominal cavity. Pneumoperitoneum forms as a result of CO_2 insufflation; increased intraabdominal pressure leads to diaphragmatic irritation, stretching of the peritoneum, stretching of the diaphragmatic muscle fibres, and as a result, abdominal and shoulder pain develop in the patient [7–9]. Moreover, high levels of abdominal distension are associated with high levels of postoperative pain during the recovery period, delaying recovery-room discharge [10].

In this study, we tried to examine the factors affecting postoperative pain and the benefit of active gas aspiration after laparoscopic sleeve gastrectomy.

Material and methods

After approval of the institutional ethical committee (Adana City Training and Research Hospital, decision number 921, 17/06/2020), informed consent was taken from each patient who took part in the study. All patients were informed according to their individual education levels in terms of anaesthesia, surgical method, complications, and postoperative process. The randomized clinical trial was conducted between November 2019 and January 2020, and it included 150 patients with a body mass index (BMI) of 40 to 60 kg/m², 18 years of age or older, and scheduled for laparoscopic sleeve gastrectomy. Exclusion criteria were an American Society of Anesthesiologists score of 3 or 4, a history of drug dependence/abuse, history of opioid intake or chronic pain disorder, coagulopathy, infections, previous abdominal surgery, and cases with surgical complications. All patients were given a liquid diet before the operation. In addition, the night before the operation, all patients were administered low-molecular-weight heparin (Enoxaparine, Sanofi, Paris, France) subcutaneously for deep venous thrombosis prophylaxis and were dressed with pneumatic compression stockings. All patients underwent upper GIS endoscopy under sedation, to evaluate anatomical anomalies and gastric mucosal pathologies before surgery. All surgeries were completed laparoscopically. Patients were randomly assigned using the envelope method to either the active gas reduction group (Group 1) or the control group (Group 2) just before the operation. The anaesthesia technique was standardized in all patients.

Anaesthesia protocol

The patients were premedicated according to their ideal weight with demizolam (0.5–0.1 mg/kg). Following pre-oxygenation, anaesthesia was induced with fentanil (1.5 µg/kg), propofol (3 mg/kg), and rocuronium (0.5–0.8 mg/kg), and orotracheal intubation was performed 2 min later. Ventilation was provided with 50% oxygen/air. 5 cm/H_2O positive end-expiratory pressure (PEEP) was opened in pressure control mode, ventilator parameters were adjusted so that end tidal CO_2 was 35–45 mm Hg. Anaesthesia was maintained with remifentanyl (0.1–0.5 µg/kg/min) and sevofluarane (1–1.5%) as an infusion. Reversal of neuromuscular blockade was achieved using sugammadex (2–8 mg/kg) followed by tracheal extubation.

Surgical technique

All LSG procedures were performed by the same surgeon; the operations were performed in the Lloyd Davies position, and a 38-F bougie was standard. The gastrectomy removed approximately 80% of the stomach, with a remnant stomach capacity of < 100 ml, and none of the cases required conversion to open surgery. All operations followed the same procedural guidelines. Briefly, the operation was started by placing 5 trocars traditionally. The gastrocolic omentum was divided, starting 4 cm proximal to the pylorus up to the angle of His. Dissection was performed up to the left crus of the hiatus, and all attachments were released to completely mobilize the fundus. The gastric pouch was created by using a linear stapler, with 2 sequential 4.8/60 mm green load firings for the antrum, followed by 3 sequential 4.8/60 mm purple cartridges for the remaining gastric corpus and fundus. The resected stomach was extracted through the 15 mm port-site [11]. After the bleeding control, a Jackson Pratt drain was placed in the lobby. The intra-abdominal gas pressure was set at a level of 17 mm Hg and monitored during the operation. After completion of the operative procedures and before the patients were placed in the supine position. CO_2 insufflation ended. In patients with active gas aspiration (Group 1), the liver, subdiaphragmatic areas on the spleen, lower pelvic area, and Douglas pouch were aspirated with direct camera vision before the valves of the trocars were opened and removed. Aspiration was performed with a flexible feeding cannula that was inserted through the most lateral Accessory port. Then, the valves of all trocars were opened and the trocars were removed. In the control group (Group 2), after the CO_2 insufflation was terminated, the trocars were removed after the gas was evacuated by opening the valves of the trocars. All patients were given a single use of antibiotic prophylaxis (ceftriaxone, 1000 mg) intravenously, and diclofenac sodium (75 mg) was administered to all patients postoperatively. Mobilization and respiratory physiotherapy were started 4 h after the operation. A liquid diet was started following flatus discharge from the anus in the postoperative period. The patients who tolerated oral intake and had no morbidity development were discharged from the hospital on the third postoperative day. The demographic data, body mass index, educational status, operation time, insufflated CO_2 volume during the operation, hospitalization period, and intraabdominal pressure were recorded. Postoperative shoulder and abdominal pain assessment was performed using an 11-point numerical pain intensity scale (NPIS), in which a rating of 0 indicated "no pain" and a rating of 10 indicated the "worst imaginable pain". Following surgery, pain assessments were measured by the patients' bed at the end of the 1^{st} h, the 24^{th} h, and the 3^{rd} day.

Statistical analysis

All statistical analyses in the study were done using SPSS 25.0 software (IBM SPSS, Chicago, IL, USA). Descriptive data are given as numbers and percentages. In terms of categorical variables, comparisons between groups were made using Pearson's χ^2 test and Fisher's exact test. Whether continuous variables were suitable for normal distribution was confirmed by the Kolmogorov-Smirnov test. The differences between the groups in terms of continuous variables were made with Student's *t*-test. The relationship between continuous variables was examined by correlation analysis. The results were evaluated within the 95% confidence interval, and $p < 0.05$ values were considered significant.

Results

A total of 150 patients who were treated for obesity in our clinic were included in the study. The patients with coagulopathy and bleeding (1), infections (1), previous abdominal surgery (1), a history of drug dependence/abuse (1), or a history of opioid intake or chronic pain disorder (1) were excluded from the study. Finally, 143 patients (33 men and 110 women) were included in the statistical analysis. The mean age was 35 years (range: 19–64 years). Group 1 included 69 patients, and Group 2 included 74 patients. Both groups had similar demographic characteristics (Table I). NPIS scores at the 24^{th} h were significantly lower in Group 1 ($p < 0.001$) (Table II). However, there were no significant differences in terms of the NPIS scores after the 1^{st} h and the 3^{rd} day. No differences were found in the operation time ($p > 0.05$) (Table I). When evaluated in terms of gender, education level, smoking, and BMI, there was no difference in terms of gender and BMI between Group 1 and Group 2 patients. The rate of smoking in Group 1 patients was lower than in Group 2 patients. The difference is statistically significant ($p < 0.001$) (Table III). The educational level was found to be lower in the passive group ($p = 0.023$). In Group 2 the pain score observed in the 1^{st} h was lower in patients with a body mass index greater than 40 ($p = 0.046$) (Table IV). In Group 1 no difference was found between pain scores according to body mass index (Tables IV, V). When Group 1 patients were evaluated in terms of smoking, educational level, and BMI

Table I. Comparison of the mean values of variables between groups

Parameter	Group 1 Active gas aspiration		Group 2 Control group		*P*-value
	Mean	SD	Mean	SD	
Age [year]	34.6	9.0	37.3	10.6	0.101
Height [cm]	165.8	8.9	166.8	9.7	0.512
Weight [kg]	111.6	15.5	116.5	19.7	0.101
BMI [kg/m²]	40.6	4.3	41.9	5.9	0.124
Surgery duration [min]	39.5	10.1	36.5	9.5	0.064
Carbon dioxide [l]	65.0	31.7	60.8	18.3	0.323
IOP	17.0	0.3	17.0	0.0	0.241

SD – standard deviation, BMI – body mass index, IOP – intraoperatif pressure. Student's t-test (independent samples t-test) was applied.

Table II. Comparison of the mean NPIS scores between groups.

Parameter	Group 1 Active gas aspiration		Group 2 Control group		*P*-value
	Mean	SD	Mean	SD	
NPIS1	3.1	0.9	3.3	0.9	0.233
NPIS24	0.5	0.8	1.6	0.7	< 0.001
NPIS3	0.01	0.12	0.05	0.28	0.282

SD – standard deviation, NPIS – numerical pain intensity scale. Student's t-test (independent samples t-test) was applied.

Table III. Comparison of gender, education, and smoking rates between active and control groups and between BMI groups

Parameter	Group 1 Active gas aspiration		Group 2 Control group		*P*-value
	n	%	*n*	%	
Gender:					0.119
Male	12	17.4	21	28.4	
Female	57	82.6	53	71.6	
Total	69	100	74	100	
Education level:					0.023
High school	41	59.4	57	77.0	
University	28	40.6	17	23.0	
Total	69	100	74	100	
Smoking:					< 0.001
No	65	94.2	30	40.5	
Yes	4	5.8	44	59.5	
Total	69	100	74	100	
BMI [kg/m^2]:					0,722
< 40	30	43.5	30	40.5	
≥ 40	39	56.5	44	59.5	
Total	69	100	74	100	

χ^2 test was used. BMI – body mass index.

Table IV. Comparison of the mean NPIS scores in the control group by education, smoking, and BMI group

Parameter	High school		University		*P*-value*
	Mean	SD	Mean	SD	
NPIS1	3.1	1.0	3.8	0.6	0.013
NPIS24	1.5	0.8	1.6	0.6	0.550
NPIS3	0.04	0.19	0.12	0.49	0.292
	Smokers		**Non-smokers**		***P*-value***
	Mean	**SD**	**Mean**	**SD**	
NPIS1	3.1	0.9	3.4	1.0	0.221
NPIS24	1.6	0.7	1.5	0.8	0.841
NPIS3	0.07	0.33	0.03	0.18	0.604
	BMI < 40 kg/m^2		**BMI ≥ 40 kg/m^2**		***P*-value***
	Mean	**SD**	**Mean**	**SD**	
NPIS1	3.5	0.8	3.1	1.0	0.046
NPIS24	1.6	0.7	1.5	0.8	0.655
NPIS3	0.07	0.4	0.05	0.2	0.753

**Student's t-test (Independent samples t-test) was used. NPIS – numerical pain intensity scale, SD – standard deviation.*

pain scores, there was no difference between the groups. We observed that age and operative time are independent factors associated with postoperative analgesic requirements. According to the correlation analysis of age and operation time in Group 1 (Table VI, VII) and Group 2, the duration of operation and the NPIS scores at the 24th h were found to be correlated in Group 1. There were no complications; hence, all patients were discharged from the hospital on the 4th postoperative day.

Discussion

Pain following a minimally invasive procedure is an important problem for the patient. Pain after minimally invasive surgery (MIS) affects quality of life and causes delayed discharge or late return to normal activities [12]. Pain after MIS can be divided into incisional pain, shoulder-type pain (STP), and/or upper abdominal pain. After laparoscopic surgery, upper abdominal pain and shoulder pain may be temporary or last for about 3 days [13].

Table V. Comparison of the mean NPIS scores within the active group by education, smoking, and BMI groups

Parameter	High school		University		*P*-value*
	Mean	SD	Mean	SD	
NPIS1	3.1	0.9	3.1	0.9	0.905
NPIS24	0.5	0.9	0.5	0.8	0.859
NPIS3	0.02	0.16	0	0	0.413
	Smokers		**Non-smokers**		***P*-value***
	Mean	**SD**	**Mean**	**SD**	
NPIS1	2.5	1.0	3.1	0.9	0.174
NPIS24	0	0	0.51	0.85	0.240
NPIS3	0	0	0.02	0.12	0.806
	BMI < 40 kg/m^2		**BMI ≥ 40 kg/m^2**		***P*-value***
	Mean	**SD**	**Mean**	**SD**	
NPIS1	2.9	0.8	3.2	0.9	0.125
NPIS24	0.4	0.7	0.6	0.9	0.333
NPIS3	0.03	0.18	0	0	0.257

**Student's t-test (Independent samples t-test) was used. NPIS – numerical pain intensity scale, SD – standard deviation, BMI – body mass index.*

Table VI. Correlation analysis between age and duration of surgery and NSIP scores within the active group

Parameter	Age		Duration of the operation	
	r	*P*-value**	*r*	*P*-value**
Duration of the operation	0.021	0.864		
NPIS1	–0.082	0.501	0.203	0.094
NPIS24	–0.013	0.916	0.241*	0.046
NPIS3	0.142	0.246	0.066	0.589

***Spearman's correlation analysis was used.*

Table VII. Correlation analysis between age and duration of surgery and NSIP scores within the control group

Parameter	Age		Duration of the operation	
	r	*P*-value**	*r*	*P*-value**
Duration of the operation	–0.146	0.215		
NPIS1	–0.247	0.034	–0.016	0.895
NPIS24	0.049	0.680	0.022	0.851
NPIS3	0.344	0.003	–0.178	0.128

**Student's t-test (Independent samples t-test) was used. **Spearman's correlation analysis was used. NPIS – numerical pain intensity scale.*

Abdominal trauma caused by the entry of trocars into the abdominal wall causes somatic pain, and intraabdominal interventions cause visceral origin pain. Other factors associated with pain are temperature and type of insufflated gas, intra-abdominal pH, presence of intraabdominal residual gas, abdominal distension, and irritation of the peritoneum [8, 14]. In addition, the conversion of CO_2 in the abdomen to carbonic acid on peritoneal surfaces causes pain [15–17]. In a study, 62% of patients had shoulder pain at the 12th h after laparoscopic surgery; this rate decreased to 9% on the 10th postoperative day, and the frequency of pain decreased as the gas pressure given for pneumoperitoneum decreased. It was found that the frequency of pain was significantly higher at the postoperative 12th, 24th, and 48th h for surgical operations longer than 45 min [18]. In our study, despite the 17 mm Hg gas pressure given, the mean operation time in both groups was 38 min. In a prospective randomized study on laparoscopic surgery and pain, it was observed that the pain scores peaked at 12–24 h postoperatively. It was reported that the pain was frequent and severe after the mobilization of the patient [19]. This has been linked to the fact that mobilization increases traction on the peritoneal reflections of the heavy viscera, which then lose suction support for their weight owing to the creation of peritoneal spaces by carbon dioxide [20]. In our study, the fact that the pain did not differ on the day of surgery (day 0) may have resulted in a similar perception of the severity of the pain because the effect of anaesthesia was not fully exceeded in both groups, and strong analgesia was used. On the other hand, it may have been more difficult to tolerate pain because the effect of anaesthesia on the first day after surgery, which is the day when the severity of pain is perceived, had passed. However, in Group 1, pain scores at the the 24th h were better than in the control group. Again, on the 3rd day, the decrease in the severity of post-operative pain may have caused the pain to be perceived at the same severity in both groups.

Although nicotine has an analgesic effect, the incidence and severity of chronic pain is higher in smokers than in non-smokers. In smokers, acute pain is more intense in the postoperative period [21]. It has been observed that smoking increases the perception of pain and that more postoperative opioid use is needed regardless of the amount of smoking. Weingarten *et al.* reported that although current tobacco smokers used more opioid analgesics in the first 48 h after surgery than non-smokers, tobacco use alone was not associated with the need for postoperative opioid after age and gender adjustment [22]. In our study, when the groups were evaluated within themselves, the effect of smoking on postoperative pain was not observed alone (Tables IV, V).

We observed that age and operative time were independent factors associated with postoperative analgesic requirements. Another independent factor associated with the postoperative analgesic requirement was the amount of intraoperative remifentanil. The findings of the study showed that prolonged surgery might cause increased use of remifentanil and that this might cause opioid tolerance or opioid-induced hyperalgesia [23, 24]. According to our findings the pain level and duration of surgery were associated with active gas aspiration patients (Table VI).

In the literature, the effect of BMI on postoperative pain is controversial. High body mass index is associated with postoperative complications and postoperative pain [25]. However, high BMI levels did not appear to be associated with increased postoperative pain in patients undergoing laparoscopic gastric bypass [26]. In our study, no effect of BMI on pain scores was observed in the actively aspirated group. In the control group, it was adversely effective, inconsistent with the literature on pain at the 1st h. We attribute this to the strong analgesia given immediately after surgery.

The results of studies evaluating the relationship between educational status and postoperative pain are different. Just as there are studies that say it has no correlation [27, 28], there are also those stating that a lower education level is associated with a higher incidence of painful conditions [29]. In our study, conversely, in the control group, more pain was found in the trained patients at the 1st h.

In the literature, there are studies indicating that active aspiration decreases the residual CO_2 volume and decreases the frequency of pain and shoulder pain in the postoperative period after abdominal operations with minimally invasive surgery [30, 31]. In our study, pain scores at the 24th h were significantly lower in the group with active gas discharge than in the control group. Nursal *et al.* [32] studied the effects of a subdiaphragmatic gas drain, which is expected to decrease the residual gas volume on postoperative pain, nausea, and vomiting after laparoscopic cholecystectomy (LC) in a prospective randomized study; they observed that the subdiaphragmatic drain effectively reduced the incidence and amount of subdiaphragmatic gas bubbles. However, they stated that the subdiaphragmatic drain used in gas discharge only provided minor benefits for postoperative pain, nausea, and vomiting after laparoscopic cholecystectomy, and this effect was probably clinically insignificant [32]. In our study, although drains were used in both groups, we observed that there was no benefit regarding pain in the postoperative period. In fact, in some of our patients, the drain itself was a source of pain.

Many studies have been conducted to decrease the level of pain after laparoscopic sleeve gastrectomy. In recent years, different methods such as transversus abdominis plane block have been tried to reduce pain after sleeve gastrectomy [33, 34]. Transversus abdominis block (TAB) is a relatively new regional anaesthetic technique in which the cutaneous branches of the L1-3 nerve roots, the T7-12 intercostal nerves, and the ilioinguinal and iliohypogastric nerves are blocked between the internal oblique and tranvsersus abdominis muscles [35]. The procedure is usually done by experienced anaesthesiologists using 18–22-gauge needles. Despite its successful results, the amount of local anaesthesia to be applied in obese patients is still controversial [36, 37]. In all these studies, attempts to control patients' pain involved invasive techniques and medical methods. Each working group argues that their methods are successful in reducing the level of postoperative pain. However, the advantage of our method over all these methods is that it is a simple and fast method to apply during surgery.

In conclusion, although the volume aspirated in our study was not calculated and some of our results differed from the literature, we found that the pain at the postoperative 24th h was significantly lower in the aspirated patient group. The active aspiration technique reduced the volume of residual CO_2 in the intraperitoneal cavity at the end of laparoscopic sleeve gastrectomy. This technique was effective in decreasing the level of abdominal distension and pain experienced post-operatively. Active aspiration of the remaining gas just before the removal of the trocars is a simple procedure, and we recommend it because it reduces pain and contributes to a more comfortable hospital stay.

Conflict of interest

The authors declare no conflict of interest.

References

1. Lazzati A, Guy-Lachuer R, Delaunay V, Szwarcensztein K, Azoulay D. Bariatric surgery trends in France: 2005-2011. Surg Obes Relat Dis 2014; 10: 328-34.
2. Reames BN, Finks JF, Bacal D, Carlin AM, Dimick JB. Changes in bariatric surgery procedure use in Michigan, 2006-2013. JAMA 2014; 312: 959-61.
3. Angrisani L, Santonicola A, Iovino P, et al. Bariatric surgery and endoluminal procedures: IFSO worldwide survey 2014. Obes Surg 2017; 27: 2279-89.
4. Kalaycı G, Çakıl D, Ekici F. Laparoskopik cerrahi ve kardiyorespiratuar fonksiyonlara Etkileri. AİBÜ İzzet Baysal Tıp Fakültesi Dergisi 2011; 6: 1-7.
5. Clayman RV, Kavoussi LR, Soper NJ, et al. Laparoscopic nephrectomy: initial case report. J Urol 1991; 146: 278-82.
6. Grabowski JE, Talamini MA. Physiological effects of pneumoperitoneum. J Gastrointest Surg 2009; 13: 1009-16.
7. Aktan B, Akbayrak T. Physiotherapy and rehabilitation in shoulder pain after gynecological laparoscopic surgery: a case report. Konuralp Tıp Dergisi 2020; 12: 334-7.
8. Memedov C, Menteş Ö, Şimşek A, et al. Laparoskopik kolesistektomi sonrası postoperatif ağrının önlenmesinde çoklu bölgeye lokal anestezik infiltrasyonu: ropivakain ve prilokainin plasebo kontrollü karşılaştırılması. GülhaneTıp Dergisi 2008; 50: 84-90.
9. Radosa JC, Radosa MP, Mavrova R, et al. Five minutes of extended assisted ventilation with an open umbilical trocar valve significantly reduces postoperative abdominal and shoulder pain in patients undergoing laparoscopic hysterectomy. Eur J Obstet Gynecol Reprod Biol 2013; 171: 122-27.
10. Tuvayanon W, Toskulkao T, Asdornwised U. Factors impacting readiness to discharge time from recovery room after laparoscopic cholecystectomy. Thai Surg 2011; 32: 53-9.
11. Mazahreh TS, Alfaqih M, Saadeh R, et al. The effects of laparoscopic sleeve gastrectomy on the parameters of leptin resistance in obesity. Biomolecules 2019; 9: 533.
12. Jackson SA, Laurence AS, Hill JC. Does post-laparoscopy pain relate to residual carbon dioxide? Anaesthesia 1996; 51: 485-7.
13. Dixon JB, Reuben Y, Halket C, O'Brien PE. Shoulder pain is a common problem following laparoscopic adjustable gastric band surgery. Obes Surg 2005; 15: 1111-7.
14. Slim K, Bousquet J, Kwiatkowski F, Lescure G, Pezet D, Chipponi J. Effect of CO(2) gas warming on pain after laparoscopic surgery: a randomized double-blind controlled trial. Surg Endosc 1999; 13: 1110-4.
15. Jackson SA, Laurence AS, Hill JC. Does post-laparoscopy pain relate to residual carbon dioxide? Anaesthesia 1996; 51: 485-7.
16. Corsale I, Fantini C, Gentili C, Sapere P, Garruto O, Conte R. Peritoneal innervation and post-laparoscopic course. Role of CO2. Minerva Chir 2000; 55: 205-10.
17. Sammour T, Kahokehr A, Hayes J, Hulme-Moir M, Hill AG. Warming and humidification of insufflation carbon dioxide in laparoscopic colonic surgery: a double-blinded randomized controlled trial. Ann Surg 2010; 251: 1024-33.
18. Kandil TS, El Hefnawy E. Shoulder pain following laparoscopic cholecystectomy: factors affecting the incidence and severity. J Laparoendosc Adv Surg Tech A 2010; 20: 677-82.
19. Hsiao-Wen T, Yi-Jen C, Chiu-Ming H, et al. Maneuvers to decrease laparoscopy-induced shoulder and upper abdominal pain: a randomized controlled study. Arch Surg 2011; 146: 1360-6.
20. Alexander JI, Hull MG. Abdominal pain after laparoscopy: the value of a gas drain. Br J Obstet Gynaecol 1987; 94: 267-9.
21. Hwan KD, Young PJ, Myong-Hwan K, et al. Smoking may increase postoperative opioid consumption in patients who underwent distal gastrectomy with gastroduodenostomy for early stomach cancer: a retrospective analysis. Clin J Pain 2017; 33: 905-11.
22. Weingarten TN, Erie EA, Shi Y, Schroeder DR, Abel M, Warner DO. Influence of tobacco use on postoperative opiate analgesia requirements in patients undergoing coronary artery bypass graft surgery. Signa Vitae 2011; 6: 72-7.
23. Tirault M, Derrode N, Clevenot D, Rolland D, Fletcher D, Debaene B. The effect of nefopam on morphine overconsumption induced by large-dose remifentanil during propofol anesthesia for major abdominal surgery. Anesth Analg 2006; 102: 110-7.
24. Delvaux B, Ryckwaert Y, Van Boven M, De Kock M, Capdevila X. Remifentanil in the intensive care unit: tolerance and acute withdrawal syndrome after prolonged sedation. Anesthesiology 2005; 102: 1281-2.
25. Gupta PK, Franck C, Miller WJ, Gupta H, Forse RA. Development and validation of a bariatric surgery morbidity risk calculator using the prospective, multicenter NSQIP dataset. J Am Coll Surg 2011; 212: 301-9.
26. Hartwig M, Allvin R, Bäckström R, Stenberg E. factors associated with increased experience of postoperative pain after laparoscopic gastric bypass surgery. Obes Surg 2017; 27: 1854-8.
27. Chia YY, Chow LH, Hung CC, Liu K, Ger LP, Wang PN. Gender and pain upon movement are associated with the requirements for postoperative patient-controlled iv analgesia: a prospective survey of 2,298 Chinese patients. Can J Anaesth 2002; 49: 249-55.
28. Lau H, Patil NG. Acute pain after endoscopic totally extraperitoneal (TEP) inguinal hernioplasty: multivariate analysis of predictive factors. Surg Endosc 2004; 18: 92-6.
29. Leclerc A, Gourmelen J, Chastang JF, Plouvier S, Niedhammer I, Lanoë JL. Level of education and back pain in France: the role of demographic, lifestyle and physical work factors. Int Arch Occup Environ Health 2009; 82: 643-52.
30. Atak I, Ozbagriacik M, Akinci OF, et al. Active gas aspiration to reduce pain after laparoscopic cholecystectomy. Surg Laparosc Endosc Percutan Tech 2011; 21: 98-100.
31. Das K, Karateke F, Menekse E, et al. Minimizing shoulder pain following laparoscopic cholecystectomy: a pro-

spective, randomized, controlled trial. J Laparoendosc Adv Surg Tech A 2013; 23: 179-82.
32. Nursal TZ, Yildirim S, Tarim A, et al. Effect of drainage on postoperative nausea, vomiting, and pain after laparoscopic cholecystectomy. Langenbecks Arch Surg 2003; 388: 95-100.
33. Arı DE, Ar AY, Karip CS, et al. Ultrasound-guided subcostal-posterior transversus abdominis plane block for pain control following laparoscopic sleeve gastrectomy. Saudi Med J 2017; 38: 1224-9.
34. Saber AA, Lee YC, Chandrasekaran A, et al. Efficacy of transversus abdominis plane (TAP) block in pain management after laparoscopic sleeve gastrectomy (LSG): a double-blind randomized controlled trial. Am J Surg 2019; 217: 126-32.
35. Ekmekçi P, Kazak Bengisun Z, Kazbek BK, Han S, Tüzüner F. Ultrasound guided TAP block for the treatment of postoperative prolonged pain – an alternative approach. Agri 2012; 24: 191-3.
36. Gravante G, Castrì F, Araco F, Araco A. A comparative study of the transversus abdominis plane (TAP) block efficacy on post-bariatric vs aesthetic abdominoplasty with flank liposuction. Obes Surg 2011; 21: 278-82.
37. Alabassi A. Ultrasound-guided subcostal-posterior transversus abdominis plane block for pain control following laparoscopic sleeve gastrectomy. Saudi Med J 2018; 39: 532-3.