ASTR

ORIGINAL ARTICLE

pISSN 2288-6575 • eISSN 2288-6796
https://doi.org/10.4174/astr.2017.92.4.208
Annals of Surgical Treatment and Research

Combined spinal-epidural anesthesia in laparoscopic appendectomy: a prospective feasibility study

Sinan Uzman, Turgut Donmez[1], Vuslat Muslu Erdem[2], Adnan Hut[3], Dogan Yildirim[3], Muzaffer Akinci[3]

Department of Anesthesiology and Reanimation, Haseki Training and Research Hospital, Istanbul, [1]Department of General Surgery, Lutfiye Nuri Burat State Hospital, Istanbul, [2]Department of Anesthesiology and Reanimation, Lütfiye Nuri Burat State Hospital, Istanbul, [3]Department of General Surgery, Haseki Training and Research Hospital, Istanbul, Turkey

Purpose: Laparoscopic appendectomy (LA) is routinely performed under general, not regional anesthesia. This study assessed the feasibility, efficacy, and side effects of combined spinal-epidural anesthesia (CSEA) in LA.
Methods: Thirty-three American Society of Anesthesiologist (ASA) physical status classification grade I patients underwent LA under CSEA. CSEA was performed using the needle-through-needle technique at the L_3–L_4 interspace. Preoperative and postoperative adverse events related to CSEA, patient satisfaction, and postoperative pain levels were recorded.
Results: LA under CSEA was performed successfully in 33 patients (84.6%). Peroperatively, right shoulder pain was observed in 8 patients (24.1%), abdominal discomfort in 6 (18.2%), anxiety in 5 (15.2%), hypotension in 2 (6.1%) and nausea-vomiting in 1 (3%). In the first 24 hours after LA, headache, urinary retention, right shoulder pain, and postoperative nausea/vomiting (PONV) occurred in 18.1%, 12.1%, 9.1%, and 0% of patients, respectively. In the first 6 hours postoperation, no patients had operation-site pain that required analgesic treatment. Thirty-one patients (94%) evaluated their satisfaction with the procedure as good or moderate.
Conclusion: CSEA is an efficient and suitable anesthesia technique in LA for ASA physical status classification grade I healthy patients. CSEA is associated with good postoperative pain control and the absence of PONV and intubation-associated complications.
[Ann Surg Treat Res 2017;92(4):208-213]

Key Words: Laparoscopy, Spinal anesthesia, Epidural anesthesia, Appendicitis

INTRODUCTION

Acute appendicitis is one of the most common abdominal emergencies and therefore appendectomy is one of the most common operations [1,2]. With the recent progress in laparoscopic surgical techniques, today most appendectomies are performed laparoscopically [3]. Laparoscopic appendectomy (LA) has advantages over open appendectomy, like less postoperative pain, fewer surgical site infections, shorter hospital stays, shorter recovery periods for daily life activities, better cosmetic results, and fewer complications [4-6].

Traditionally, LA is performed under general anesthesia with endotracheal intubation to prevent carbon dioxide pneumoperitoneum-induced aspiration, abdominal and pulmonary discomfort, and hypercarbia [7-9]. Although many studies show the success of regional anesthesia in laparoscopic cholecystectomy and inguinal hernia repair operations, only a handful of studies examined the use of regional anesthesia in LA [7-12].

In this study, we evaluated the convenience and efficacy of LA under combined spinal-epidural anesthesia (CSEA) in a case series of 33 LAs performed under CSEA.

Received September 22, 2016, **Revised** November 16, 2016, **Accepted** November 23, 2016

Corresponding Author: Sinan Uzman
Department of Anesthesiology and Reanimation, Haseki Traininng and Research Hospital, Fatih, Istanbul, Turkey
Tel: +90-5055645271, **Fax:** +90-2125896229
E-mail: drsinanuzman@yahoo.com

METHODS

Study design and patient selection

This is a prospective feasibility study on use of CSEA in LA. It was carried out according to the Declaration of Helsinki with the approval of the Hospital Ethics Committee (Date/number: 22 July 2015/235) and the oral and written consent of patients. Thirty-three consecutive patients with American Society of Anesthesiologist (ASA) physical status classification grade I that underwent LA between August 2015 and October 2015 were included in the study (Fig. 1). The exclusion criteria were as follows: any cause of contraindication for spinal anesthesia or pneumoperitoneum, lack of cooperation, psychiatric disease, bleeding disorders, known sensibility to local or narcotic analgesics, being younger than 18 or older than 65 years of age, a history of abdominal surgery, or pregnancy.

Preoperative evaluation

The same surgical and anesthesiology team performed the LAs for all cases. Patients were informed, by the anesthesiologist, before the operation that they may experience anxiety, shoulder pain, or abdominal discomfort. Patients were also informed that, in cases of insufficient intravenous (IV) midazolam or analgesic treatment or if the patient wanted to, they could convert to general anesthesia.

Anesthesia procedure

Premedication was not used on patients. IV lines were placed and 10 mL/kg of Ringer's Lactate solution were administered for volume loading 20 minutes before regional anesthesia. CSEA was administered via the needle-through-needle technique from the L_3–L_4 interspace at a sitting position. One percent lidocaine was administrated intradermally for local anesthesia. Using the loss of resistance to saline technique, an 18-G Tuohy needle was inserted into the epidural space at midline approach, and then a 26-G pencil point spinal needle was inserted through the Tuohy needle into the subarachnoid space. After the flow of cerebrospinal fluid was confirmed, 3 mL of 0.5% hyperbaric bupivacaine and 10-μg fentanyl were injected in 30 seconds. Lastly, the spinal needle was removed and a 20-G epidural catheter was placed into the epidural space in the cephalic direction and fixed at 4 cm. Twenty milliliters of a mixture of 10 mL 0.5% bupivacaine, 5 mL 2% lidocaine, 1-mL fentanyl, and 4-mL isotonic saline were injected into the epidural space. Patients were positioned at a 15° Trendelenburg position and the sensorial block level was checked with a pinprick test every minute. The surgical procedure began when the block reached the T4 level. In cases of insufficient anesthesia and when the patient wished for it, CSEA was converted to general anesthesia.

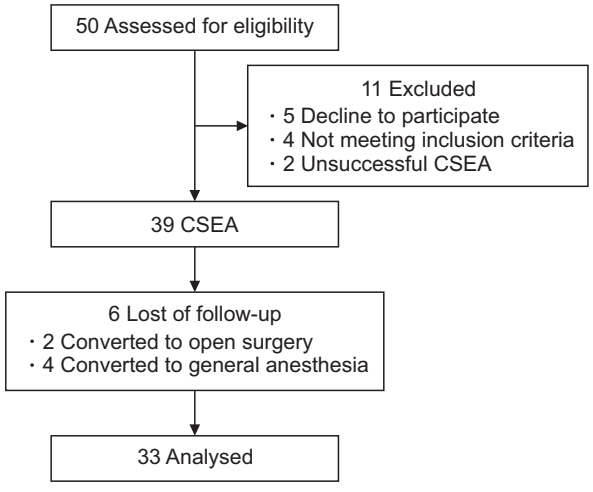

Fig. 1. Flowchart of the study. CSEA, combined spinal/epidural anesthesia.

Surgical procedure

Surgery was initiated when the sensorial block reached the T4 level. The patients were in the supine position. The midline incision was made under the umbilicus, a veress needle was inserted, and the abdomen was insufflated until it reached 10 mmHg. A 10-mm trocar was inserted from under the umbilicus for the 0 degree camera. Two other trocars, a 10 mm from McBurney and a 5 mm from the lower-left quadrant were inserted. The mesoappendix was cauterized by an Endo Hook and dissected. The stump of the appendix was closed using the laparoscopic intracorporeal knot technique, an endoclip was placed above the knot, and the appendectomy was performed between them. The appendix was removed from the abdomen using an endobag.

Monitorization and data collection

In all cases, electrocardiographic findings, noninvasive arterial blood pressure (NIBP), heart rate (HR), and peripheral oxygen saturation (S_pO_2) were recorded from the preoperative room until the general surgery clinic. NIBP, HR, and S_pO_2 were documented: before volume loading, every minute for 15 minutes after CSEA, every 5 minutes until the patient was back at the clinic, and every 30 minutes until the 24th hour. Demographic profiles, surgery time (interval between the first incision and the last suture), and total time (interval between the first spinal needle insertion and the last suture) were recorded. Cases of hypotension (>30% decrease in baseline mean arterial pressure or systolic arterial pressure <90 mmHg), bradycardia (HR < 50 beats/min), hypoxemia (S_pO_2 < 90%), headache, nausea/vomiting, right shoulder pain, anxiety, and abdominal pain were recorded.

Postoperative surgical site pain was assessed by a visual analogue scale (VAS; 0, no pain; 10, severe pain) and recorded at 1, 6, 12, and 24 hours after the operation (VAS1, VAS6,

VAS12, and VAS24, accordingly). Postoperative hypotension, bradycardia, hypoxemia, headache, nausea/vomiting, right shoulder pain, abdominal pain and/or discomfort, and urinary retention were recorded as adverse events. Patients were asked to evaluate their satisfaction of the procedure as good, moderate, or bad 1 day after the operation. An independent anesthesiologist collected all preoperative and postoperative data without informing the anesthesiology and surgery team about the purpose of the study.

Treatment of adverse events

Patients with hypotension were treated with 250 mL of isotonic saline infused in a 5-min period. Five milligrams of IV ephedrine were administered when hydration was insufficient and systolic blood pressure was ≤90 mmHg. Bradycardia was treated with IV administration of 0.5 mg of atropine. Shoulder pain or abdominal pain/discomfort was treated with 1- to 2-μg/kg fentanyl and anxiety was treated with 0.03-mg/kg midazolam. One liter of Ringer's Lactate and 1 L of isotonic saline were used in 24 hours for postoperative fluid replacement. An additional 1 L of saline and 50 mg of tramadol in 100-mL isotonic saline were administered in 30 minutes in cases of postspinal puncture headache (PSPH). Fifty milligrams of tramadol (in 100-mL isotonic saline) were also administered postoperatively to patients with VAS scores ≥4.

RESULTS

Fifty patients diagnosed with appendicitis with medical history, clinical findings, and abdominal ultrasound examinations were included in the study. Five patients who did not want to participate, 4 who did not fulfill the criteria, and 2 with unsuccessful CSEA were excluded from the study. CSEA technique was successfully administered at the first attempt on 39 patients. In the 2 cases that were converted to open surgery, 1 patient had abdominal fluid and adhesions and the other had perforated appendicitis. The procedure was converted to general anesthesia in 1 patient who asked for general anesthesia right before the operation, in 2 patients whose muscle relaxation was not sufficient, and 1 patient who had an anxiety attack. In 33 patients that underwent LA, LA was successfully completed with CSEA (Fig. 1). Intraabdominal carbon dioxide pressure was maintained at 10 mmHg throughout the operation.

Demographic characteristics of the patients, maximal sensorial block height, surgery time, total time, and hospital stay were summarized in Table 1. Intraoperative adverse events are shown in Table 2. The most common intraoperative adverse events were shoulder pain (24.2%) and abdominal discomfort (18.2%). We observed headache (18.1%), shoulder pain (9.1%) and urinary retention (12.1%) due to regional anesthesia in postoperative 48 hours (Table 3).

Intravenous fentanyl was administered during the operation because of abdominal pain/discomfort or shoulder pain in 11 cases. In 5 patients who experienced abdominal pain/discomfort or shoulder pain together with anxiety, fentanyl and midazolam were administered together. Fentanyl and/or midazolam treatment was not necessary in 22 patients (66.7%). One patient experienced nausea before pneumoperitoneum that regressed after administration of 8 mg IV ondansetron. None of the patients had bradycardia or respiratory depression.

Postoperative pain scores are shown in Table 4. In the first 6 hours after surgery, none of the patients required analgesic treatment. At the 6th hour, the VAS scores of all patients were between 4 and 6 and 50 mg of IV tramadol were administered, after which no further analgesic treatment was required.

Twenty-two patients evaluated their satisfaction of the procedure as good, 9 patients as moderate, and 2 patients as bad.

Table 1. Characteristics of the patients and procedure-related times (n = 33)

Characteristic	Value
Age (yr)	28.2 ± 9.8
Sex, male:female	27:6
Weight (kg)	70.7 ± 12.7
Height (cm)	172.2 ± 8.6
Body mass index (kg/m^2)	23.83 ± 3.79
MSB, T_2:T_3:T_4	3: 23:7
Surgery time (min)	26.1 ± 7.0
Total time (min)	53.2 ± 6.5
Hospital stay (day)	1 (1–3)

Values are presented as mean ± standard deviation, number of patients, or median (range).
MSB, maximal sensorial block height (dermatomal level).

Table 2. Intraoperative adverse events (n = 33)

Adverse event	No. (%)
Abdominal discomfort	6 (18.2)
Anxiety	5 (15.2)
Shoulder pain	8 (24.2)
Nausea/vomiting	1 (3.0)
Hypotension	2 (6.1)
Bradycardia	0 (0)
Respiratory discomfort/depression	0 (0)

Table 3. Postoperative adverse events (n = 33)

Adverse event	No. (%)
Headache	6 (18.2)
Shoulder pain	3 (9.1)
Urinary retention	4 (12.1)
Nausea/vomiting	0 (0)

Table 4. Postoperative pain evaluation

Measurement time	Median (range)
VAS 1 hr	0 (0–0)
VAS 6 hr	4 (4–5)
VAS 12 hr	2 (1–2)
VAS 24 hr	0 (0–1)

VAS, visual analogue scale.

DISCUSSION

General anesthesia is the routine anesthesia technique for LA. In this prospective feasibility study conducted with 33 patients, CSEA was an efficient and suitable anesthesia technique for LA. Although the optimum sensorial block level hasn't yet been determined, T4–T6 is sufficient for LA [11,12]. In this study, we found that the T2–T4 sensory block level reached with CSEA (without adverse effects caused by neuraxial anesthesia) is sufficient for the operation.

The most important finding of the study is that the subarachnoid and epidural local anesthetic and analgesic effects of CSEA continue after the operation, resulting in a long painless period at the site of surgery. Patients did not require any analgesic treatment for 6 hours after the surgery and a 50-mg tramadol infusion was sufficient for pain control after the 6th hour.

Right shoulder pain was one of the adverse events that occurred intraoperatively during LA under CSEA. Shoulder pain during laparoscopic surgery is caused by diaphragmatic irritation due to the carbon dioxide-generated pneumoperitoneum. Trendelenburg positioning may also contribute to the shoulder pain due to the positioning of intraabdominal fluid closer to the diaphragm [12].

There are 2 studies on the incidence of shoulder pain in LA under spinal anesthesia that showed 25% and 30.8% of patients with shoulder pain, respectively, and the pain regressed with IV fentanyl treatment [11,12]. In our study, we encountered shoulder pain that regressed with fentanyl treatment in 24.2% of the patients. None of the patients experienced shoulder pain that required conversion to general anesthesia. Three patients had shoulder pain that did not require analgesic treatment in first few postoperative hours. The fact that all these patients had shoulder pain in the preoperative period supported the idea that this pain may be caused by residual carbon dioxide in the abdomen, causing diaphragmatic irritation.

Abdominal discomfort and anxiety were the other adverse events after pneumoperitoneum. Abdominal discomfort was observed in 12.5%–23.1% of patients that underwent LA under spinal anesthesia [11,12]. Six patients (18.2%) had abdominal discomfort and 5 patients (15.2%) had anxiety. Four of the 5 patients who had anxiety also experienced concomitant abdominal discomfort, and this association raises the idea that abdominal distress in patients undergoing LA under spinal anesthesia may cause anxiety; 0.03-mg/kg midazolam and 1- to 2-mg fentanyl effectively relieved these patients.

Hypotension is the most common and important complication of spinal anesthesia. Hypotension is caused by blockage of sympathetic efferent fibers, leading to decreased systemic vascular resistance and venous return to the heart [13]. The hypotension incidence in LA under regional anesthesia was determined by Mane et al. [12] and Jun et al. [11] as 11.5% and 12.5%, respectively; we observed fewer cardiovascular symptoms in our study. After CSEA, only 2 patients experienced hypotension, which was treated by fluid administration and did not require additional ephedrine treatment. None of the patients experienced bradycardia. The sensorial block level is an independent risk factor for hypotension [14]. Even though the sensorial block reached the T2–T4 levels, the low incidence of hypotension in this study can be explained by the effects of prehydration and pneumoperitoneum. Volume preloading with 10ml/kg of Ringer's Lactate 15 minutes before CSEA and a 6-mL/kg/hr infusion during the surgery prevented hypotension in patients. Elevated intraabdominal pressure during pneumoperitoneum increases sympathetic tonus by activating the renin-angiotensin-aldosterone system [15]. Moreover, increasing intraabdominal pressure (but below 10 mmHg) increases the systemic venous return by reducing splanchnic blood volume in patients having sufficient intravascular volume loading. Thus cardiac output and arterial pressure are increased [15-18]. These effects of pneumoperitoneum, together with intravascular volume pre-loading, caused the low incidence of hypotension.

Headache and urinary retention were adverse events that occurred postoperatively after spinal anesthesia (Table 3). Postoperative spinal anesthesia-induced headache is reported in 0%–5.49% of patients after laparoscopic surgery and may cause longer hospital stays [8,9,19,20]. Our study had a higher incidence of headache. The main reason for this difference is that in other cases postoperative nonsteroid anti-inflammatory medication was administered immediately, whereas in our study, postoperative analgesics were used a minimum of 6 hours after the operation. Two other independent risk factors, lower body mass index (BMI) and younger age, also contributed to this difference [21]. Postoperative headache was treated with an additional 1 L of isotonic saline and a 50-mg tramadol infusion in the study. Postoperative urinary retention is reported as 0.41%–6.1% [8,9,21]. In this study, 4 patients (12.1%) developed urinary retention and were treated with urinary catheterization. Catheters were removed in 3 hours and none of the patients had complications due to catheterization.

Half of the LA patients who undergo general anesthesia have postoperative nausea and vomiting (PONV) [22,23]. In contrast, 0%–12.5% PONV is reported in LA cases under

regional anesthesia [11,12]. In this study, none of the patients experienced PONV, which supports the findings of previous studies.

The anesthesiologist's goals in LA under CSEA should be: ensuring adequate sensory block level for surgery, elimination of preoperative shoulder pain, eliminating abdominal pain/discomfort and anxiety, treatment of postoperative pain, and treating other adverse events. The low rate of side effects that were easily treated with sedatives and analgesics led to the high patient rate of satisfaction with the operation.

This study included a limited number of perforated appendicitis. Moreover BMI of the patients were within normal limits. Regional anesthesia was converted to general anesthesia in 2 patients who had perforated appendicitis due to insufficient abdominal wall relaxation and these patients were excluded from the study. Deep neuromuscular block reduces intra-abdominal pressure requirements during laparoscopic surgery [24]. In the present study 10 mmHg of pneumoperitoneum pressure was used. Higher intra-abdominal pressure may be needed in patients with perforated appendicitis and obesity. However CSEA anesthesia may not provide adequate muscle relaxation or adverse effects due to higher intra-abdominal pressure may not be tolerated in awake patients under CSEA. In conclusion, we have shown that LA can be carried out under CSEA without any significant side effects. Providing a long-term postoperative painless period, preventing PONV, and protecting patients from complications related to intubation are the advantages of CSEA, relative to general anesthesia. Preoperative and postoperative side effects due to pneumoperitoneum can be easily treated and should be dealt with carefully. In patients who have contraindications or high risk factors for general anesthesia, CSEA may be a suitable choice.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Buckius MT, McGrath B, Monk J, Grim R, Bell T, Ahuja V. Changing epidemiology of acute appendicitis in the United States: study period 1993-2008. J Surg Res 2012;175:185-90.
2. Lee JH, Park YS, Choi JS. The epidemiology of appendicitis and appendectomy in South Korea: national registry data. J Epidemiol 2010;20:97-105.
3. Masoomi H, Mills S, Dolich MO, Ketana N, Carmichael JC, Nguyen NT, et al. Comparison of outcomes of laparoscopic versus open appendectomy in adults: data from the Nationwide Inpatient Sample (NIS), 2006-2008. J Gastrointest Surg 2011;15:2226-31.
4. Guller U, Hervey S, Purves H, Muhlbaier LH, Peterson ED, Eubanks S, et al. Laparoscopic versus open appendectomy: outcomes comparison based on a large administrative database. Ann Surg 2004;239:43-52.
5. Minutolo V, Licciardello A, Di Stefano B, Arena M, Arena G, Antonacci V. Outcomes and cost analysis of laparoscopic versus open appendectomy for treatment of acute appendicitis: 4-years experience in a district hospital. BMC Surg 2014;14:14.
6. Jaschinski T, Mosch C, Eikermann M, Neugebauer EA. Laparoscopic versus open appendectomy in patients with suspected appendicitis: a systematic review of meta-analyses of randomised controlled trials. BMC Gastroenterol 2015;15:48.
7. Wittgen CM, Andrus CH, Fitzgerald SD, Baudendistel LJ, Dahms TE, Kaminski DL. Analysis of the hemodynamic and ventilatory effects of laparoscopic cholecystectomy. Arch Surg 1991;126:997-1000.
8. Tzovaras G, Fafoulakis F, Pratsas K, Georgopoulou S, Stamatiou G, Hatzitheofilou C. Spinal vs general anesthesia for laparoscopic cholecystectomy: interim analysis of a controlled randomized trial. Arch Surg 2008;143:497-501.
9. Tiwari S, Chauhan A, Chaterjee P, Alam MT. Laparoscopic cholecystectomy under spinal anaesthesia: a prospective, randomised study. J Minim Access Surg 2013;9:65-71.
10. Lal P, Philips P, Saxena KN, Kajla RK, Chander J, Ramteke VK. Laparoscopic total extraperitoneal (TEP) inguinal hernia repair under epidural anesthesia: a detailed evaluation. Surg Endosc 2007;21:595-601.
11. Jun GW, Kim MS, Yang HJ, Sung TY, Park DH, Cho CK, et al. Laparoscopic appendectomy under spinal anesthesia with dexmedetomidine infusion. Korean J Anesthesiol 2014;67:246-51.
12. Mane RS, Patil MC, Kedareshvara KS, Sanikop CS. Combined spinal epidural anesthesia for laparoscopic appendectomy in adults: a case series. Saudi J Anaesth 2012;6:27-30.
13. Brull R, Macfarlane AJ, Chan WV. Spinal, epidural and caudal anesthesia. In: Miller RD, Cohen NH, Eriksson LI, Fleisher LA, Wiener-Kronish JP, Young WL., editors. Miller's Anesthesia. 8th ed. Philadelphia (PA): Elsevier Saunders; 2015. p. 1684-21.
14. Hartmann B, Junger A, Klasen J, Benson M, Jost A, Banzhaf A, et al. The incidence and risk factors for hypotension after

spinal anesthesia induction: an analysis with automated data collection. Anesth Analg 2002;94:1521-9.
15. Gutt CN, Oniu T, Mehrabi A, Schemmer P, Kashfi A, Kraus T, et al. Circulatory and respiratory complications of carbon dioxide insufflation. Dig Surg 2004;21:95-105.
16. Dexter SP, Vucevic M, Gibson J, McMahon MJ. Hemodynamic consequences of high- and low-pressure capnoperitoneum during laparoscopic cholecystectomy. Surg Endosc 1999;13:376-81.
17. Cunningham AJ. Anesthetic implications of laparoscopic surgery. Yale J Biol Med 1998;71:551-78.
18. Kazama T, Ikeda K, Kato T, Kikura M. Carbon dioxide output in laparoscopic cholecystectomy. Br J Anaesth 1996;76:530-5.
19. Imbelloni LE. Spinal anesthesia for laparoscopic cholecystectomy: Thoracic vs. Lumbar Technique. Saudi J Anaesth 2014;8:477-83.
20. Sinha R, Gurwara AK, Gupta SC. Laparoscopic surgery using spinal anesthesia. JSLS 2008;12:133-8.
21. Jabbari A, Alijanpour E, Mir M, Bani Hashem N, Rabiea SM, Rupani MA. Post spinal puncture headache, an old problem and new concepts: review of articles about predisposing factors. Caspian J Intern Med 2013;4:595-602.
22. Lee SJ, Lee JN. The effect of perioperative esmolol infusion on the postoperative nausea, vomiting and pain after laparoscopic appendectomy. Korean J Anesthesiol 2010;59:179-84.
23. do Amaral PC, Filho Ede M, Galvao TD, Junior EE, de Magalhaes Neto GE, Mascarenhas F, et al. Factors leading to long-term hospitalization after laparoscopic appendectomy. JSLS 2006;10:355-8.
24. Van Wijk RM, Watts RW, Ledowski T, Trochsler M, Moran JL, Arenas GW. Deep neuromuscular block reduces intra-abdominal pressure requirements during laparoscopic cholecystectomy: a prospective observational study. Acta Anaesthesiol Scand 2015;59:434-40.