Doi: 10.5152/TJAR.2019.31855

Original Article
General Anaesthesia

Turkish Journal of Anaesthesiology & Reanimation

Perioperative Effects of Induction with High-dose Rocuronium during Laparoscopic Cholecystectomy

Selim Turhanoğlu[1], Mehmet Tunç[1], Menekşe Okşar[1], Muhyittin Temiz[2]

[1]Department of Anaesthesiology and Intensive Care, Hatay Mustafa Kemal University School of Medicine, Hatay, Turkey
[2]Department of General Surgery, Hatay Mustafa Kemal University School of Medicine, Hatay, Turkey

Cite this article as: Turhanoğlu S, Tunç M, Okşar M, Temiz M. Perioperative Effects of Induction with High-dose Rocuronium during Laparoscopic Cholecystectomy. Turk J Anaesthesiol Reanim 2020; 48(3): 188-95.

Abstract

Objective: We aimed to investigate the effects of high-dose rocuronium administration on intra-abdominal pressure (IAP) and surgical conditions during anaesthesia induction and laparoscopic cholecystectomy anaesthesia induction, respectively. Further, we aimed to determine postoperative nausea and vomiting (PONV) and pain scores following the laparoscopic cholecystectomy.

Methods: Patients with American Society of Anesthesiologists (ASA) score of I–III, aged 18 to 75 years and who were scheduled for surgery under general anaesthesia were included in the study. Patients were randomised and a high-dose of 1.2 mg kg^{-1} rocuronium was given to Group A and 0.6 mg kg^{-1} rocuronium to Group B. The intraoperative train of four (TOF) ratio and post-tetanic count (PTC) were measured. Surgery was initiated with a low IAP of 7 mmHg. The surgeon evaluated surgical conditions with a 4-step surgical field scale and increased the IAP when necessary. PONV at 4, 12 and 24 hours and postoperative pain at 2 and 24 hours and 3 days were evaluated.

Results: There were no significant differences in the demographic and haemodynamic parameters between the groups. In high-dose rocuronium Group A, IAP values were significantly lower in the first 20 minutes compared to Group B. The duration of operations was significantly shorter in Group A (29.00±7.39 minute vs. 34.63±12.00 minute, p=0.044). PONV in the first 12 hours was significantly lower in Group A ($p<0.05$).

Conclusion: High-dose rocuronium-induced deep neuromuscular block helped perform laparoscopic cholecystectomy operations with lower values of IAP compared to a normal dose rocuronium. It also shortened duration of operation and reduced PONV and pain.

Keywords: Cholecystectomy, laparoscopic, nausea vomiting, neuromuscular blockade, pain, postoperative, rocuronium

Introduction

Laparoscopic cholecystectomy is a more commonly preferred surgery compared to the laparotomic procedure owing to the shorter duration of hospital stay and faster recovery period (1). The pneumoperitoneum pressure applied is considered an important factor for the development of postoperative abdominal and shoulder pains. In the recent years, studies have reported that the intra-abdominal pressure (IAP) could be decreased without interrupting the surgical conditions by applying a deep neuromuscular block (NMB) during a laparoscopic cholecystectomy procedure, and hence complications, such as the postoperative pain, nausea and vomiting, could be alleviated (2, 3). A rocuronium dose of 1.2 mg kg^{-1} does not create a significant difference with regard to the intubation conditions compared to succinylcholine application during the induction of anaesthesia (4). The duration from the injection of rocuronium until the receipt of a primary tactile intraoperative train of four (TOF) response without inflicting any cardiovascular effects is an average of 60 minutes (5). The administration of a single high-dose rocuronium during the induction of anaesthesia provides the possibility of using lower IAPs during laparoscopic cholecystectomy, along with decreasing postoperative pain, nausea and vomiting, without prolonging the recovery period after surgery. In this study, we primarily aimed at investigating the effects of high-dose rocuronium (1.2 mg kg^{-1}) application on

Corresponding Author: Selim Turhanoğlu E-mail: adat63@gmail.com

Received: 07.02.2019 Accepted: 20.07.2019
Available Online Date: 22.10.2019

the abdominal pressure and surgical conditions during the induction of anaesthesia for the laparoscopic cholecystectomy surgery; the secondary objective was to investigate the effects of the high-dose on postoperative complications, such as the pain, nausea and vomiting.

Methods

In total, 54 patients with the American Society of Anesthesiologists (ASA) classification of I–III adult, aged 18–75 years and who were scheduled for an elective laparoscopic cholecystectomy surgery were included in this study. Ethical consent was obtained from the Medical Faculty's Health and Research Hospital Clinical Trials (02/08/2017/39). A randomised double-blind study was designed. The cases were randomly allocated to two groups, with 27 patients in each group. All patients were informed about the study in detail, and written consent was obtained from each patient. The exclusion criteria for the cases were allergies to rocuronium or sugammadex, pregnancy or lactation, neuromuscular disorders that might disrupt the NMB, hepatic or renal dysfunctions, age less than 18 years or older than 75 years, failing to provide written consent, obesity (body mass index [BMI] ≥35 kg m^{-2}), history of abdominal surgery and long-term usage of non-steroid anti-inflammatory drugs or other analgesics.

Height and weight of the patients were measured; BMI and ideal body weights (IBW) are calculated and recorded (BMI: weight/height squared; IBW: height (cm) minus, 100 for males and 105 for females). No medicine was administered to the patients for premedication purposes. Neuromuscular monitoring was ensured using the TOF-WATCH® SX (Organon, Ireland) device along with the TOF ratio and the post-tetanic count (PTC).

Anaesthesia induction was performed intravenously using 2 mg kg^{-1} propofol and 2 µg kg^{-1} fentanyl. Following the disappearance of the eyelash reflex, the rocuronium dose calculated according to the IBW was intravenously applied to the first group (Group A) at 1.2 mg kg^{-1} dosage and to the second group (Group B) at 0.6 mg kg^{-1} dosage. An equivalent amount of 0.09% sodium chloride was added to the calculated dose for Group B, and the dosage was balanced according to the volume with Group A. The intubation process was performed after the patients were ventilated with the mask until their TOF values were 0, with the fraction of inspired oxygen (FiO_2) maintained at 100%. The time elapsed between the rocuronium application and the realisation of intubation was recorded. The FiO_2 was then decreased to 50%, and remifentanil was administered intravenously at a rate of 0.01–0.3 µg kg^{-1} min^{-1} and titrated according to the pulse and blood pressure values, as desflurane was applied at MAC 6% through inhalation for all the patients. The respiration rate was set at the pressure of end-tidal carbon dioxide ($ETCO_2$) to a 34–38 mmHg range. A nasogastric tube was inserted in all the patients following endotracheal intubation.

Main Points:

- Laparoscopic cholecystectomy is a more commonly preferred surgery compared to the laparotomic procedure owing to the shorter duration of hospital stay and faster recovery period.
- The pneumoperitoneum pressure applied is considered an important factor for surgical conditions and possible complications such as pain, nausea and vomiting.
- Deep neuromuscular block can improve surgical conditions by affecting pneumoperitonium pressure level, and it can also prevent complications such as postoperative pain, nausea, and vomiting.

Carbon dioxide insufflation was performed to attain a pressure of 10 mmHg in the pneumoperitoneum and supplied through a veress needle at the beginning of the operation. The pressure was then decreased to 7 mmHg after the insertion of four trochars. All the laparoscopic surgeries were performed by the same surgeon. The surgeon evaluated the surgical site conditions on a 4-point-scale (first class [optimal]: optimal surgical site conditions, second class [good]: non-optimal conditions with no intervention required, third class [acceptable]: intervention might be considered to improve the surgical site conditions and fourth class [poor]: insufficient conditions with intervention required to provide acceptable surgical site conditions). The surgeon evaluated the surgical site conditions without the knowledge of the IAP and increased the IAP by 1 mmHg consistently until the surgical site conditions were sufficient for the third and fourth class site conditions. In case the surgical site conditions were not sufficient when the IAP reached 12 mmHg, an additional 0.1 mg kg^{-1} dose of rocuronium was applied, and this application was recorded. The IAP values were recorded every 5 minutes during the surgery starting from the decrease of the pressure to the initial value of 7 mmHg, until the trochars are removed. The time when four trochars were inserted and the pressure decreased to 7 mmHg was recorded as the beginning, and the gas consumption until the trochars are inserted along with the gas consumption at the time of trochar removal were recorded. In addition, the elapsed time between the placement of the veress needle and last suture was recorded as the duration of the operation. The surgeon again evaluated the surgical field conditions on a 4-point-scale at the end of the operation and the results were recorded.

Remifentanil infusion was terminated after the gall bladder was resected, and an intravenous infusion of 100 mg tramadol with 1 g paracetamol was initiated. Desflurane application however was terminated after the last suture was performed, and the patient was placed into the waking process. The previously inserted nasogastric catheter was removed

through aspiration. Sugammadex was intravenously administered to all the patients with a dose of 2 mg kg^{-1} according to their measured actual body weight. Neuromuscular monitoring was performed until the end of anaesthesia application and the TOF rate was at least 90%; the time elapsed between the application of sugammadex until a TOF rate of 90% was recorded. The trachea was extubated when the patient started breathing spontaneously and was waking up (i.e. patient made purposeful movements). The time from the termination of desflurane application to the extubation of the patient was recorded. Also, the time from the beginning of induction to extubation was recorded as the anaesthesia time.

The TOF rates and PTC values during intubation and every 5 minutes until the application of the first dose of sugammadex were recorded. IAP was recorded every 5 minutes after the insertion of four trochars and the decrease to 7 mmHg, with the first recording taken at the fifth minute after the pressure decrease.

The patients were given intravenous 1 g paracetamol at 8-hour intervals during the first 24 postoperative hours for analgesic purposes. The pain score was evaluated and recorded for each patient under the categories of incisional pain, abdominal pain and shoulder pain, according to the visual analogue scale (VAS; 0=no pain, 100=intolerably high level of pain) at rest and in motion for the postoperative second and twenty-fourth hours and 3 days.

In addition, the nausea and/or vomiting incidences of patients during the first 24 hours and first postoperative defecation times were recorded. The postoperative nausea and vomiting (PONV) risk scores for all cases were calculated according to the Apfel scoring system (female, non-smoker, history of motion sickness, usage of postoperative opioid), where each risk group is scored as 1; the resulting total score was recorded. Patients' incidences of nausea and vomiting during the first 24 hours of the postoperative period were evaluated and recorded in three distinct periods (0–4, 4–12 and 12–24 hours), and their severities were evaluated according to the 5-point scale (0=no complaint, 1=mild complaint of nausea, 2=moderate nausea, 3=frequent vomiting [4 times] and 4=severe vomiting [continuous]).

Statistical analysis

We estimated that 25 cases were sufficient for each group such that a 30% decrease in 12 mmHg IAP value could be detected by Type I 0.05% and Type II 20% errors (6). Therefore, 54 cases were included in the study to the possibility of decreasing the number of cases for including 27 cases in each group. The normality check of continuous data was performed using the Shapiro–Wilk test. Student's t test was used for comparing two normally distributed independent groups, where the descriptive statistics were expressed as mean ± standard deviation. The Mann–Whitney U test was used for comparing two non-normally distributed independent groups, where the descriptive statistics were expressed as median (25%–75% quartile) and minimum and maximum values. For the analysis of categorical variables, the Chi square test was used for tables with a sample size higher than 5. The Fisher Exact test was used when the minimum expected count was less than 5 in a 2×2 cross table, and the Linear-by-Linear association test was used for the cases with categories more than 2, where the sample size is less than 5 (7). Comparison of two ratios was used for the results that revealed significant relationships. Descriptive statistics were expressed in terms of frequencies and percentages. The statistical significance level was taken at 0.05 for the entire analyses, and the IBM Statistical Package for Social Sciences (IBM SPSS Corp.; Armonk, NY, USA version 21 programme) is used for the analyses.

Results

In total, 54 patients diagnosed with cholelithiasis and planned to undergo elective laparoscopic cholecystectomy were included in the study. All cases were operated by the same surgeon. The patients in both groups were similar in terms of age, height, weight, BMI and IBW (Table 1).

Group A cases had significantly shorter intubation durations than those of Group B ($p<0.001$). There was a significant difference in the operation durations between the two groups ($p<0.05$). The tracheas were extubated when the TOF rate was 90%. Furthermore, it was observed that the extubation durations were significantly longer for Group A ($p<0.001$). The duration of anaesthesia was significantly shorter for Group A patients ($p<0.01$). The total rocuronium and sugammadex doses and the durations of operations, intubation, extubation and anaesthesia times are provided in Table 1.

The TOF ratio and the PTC values for Group B were found to be higher than that of Group A. PTC values indicating a deep block demonstrated the deep block at the fifteenth minute for 24 cases (89%), twentieth minute for 21 cases (78%) and twenty-fifth minute for 12 cases (44%) among the Group A patients; in contrast, the PTC values indicating a deep block within the same periods for Group B was 17 (63%), 12 (44%) and 6 (22%), respectively (Table 2). In addition to the rocuronium dose applied during the induction, an additional 0.1 mg kg^{-1} extra dose was applied to the 7 cases in Group B for whom the IAP was found insufficient despite increase by 5 mmHg during the evaluation of the surgical field condition.

The IAP values were provided until the thirtieth minute since the number of cases to be evaluated in Group A for the periods exceeding 30 minutes were not sufficient for statistical analysis. A statistically significant difference between the groups was observed in terms of the fifth (p=0.018), tenth (p=0.005), fifteenth (p=0.024) and twentieth minute (p=0.035) IAP averages. The IAP values of Group B for these timings were found to be significantly higher than those of Group A. No significant difference was observed when the amount of gas consumed, surgeon's satisfaction, Modified

Table 1. Patient characteristics, total rocuronium and sugammadex doses, durations of operations and intubation and extubation times

	Group A n=27	Group B n=27	p
Age (years) (mean±SD)	45.00±14.97	44.33±15.84	0.874*
Height (cm) (mean±SD)	166.00±8.98	166.41±7.66	0.858*
Weight (kg) (mean±SD)	74.30±8.39	72.67±11.07	0.545*
BMI (mean±SD)	26.96±3.99	26.14±3.23	0.413*
IBW (mean±SD)	63.59±11.68	63.19±9.34	0.888*
Gender (F/M)	20 (74.1%)/7 (25.9%)	18 (66.7)/9 (33.3)	0.551**
ASA			
I	11 (40.7)	13 (48.1)	
II	15 (55.6)	10 (37.0)	0.834***
III	1 (3.7)	4 (14.8)	
Rocuronium dose (mg)	74.63±10.51	41.52±8.96	<0.001*
Intubation time (s)	119.85±36.96	215.63±55.56	<0.001*
Operation time (min)	29.00±7.39	34.63±12.00	0.044*
Sugammadex dose (mg)	150.33±17.06	146.59±21.68	0.484*
Extubation time (s)	213.67±42.69	169.63±42.04	<0.001*
Anaesthesia time (min)	37.63±5.11	41.96±6.33	<0.01*

*p: Student's t Test; **p: Chi Square; ***p: Linear-by-Linear Association. SD: standard deviation; BMI: body mass index; IBW: ideal body weight; F: female; M: male; ASA: American Society of Anesthesiology.

Table 2. TOF ratio and PTC values

	Group A				Group B				
TOF ratio	**n**	**Median**	**Min**	**Max**	**n**	**Median**	**Min**	**Max**	**p**
0 minute	27	0 (0–0)	0	0	27	0 (0–1)	0	1	<0.001
5 minute	27	0 (0–0)	0	1	27	0 (0–1)	0	3	0.003
10 minute	27	0 (0–0)	0	2	27	0 (0–1)	0	3	0.021
15 minute	27	0 (0–0)	0	3	27	0 (0–1)	0	2	0.078
20 minute	22	0 (0–0)	0	2	23	0 (0–1)	0	3	0.002
25 minute	13	0 (0–0)	0	2	17	1 (0–1)	0	3	0.012
30 minute	6	0 (0–1)	0	3	12	2 (1–2)	0	3	0.067
35 minute	4	0 (0–1)	0	1	10	1 (1–2)	0	2	0.036
40 minute	3	0 (0–0)	0	0	6	2 (1–2)	1	2	0.024
PTC									
0 minute	27	0 (0–0)	0	15	15	2 (0–7)	0	15	0.010
5 minute	26	0 (0–0)	0	15	17	6 (0–14)	0	15	0.002
10 minute	24	0 (0–0)	0	15	16	9 (3–14)	0	15	<0.001
15 minute	24	0 (0–0)	0	15	17	10 (7–15)	0	15	<0.001
20 minute	21	0 (0–3)	0	15	12	11 (8–15)	0	15	0.001
25. minute	12	0 (0–14)	0	15	6	10 (6–12)	0	15	0.250
30 minute	5	0 (0–15)	0	15	2	12 (10–*)	10	13	0.857

TOF: train of four; PTC: post-tetanic count; p: Mann–Whitney U Test

Aldrete Score values and first defecation timings for the two groups were compared.

No significant difference was found between the cases in terms of the PONV risk that is evaluated using the Apfel risk score. As the cases were evaluated in terms of nausea and vomiting in the first 24 hours of the postoperative period, it is observed that the cases in Group B patients had a significantly higher number of postoperative nausea complaints during the 0–4-hour and 4–12-hour periods, whereas no significant difference was identified between the groups for the 12–24-hour period (Table 3).

The postoperative pain for the cases was evaluated using the 0–100 mm VAS. Pain assessments for both groups were re-

Table 3. Postoperative nausea and vomiting

PONV	Group A n=27	Group B n=27	p
0–4 hours			0.024
No	14 (51.9)	5 (18.5)	
Mild	8 (29.6)	13 (48.1)	
Moderate	5 (18.5)	9 (33.3)	
4–12 hours			0.022
No	20 (74.1)	12 (44.4)	
Mild	7 (25.9)	14 (51.9)	
Moderate	0 (0.0)	1 (3.7)	
12–24 hours			0.192
No	26 (96.3)	22 (81.5)	
Mild	1 (3.7)	5 (18.5)	
Moderate	0 (0.0)	0 (0.0)	

PONV: postoperative nausea and vomiting; p: Linear-by-Linear Association

Table 4. VAS scores (0–100 mm) of abdominal incisional and shoulder pain at 2 and 24 hours and 3 days

	Group A n=27 (mean±SD)	Group B n=27 (mean±SD)	p
Abdominal pain			
Rest 2 hour	27.78±8.47	30.37±10.91	0.334
Motion 2 hour	34.44±8.01	38.15±13.02	0.214
Rest 24 hour	20.37±9.40	37.04±13.53	<0.001
Motion 24 hour	27.04±8.69	42.96±12.65	<0.001
Rest 3 day	17.78±6.98	23.70±6.29	0.002
Motion 3 day	21.48±6.62	26.30±7.42	0.015
Incisional pain			
Rest 2 hour	30.74±8.29	30.37±8.08	0.869
Motion 2 hour	38.15±8.34	36.67±9.61	0.548
Rest 24 hour	22.22±7.51	31.85±7.86	<0.001
Motion 24 hour	28.52±7.18	37.78±8.47	<0.001
Rest 3 day	15.56±7.51	17.04±7.24	0.464
Motion 3 day	16.30±8.39	21.85±6.81	0.010
Shoulder pain			
Rest 2 hour	0.37±1.92	0.00±0.00	0.327
Motion 2 hour	0.37±1.92	0.00±0.00	0.327
Rest 24 hour	1.11±5.77	4.44±9.74	0.134
Motion 24 hour	1.11±5.77	4.44±9.74	0.134
Rest 3 day	0.74±3.85	1.48±3.62	0.470
Motion 3 day	0.74±3.85	1.92±4.91	0.333

p: Student's t Test. VAS: visual analogue scale

alised by measuring the abdominal, incisional and shoulder pain both at rest and in motion using VAS. No statistically significant difference was observed between the groups as per the assessments conducted during the first 2 hours. Considering the twenty-fourth-hour and third day evaluation of the abdominal pain, higher VAS values were measured for the cases in Group B, and these values were statistically significantly compared to Group A values. However, the evaluation of incisional pain at the twenty-fourth hour revealed a statistically significant difference both at rest and in motion for the groups, where the pain levels of Group B cases were found to be higher. No statistically significant difference among the groups were observed for the third day evaluation of the incisional pain at rest; however, significantly higher VAS values for incisional pain in motion were obtained for Group B cases compared to Group A. No significant difference was observed between the groups in terms of shoulder pain severity according to the assessments conducted on the second and twenty-fourth hour and the third day. The VAS scores related to the pain assessments of the cases are provided in Table 4.

Discussion

The primary hypothesis of the study was that better surgical site conditions is achieved in lower pneumoperitoneum pressures in patients given deep block. In the high-dose rocuronium group, IAP values were significantly lower in the first 20 minutes compared to the control group. In the evaluation of abdominal pain at the postoperative twenty-fourth hour and third day, lower VAS values were detected in the high-dose rocuronium group. Similarly, incisional pain at the postoperative twenty-fourth hour and motion-induced incisional pain score on the third day were lower in the high-dose rocuronium group. When the patients were evaluated in terms of nausea and vomiting for the first 24 hours of the postoperative period, more number of postoperative nausea complaints was detected in 0–4 hours and 4–12 hours.

The depth of the NMB in the pneumoperitoneum pressure is one of the most important factors affecting the condition of the surgical site. Some studies have been conducted demonstrating that surgical site conditions were healed with low IAP in different types of laparoscopic surgeries with the deep NMB effect of high-dose rocuronium (8-10). The study by Koo et al. (9), which is one of the studies evaluating surgical site conditions, used a 4-digit surgical site assessment scale and found 1–2 score in the normal NMB group to be 34.5% and in the deep NMB group to be 68.5%. Koo et al. (9) found that the increased rate of IAP was significantly lower in the deep NMB group (12.5%) compared to the moderate NMB group (34.4%). A study by Rosenberg et al. (11) evaluating surgical conditions from 0 to 10 according to the numerical pain assessment scale found that the worst surgical conditions were in the normal NMB low pressure group and that the normal NMB standard pressure group had better surgical conditions than the high NMB low pressure group.

In a study by Staehr-Rye et al. (6), in only 35% of patients in the moderate NMB group and in 60% of patients in deep NMB group, the operation was completed at 8 mmHg IAPs. In the study where the lowest IAP was used and which allowed acceptable surgical conditions in both groups, Kim et al. (10) found that the mean IAP values were significantly lower in the deep NMB group. Studies investigating the effects of deep block on pneumoperitoneum pressures of 8 and 12 mmHg found that deep NMB increases the abdominal cavity at both pressure levels (12-14). In studies investigating the effects of deep NMB, the operation was started with a pneumoperitoneum pressure of 8 mmHg in the compared groups, and IAP was increased in insufficient surgical conditions (6, 9, 15). All three studies found a lower rate of standard pneumoperitoneum pressure under deep NMB. In our study, the surgeon evaluated the surgical site conditions completely unaware of the IAP value and increased the IAP value when he found it to be insufficient. Since all laparoscopic cholecystectomy cases were performed by the same surgeon in our study, the difference in the satisfaction of the surgeon is noteworthy although not statistically significant.

In contrast to studies showing that deep NMB administration allows laparoscopic surgery at lower IAP values, Kopman and Naguib (16) conducted a review evaluating the evidence whether deep block is advantageous in laparoscopic surgery and reported no evidence of the superiority of the deep block against normal NMB in laparoscopy. The most important issue underlined by these authors is that many studies have compared deep NMB with surface or minimal NMB in a significant part of the surgical procedure. The authors stated that they regarded excision of the gall bladder at the end of the surgical procedure from a small incision and closure of the abdominal fascia as an important part of surgery. They also argued that the endpoint of the protocol should be PTC 2 or less for the deep block until the peritoneal closure, whereas it should be in the 1–3 range for the moderate NMB. When deep block and moderate NMB were compared in this manner, the question whether deep block provides superior surgical conditions for laparoscopy cannot be answered based on the evidence by current studies. The comparison of deep block with superficial or minimal block proposed by Kopman and Naguib (16) is not valid for our study. Therefore, we think that the findings of IAP, amount of the gas spent, operation time and surgeon satisfaction should be evaluated in favour of deep block application.

In a study of patients who underwent bariatric surgery, Torensma et al. (17) found a significant reduction in shoulder

pain in the group administered deep NMB. However, abdominal pain did not decrease after 24 hours. In a study conducted in laparoscopic hysterectomy patients, Madsen et al. (18) reported a decrease in shoulder pain by 14 days of postoperative period in a group administered low IAP deep NMB. However, they could not find a significant difference between abdominal pain scores. In a study comparing deep and normal NMB in patients with laparoscopic cholecystectomy, Staehr-Rye et al. (6) found no difference in postoperative pain between the two groups. Similarly, in a study comparing deep NMB and no-NMB groups in patients who underwent laparoscopic cholecystectomy, Blobner et al. (19) found no difference in terms of postoperative pain between the groups. In the study comparing deep and normal NMB, Koo et al. (9) found no difference between the groups in terms of postoperative thirtieth minute pain and shoulder pain. However, they found less shoulder pain in the deep NMB group at the twenty-fourth hour of the postoperative period. The reason why there was no difference in the pain scores at the postoperative second hour may be attributed to the effect of analgesics administered for the postoperative pain. However, subsequent pain assessments revealed that patients in the deep block group had less pain scores. The third day assessments particularly revealed that motion-induced abdominal and incisional pain scores were significantly lower in the deep block group. Although there was no significant difference in terms of shoulder pain, the pain scores of the patients in the deep block group were found to be lower. The results of our study indicate that postoperative pain scores were lower in patients in the deep block group.

The PONV risk is higher in the post-laparoscopic cholecystectomy surgery period than other surgeries (20). In the study comparing normal and deep NMB patients under low pressure, Staehr-Rye et al. (6) found no difference in terms of PONV between the two groups. Similarly, in the study comparing deep and normal NMB cases, Koo et al. (9) found no difference in terms of PONV between the groups. Barczyński et al. (2) found no difference in PONV between the groups when low and standard IAPs in laparoscopic cholecystectomy patients were compared. As it can be observed, the studies comparing low and high IAPs have not found any difference between groups in terms of PONV. The finding that there was less nausea and vomiting in the deep block group in the first 12 hours in our study is not consistent with the results of the studies on this subject. We could not link this difference seen in terms of PONV to a definite cause. At the end of the laparoscopic surgery, intra-abdominal gas is discharged before the trocar withdrawal, but residual gas may be witnessed in the abdomen. In a study investigating residual pneumoperitoneum, Sarvestani and Zamiri (21) reported that of the 55 female patients who underwent laparoscopic cholecystectomy, 17 (30.9%) had no residual pneumoperitoneum, 23 (41.81%) had mild, 8 (14.54%) had moderate and 7 (12.72%) had severe residual pneumoperitoneum. They suggested that residual pneumoperitoneum is a factor contributing to postoperative cholecystectomy pain. We did not investigate the presence of residual pneumoperitoneum in our study. However, we think that the presence of possible residual pneumoperitoneum due to increased intra-abdominal gas consumption in Group B increased postoperative pain, causing the differences between the groups in terms of PONV.

Conclusion

In our study, deep NMB provided with high-dose of rocuronium allowed the operation to be performed with lower IAP values in patients undergoing laparoscopic surgery, reduced operation duration and decreased postoperative PONV and pain. Based on our findings, we can conclude that if the NMB due to rocuronium is reversible with sugammadex, high-dose rocuronium-induced deep block should be administered in laparoscopic cholecystectomy patients.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Mustafa Kemal University Medical Faculty's Health and Research Hospital Clinical Trials (02/08/2017/39).

Informed Consent: Written informed consent was obtained from patient who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – S.T., M.T., M.Temiz.; Design – S.T., M.T.; Supervision – S.T., M.T., M.Temiz., M.O.; Materials – S.T., M.O., M.T.; Data Collection and/or Processing – S.T., M.T., M.Temiz., M.O.; Analysis and/or Interpretation – S.T., M.O., M.T.; Literature Search – S.T., M.T.; Writing Manuscript – S.T., M.T.; Critical Review – S.T., M.T., M.Temiz., M.O .

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

References

1. Keus F, de Jong J, Gooszen H, Laarhoven CJ. Laparoscopic versus open cholecystectomy for patients with symptomatic cholecystolithiasis. The Cochrane Library 2006; 4: CD006231. [CrossRef]
2. Barczyński M, Herman R. A prospective randomized trial on comparison of low-pressure (LP) and standard-pressure (SP) pneumoperitoneum for laparoscopic cholecystectomy. Surg Endosc 2003; 17: 533-8. [CrossRef]

3. Gurusamy KS, Vaughan J, Davidson BR. Low pressure versus standard pressure pneumoperitoneum in laparoscopic cholecystectomy. Cochrane Database Syst Rev 2014; 3: CD006930. [CrossRef]
4. Tran DT, Newton EK, Mount VA, Lee JS, Wells GA, Perry JJ. Rocuronium versus succinylcholine for rapid sequence induction intubation. The Cochrane Library 2015; 10: CD002 788. [CrossRef]
5. Heier T, Caldwell JE. Rapid tracheal intubation with large-dose rocuronium: a probability-based approach. Anesth Analg 2000; 90: 175-9. [CrossRef]
6. Staehr-Rye AK, Rasmussen LS, Rosenberg J, Juul P, Lindekaer AL, Riber C, et al. Surgical space conditions during low-pressure laparoscopic cholecystectomy with deep versus moderate neuromuscular blockade: a randomized clinical study. Anesth Analg 2014; 119: 1084-92. [CrossRef]
7. Bal C, Er F, Sonmez H. A review of statistical techniques for 2x2 and RxC categorical data tables in SPSS. Journal of Pediatric Sciences 2009; 1: e1.
8. Özdemir-van Brunschot DMD, Braat AE, van der Jagt MFP, Scheffer GJ, Martini CH, Langenhuijsen JF, et al. Deep neuromuscular blockade improves surgical conditions during low-pressure pneumoperitoneum laparoscopic donor nephrectomy. Surg Endosc 2018; 32: 245-51. [CrossRef]
9. Koo BW, Oh AY, Seo KS, Han JW, Han HS, Yoon YS. Randomized clinical trial of moderate versus deep neuromuscular block for low-pressure pneumoperitoneum during laparoscopic cholecystectomy. World J Surg 2016; 40: 2898-903. [CrossRef]
10. Kim MH, Lee KY, Lee KY, Min BS, Yoo YC. Maintaining optimal surgical conditions with low insufflation pressures is possible with deep neuromuscular blockade during laparoscopic colorectal surgery: a prospective, randomized, double-blind, parallel-group clinical trial. Medicine 2016; 95: e2920. [CrossRef]
11. Rosenberg J, Herring WJ, Blobner M, Mulier JP, Rahe-Meyer N, Woo T, et al. Deep neuromuscular blockade improves laparoscopic surgical conditions: a randomized, controlled study. Adv Ther 2017; 34: 925-36. [CrossRef]
12. Barrio J, Errando CL, San Miguel G, Salas BI, Raga J, Carrión JL, et al. Effect of depth of neuromuscular blockade on the abdominal space during pneumoperitoneum establishment in laparoscopic surgery. J Clin Anesth 2016; 34: 197-203. [CrossRef]
13. Lindekaer AL, Springborg HH, Istre O. Deep neuromuscular blockade leads to a larger intraabdominal volume during laparoscopy. J Vis Exp 2013; 76: e50045 [CrossRef]
14. Madsen MV, Gätke M, Springborg H, Rosenberg J, Lund J, Istre O. Optimising abdominal space with deep neuromuscular blockade in gynaecologic laparoscopy-a randomised, blinded crossover study. Acta Anaesthesiol Scand 2015; 59: 441-7. [CrossRef]
15. Yoo YC, Kim NY, Shin S, Choi YD, Hong JH, Kim CY, et al. The intraocular pressure under deep versus moderate neuromuscular blockade during low-pressure robot assisted laparoscopic radical prostatectomy in a randomized trial. PLoS One 2015; 10: e0135412. [CrossRef]
16. Kopman AF, Naguib M. Is deep neuromuscular block beneficial in laparoscopic surgery? No, probably not. Acta Anaesthesiol Scand 2016; 60: 717-22. [CrossRef]
17. Torensma B, Martini CH, Boon M, Olofsen E, Liem RS, Knook MT, et al. Deep neuromuscular block improves surgical conditions during bariatric surgery and reduces postoperative pain: a randomized double blind controlled trial. PloS One 2016; 11: e0167907. [CrossRef]
18. Madsen MV, Istre O, Staehr-Rye AK, Springborg HH, Rosenberg J, Lund J, et al. Postoperative shoulder pain after laparoscopic hysterectomy with deep neuromuscular blockade and low-pressure pneumoperitoneum: a randomised controlled trial. Eur J Anaesthesiol 2016; 33: 341-7. [CrossRef]
19. Blobner M, Frick CG, Stäuble RB, Feussner H, Schaller SJ, Unterbuchner C, et al. Neuromuscular blockade improves surgical conditions (NISCO). Surg Endosc 2015; 29: 627-36. [CrossRef]
20. Helmy S. Prophylactic anti-emetic efficacy of ondansetron in laparoscopic cholecystectomy under total intravenous anaesthesiaA randomised, double-blind comparison with droperidol, metoclopramide and placebo. Anaesthesia 1999; 54: 266-71. [CrossRef]
21. Sarvestani AS, Zamiri M. Residual pneumoperitoneum volume and postlaparoscopic cholecystectomy pain. Anesth Pain Med 2014; 4: e17366. [CrossRef]