

FACTORS ASSOCIATED WITH RESIDUAL NEUROMUSCULAR BLOCKADE WITH ROCURONIUM AFTER LAPAROSCOPIC ABDOMINAL SURGERY

ABSTRACT

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Objective: Residual neuromuscular blockade commonly occurs after laparoscopic abdominal surgery, impacting patient recovery and safety. This study aimed to identify factors associated with residual neuromuscular blockade when using rocuronium in laparoscopic procedures.

Method: The researchers conducted a cross-sectional descriptive study on 92 patients undergoing laparoscopic surgery in the Department of Anesthesia and Resuscitation, Nguyen Tri Phuong Hospital. The residual neuromuscular blockade was monitored using the TOF (train of four) index with the TOF-watch nerve stimulator, a device used to monitor neuromuscular function, was applied at the time of extubation.

Results: The incidence of residual neuromuscular blockade with rocuronium (TOF < 0.9) at the time of extubation following laparoscopic abdominal surgery was 53.3%, patients who did not receive prophylactic antibiotics had a higher rate of residual neuromuscular blockade compared to those who did ($p < 0.05$). The duration of surgery was longer in patients with residual neuromuscular blockade, averaging 10 minutes more than those without residual blockade ($p < 0.0125$). Additionally, the time from administration of the reversal agent to extubation was longer in patients with residual neuromuscular blockade, averaging 4 minutes more than those without residual blockade ($p < 0.015$).

Conclusion: The incidence of residual neuromuscular blockade with rocuronium following laparoscopic abdominal surgery is relatively high. There is a correlation between residual neuromuscular blockade and the use of prophylactic antibiotics, duration of surgery, and the time from administration of the reversal agent to extubation. It is essential to monitor, recognize, and assess the risk of residual neuromuscular blockade early to reduce the risks and complications associated

with residual blockade and to improve the quality of patient recovery.

Keywords: *residual neuromuscular blockade, laparoscopic surgery*

I. INTRODUCTION

Laparoscopic abdominal surgery is a minimally invasive surgical technique that offers numerous benefits for patients, including reduced postoperative pain, faster recovery times, and a lower risk of infection [1], [2]. However, to ensure safety and efficacy during surgery, general anesthesia with the support of neuromuscular blocking agents is necessary. Rocuronium, a non-depolarizing neuromuscular blocker, is commonly used in these surgeries to facilitate endotracheal intubation and to provide optimal conditions for the surgeon to perform the procedure [3].

Although rocuronium has many advantages, residual neuromuscular blockade post-surgery remains a significant concern. Residual blockade can lead to serious complications such as respiratory failure, cardiovascular complications, increased risk of infection, and prolonged recovery time after surgery [4]. Monitoring and assessing the degree of residual neuromuscular blockade post-surgery using devices such as the Train-of-Four (TOF) Watch is crucial to reduce the risk of complications and enhance the quality of patient recovery [5].

Globally, numerous studies have been conducted to evaluate the incidence of residual neuromuscular blockade and preventive measures. However, in Vietnam, research on this issue is still limited and has not received adequate attention. Therefore, conducting the study "Survey on the Residual Neuromuscular Blockade with Rocuronium after Laparoscopic Abdominal Surgery at Nguyen Tri Phuong Hospital, Ho Chi Minh City" is necessary to provide additional scientific data, enhance the quality of care, and ensure patient safety during surgery and recovery. The objective of the study was to determine the relationship between residual neuromuscular blockade and individual factors, medication characteristics and surgical characteristics.

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Received date: 29/10/2024

Revised date: 11/12/2024

Accepted date: 17/12/2024

II. SUBJECTS AND METHODS

2.1. Subjects

All patients undergoing laparoscopic abdominal surgery at the Department of Anesthesiology and Resuscitation, Nguyen Tri Phuong Hospital, Ho Chi Minh City.

Research method

A cross-sectional descriptive study.

Sample size

Sample size was calculated using the formula for estimating the proportion of a population

$$n = Z_{(1-\alpha/2)}^2 \frac{p(1-p)}{d^2}$$

n: sample size.

Z: Standard normal distribution value at 95% confidence level.

α : The probability of a Type I error is 0.05, thus $Z_{(1-\alpha/2)} = 1.96$.

d: Margin of error (confidence interval) with d = 0.05.

p: Estimated proportion, p = 0.106, based on the data from Kocaturk's study [6].

We selected a sample loss rate of 10%, thus the minimum sample size calculated using the above formula is n = 92 patients

Inclusion criteria

Patients over 16 years old who are scheduled for laparoscopic abdominal surgery, use rocuronium as a neuromuscular blocker, and agree to participate in the study.

Exclusion criteria

Patients with neuromuscular disorders, those who require conversion to open surgery during the procedure, or those who experience complications necessitating postoperative care in the intensive care unit will be excluded from the study.

III. RESULTS

2.2. Definitions of Variables

Primary Outcome Variable: Residual neuromuscular blockade (TOF < 0.9) at the time of extubation.

- Baseline Variables:

- Gender (male/female)
- Medical history of the patient (yes/no)
- Medication characteristics:
 - Use of antibiotics (yes/no)
 - Additional neuromuscular blockade drugs during surgery (yes/no)
- Surgical characteristics:
 - Duration of surgery
 - Duration from injection of reversal neuromuscular blockade drugs to extubation

2.3. Data Processing

The data in the study were processed using licensed Stata 14.0 statistical software. Quantitative variables are presented as mean $\pm$ standard deviation for normally distributed data or as median and interquartile range for non-normally distributed data. Qualitative variables are expressed as percentages (%). The association between each factor and residual neuromuscular blockade was assessed using the Chi-square test. All differences were considered statistically significant with a p-value < 0.05.

2.4. Ethical Considerations

The study was approved by the Ethics Committee of Nguyen Tri Phuong Hospital, approval number 190/NTP-HĐĐĐ, dated February 10, 2023. From February 2023 to May 2023, the study included 92 eligible patients from the Department of Anesthesiology and Intensive Care at Nguyen Tri Phuong Hospital.

■ Residual Neuromuscular Blockade (TOF < 0.9)
 ■ NO Residual Neuromuscular Blockade (TOF $\geq$ 0.9)

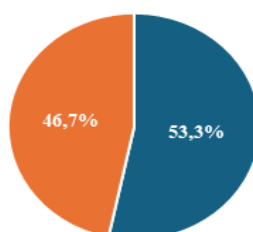


Figure 1. Proportion of residual neuromuscular blockade at the time of extubation

The proportion of patients with residual neuromuscular blockade at the time of extubation is 53.3%, which is 1.14 times higher than the proportion of patients without residual neuromuscular blockade at that time (46.7%).

Table 1. The correlation between residual neuromuscular blockade and individual factors (n=92)

		Quantity (Ratio %)	Residual neuromuscular blockade		p value	OR (CI 95%)
			Yes	No		
Gender	Female	54 (58.7)	28 (51.9)	26 (48.1)	0.75 ^a	1
	Male	38 (41.3)	21 (55.3)	17 (44.7)		1.15 (0.46 – 2.87)
Medical history	No	79 (85.8)	44 (55.7)	35 (44.3)	0.25 ^a	1
	Yes	13 (14.2)	5 (38.5)	8 (61.5)		0.49 (0.11 – 1.92)

^a: Fisher's exact test

The results show that females have a higher rate than males (58.7% compared to 41.3%). Most patients in the study had no history of internal medicine diseases (85.5%). The study did not find any correlation between residual muscle relaxants and characteristics such as gender or medical history of the patients.

Table 2. The correlation between residual muscle relaxants and medication characteristics during surgery (n=92)

			Residual neuromuscular blockade		p value	OR (CI 95%)
			Yes	No		
Antibiotics	No	9 (9.8)	8 (88.9)	1 (11.1)	0.034 ^a	1
	Yes	83 (90.2)	41 (49.4)	42 (50.6)		0.1 (0.01 – 0.62)
Additional neuromuscular blockade drugs	No	64 (69.6)	30 (46.9)	34 (53.1)	0.063 ^a	1
	Yes	28 (30.4)	19 (67.9)	9 (32.1)		2.39 (0.86 – 6.9)

^a: Fisher exact

The study results indicated that 90.2% of patients received prophylactic antibiotics (with metronidazole) prior to surgery, a rate 9.2 times higher than those who did not receive prophylactic antibiotics. Approximately one-third of the patients (30.4%) were administered additional muscle relaxants during surgery. Furthermore, patients who did not receive prophylactic antibiotics exhibited a significantly higher rate of residual muscle relaxants compared to those who did, with a p-value of less than 0.05. The study also found no significant correlation between the intraoperative administration of additional muscle relaxants and the presence of residual muscle relaxants at the time of extubation.

Table 3. The correlation between residual muscle relaxants and surgical characteristics (n=92)

	Tồn dư giãn cơ		Giá trị p
	Có	Không	
Duration of surgery*	55 (40 – 75)	45 (30 – 55)	0.0125
Duration from injection of reversal neuromuscular blockade drugs to extubation **	16.6 ± 9.6	12.6 ± 5	0.015

* Median (Interquartile Range)– Kruskal Wallis test

**t - test

The results indicate that patients with residual muscle relaxants had a longer surgery duration compared to those without residual muscle relaxants, with an average difference of 10 minutes. This difference was statistically significant with a p-value of less than 0.0125. Additionally, patients with residual muscle relaxants had a longer time from muscle relaxant reversal to extubation compared to those without residual muscle relaxants, with an average difference of 4 minutes. This difference was also statistically significant with a p-value of less than 0.015.

IV. DISCUSSION

Residual muscle relaxants are a major risk factor in the postoperative period, with the most concerning consequences being respiratory function impairment, upper airway muscle issues, and swallowing problems, leading to gastric content aspiration. In our study, the rate of patients with residual muscle relaxants (TOF<0.9) at the time of extubation was 53.3%. This rate is higher compared to the studies by Doan Minh Nhut (39.58%) and Le Ngoc Han (40%) [1], [7]. Bui Hanh Tam reported that the rate of residual muscle relaxants at TOF between 0.7 and 0.9 was 38.7% for the continuous infusion group and 69.5% for the intermittent bolus group. The rate of residual muscle relaxants at TOF <0.7 was 26.8% and 13% for these two groups, respectively [8].

Comparing with other international studies, our rate of residual muscle relaxants is higher than that reported by Martinez-Ubieto et al, which was 27.9% [9]. Fortier et al. conducted a study in Canada on 300 patients across 8 hospitals, where 99% of the patients received rocuronium and were reversed with neostigmine post-surgery, resulting in a residual muscle relaxant rate of 63.5% at the time of extubation [10]. The differences in these rates across various studies may be due to the selection of study subjects and individual responses to the drugs. Additionally, some recent studies in Vietnam reported figures without prior muscle relaxant titration or the use of neuromuscular monitoring during surgery.

Our study did not find a statistically significant correlation between residual muscle relaxants and demographic characteristics such as gender or medical history. Although many studies have suggested that females are generally more sensitive to muscle relaxants, including rocuronium, compared to males, resulting in a longer half-life. S Chetty et al (2020) reported that female patients had a higher rate of residual muscle relaxants than male patients ($p=0.001$) [11]. In comparison, Bui Hanh Tam's publication showed no differences in gender, age, or medical history between the continuous infusion and intermittent bolus groups concerning residual muscle relaxants [8]. Similarly, Fortier et al. also found no differences in residual muscle relaxants based on gender, age, or postoperative complication rates [10].

Furthermore, patients who did not use prophylactic antibiotics had a significantly higher rate of residual muscle relaxants compared to those who did, with $p<0.05$ and $OR=0.1$. We have not found studies investigating the correlation between the use of antibiotics during surgery and the incidence of postoperative residual curarization (PORC). Additionally, we did not find a correlation between residual muscle relaxants and the use of additional muscle relaxants during surgery ($p > 0.05$). This result is consistent with the findings of Doan Minh Nhut, who investigated residual muscle relaxants after appendectomy [1]. Future studies are needed to evaluate the effectiveness of this muscle relaxant and compare it with other muscle relaxants such as sugammadex.

In this study, patients at Nguyen Tri Phuong Hospital with residual muscle relaxants had longer surgery durations compared to those without residual muscle relaxants, with an average difference of 10 minutes ($p<0.0125$). Bui Hanh Tam concluded that prolonged anesthesia time is a factor that delays muscle relaxant recovery at TOF ≥ 0.7 [8]. Tran Thi Gan's study (2020) compared muscle relaxant recovery time and the rate of residual muscle relaxants after surgery using rocuronium with two methods: intermittent bolus and continuous infusion during prolonged laparoscopic surgery. Additionally, another study indicated that the use of muscle relaxants in prolonged laparoscopic surgery could lead to higher rates of residual muscle relaxants, especially with drugs like vecuronium, rocuronium, and atracurium [12].

A 2022 review by Murphy GS and Brull SJ examined the use of quantitative neuromuscular monitoring devices and their impact on postoperative outcomes. This study showed that the application of quantitative monitoring during surgery could significantly reduce the risk of postoperative residual curarization and related complications [13]. Furthermore, a 2023 study by Wachtendorf et al. discussed the best strategies for muscle relaxant management, including using the lowest possible doses of muscle relaxants and quantitative monitoring to ensure full recovery or reversal of muscle relaxation before extubation [14].

Our study also indicated that patients with residual muscle relaxants had a longer time from muscle relaxant reversal to extubation, averaging

4 minutes longer. This difference was statistically significant with $p < 0.015$. These results are consistent with the findings of Mc Caul et al., who used a TOF cutoff of >0.7 and ≤ 0.7 to evaluate postoperative residual neuromuscular blockade. Their results showed that those with residual muscle relaxants had an average extubation delay of 7 minutes, with statistical significance at $p < 0.005$. In Vietnam, there are currently few studies evaluating the correlation between residual muscle relaxants and the time from muscle relaxant reversal to extubation. Future research should focus on laparoscopic surgery patients to provide more practical conclusions.

V. CONCLUSION

The rate of patients with residual rocuronium muscle relaxants after laparoscopic surgery is relatively high. There is a correlation between postoperative residual muscle relaxants and the use of prophylactic antibiotics, surgery duration, and the time from muscle relaxant reversal to extubation.

Recommendations: It is necessary to monitor, identify, and assess the risk of residual muscle relaxants early after surgery to reduce the risk and complications caused by residual drugs.

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