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SHORT COMMUNICATION

# Estimation of the success rate of anesthetic management for thymectomy in patients with myasthenia gravis treated without muscle relaxants: a retrospective observational cohort study

**Yoshihito Fujita[1] · Satoru Moriyama[2] · Satoshi Aoki[3] · Saya Yoshizawa[3] · Maiko Tomita[3] · Taiki Kojima[3] · Yukiko Mori[3] · Naoko Takeuchi[3] · Min-Hye So[3] · Motoki Yano[2] · Kazuya Sobue[3]**

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**Abstract** Although maintaining anesthesia for myasthenia gravis (MG) with minimal muscle relaxants (MR) is common, the success rate of anesthetic management for MG without MR is not clear. We therefore retrospectively examined the success rate of anesthetic management for MG without MR among 66 consecutive cases of thymectomy for MG performed at our hospital between January 2004 and April 2010, before approval of using sugammadex. A total of 60 patients (90.9 %) were treated without MR (N group). Among the 60 cases, 17 (28.3 %) patients were not extubated in the operating room due to postoperative respiratory depression or other reasons. Therefore, the success rate of anesthetic management for thymectomy in patients with MG without treating MR was 71.7 % (43/60) [95 % confident interval (CI): 65.9–77.5 %]. The reasons for using MR included coughing at intubation in one case, bucking during surgery in two cases, and MR was considered to be safer by the attending anesthesiologist in three cases. The number of cases of impossible extubation requiring ventilation on that day was three in the N group and none in the R group. Finally, the success rate of anesthetic management for MG without MR was estimated to be 71.1 % (95 % CI: 65.9–77.5 %).

**Keywords** Myasthenia gravis · MG · Thymectomy · Muscle relaxant

The most serious problem in the anesthetic management of patients with myasthenia gravis (MG) is postoperative respiratory depression due to the persistent effects of non-depolarizing muscle relaxants (MR). A new very strong agent for reversing the effects of rocuronium, sugammadex, was recently developed, making providing treatment for MR easier, including the anesthetic management of MG [1]. However, MG patients are known to be sensitive to MR [2, 3] and the future effects of MR after reversal with sugammadex are not clear. Achieving anesthetic management for MG without MR is desirable, if possible. Although it is common to maintain anesthesia with minimal MR using muscle-relaxing monitoring, the rate of successful anesthetic management for MG without MR is not clear in the clinical setting. We therefore retrospectively examined the use of MR in patients undergoing thymectomy for MG to determine the success rate of anesthetic management for MG without MR.

The study protocol was approved by our institutional ethics committee. A total of 66 consecutive patients treated with thymectomy for MG between January 2004 and April 2010, before approval of using sugammadex, were selected. Retrospectively examined parameters included the background characteristics of the patients, degree of difficulty of intubation (Cormack grade), presence of MR, dosage, method of anesthesia, use of epidural anesthesia, cough reflex, time to extubation after surgery, respiratory depression, postoperative sore throat, and other complications.

✉ Yoshihito Fujita
fujita.yoshihito.823@mail.aichi-med-u.ac.jp

[1] Department of Anesthesiology, Aichi Medical University School of Medicine, 1-1 Karimata, Yazako, Nagakute, Aichi 480-1195, Japan

[2] Department of Oncology, Immunology and Surgery, Nagoya City University Graduate School of Medical Sciences, 1 Kawasumi Mizuho-cho Mizuho-ku, Nagoya, Japan

[3] Department of Anesthesiology and Medical Crisis Management, Nagoya City University Graduate School of Medical Sciences, 1 Kawasumi Mizuho-cho Mizuho-ku, Nagoya, Japan

**Table 1** Baseline characteristics of the patients

| | $n = 66$ |
|---|---|
| Male/female (cases) | 27/39 |
| Age (years) | 46.6 ± 12.8 |
| Body weight (kg) | 58.2 ± 14.0 |
| Height (cm) | 161.2 ± 8.8 |
| BMI (kg/m$^2$) | 22.2 ± 4.0 |
| Osserman classification (cases) | |
| I | 27 |
| IIa | 18 |
| IIb | 19 |
| III | 2 |
| %VC | 102.8 ± 17.5 |
| %FEV1.0 | 84.6 ± 10.5 |
| Anti-AchR antibody (nmol/l) | 26.0 (9.4, 88.3) [1, 670] |
| Thymoma (cases) | 41 (62 %) |
| Oral administration (cases) | |
| Steroid | 20 (30 %) |
| Cholinesterase inhibitor | 60 (91 %) |

Data with a normal distribution: mean ± standard deviation

Data with a non-normal distribution: median (interquartile range) [minimum, maximum]

We considered a 95 % confidence interval (CI) of 15 % to be useful in the clinical setting and determined a sample size of more than 61.5 based on previous data [4].

The baseline characteristics of the patients were shown in Table 1 and the summary of anesthetic management in Table 2. Anesthesia was maintained primarily with sevoflurane and epidural anesthesia. A total of 60 patients, 90.9 % (95 % CI: 84.6–97.2 %) were treated without MR (N group) and six patients were treated with MR (R group). Reasons for using MR included coughing at intubation in one case, bucking during surgery in one case, and the attending physician considered muscle relaxants to be safer in four cases. As for the degree of difficulty of intubation (Cormack grade), 42 cases were grade 1, 11 cases were grade 2, six cases were grade 3, and one case was grade 4 in the N group. In the one grade 4 case, we succeeded in performing endotracheal intubation blindly on the second try while preparing for difficult airway management. In the R group, all six cases were grade 1, and the doses of MR agents at intubation were 2–4 mg of vecuronium five cases and 50 mg of rocuronium one case. Two patients required additional MR for bucking. Anesthetic induction was smooth in all cases in association with muscle paralysis, except for one case of coughing in the R group. Sixty-three (95.5 %) patients received epidural anesthesia and two received epidural anesthesia; however, epidural cannulation was not successful due to technical problems. The other patient had a low platelet count as a result of coexisting idiopathic thrombocytopenic purpura. The number of patients not extubated in the operating room (OR) due to postoperative respiratory depression or other reasons was 17 (28.3 %) in the N group and three (50 %) in the R group. Among the 60 cases, 17 (17/60, 28.3 %) patients were not extubated in the OR due to postoperative respiratory depression or other reasons. Therefore, the success rate of anesthetic management for thymectomy in patients with MG without treating MR was 71.7 % (43/60) (95 % CI: 65.9–77.5 %) (Table 2).

The number of cases involving impossible extubation requiring ventilation on that day was three (5 %) in the N group and none (0 %) in the R group. There were no problematic cases of vocal cord damage, 0 % (CI: 0–4.5 %) with ambulatory follow-up for more than 3 years.

In this report, we demonstrated an estimated success rate of anesthetic management of thymectomy for MG without MR of 71.7 % (95 % CI: 65.9–77.5 %). We believe that this figure is informative for improving the anesthetic management of thymectomy for MG without MR.

Postoperative ventilator support is required more frequently in patients given MR [5]. Therefore, if possible, providing anesthetic management of MG without MR is preferable. In the clinical setting, the primary concern for the anesthesiologist is whether management without MR is possible. To our understanding, there are no previous data regarding the success rate of this management strategy, and our figure of 71.7 (CI: 65.9–77.5 %) may be helpful for application in various clinical settings.

In this study, we defined that the successful anesthetic management for thymectomy in the patients with MG is the successful extubation in OR without MR. Even without using MR, a significant part of patients may require postoperative respiratory care. In addition, 90.9 % (60/66) was the rate of anesthetic management for MG without MR. Among the 60 cases, 17 (17/60, 28.3 %) patients were not extubated in the OR due to postoperative respiratory depression or other reasons. Therefore, we thought that definition was reasonable in clinical settings. Moreover, even in the N group three patients were cases of impossible extubation on that day and besides the use of MR, other factors seemed to affect the ventilation of patients with MG.

The true success rate of anesthetic management of thymectomy for MG without MR may be greater than 71.7 % for several reasons. First, aggressive non-MR management is helpful for achieving a higher success rate. In a report published in 2003 comparing two non-MR anesthetic techniques with sevoflurane versus propofol, 68 consecutive MG patients underwent successful anesthetic management of MG without MR [4]. In another previous study, investigating the efficacy of total intravenous anesthesia with propofol for MG without MR, 20 out of 22 patients were treated successfully [6]. Among our cases,

**Table 2** Anesthetic management

| | All cases ($n = 66$) | Cases with muscle relaxants ($n = 6$) |
|---|---|---|
| Anesthesia time (min) | 225.0 ± 121.0 | 255.2 ± 152.5 |
| Operation time (min) | 162.6 ± 116.2 | 179.8 ± 151.1 |
| Extubation in operation room (cases) | 49 (74 %) | 3 (50 %) |
| Time to extubation after operation (min) | 10.3 ± 5.2 | 18.3 ± 10.5 |
| Anesthesia (cases) | | |
| TIVA with propofol | 1 | |
| GOS | 42 | 5 |
| AOS | 23 | 1 |
| With epidural anesthesia | 63 (95.5 %) | 6 |
| With fentanyl administration | 16 (24.2 %) | 2 |
| With remifentanil administration | 22 (33.3 %) | 1 |
| Muscle relaxant | 6 (9.1 %) | 6 |
| Intubation Cormack grade (cases) | | |
| 1 | 48 (72.7 %) | 6 |
| 2 | 11 (16.7 %) | |
| 3 | 6 (9.1 %) | |
| 4 | 1 (1.5 %) | |
| Extubation at ICU (cases) | 17 | 3 |
| The very day of operation | 14 | 3 |
| 1-postoperative day | 2 | |
| 4-postoperative day | 1 | |

*TIVA* total intravenous anesthesia, *GOS* nitrous oxide, oxygen, sevoflurane, *AOS* air, oxygen, sevoflurane, *ICU* intensive care unit, *min* mean ± standard deviation, *cases* number (percentage)

four patients were treated with MR because the attending physician considered management with MR to be safer and easier without trying to avoid MR; these four cases were classified as Cormack grade 1. If the attending physician deliberately attempts to perform anesthetic management without MR, they may find that the procedure can be accomplished without these agents. Second, further progress in anesthetic drugs would be helpful. Remifentanil, which was approved for use in Japan in 2006, is another helpful drug for anesthetic management without MR, especially during intubation. In a study of healthy patients comparing the condition at intubation between those treated with and without MR, the application of a moderate dose of remifentanil and propofol resulted in a high rate of patients with a good-to-excellent condition for tracheal intubation, regardless of the use of MR [7].

In addition, sugammadex may alter the strategy for the anesthetic management for thymectomy of MG. Sugammadex was recently introduced and exhibits the effects of steroidal neuromuscular blocking drugs, thus facilitating normalization of the muscle function. The use of sugammadex in a patient with MG was recently reported [1], and we experienced no adverse effects of this agent for MG. Nevertheless, recurarization after sugammadex reversal in an obese patient was recently reported [8]. The future effects of MR after reversal with sugammadex are not clear. If possible, physicians should attempt to carry out non-MR anesthetic management first.

In our study, the number of patients not extubated in the OR due to postoperative respiratory depression or other reasons was 17 (28.3 %) in the N group and three (50 %) in the R group, and this high rate might be criticized. The attending anesthesiologist made the decision to extubate in OR or intensive care unit (ICU). In our hospital, postoperative care in all the patients with MG was performed in ICU for 2 days at least. Some anesthesiologists might not try to extubate in OR and might expect proper care in ICU. Except for the three patients who could not be extubated at that day, the other patients did not have any problems for extubation and after awakening, all of the patients were extubated in ICU without problems.

The three patients could not be extubated at that day and required ventilation in the N group. We thought that the main reason might be anesthetic effect because they recovered within a few days. In addition, the incidence (3/60, 5 %) in the N group was not high to that in R group (0/6, 0 %), statistically ($p = 0.2183$).

In this study, there were no problematic cases of vocal cord damage (95 % CI: 0–4.5 %) due to anesthetic management without MR. There are conflicting reports regarding the incidence of laryngeal injury in patients treated with MR. In one report, the incidence of symptomatic laryngeal

injury did not increase in association with non-muscle relaxant anesthetic management [7]. In another study, post-intubation symptoms were more frequent in patients intubated without the use of MR, whether 2 or 24 h after extubation [9]. The lack of vocal cord damage in the current study is in agreement with the findings of a former report.

In conclusion, we herein demonstrated that the estimated success rate of anesthetic management thymectomy for MG without MR is 71.7 % (95 % CI: 65.9–77.5 %).

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